

Adherence to Mediterranean dietary pattern and depression, anxiety and stress among high-school female adolescents

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Abstract.

BACKGROUND: Few studies have shown the protective effects of Mediterranean Dietary Pattern (MDP) in psychological disorders.

OBJECTIVE: This cross-sectional study was designed to determine the association between adherence to MDP and depression, anxiety and stress among female adolescents aged 16.20 ± 0.97 in Tehran, Iran.

METHODS: Data from 263 participants were analyzed. Adherence to MDP was determined using Mediterranean-Style Dietary Pattern Score (MSDPS). Depression, anxiety and stress scores were characterized by DASS-21 (Depression Anxiety Stress Score-21 items) questionnaire.

RESULTS: Multivariable logistic regression was used to determine the prevalence of depression, anxiety, and stress across quintiles of MSDPS. After adjustment for age, the odds ratio (OR) for depression in the highest quintile of MSDPS was 0.44 (95% confidence interval [95%CI], 0.19–0.95), (P for trend = 0.009) compared to the lowest quintile. After additional adjustment for BMI, energy intake, physical activity, ethnicity, parents education level and total family income, subjects in the highest quintile had a 59% lower prevalence of depression compared to those in the lowest quintile of MSDPS (OR = 0.41; 95%CI, 0.17–0.97), (P for trend = 0.010). However, the MSDPS was not significantly associated with the presence of anxiety and stress.

CONCLUSION: Adherence to MDP is associated with a reduced presence of depressive symptoms in female adolescents.

Keywords: Mediterranean diet, depression, anxiety, stress, MSDPS, adolescents

1. Introduction

Adolescence is a critical period of life for development of psychological disorders [1]. Around 20% of children and adolescents are suffering from problems related to mental health worldwide [2]. Of those, depression with a high prevalence, has attracted much attention [3]. According to the World Health Organization (WHO) report,

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depression was the fourth explanation of inability in the world in 2000 and it would be the second reason in 2020 [4]. Furthermore, several studies show that there is a high coincidence of depression, stress and anxiety disorders in young people [5, 6]. In a review article in 2009, the global prevalence of depression among children and adolescents was reported from 0.6% in Britain to 3% in Puerto Rico and the average prevalence of anxiety was estimated 8% [7]. Moreover, two review articles have reported the high prevalence of depression and anxiety among Iranian children and adolescents [8, 9]. Overall, psychological disorders are more prevalent among girls rather than boys [10]. The comparative studies demonstrated the lower prevalence of mental disorders in Mediterranean countries than in Northern European countries so that, the suicide rates which may reflect the severe depression is the lowest in Mediterranean countries [11]. Thus, the theory of the protective role of Mediterranean Dietary Pattern (MDP) against mental disorders seems logical. MDP is characterized by a high fruits, nuts, vegetables, legumes, whole grains, olive oil and fish consumption, accompanied with a low meat and dairy products consumption and a moderate alcohol intake, [12, 13]. This dietary pattern has some beneficial effects on fat metabolism, blood pressure, body mass index (BMI), markers of coagulation and inflammation and the antioxidant capacity of plasma [14]. Evidence that supports the protective role of the MDP against depression has been reported in some studies [12, 15, 16]. A small trial [17] conducted on obese children and a cross-sectional study [18] that investigated a large sample of Spanish population reported that compliance with the MDP associated with a reduced risk of depression and improved mental health. Hence, considering the high prevalence of psychological disorders among female adolescents and prominence of the MDP as one of the probable protective factor, this study was designed to assess the association of adherence to the MDP with depression, anxiety and stress among high-school female adolescents aged 15–18 years in Tehran, Iran.

