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Adherence to a healthy dietary pattern is associated with less severe depressive symptoms among adolescent girls

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ABSTRACT

There is growing interest on the impact of diet on depressive disorders. However, there are limited data on the association between dietary patterns and depression symptoms among Iranian adolescents. The aim of this study was to evaluate the association between dietary patterns and depression score among Iranian adolescent girls. Data were obtained from 750 adolescent girls, who were recruited from several schools using a random cluster sampling. Dietary data were collected using a valid and reliable food frequency questionnaire (FFQ). Beck's depression inventory (BDI-II) was used to assess depression severity score. The prevalence of girls diagnosed with depression was 29.1%. Three major dietary patterns were identified in the study based on factor analysis: "Healthy", "Traditional" and "Western". The multivariate-adjusted odds ratio of having depressive symptoms was 0.55 (95% confidence intervals, 0.34–0.89) for the highest versus lowest quartile of the healthy dietary pattern score. However, there were no significant associations between the Traditional and Western dietary patterns and depression symptoms. Our results indicate that adherence to a Healthy dietary pattern characterized by high intakes of fruits, vegetables, fish and dairy products is associated with a lower probability of having depressive symptoms among Iranian adolescent girls.

1. Introduction

Psychological disorders are a serious public health concern globally (Kessler et al., 2003; Mathers and Loncar, 2006). It is estimated that about 50% of all mental illnesses are started by the age of 14 (Nguyen et al., 2015; O'Neil et al., 2015). Present global epidemiological data estimate that 50% of all adult mental disorders stem from adolescence (Belfer, 2008). Depression is a recurrent chronic disease that can affect both sexes, especially females (Kessler et al., 2003). The prevalence of depression substantially increases during adolescence, particularly in girls, due to physical and emotional development as well as exposure to novel stressors (Hankin et al., 1998). A systematic review and meta-analysis has reported a prevalence rate of 43.5% for depression symptoms among children and adolescents (30.0% of boys versus 57.6% of girls), when using Beck depression inventory (BDI) as a screening tool (Sajjadi et al., 2013). Pajoumand et al. evaluated the characteristics of Iranian suicide attempters aged 8–16 years and found that the majority of them were girls (77.4%) and between ages 12 and 16 years (93.2%) (Pajoumand et al., 2012). It has been shown that depression is associated with several non-communicable diseases including cancer, cardiovascular disease (CVD) and diabetes mellitus (Chapman et al., 2005; Glassman, 2008; Spiegel and Giese-Davis, 2003). Therefore, prevention of depressive disorders is a global public health priority, with special emphasis in adolescent girls.

There is increasing interest on preventing depression by means of diet (Quirk et al., 2013). Most of the studies in this area have examined the association between risk of depression and either nutrients such as folate, zinc, omega-3 fatty acids and monounsaturated fatty acids

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(Deacon et al., 2017; Gonoodi et al., 2018a) or specific food items and groups including olive oil, fish, and a diet rich in fruits, vegetables, nuts and legumes (Li et al., 2016; Shafiee et al., 2018b; Zirak et al., 2018). Due to potential interaction between the elements of the diet and the fact that people often consume complex meals rather than isolated food items (Bonnet et al., 2005), the relationship between dietary patterns and depression has attracted increasing attention. Weng et al. conducted a study on a random sample of 5003 adolescents aged 11–16 years and identified three major dietary patterns based on factor analysis including ‘snack’, ‘animal food’ and ‘traditional’. The results showed that high consumption of snacks and animal foods were associated with a higher risk of psychological symptoms. Conversely, adherence to traditional dietary pattern was associated with lower odds for depression and anxiety (Weng et al., 2012). In another study on 7114 adolescents aged 10–14 years, Jacka et al. found an association between diet quality and adolescent depression, over and above the influence of socioeconomic, family, and other potential confounding factors (Jacka et al., 2010a). Khalid and colleagues conducted a systematic review, and found that, in most studies, a high-quality diet was associated with lower levels of depression or better mental health in children and adolescents. Similarly, the authors observed a relationship between low-quality diet and depression or poor mental health (Khalid et al., 2016). A recent meta-analysis also suggested that a western dietary pattern may increase the risk of depression, whereas healthy dietary pattern may decrease the risk of depression (Li et al., 2017). Considering that adolescence is a critical period of brain evolution and biological changes, diet may play a crucial role in preventing psychiatric disorders among adolescents.

