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Original Article Open Access

The association of major dietary patterns with depression, anxiety, and stress in apparently healthy adults

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Article History
Received:
08-July-2016
Revised:
15 September 2016
Accepted:
12 October 2016

key words:
dietary pattern,
depression,
anxiety,
stress,
mental disorders

ABSTRACT

Background: Mental disorders are prevalent worldwide and may expose people to many injuries. Diet plays an important role in the development or progression of mental illnesses. Therefore, we investigated the possible association between major dietary patterns and depression, anxiety, and stress in adults.

Methods: This cross-sectional study was conducted in a random sample of participants (n = 265) in Tehran. Anthropometric measures and physical activity were recorded. Dietary patterns were determined using factor analysis on 25 food groups using a validated 147-item semi-quantitative food-frequency questionnaire (FFQ). Blood samples were taken for measurement of blood parameters. Data on depression, anxiety, and stress were collected using the Depression, Anxiety, and Stress Scale-21 Items (DASS-21).

Results: Two dietary patterns, namely the unhealthy and healthy dietary pattern, were identified. Higher adherence to the healthy dietary pattern was associated with a significant reduction in the mean depression score (p = 0.03). There was no statistically significant association between the unhealthy dietary pattern and the scores on depression, anxiety, and stress. In logistic regression models, after adjusting for potential confounders, higher adherence to the healthy dietary pattern was related to a reduction in anxiety odds ratio (p = 0.03). There was no statistically significant association between the major dietary patterns and the risk of depression and stress in crude and adjusted models.

Conclusion: Adherence to a healthy dietary pattern is associated with a reduced odds of depression and anxiety.

Introduction

The prevalence of psychological disorders such as depression, anxiety, and stress is increasing in the wo3rld [1]. Psychological disorders are correlated with an increased risk of many injuries [2] and can lead to disability in individuals [3,4]. Anxiety disorders are the most prevalent mental disorders in adults [5,6]. Studies on the relationship between dietary pattern and depression and the contribution of diet to the prevention of depression are rare [7,8]. A study estimated that at least 7 million Iranians had one or more psychological disorders and that the disorders were more prevalent in women than men [9].

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Diet plays an important role in the development or progression of mental illness [10], and nutrition is one of the most important modifiable factor affecting mental and physical health [11]. The association between dietary patterns and mental health and the significant association between increased consumption of processed foods and anxiety have been revealed in previous studies. Modifying dietary patterns is a valuable step in reducing nutrition-related psychiatric disorders such as depression, anxiety, and stress [12,13]. Evidence suggests that the consumption of animal foods is more likely to lead to mental disorders than a vegetarian diet [14-17]. One study found that adherence to the Mediterranean diet was associated with reduced mental health problems [18]. Also, adherence to the Mediterranean diet prevented the development of depression [19-21]. Studies have demonstrated that dietary patterns and diet have a possible role in the prevention and management of depression [22]. The association between dietary patterns and depression has been investigated in a small number of studies and the results are controversial [3].

This study was conducted to investigate the association of dietary patterns with depression, anxiety, and stress in adults.

Materials and methods

Study design

A total of 265 individuals (139 females and 126 males) aged 18 to 55 years participated in this cross-sectional study. The study sample was recruited from western and central municipal regions of Tehran through cluster sampling. All participants signed an informed consent for taking part in the study. Inclusion criteria were being 18 to 55 years old, not using alcohol or drug, having no acute or chronic inflammatory disease, having no history of hypertension, and not being pregnant. Exclusion criteria were being a current smoker; having thyroid, hepatic, renal, or cardiovascular disease; and having heart failure, malignancy, diabetes mellitus, or any infection.

The study was approved by the local ethics committee at Endocrinology and Metabolism Research Center of Tehran University of Medical Sciences (Reference No.: 93-04-161-27722-149580).

Anthropometric assessments

Weight and height were measured in light clothing and barefoot, respectively. Waist circumference was measured at the narrowest area at the end of a normal exhalation with a nonelastic tape to the nearest 0.1 cm. Hip circumference was measured at the largest part of the hip over light clothing.