2. Methods and materials

2.1. Study population

This cross-sectional study was conducted on 280 female adolescents, which were selected using multistage stratified cluster sampling method. They were chosen randomly from high schools of three educative districts in Tehran, called affluent, middle class and disadvantaged (according to the definition of Ministry of Education). The participants who were smoker, chronic disease patients, anti depressant or sedative medication users, attendant who reported physician-diagnosed depression or anxiety disorders and participants who followed a distinct diet were excluded from the study. Data for 17 participants were ruled out from the analysis due to the fact that either their food frequency questionnaire (FFQ) data were missed or their reported total energy intake was excessively high (more than 4800 kcal/day⁻¹). Finally data from 263 participants were available for analysis. A minimum sample size of 114 subjects required for this study was calculated according to an equation presented by Norman and Streiner [19]. In order to predict the exclusion of several subjects and for having higher precision and effect size calculation, the present study was conducted on 280 sample population.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Ethics Committee of the National Nutrition and Food Technology Research Institute (WHO Collaborating Center), Shahid Beheshti University of Medical Sciences, Tehran, Iran (ethics number 054577). Written informed consent was obtained from all participants.

2.2. Depression, stress and anxiety assessment

The Persian version of Depression, Anxiety, Stress Scale-21 (DASS-21), the short form of the primary scale (DASS-42), which was firstly introduced by Lovibond and Lovibond [20] has been used to determine the severity of depression, anxiety and stress in this study. Each of the three subscales of this questionnaire contains seven items. By summing the scores of relevant questions, the final score for each subscale is obtained. Evidence verified

the reliability and validity of the Persian form of DASS-21 [21, 22]. In the present study, regarding depression, anxiety and stress, we classified the participants in two groups according to Lovibond score classification [20]. Those within a normal range considered healthy and the rest described as unhealthy (e.g. in depression subscale, participants with a score of ≤ 9 considered healthy and subjects with a score of ≥ 10 marked as unhealthy).

2.3. Dietary intake assessment

Participant's food intake was assessed using a valid and reproducible semi-quantitative FFQ [23]. This FFQ consists of 168 food items with a standard serving size for each item, which is mostly consumed by Iranian individuals. Food consumption frequency for each person was determined on daily, weekly or monthly basis. The daily standard serving size for all food items was converted to daily grams of food intake using a manual for household measures [24]. The energy content of each food item was calculated using the United State Department of Agriculture (USDA) food composition data included in Nutritionist 4 software (First Databank; Hearst, San Bruno, CA, USA) due to this fact that Iranian food composition table (IFCT) [25] is not complete. Nevertheless, for Iranian food items, which do not exist in Nutritionist 4, (e.g., Kashk a dairy product) the IFCT was used. It should be noted that the energy and macronutrient content of many food items (e.g., bread and fruits) in IFCT are approximately similar to substitute food items in the USDA food composition table with a correlation of >0.9 [26]. The Mediterranean-Style Dietary Pattern Score (MSDPS) has 13 dietary item scores according to the Mediterranean diet pyramid [27] namely, whole-grain cereals, fruits, vegetables, dairy products, wine, fish and other seafood, poultry, olives/legumes/nuts, potatoes and other starchy roots, eggs, sweets, meat and olive oil [28]. However, in this study only 12 scores were obtained, because the participants religious beliefs prohibited them responding the frequency of alcoholic beverages consumption [29]. For each food group, there is a recommendation by the food guide pyramid which individuals should aim to follow. Except olive oil, the other MSDPS components were scored continuously from 0 to 10 according to the degree of individual adherence to Mediterranean pyramid recommendation. A penalty designated for the overconsumption instances which was proportional to the number of consumed servings over the recommendations. Exerting the penalty can prevent obtaining higher scores merely by food overconsumption [28]. Zero score assigned for those who had a negative total MSDPS due to the overconsumption penalty. Olive oil was scored categorically based on the restrict use of olive oil (score 10), olive oil consumption along with other vegetable oils (score 5), or no olive oil (score 0). Finally, scores for each MSDPS component were summed and the total MSDPS which was standardized to a 0–100 scale calculated by the following equation.

$$\text{MSDPS} = \left[\left(\frac{\sum_{i=1}^{12} s_i}{120} \right) \times 100 \right] \times p,$$

S_i refers to the individual item score and p , is the proportion of total energy intake from Mediterranean diet pyramid.