Although the relationship between dietary patterns and depression has been previously investigated in different regions of the world, to the best of authors’ knowledge, no previous studies have evaluated the relationship between major dietary patterns and depressive symptoms among adolescents in Iran. Thus, the aim of this study was to explore the association between major dietary patterns and depression symptoms among a large representative population of Iranian adolescent girls.

2. Methods

2.1. Study population

In this cross-sectional study, a total of 750 adolescent girls were recruited using a random cluster sampling method from several schools in different areas in the cities of Mashhad and Sabzevar, in northeastern Iran. After random sampling was completed, the participants were invited to come to the public health centers for clinical examination and anthropometric assessments. Participants were given sociodemographic questionnaires as well as questionnaires concerning their dietary intake and depression status. All questionnaires were paper-based and written in the Persian language. The questionnaires were administered by trained interviewers. Only adolescent girls between the ages of 12 and 18 and those without a history of chronic diseases such as colitis, diabetes, CVD, cancer and hepatitis were included. Moreover, individuals taking anti-inflammatory, antidepressant, anti-diabetic, or anti-obesity drugs as well as those on vitamin D, calcium supplementation, or hormone therapy within the last 6 months were not included. Participants with total energy intake outside the range of mean ± 3 SD were excluded from the study ($n = 80$). All the subjects and their parents were asked to complete written informed consent before participating in the study. The study was approved by the ethic committee of Mashhad University of Medical Sciences (MUMS).

2.2. Assessment of demographic status

General demographic data including age, smoking status, menstruation status, medical history, supplement use, psychological treatment and chronic diseases were collected by experienced interviewers. Physical activity information was obtained by using the validated Modifiable Activity Questionnaire (MAQ) (Delshad et al., 2015). Physical activity level was calculated based on metabolic equivalent task (MET) minutes per week.

Table 1
Food grouping used in the dietary patterns.

Food groups	Food items
Refined grains	White breads (lavash, baguettes), rice, Macaroni, noodles
Whole grains	Dark breads (Iranian), corn, Barley, bulgur
Potatoes	Potatoes
Snacks	French fries, chips, crackers
Legumes	Beans, peas, lentils, soy, mung, split peas
Other vegetables	broad beans, Cucumber, mixed vegetables, eggplant, celery, green peas, green beans, Sweet pepper, turnip, squash, mushrooms, carrots, onions
Red meats	Beef, hamburger, lamb, minced meat
Poultry	Chicken
Fish	Canned tuna fish, other fish
Organ meats	Heart, liver and kidney, intestine and viscera
Processed meats	Sausages
Eggs	Eggs
Pizza	Pizza
Low fat dairy products	Skim or low-fat milk, low-fat yogurt
High fat dairy products	High-fat milk, whole milk, chocolate milk, cream, high-fat yogurt, cream yogurt, cream cheese, other cheeses, ice cream
Yoghurt drink	Doogh
Butter	Butter
Margarine	Margarine
Cruciferous vegetables	Cabbage, cauliflower, Brussels sprouts, Kale
Tomatoes	Tomatoes, red sauce
Green leafy vegetables	Spinach, lettuce
Garlic	Garlic
Fruits	Orange, tangerine, lemon, lime, grapefruit, banana, apple, pear, strawberry and other berries, peach, cherries, fig, melon, watermelon and Persian melon, cantaloupe, raisins or grapes, kiwi, apricots, nectarine, mulberry, plums, persimmons, pomegranates, date
Dried fruits	Raisins, dried berries, other dried fruits
Fruit juice	Lemon juice, All types of juice
industrial Juice and fruit compote	industrial Juice, fruit compote
Olives	Olives, olive oils
Hydrogenated fats	hydrogenated vegetable oils, animal oils
Vegetables oil	Vegetable oils (except for olive oil)
Mayonnaise	Mayonnaise
Nuts	Walnut, all types of nuts
Sugars	Sugar, candy
Soft drinks	Soft drinks
Sweets and desserts	Jam, Iranian confectioneries (gaz, sohan), chocolates, biscuits, Cakes, confections
Honey	Honey
Tea	Tea
Coffee	Coffee
Salt	Salt
Pickle	Pickle
Spices	Spices, green pepper