Dietary intake assessment and extraction of dietary patterns

Participants consumed their usual diet. They were instructed to fill a 147-item food-frequency questionnaire (FFQ) that was validated previously [23]. The questionnaire was completed in the presence of a trained dietitian. Data were recorded in household measures and serving sizes and then converted into grams and milliliters. Dietary intake data were analyzed using the Nutritionist IV (First DataBank, San Bruno, CA) food analyzer. First, based on the similarity of nutrients, food items were grouped into 25 predefined categories [24,25]. Then, adjusted means for energy were calculated for each category through analysis of residuals. In the next step, to determine the suitability of the model, the KMO and Bartlett's test was used. Dietary patterns were identified using factor analysis. To this end, principal components analysis with varimax rotation was applied to energy-adjusted food categories. The extracted factors were checked on the basis of eigenvalues for the energy-adjusted food categories, and factors having an eigenvalue of greater than 1.5 were considered major dietary patterns. The designation of patterns was based on the interpretation of food items in each factor, which together accounted for 26.97% of the total variance on the basis of the scree plot and varimax rotation on 25 food groups [26]. It should be noted that other food patterns were identified but were not considered as their contribution to the total variance was too small. Then, we categorized the subjects according to the tertiles of the dietary pattern scores. The naming of the major dietary patterns was done on the basis of previous knowledge.

Blood sampling and biochemical parameters

The participants were referred to Shariati Hospital's outpatient clinic. Blood samples were obtained between 8:00 AM and 10:00 AM after 10 to 12 hours of overnight fasting. After centrifugation, serum was isolated and stored at 80ºC. All assessments were performed at the Endocrinology and Metabolism Research Center Laboratory, Shariati Hospital. Assessments were as follows:

Fasting blood sugar (FBS) levels were measured using a colorimetric method based on glucose oxidase–phenol 4-aminoantipyrine peroxidase (GOD-PAP) method. Triglyceride measurement was performed by the enzyme glycerol-3-phosphate oxidase–phenol 4-aminoantipyrine peroxidase (GPO-PAP) method. Total cholesterol (TC) was determined using the enzymatic endpoint method, and low-density lipoprotein and high-density lipoprotein cholesterol were determined by the direct enzymatic clearance assay. Seven Randox Laboratories kits (Random Laboratories Ltd., Ardmore, UK) were used

for the evaluations. Serum high-sensitivity C-reactive protein (hs-CRP), a proinflammatory marker, was evaluated using a high-sensitivity immunoturbidimetric assay (Hitachi 902; Hitachi Ltd., Tokyo, Japan). Serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were determined by automatic analysis system (Autoanalyzer; Hitachi Ltd, Tokyo, Japan) with Randox Laboratories kit.

Mental health assessment

The Depression, Anxiety, and Stress Scale-21 Items (DASS-21) is a self-report questionnaire comprising three scales designed to measure the emotional states of depression (loss of self-esteem/incentives and depressed mood), anxiety (fear and anticipation of negative events), and stress (persistent state of overarousal and low frustration tolerance) [27]. Each scale has 7 items rated on a 4-point scale. Participants were asked to rate how much each item (in the form of a statement) applied to them over the past week, with 0 = "did not apply to me at all" to 3 = "applied to me very much, or most of the time." To calculate scores comparable with the complete DASS, the score on each scale was multiplied by two. The higher the score, the more severe the emotional distress was.

Statistical analysis

Normality of the data distribution was confirmed using the Kolmogorov-Smirnov test. Principal components analysis was used to extract dietary patterns. The differences among the tertiles in each variable were evaluated with ANCOVA, followed by Turkey post hoc test when applicable. We used ANCOVA to evaluate quantitative variables among the tertiles of major dietary patterns and to adjust the effect of confounders. The logistic regression models were used to evaluate the association between major dietary patterns and the risk of depression, anxiety, and stress. In all statistical analyses, a significant difference was detected when $p < 0.05$. Statistical analyses were performed using SPSS version 16.0 (Chicago, IL, USA).