2.4. Anthropometric measurement

Weight was measured using a digital scale (Seca 881, Germany) to the nearest 0.1 kg while the participants were minimally clothed with bare feet. Height was measured without shoes, using a portable non-stretch meter which was recorded to the nearest 0.5 cm. BMI was calculated as weight in kilograms divided by square of height in meter. Waist circumference and hip circumference were measured using a non-stretch meter tape. The former was measured at the slimmer part of the waist and the latter was measured at the widest part of the hip. Weight to Hip Ratio (WHR) was determined by dividing waist circumference in centimeter to hip circumference in centimeter.

2.5. Physical activity assessment

Physical activity data were acquired by a valid self-reported questionnaire [30] and described as metabolic equivalent hours per day (MET.h.d). This questionnaire was formerly used in a representative sample of Iranian women and demonstrated persistent outcomes [31].

2.6. Other variables assessment

Face-to-face interviews conducted to collect information on age (years), ethnicity (Fars, Turk, Gilak, Others), father/mother's employment status (employed/unemployed), father/mother's education level (high school and diploma, university education), parent Marital status (married, unmarried), total family income, and supplement intake (yes, no), through structured questionnaires.

3. Statistical analysis

All analyses were conducted using the Statistical Package for the Social Sciences, version 21 (SPSS) and a P value of <0.05 was considered statistically significant. MSDPS was divided in quintiles. Distribution of qualitative variables across MSDPS quintiles were compared by Chi-square or Fisher's exact test. The normality of quantitative variables was checked by Kolmogorov smirnov test. Since the distribution of all quantitative variables was abnormal, they converted to normal distribution by logarithmic conversion. To determine the odds ratio (OR) and 95% confidence interval (95%CI) of depression, anxiety, and stress across quintiles of MSDPS, multivariable logistic regression models were conducted with the lowest MSDPS quintile considered as the reference category. Logistic regression models were adjusted for age, BMI, energy intake, physical activity, ethnicity, mother/father's education level and total family income. To assess the overall trends of OR across quintiles of MSDPS, we used the median of each quintile as a continuous variable in the logistic regression models.

4. Results

The mean MSDPS in this study was 15.99 ± 5.64 out of a maximum possible score of 100. The mean depression, anxiety and stress scores were 9.89, 8.43 and 14.00 respectively. Among serving per day Mediterranean food groups, median intake distribution was the highest for fruit consumption that resulted in the lowest median component score for the mentioned group due to overconsumption (penalty principle). In contrast, the lowest median intake distribution was observed for the whole grain group. Furthermore, median component scores were the highest for dairy products (Table 1). Compared to the participants in the lowest quintile, (Table 2) those in the highest quintile of MSDPS were more likely to be Fars and Gilak (84% vs 75% in Fars category and 3.80% vs 0 in Gilak category, $P < 0.05$) and had more highly educated mothers (26.90% vs 15.40%, $P = 0.05$). Moreover, energy intake was significantly higher in the highest quintile of MSDPS compared to the lowest quintile ($P < 0.001$). Table 3 shows the crude and adjusted ORs and 95% CIs of depression, anxiety and stress scores across the quintiles of MSDPS. In crude model, a significant lower prevalence of depression was observed in the highest compared to the lowest quintile of MSDPS (OR=0.44; 95% CI, 0.19 – 0.95). In the 2nd model, after adjustment for age, the odds ratio of depression in the 5th quintile of MSDPS was 0.42 (95% CI, 0.18 – 0.94). Also, after additional adjustment for BMI, energy intake, physical activity, ethnicity, mother/father's education level and total family income, subjects in the highest quintile had a 59% lower prevalence of depression compared with those in the lowest quintile of MSDPS (OR=0.41; 95% CI, 0.17–0.97). Furthermore, there was a significant trend in risk of depression across increasing quintiles of MSDPS