2.3. Dietary assessment

A valid and reliable food frequency questionnaire (FFQ) containing 147 food items was administered by trained interviewers to estimate dietary intakes of the study participants (Esfahani et al., 2010). This FFQ has nine multiple-choice frequency response categories that varies from “never or <1/mo” to “≥ 12/d. To calculate daily nutrient intakes for each participant, we used US Department of Agriculture's (USDA) national nutrient databank (Pehrsson et al., 2000). To identify dietary patterns, we evaluated 40 predefined food groups (Table 1). Certain food groups were created based on the similarity of nutrients and their association with depression symptoms.

2.4. Anthropometric and biochemical assessment

Anthropometric measurements include weight, height and waist circumferences (WC) were conducted by trained study nurses using standard protocol. Body mass index (BMI) calculated as weight (kg) divided by square of height (m^2). All anthropometric measurements were done twice and averaged. Blood pressure was measured using a standardized protocol, and the average was recorded. Biochemical parameters including fasting blood glucose (FBG), triglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C) and high sensitivity C-reactive protein (hs-CRP) were measured as described previously (Gonoodi et al., 2018b).

2.5. Assessment of depression

A Persian version of the Beck Depression Inventory (BDI) was used for the assessment of depression in the current study. BDI is a self-administered questionnaire of 21 items with various options. The score for the BDI ranges between 0 and 63 points. Scores are classified as the following: 0–13 no or minimal depression, 14–19 mild depression, 20–28 moderate depression and 29–63 severe depression symptoms (Scogin et al., 1988). Ghassemzadeh et al. have validated the Persian translation of this questionnaire with an acceptable internal consistency (Cronbach's alpha = 0.87) and test-retest reliability ($r = 0.74$) (Ghassemzadeh et al., 2005). This questionnaire has also been validated for use in adolescents (Ambrosini et al., 1991; Blom et al., 2012).

2.6. Statistical methods

Principal component analysis was used to identify major dietary patterns based on the 40 food groups and factors were rotated by varimax rotation. We determined three factors with Eigen values >1.5 and interpretation of a scree plot. Therefore, three major dietary patterns were identified and then labeled based on our interpretation of the data and of the previous studies. For all participants, the factor scores of each derived pattern were obtained by summing intakes of foods weighed by their factor loading. We categorized individuals by quartiles of dietary pattern scores. We used one-way analysis of variance to examine significant differences in continuous variables across quartiles of dietary pattern scores. Moreover, a chi-squared test was performed for assessing the categorical variables across quartiles of dietary patterns in participants. Intakes of foods and nutrients were examined by one-way analysis of variance across quartiles of dietary patterns. Logistic regression in various models was used to investigate the relationship between dietary patterns and depression. In the first model, we controlled for age and energy intake. In the second model, further adjustments were made for passive smoking, physical activity and menstruation. Additional adjustments were performed for BMI. We examined overall trends for the odds ratios by increasing quartiles of dietary patterns scores by using of Mantel- Haenszel extension. A p-value < 0.05 was defined statistically significant. Statistical analysis was carried out by a biostatistician using the SPSS software version 15.0 (SPSS Inc, Chicago, IL, USA) (Table 2).

3. Results

3.1. General characteristics study participants

Demographic and biochemical characteristics of the study population are presented in Table 1. The mean age of the study sample was 14.5 years (SD = 1.5). More than 29% ($n = 195$) of adolescents had mild to severe depression symptoms and about 71% ($n = 475$) had no or minimal depression symptoms. Around 87% of participants had regular menstruation and 31% were passive smokers. Mean systolic and diastolic blood pressures were 96.8 ± 14.0 mmHg and 62.9 ± 13.2 mmHg, respectively (Table 1).

Table 2
General characteristics, anthropometrics and clinical parameters of study participants.