Results

Anthropometric and biochemical characteristics of the participants are presented in Table 1. The mean (SD) age, weight, height, and BMI of the participants were 35.08 (8.79) years, 73.51 (15.66) kg, 168.24 (9.44) cm, and 25.93 (4.90) kg/m2. The mean (SD) depression, anxiety, and stress scores were 11.24 (9.80), 9.85 (7.66), and 17.86 (9.73), respectively(Table1).

Dietary patterns

The major dietary patterns identified were as follows:

A) Unhealthy dietary pattern: high consumption of high-energy drinks and beverages, fast foods, seasonings, sweets and desserts, snacks, solid fat, pickles, Mayonnaise, and high-fat dairy.

B) Healthy dietary pattern: This dietary pattern was rich in fruits and natural juices, vegetables, dried fruits, nuts and seeds, low-fat dairy, legumes, olive and olive oil, fish and poultry meat, red meat, starchy vegetables.

Table 2 shows the loadings for the food items in each major dietary pattern. The greater loading of a food group in a given dietary pattern is indicative of the higher proportion of that food group in that dietary pattern. The unhealthy and healthy dietary pattern explained 15.68% and 11.29% of the variance, respectively. We categorized the scores of these patterns into tertiles.

The comparisons of anthropometric and biochemical characteristics, depression, anxiety, and stress among the tertiles of major dietary patterns are shown in Table 3. P values for all variables in each

Table 1. Description of demographic-anthropometric and biochemical characteristics (n = 265)

BMI: body mass index;
FBS: fasting blood sugar;
TG: triglyceride;
TC: total cholesterol;
HDL-C: high-density lipoprotein cholesterol;
LDL-C: low-density lipoprotein cholesterol;
AST: aspartate transaminase;
ALT: alanine transaminase;
hs-CRP: high-sensitivity C-reactive protein

Table 2. Factor loadings for the two identified dietary patterns in the study (n = 265)

	Dietary patterns	
Food Groups	Unhealthy pattern	Healthy pattern
High-energy drinks and beverages	0.709	
Fast foods	0.605	
Seasonings	0.558	
Sweets and desserts	0.554	
Snacks	0.548	
Solid fat	0.528	
Pickle	0.513	
Mayonnaise	0.482	
High-fat dairy	0.473	
Fruits and natural juices		0.740
Vegetable		0.721
Dried fruits		0.649
Nuts and seeds		0.553
Low-fat dairy		0.525
Legumes		0.472
Olive and olive oil		0.465
Fish and poultry meat		0.373
Red meat		0.323
Starchy vegetables		0.301
%of variance	15.68	11.29

Factor loadings below ±0.3 are not shown in the table for simplicity. † Eigenvalues > 1.5, (KMO) index: 0.73.

tertile of major dietary patterns were determined with ANCOVA model after adjusting for age, sex, weight, calorie intake, and physical activity. Higher adherence to the healthy dietary pattern was associated with a lower depression score (p = 0.03) (Table 3). It was also observed that age was positively associated with adherence to the healthy dietary pattern (p = 0.007) and negatively associated with adherence to the unhealthy dietary pattern (p < 0.0001).

There was no statistically significant difference among the tertiles of unhealthy dietary pattern in anthropometric and biochemical characteristics and depression, anxiety, and stress scores. Also, there was no statistically significant difference among the tertiles of healthy dietary pattern in anthropometric and biochemical characteristics and anxiety and stress scores (Table 3).

In the next step, the association between the major dietary patterns and the risk of depression, anxiety, and stress was evaluated using logistic regression models, both crude and adjusted for sex, age, weight, calorie intake, and physical activity. There was no statistically significant association between the major dietary patterns and the risk of depression in the crude and adjusted model (Table 4). However, the adjusted model revealed that adherence to the healthy dietary pattern was associated with a decreased odds of anxiety (1st tertile β = 0.95, OR = 2.59, p = 0.02; 2nd tertile β = 0.82, OR = 2.28, p = 0.03; p-trend = 0.04) (Table 5).