Table 1
Dietary intakes, score distribution and spearman rank correlation of the Mediterranean-style dietary pattern score (MSDPS) in Tehranian high-school female adolescents

Food groups	Intake distribution ¹	Score distribution ¹	Spearman rank correlation to total MSDPS ²
Serving/day			
Whole grain	0.16 (0.00–1.88)	0.21 (0.00–2.35)	0.26
Fruits	7.74 (2.52–21.37)	0.00 (0.00–8.54)	0.10
Vegetables	3.33 (0.89–8.94)	5.06 (1.10–9.30)	0.44
Dairy	1.08 (0.13–2.95)	5.11 (0.44–9.37)	0.52
Serving/week			
Fish and other seafood	0.66 (0.00–3.30)	0.15 (0.00–0.78)	0.31
Poultry	2.40 (0.48–6.70)	0.85 (0.17–2.39)	0.28
Olives, legumes and nuts	11.96 (2.1–50.77)	3.47 (0.57–9.07)	0.31
Potatoes and other starchy roots	2.70 (0.60–10.23)	1.28 (0.28–4.86)	0.12
Eggs	2.00 (0.23–7.00)	0.95 (0.11–3.33)	0.31
Sweets	14.49 (4.03–44.26)	5.34 (0.00–9.40)	0.17
Meat	3.09 (0.22–12.24)	3.77 (0.03–9.21)	0.41
Olive oil	—	—	0.45

¹Data are median (5th, 95th percentile). ²Total MSDPS was calculated by summation of 12 components of MSDPS which was standardized to a 0–100 scale and weighted to the proportion of total energy intake from Mediterranean diet pyramid.

(*P* for trend < 0.05). However, the higher MSDPS were not associated significantly with presence of anxiety and stress.

5. Discussion

According to the findings of the present study, individuals with higher adherence to the MDP had lower risk of depression after controlling for potential confounders. However, no significant association was observed in regard to risk of anxiety and stress prevalence. Similar results related to protective role of the MDP against depressive disorders have been reported in several studies [12, 15, 17, 18, 32]. Although the specific mechanisms of the MDP role in depression prevention are not well known, here we suggest some hypothesized that may justify this association. Mediterranean diet adherence guarantees adequate intake of vitamins B6, B9 and B12 [33]. Some previous studies [34–36] have demonstrated the beneficial role of these vitamins in depression. Vitamins B6, B9 and B12 are participating in Methionine-Homocysteine cycle [15, 37]. Methionine is a precursor of S-adenosylmethionine which has prominent role in monoamines (i.e. Serotonin) production. Serotonin acts as an antidepressant. Besides participating in Methionine-Homocysteine cycle, folate has a main role in bipterin-dependent neurotransmitters synthesis. Tetrahydrobiopterin is an essential cofactor for biogenic amines formation whose Tyrosine and Tryptophan are precursors of them. Therefore, folate deficiency may decrease the serotonin, dopamine or norepinephrine synthesis. MDP leads to an increased intake of omega-3 fatty acids (from fish), which is another reason for its protective role against depression [15]. Several studies have shown the beneficial role of omega-3 fatty acids intake in depression prevention and treatment [38–40]. MDP and its depression protective characteristic may be partly due to high olive oil consumption. Olive oil is the main source of fat (mostly MUFAs

Table 2
 Characteristics of participants across the Mediterranean-Style Dietary Pattern Score (MSDPS)
 Quintiles in Tehranian high-school female adolescents