Variables	Total (N = 670)
Depression symptoms, yes (%)	29.1
Age (y) *	14.5 ± 1.5
Weight (kg)	52.7 ± 11.7
BMI (kg/m^2)	21.2 ± 4.2
WC (cm)	70.4 ± 9.08
Physical activity (MET)	45.3 ± 3.4
SBP (mmHg)	96.8 ± 14.0
DBP (mmHg)	62.9 ± 13.2
hs-CRP (mg/L)	1.5 ± 1.7
Passive smoker, yes (%)	31.0
Menstruation, yes (%)	87.1
FBG (mg/dl)	86.2 ± 11.5
HDL-C (mg/dl)	46.9 ± 8.6
LDL-C (mg/dl)	99.7 ± 25.8
TC (mg/dl)	160.6 ± 28.7
TG (mg/dl)	85.1 ± 39.5

Values are expressed as mean ± SD. Categorical data are expressed as percentage. BMI: body mass index; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure; hs-CRP: high sensitivity C-reactive protein; FBG: fasting blood glucose; HDL-C: high-density lipoprotein protein cholesterol; LDL-C: low-density lipoprotein cholesterol; TC: total cholesterol; TG: triglyceride.

3.2. Identified major dietary patterns

Principal component analysis allowed us to identify three major dietary patterns that we labeled as: Western, Traditional and Healthy dietary patterns. The healthy dietary pattern was characterized by high intakes of legumes and other vegetables, fish, eggs, yoghurt, both cruciferous and green leafy vegetables, tomatoes, garlic, fruits, olives, mayonnaise, both low and high fat dairy products. In the Traditional dietary pattern, the intakes of potatoes, snacks, hydrogenated fats, vegetables oil, sugar, soft drinks, sweets and desserts, tea, salt and spices were higher than two other dietary patterns. The western dietary pattern was loaded with high intakes of refined grains, snacks, red meats, poultry, fish, organ meats, pizza, fruit juices, industrial juice and compote, mayonnaise, nuts, soft drinks, sweets and desserts, coffee and pickle. The factor loading matrixes for the three mentioned dietary patterns are illustrated in Table 3.

3.3. General characteristics and dietary habits of study participants

General characteristics, anthropometric measures and the clinical parameters of the study participants across quartiles of major dietary patterns are shown in Table 4. There were no significant differences between age, weight, WCs, diastolic blood pressure, serum hs-CRP, menstruation, fasting blood glucose, total and LDL cholesterol and TG across quartiles of different dietary pattern scores. However, BMI was higher in the first quartile of the Traditional dietary pattern than in the fourth one ($p = 0.03$). In addition, participants in the highest quartiles of the healthy ($p = 0.005$) and the western ($p = 0.02$) dietary patterns tended to be more physically active compared with those in the lowest quartiles. Nevertheless, individuals in the fourth quartiles of the Traditional dietary pattern were less likely to be physically active ($p = 0.02$). Moreover, systolic blood pressure was higher in the first quartile of the Traditional dietary pattern than in the fourth quartile ($p < 0.001$). Additionally, subjects in the lowest quartile of the healthy pattern were more likely to be exposed to smoking compared with those in the highest quartile ($p = 0.01$). HDL-C was found to be lower in the fourth quartile of the healthy dietary pattern than in the first quartile ($p = 0.02$) (Table 4).

Table 3
Food loading matrix for major dietary patterns*.