There was no statistically significant association between the major dietary patterns and the risk of stress in the crude and adjusted model (Table 6).

Table 3. Comparison of quantitative variables among the tertiles of major dietary patterns

Parameters	Unhealthy dietary pattern			p_ANCOVA*	Healthy dietary pattern			p_ANCOVA*
	1st tertile Mean ± SD	2nd tertile Mean ± SD	3rd tertile Mean ± SD		1st tertile Mean ± SD	2nd tertile Mean ± SD	3rd tertile Mean ± SD	
Age, y	38.64 ± 8.66	34.77 ± 8.52	31.40 ± 7.85	<0.0001	33.61 ± 8.46	35.13 ± 8.32	36.05 ± 9.57	0.007
Weight, kg	71.37 ± 14.85	71.87 ± 15.94	77.14 ± 16.03	0.60	70.42 ± 15.98	75.76 ± 16.87	74.08 ± 14.01	0.19
Height, cm	165.08 ± 8.66	169.05 ± 9.80	170.99 ± 9.14	0.58	168.81 ± 9.87	168.10 ± 9.29	168.11 ± 9.43	0.005
BMI, kg/m^2	26.12 ± 4.57	25.11 ± 5.14	26.35 ± 4.81	0.49	24.63 ± 4.81	26.70 ± 4.97	26.27 ± 4.60	0.06
Waist, cm	88.37 ± 12.21	86.80 ± 12.91	90.62 ± 12.16	0.43	85.85 ± 12.49	90.86 ± 13.09	88.95 ± 11.50	0.07
Hip, cm	103.13 ± 9.65	100.73 ± 10.15	103.54 ± 8.43	0.77	99.80 ± 9.97	103.74 ± 9.15	103.75 ± 8.93	0.81
FBS, mmol/L	96.89 ± 26.63	92.88 ± 11.95	92.31 ± 14.18	0.28	93.40 ± 16.74	94.35 ± 23.51	94.34 ± 15.21	0.68
TG, mmol/L	117.36 ± 71	125.14 ± 104.85	132.77 ± 94.98	0.46	125.06 ± 78.91	141.67 ± 108.79	108.46 ± 81.12	0.10
TC, mg/dL	193.48 ± 48.41	176.58 ± 29.76	182.12 ± 35.04	0.12	182.85 ± 43	191.79 ± 38.76	177.48 ± 33.87	0.06
HDL-C, mg/dL	51.74 ± 11.41	49.01 ± 12.43	45.29 ± 10.35	0.61	48.75 ± 12.03	48.62 ± 12.96	48.72 ± 10.03	0.73
LDL-C, mg/dL	105.95 ± 34.93	95.55 ± 19.00	101.32 ± 21.99	0.08	100.05 ± 28.86	105.81 ± 27.11	96.89 ± 22.55	0.08
AST, IU/L	19.60 ± 6.31	20.81 ± 8.05	20.51 ± 5.32	0.71	21.15 ± 7.61	20.65 ± 5.87	19.13 ± 6.29	0.16
ALT, IU/L	15.08 ± 8.10	17.81 ± 14.68	18.24 ± 9.14	0.71	17.76 ± 14.40	18.71 ± 8.76	14.66 ± 8.88	0.11
hs-CRP, mg/L	2.54 ± 3.57	2.06 ± 3.37	2.31 ± 3.09	0.87	2.33 ± 3.81	2.02 ± 2.33	2.55 ± 3.70	0.38
Depression	11.37 ± 11.13	10.67 ± 9.14	11.58 ± 8.79	0.82	12.58 ± 10.83	12.36 ± 9.86	8.68 ± 7.86	0.03
Anxiety	9.73 ± 7.48	9.93 ± 7.28	9.89 ± 8.33	0.63	10.55 ± 8.07	10.29 ± 7.69	8.73 ± 7.15	0.07
Stress	17.46 ± 10.73	17.76 ± 9.29	18.53 ± 9.22	0.97	18.46 ± 10.18	18.55 ± 9.38	16.73 ± 9.66	0.14