	MSDPS Quintiles			P-value
	Q1	Q3	Q5	
Age, y	15.92 ± 0.85	16.11 ± 0.99	16.34 ± 0.98	0.07
Duration of residence in Tehran, y	15.80 ± 1.18	15.83 ± 1.32	16.11 ± 1.38	0.42
Total family income/mo (US)	86.28 ± 76.25	77.48 ± 48.49	75.12 ± 54.20	0.83
Ethnicity n(%)				0.02
Fars	39 (75.0)	39 (73.60)	44 (84.60)	
Turk	10 (19.20)	11 (20.80)	3 (5.80)	
Gilak	0 (0)	0 (0)	2 (3.80)	
Others	3 (5.80)	3 (5.70)	3 (5.80)	
Mother's education level n(%)				0.05
High school and diploma	44 (84.60)	31 (58.50)	38 (73.10)	
University degree	8 (15.40)	22 (41.50)	14 (26.90)	
Father's education level n(%)				
High school and diploma	39 (75.0)	31 (58.50)	33 (63.50)	
University degree	13 (25.0)	22 (41.50)	19 (36.50)	
Mother's employment status n(%)				0.10
Employed	13 (25.0)	11 (20.80)	13 (25.0)	
Unemployed	39 (75.0)	42 (79.20)	39 (75.0)	
Father's employment status n(%)				0.41
Employed	52 (100.0)	53 (100.0)	52 (100.0)	
Unemployed	0 (0)	0 (0)	0 (0)	
Parent marital status n(%)				0.40
Married	50 (96.20)	50 (94.30)	51 (98.10)	
Unmarried	2 (3.80)	3 (5.70)	1 (1.90)	
Energy intake (Kcal/day)	2372.82 ± 939.13	2734.78 ± 883.98	2824.03 ± 744.58	<0.001
Physical activity (MET.h.d)	35.52 ± 6.56	35.72 ± 5.47	37.14 ± 6.53	0.55
Supplement intake n(%)	14 (26.90)	11 (20.80)	23 (44.20)	0.06
Body mass index (kg/m ²)	22.03 ± 4.24	22.10 ± 4.25	22.79 ± 4.49	0.78
Depression score	11.57 ± 9.49	12.75 ± 10.48	7.50 ± 8.16	0.07
Anxiety score	8.34 ± 7.51	9.88 ± 8.41	7.46 ± 6.56	0.87
Stress score	14.46 ± 10.11	17.13 ± 10.04	12.23 ± 8.91	0.43

Data are presented as mean ± SD for continuous variables and n (percent) for categorically distributed variables. The P-value was determined using Chi-square test (Fisher's exact) for quantitative variables and one-way analysis of variance (ANOVA) for qualitative variables.

Oleic acid) in this dietary pattern [41, 42]. Along with antioxidant properties olive oil increases δ -9 desaturase enzyme activity and preserves the physiochemical properties of neuronal membranes [42]. However, there are limited studies that investigate the association between olive oil intake and depression [43–45]. Depression is associated with elevation in proinflammatory cytokines such as interleukins 1, 6 and C-reactive proteins. These cytokines can decrease the neuronal growth factors such as brain derived neurotrophic factor (BDNF). BDNF is synthesized by endothelial cells [46]; this peptide is essential for synaptic elasticity, neuronal endurance and axonal growth [47]. According to some evidence, patients with depression have lower levels of BDNF and antidepressants can upregulate BDNF and other neuronal growth factors [48]. Besides its anti inflammatory effect

Table 3
Crude and adjusted odds ratios (OR) and 95% confidence intervals (95% CIs) of depression, anxiety, and stress across quintiles of the MSDPS in Tehranian high-school female adolescents

	Quintiles of MSDPS			P for trend*
	Q1	Q3	Q5	
Depression				
Model 1	1.00 (Ref)	1.20 (0.56 – 2.60)	0.44 (0.19 – 0.95)	0.014
Model 2	1.00 (Ref)	1.18 (0.54 – 2.54)	0.42 (0.18 – 0.94)	0.009
Model 3	1.00 (Ref)	1.38 (0.60 – 3.16)	0.41 (0.17 – 0.97)	0.010
Anxiety				
Model 1	1.00 (Ref)	1.03 (0.48 – 2.23)	0.92 (0.43 – 1.99)	0.888
Model 2	1.00 (Ref)	1.01 (0.47 – 2.19)	0.88 (0.40 – 1.93)	0.984
Model 3	1.00 (Ref)	1.14 (0.51 – 2.55)	0.87 (0.38 – 1.97)	0.936
Stress				
Model 1	1.00 (Ref)	1.41 (0.65 – 3.04)	0.72 (0.33 – 1.59)	0.548
Model 2	1.00 (Ref)	1.36 (0.63 – 2.96)	0.67 (0.30 – 1.49)	0.434
Model 3	1.00 (Ref)	1.47 (0.65 – 3.35)	0.60 (0.25 – 1.40)	0.250