Food groups	Dietary patterns Pattern 1	Pattern 2	Pattern 3
Refined grains	–	–	0.22
Whole grains	–	–	–
Potatoes	–	0.21	–
Snacks	–	0.23	0.50
Legumes	0.25	–	–
Other vegetables	0.71	–	–
Red meats	–	–	0.35
Poultry	–	–	0.36
Fish	0.23	–	0.31
Organ meats	–	–	0.20
Eggs	0.32	–	–
Pizza	–	–	0.31
Yoghurt	0.40	–	–
Butter	–	–	–
Margarine	–	–	–
Cruciferous vegetables	0.44	–	–
Tomatoes	0.62	–	–
Grean leafy vegetables	0.61	–	–
garlic	0.33	–	–
Fruits	0.32	–	–
Dried fruits	–	–	–
Fruit juices	–	–	0.30
Industrial juice and compote	–	–	0.48
Olives	0.25	–	–
Hydrogenated fats	–	0.37	–
Vegetables oil	–	0.26	–
Mayonnaise	0.23	–	0.26
Nuts	–	–	0.28
Sugars	–	0.63	–
Soft drinks	–	0.28	0.45
Sweets and desserts	–	0.25	0.43
Honey	–	–	–
Tea	–	0.65	–
coffee	–	–	0.26
Low fat dairy products	0.39	–	–
High fat dairy products	0.35	–	–
Salt	–	0.62	–
Pickle	–	–	0.22
Spices	–	0.65	–
Percent of variance explained	8.69	5.59	4.1

Pattern 1: Healthy dietary pattern.
Pattern 2: Traditional dietary pattern.
Pattern 3: Western dietary pattern.
* Values less than 0.20 are not reported.

Energy-adjusted intakes of food groups and nutrients across quartile categories of dietary pattern scores are shown in Table 5. Dietary intakes of low-fat and high-fat dairy products as well as fruits, legumes and coffee were significantly higher among individuals in the fourth quartile of healthy dietary pattern. However, subjects in the fourth quartile tended to consume lower amounts of refined grains (g per 1000 kcal). Moreover, protein, fat, monounsaturated fatty acids (MUFAs), vitamin C, vitamin A and folic acid intakes were significantly higher among those in the last quartile (per 1000 kcal). As presented in Table 5, those in the last quartile of Traditional dietary pattern had higher dietary intakes of vegetables oil, spices and salt, and lower intakes of high fat dairy, coffee, whole grains and refined grains, when compared with the first quartile (g per 1000 kcal). These individuals also tended to consume lower amounts of protein, carbohydrates, fiber and vitamin A, but significantly higher amounts of fat, MUFAs and polyunsaturated fatty acids (PUFAs) (per 1000 kcal). Furthermore, as shown in Table 5, red meat, processed meat, high fat dairy, coffee, refined grains and nuts were consumed more frequently in subjects in the highest quartile of the western dietary pattern. These subjects also tended to consume lower amounts of dietary fiber, MUFAs, PUFAs and vitamin E (per 1000 kcal).

3.4. Relationship between identified habitual dietary patterns and depression in the study participants

Multi-variable adjusted odds ratios (ORs) for depression categories across quartiles of dietary pattern scores are presented in Table 6. Generally, there was no significant association between the Traditional or the Western dietary patterns, and depression score, applying crude or adjusted models. However, subjects in the fourth quartile of the healthy dietary pattern had a 37% lower probability of having depressive symptoms compared to those in the first quartile (OR: 0.63; 95% CI: 0.40–0.97, *p*-trend = 0.02). After adjusting for age and energy intake and after further adjusting for passive smoking, physical activity and menstruation, individuals in the highest quartile of the healthy dietary pattern were 45% less likely to experience mild to severe depression symptoms rather than those in the lowest quartile. (OR: 0.55; 95% CI: 0.34–0.88, *p*-trend = 0.009), (OR: 0.55; 95% CI: 0.34–0.89, *p*-trend = 0.01), respectively. Moreover, after additional adjustment for BMI, the risk of having mild to severe depression symptoms trended to be 44% lower in the fourth quartile of the healthy dietary pattern in comparison to the first one (OR: 0.56; 95% CI: 0.35–0.92, *p*-trend = 0.02).

Table 4
General characteristics, anthropometrics and clinical parameters of study participants by quartiles (Q) categories of dietary pattern score.