*BMI: body mass index; FBS: fasting blood sugar; TG: triglyceride; TC: total cholesterol; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; AST: aspartate transaminase; ALT: alanine transaminase; hs-CRP: high-sensitivity C-reactive protein * adjusted for sex, age, weight, energy intake, and physical activity*

Table 4. The association between the major dietary patterns and the risk of depression

	β ± SE	OR	95% CI	p	p-trend
Unhealthy pattern					
Crude Model					
1st tertile	−0.21 ± 0.32	0.81	0.43-1.52	0.52	
2nd tertile	−0.40 ± 0.32	0.67	0.36-1.25	0.21	0.46
3rd tertile	1				
Adjusted Model*					
1st tertile	-0.03 ± 0.41	0.97	0.43-2.19	0.95	
2nd tertile	-0.25 ± 0.36	0.78	0.38-1.58	0.49	0.70
3rd tertile	1				
Healthy pattern					
Crude Model					
1st tertile	0.42 ± 0.31	1.52	0.82-2.81	0.18	
2nd tertile	0.47 ± 0.32	1.61	0.86-3.01	0.14	0.26
3rd tertile	1				
Adjusted Model*					
1st tertile	0.71 ± 0.40	2.03	0.92-4.48	0.08	
2nd tertile	0.65 ± 0.37	1.92	0.93-3.93	0.08	0.15
3rd tertile	1				

**Adjusted for sex, age, weight, energy intake and physical activity.*

Table 5. The association between the major dietary patterns and the risk of anxiety

	β ± SE	OR	95% CI	p	p-trend
Unhealthy pattern					
Crude Model					
1st tertile	0.08 ± 0.32	1.08	0.58-2.04	0.80	
2nd tertile	0.22 ± 0.32	1.25	0.66-2.35	0.49	0.78
3rd tertile	1				
Adjusted Model*					
1st tertile	−0.20 ± 0.42	0.82	0.36-1.88	0.64	
2nd tertile	−0.02 ± 0.37	0.98	0.47-2.04	0.96	0.85
3rd tertile	1				
Healthy pattern					
Crude Model					
1st tertile	0.42 ± 0.32	1.52	0.82-2.82	0.19	
2nd tertile	0.57 ± 0.32	1.76	0.93-3.34	0.08	0.19
3rd tertile	1				
Adjusted Model*					
1st tertile	0.95 ± 0.41	2.59	1.15-5.83	0.02	
2nd tertile	0.82 ± 0.38	2.28	1.09-4.76	0.03	0.04
3rd tertile	1				

**Adjusted for sex, age, weight, energy intake and physical activity.*

Table 6. The association between the major dietary patterns and the risk of stress

	β ± SE	OR	95% CI	p	p-trend
Unhealthy pattern					
Crude Model					
1st tertile	−0.49 ± 0.32	0.61	0.32-1.16	0.13	
2nd tertile	−0.49 ± 0.32	0.61	0.32-1.15	0.13	0.22
3rd tertile	1				
Adjusted Model*					
1st tertile	−0.61 ± 0.42	0.54	0.24-1.25	0.15	
2nd tertile	−0.49 ± 0.37	0.61	0.30-1.27	0.19	0.31
3rd tertile	1				
Healthy pattern					
Crude Model					
1st tertile	0.36 ± 0.31	1.44	0.78-2.66	0.24	
2nd tertile	0.39 ± 0.32	1.48	0.79-2.76	0.22	0.38
3rd tertile	1				
Adjusted Model*					
1st tertile	0.68 ± 0.41	1.97	0.89-4.37	0.09	
2nd tertile	0.56 ± 0.37	1.75	0.85-3.59	0.13	0.20
3rd tertile	1				

**Adjusted for sex, age, weight, energy intake and physical activity.*

Discussion

The findings of this cross-sectional study indicate that dietary pattern can affect mental health. We found a significant, negative association between adherence to the healthy dietary pattern and depression score. Also, in the logistic regression model, after adjusting for potential confounders, it was revealed that by increasing the adherence to the healthy dietary pattern, the odds of anxiety was decreased. However, there was no statistically significant association between the healthy dietary pattern and stress. We did not find any significant association between the unhealthy dietary pattern and the scores for depression, anxiety, and stress.