*Based on logistic regression model using median MSDPS in each quintile as a continuous variable. Model 1: Crude model. Model 2: Adjusted for age. Model 3: Additionally adjusted for BMI, energy intake, physical activity, ethnicity, mother/father's education level, total family income.

[49], MDP improves BDNF production through advantageous effects on endothelial cells [50, 51]. Moreover, MDP has high sociocultural food profit. according to the acknowledgment of the United Nations Educational, Scientific and Cultural Organization, Mediterranean diet is considered as an Intangible Cultural Heritage of Humanity with the emphasize on eating together, geniality and hospitality [52]. In culture of the Mediterranean regions, family and conjoint meals are encouraged for bringing fun and enjoyment [53]. Traditional food nature of MDP besides its concept that involves diversity, quality, continuity and amiability [54, 55] are other possible mechanisms by which, MDP prevents depression. The most previous studies have observed an inverse relationship between diet quality and anxiety and stress. Vriendt et al. demonstrated a converse association between diet quality and stress levels in a sample of European students aged 12–17 years [56]. A cross-sectional study conducted on a sample of Norwegian adults reported that women with better diet quality had lower anxiety scores [57]. Bakhtiari et al. found a positive relationship between processed foods consumption and anxiety levels among Tehranian adults [58]. Consistent with our findings, Khodabakhshi et al. reported no significant relationship between healthy dietary pattern and anxiety among male adolescents living in Baharestan province, Iran [59]. There are strengths related to this study. To our knowledge, this is the first study in Middle Eastern countries to examine the association of compliance with the Mediterranean dietary pattern with depression, anxiety and stress. Moreover, considering general diet quality rather than personal dietary factors could be an encouraging substitute for demonstrating the multidimensional characteristics of individual's diet and may be useful in assessment of diet regard to depression prevalence [60]. There are some limitations, first, due to the cross-sectional design of the study, causality determination between MDP adherence and depression, anxiety and stress is impossible. Second, relatively small sample size makes it difficult to find significant associations and the third; we excluded alcohol consumption due to some barriers regarding cultural and religious beliefs in participants. Because of prohibition issues on the import of alcoholic beverages in Iran, the alcohol content of beverages consumed by Iranian people is significantly different compared to the other countries and are usually reported in Food Content Tables (FCTs) and the Iranian FCT has no information on content of different types of alcohol [61]. Several confounding factors may exist which are not considered in this study such as increasing stress and anxiety levels among students with the rise of grades due to pressure of getting acceptance in university entrance exams which

is mostly attributed to Iran educational system. Family structures and parent's psychological status are two main factors which may affect these subscale scores. The non-only child have higher anxiety score than only child because of this fact that they may don't receive enough spiritual support and have more economic burden [62]. Furthermore, in the present study, the variance of stress and anxiety scores was low. It may be another reason for absence of significant association of adherence to the MDP with anxiety and stress.

6. Conclusion

The results of this study show an inverse relationship between adherence to MDP and the presence of depression symptoms. We acknowledge that the results of the present study should be confirmed by more prospective studies with considering a large number of confounding factors. In order to create preventive strategies to reduce such disorders, the concentration should be on overall dietary pattern.

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Conflicts of interest

"None."

Authorship

A. NT., B. R. and R. M. contributed in conception and design, H. F. contributed in statistical analysis.

A. NT. And B. B. contributed in generation, collection and assembly, A. NT., H. F. and A. S. contributed in data interpretation and manuscript drafting. A. NT., A. S., A. H. and H. F. contributed in manuscript revision. All authors approved the final version of the manuscript.

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