	Healthy pattern Q1 (*n* = 167)	Q4 (*n* = 168)	*p*-value[a]	Traditional pattern Q1 (*n* = 167)	Q4 (*n* = 168)	*p*-value	Western pattern Q1 (*n* = 167)	Q4 (*n* = 168)	*p*-value
Age (y)*	14.6 ± 1.5	14.6 ± 1.5	0.2	14.3 ± 1.61	14.6 ± 1.5	0.2	14.4 ± 1.4	14.5 ± 1.5	0.4
Weight (kg)	51.6 ± 12.6	53.8 ± 12.5	0.2	54.4 ± 13.7	52.9 ± 14.1	0.1	52.6 ± 13.9	53.7 ± 11.6	0.1
BMI (kg/m^2)	20.5 ± 3.5	21.7 ± 5.4	0.05	21.9 ± 4.8	21.3 ± 5.1	0.03	21.1 ± 5.3	21.4 ± 4.06	0.1
WC (cm)	69.9 ± 7.8	71.3 ± 9.6	0.2	71.7 ± 9.9	70.5 ± 9.2	0.1	70.2 ± 8.6	70.9 ± 8.8	0.1
Physical activity (MET)	44.6 ± 2.6	45.7 ± 3.5	0.005	45.3 ± 3.47	45.2 ± 3.6	0.02	44.7 ± 2.4	45.5 ± 3.8	0.02
SBP (mmHg)	96.02 ± 13.4	97.6 ± 14.3	0.7	96.7 ± 12.8	94.2 ± 12.5	<0.001	97.2 ± 14.8	97.4 ± 14.1	0.5
DBP (mmHg)	63.5 ± 12.4	63.2 ± 13.09	0.4	63.2 ± 12.8	62.4 ± 13.4	0.4	61.1 ± 13.4	63.8 ± 13.1	0.1
hs-CRP (mg/L)	1.24 ± 1.53	1.61 ± 1.76	0.1	1.79 ± 2.03	1.39 ± 1.7	0.1	1.24 ± 1.24	1.55 ± 1.72	0.2
Passive smoker (%) (yes)	33.0	30.4	0.01	28.3	35.3	0.1	31.3	31.7	0.9
Menstruation (%) (yes)	89.4	89.2	0.6	86	86.3	0.6	87.6	88.7	0.7
FBG (mg/dl)	85.8 ± 11.4	85.8 ± 12.2	0.8	85.8 ± 13.2	85.6 ± 11.6	0.5	87.8 ± 10.3	86.7 ± 11.8	0.06
HDL-C (mg/dl)	46.8 ± 8.8	46.01 ± 7.87	0.02	47.2 ± 8.5	46 ± 9.06	0.09	47.2 ± 7.6	47.3 ± 8.6	0.7
LDL-C (mg/dl)	98.5 ± 24.7	100.4 ± 27.1	0.8	101.4 ± 26.4	96.7 ± 25.9	0.2	99.1 ± 21.8	102.5 ± 24.8	0.4
TC (mg/dl)	159.7 ± 27.8	159.7 ± 32.2	0.6	164.2 ± 27.3	158.6 ± 29.2	0.07	160.9 ± 23.7	164.3 ± 27.7	0.3
TG (mg/dl)	78.7 ± 34.2	88.3 ± 45.3	0.1	88.2 ± 41.2	82.9 ± 40.7	0.3	87.9 ± 41.7	87.2 ± 36.9	0.2

BMI: body mass index; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure; hs-CRP: high sensitivity C-reactive protein; FBG: fasting blood glucose; HDL-C: high-density lipoprotein protein cholesterol; LDL-C: low-density lipoprotein cholesterol; TC: total cholesterol; TG: triglyceride.
* All values are mean ± SD.
[a] ANOVA for continuous variables and Chi-squared test for categorical variables.

Table 5
Dietary intakes of study participants by quartiles (Q) categories of dietary pattern scores.