After adjusting for potential confounders, was found that age was positively associated with adherence to the healthy dietary pattern and negatively associated with adherence to the unhealthy dietary pattern. A previous study showed that women and older adults were more likely to adopt a healthy dietary pattern [28].

Li et al conducted a meta-analysis to investigate the relationship between dietary patterns and depression. They reported that a dietary pattern with high consumption of fruits, vegetables, low-fat dairy, olive oil, fish, and whole grains was associated with a decreased risk of depression [29]. Other studies have also shown that a dietary pattern rich in fruits, vegetables, nuts, fish, and seafood was associated with a decreased risk of depression and mental disorders [30-32]. Similarly, adherence to a healthy diet was inversely associated with the risk of depression and anxiety in Iranian adults [33]. Unlike our study, previous studies have also shown a relationship between unhealthy dietary patterns and depression symptoms [28,34], although many studies found no statistically significant correlation between the Western diet and depression [11,35].

Also, it was reported that the highest quartile of a fruit and vegetables dietary pattern was negatively associated with the prevalence of severe depression symptoms, while the sweets and animal foods pattern was associated with the higher prevalence of severe depression symptoms [36]. Similarly, another study found a significant relationship between increased consumption of processed food and anxiety in adults [12].

Observational studies have shown that traditional dietary patterns, such as the Mediterranean diet, have a protective effect on mental health [34,37-39]. An inverse association has been observed between fruit and vegetable intake and the risk of depression, anxiety, and mental disorders [40,41]. Research has shown that consumption of sweets, meat, and meat products is positively associated with anxiety in women and that legumes/cereals intake is inversely associated with anxiety in men [42].

All of the evidence clearly shows the relationship between mental health and healthy dietary patterns, such that adherence to an unhealthy dietary pattern would increase the likelihood of having a mental disorder. These results are in line with the results of our study, although there was no significant relationship between unhealthy dietary pattern and depression, anxiety, or stress in the present study.

Previous studies have shown that the Western dietary pattern reduces brain-derived neurotrophic factor (BDNF) in the short term, which is independent of nutritional deficiencies [43]. Because BDNF protects neurons against oxidative stress [44], diet could affect the mental status of individuals through modification of BDNF levels [12]. Interposition of some essential elements such as zinc, magnesium, lithium, iron, calcium, copper, selenium, manganese, iodine and vanadium has been seen in depression and anxiety [45,46]. Therefore, it seems that a healthy dietary pattern, rich in fruits, vegetables, nuts, and legumes, would supply vitamins and minerals that the brain needs, playing an important role in mental health. By contrast, an unhealthy dietary pattern, including the Western diet, in which consumption of high-energy drinks and beverages, fast foods, sweets, solid fat, and processed food is high, lacks necessary vitamins, minerals, healthy fats, fiber, and other nutrients, therefore increasing the risk of mental disorders.

To our knowledge, the strengths of this study were a large sample size and adjustments for some major confounders. The methodological limitation was the cross-sectional design of the study, which makes it impossible to establish a causal relationship between the variables.

Conclusion

There is a significant relationship between a healthy dietary pattern and mental health. Further randomized clinical trials and observational prospective studies are needed to confirm the relationship between diet and mental disorders.

Acknowledgments

We are grateful to all the participants in the study and to Tehran University of Medical Sciences for funding the study. This study was supported by a grant from Tehran University of Medical Sciences (Grant ID: 93-04-161-27722, 93-04-159-28031).

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