	Healthy pattern			Traditional pattern			Western pattern		
	Q1 (n = 167)	Q4 (n = 168)	P-value[a]	Q1 (n = 167)	Q4 (n = 168)	P-value	Q1 (n = 167)	Q4 (n = 168)	P-value
Food groups (g/1000 Kcal)									
Red meat*	4.52 ± 4.41	5.1 ± 4.6	0.09	5.6 ± 4.6	5.4 ± 5.4	0.1	3.43 ± 3.44	6.72 ± 6.78	< 0.001
Processed meat	1.89 ± 2.53	1.85 ± 2.86	0.9	1.9 ± 1.86	1.5 ± 1.7	0.2	0.89 ± 1.22	3.2 ± 3.6	< 0.001
Low fat dairy	53.3 ± 51.2.5	93.1 ± 75.9	< 0.001	88.1 ± 73.3	73.06 ± 69.9	0.1	86.1 ± 70.8	65.09 ± 54.2	0.002
High fat dairy	41.7 ± 41.2	81 ± 70.4	< 0.001	70.2 ± 63.8	50.9 ± 43.3	0.006	53.1 ± 48.8	60.7 ± 47.1	0.01
Fruits	61.7 ± 58.09	98.3 ± 68.5	< 0.001	86.3 ± 66.6	71.5 ± 63.3	0.1	69.7 ± 49.6	82.1 ± 66.7	0.1
Vegetables oil	1.9 ± 2.8	1.9 ± 2.5	0.5	1.39 ± 1.7	2.3 ± 3.01	0.001	2.46 ± 3.46	1.65 ± 1.89	0.03
Legumes	28.5 ± 24.4	35.2 ± 26.7	0.03	33.4 ± 27.2	28.7 ± 22.8	0.2	35.8 ± 29.6	28.01 ± 20.6	0.01
Coffee	2.4 ± 7.5	4.1 ± 11	0.01	4.7 ± 13.6	3.05 ± 9.6	0.01	1.67 ± 5.23	5.18 ± 12.2	0.001
Whole grains	78.4 ± 63.3	74.3 ± 60.3	0.4	78.6 ± 59.9	63.3 ± 51.9	0.01	89.09 ± 67.6	55.4 ± 44.01	< 0.001
Refined grains	139.4 ± 80.6	83.6 ± 40.7	< 0.001	128.7 ± 74.9	89.5 ± 48.07	< 0.001	104.5 ± 59.5	105.9 ± 67.04	0.04
Spices	1.09 ± 1.18	1.02 ± 1.14	0.5	0.55 ± 0.61	1.62 ± 1.67	< 0.001	1.25 ± 1.45	0.92 ± 0.89	0.02
Nuts	5.08 ± 9.3	6.1 ± 7.4	0.6	4.6 ± 7.7	6.2 ± 10.07	0.2	4.23 ± 7.21	7.6 ± 10.8	0.001
Salt	1.62 ± 0.56	1.5 ± 0.48	0.2	1.42 ± 0.39	1.70 ± 0.69	< 0.001	1.68 ± 0.57	1.48 ± 0.46	0.001
Nutrients (per 1000 kcal)									
Protein (g)	31.8 ± 5.4	35.6 ± 5.6	< 0.001	37.6 ± 5.5	30.3 ± 5.4	< 0.001	33.9 ± 6.09	33.5 ± 5.8	0.2
Carbohydrates (g)	143.2 ± 19.6	132 ± 16.8	< 0.001	141.9 ± 18.5	130.9 ± 20.3	< 0.001	135.4 ± 22.3	137.1 ± 16.7	0.5
Dietary fiber (g)	17.7 ± 7.3	17.1 ± 5.2	0.08	18.07 ± 6.6	15.6 ± 5.7	< 0.001	18.2 ± 6.59	15.3 ± 5.37	< 0.001
Fat (g)	35.6 ± 9.5	39.3 ± 7.97	< 0.001	33.7 ± 8.03	42.08 ± 9.54	< 0.001	38.5 ± 10.8	37.7 ± 7.46	0.2
MUFAs (g)	11.6 ± 3.7	12.4 ± 3.3	0.003	10.7 ± 2.9	13.8 ± 4.2	< 0.001	12.8 ± 4.6	11.8 ± 2.62	0.01
PUFAs (g)	8.75 ± 3.41	8.11 ± 2.97	0.09	6.8 ± 2.36	10.2 ± 3.9	< 0.001	9.09 ± 4.25	8.2 ± 2.42	0.003
Vitamin C (mg)	26.1 ± 19.2	48.3 ± 22.2	< 0.001	38.05 ± 22.7	34.05 ± 18.1	0.2	37.4 ± 20.5	39.04 ± 19.4	0.2
Vitamin E (mg)	5 ± 2.02	5.1 ± 1.9	0.1	4.19 ± 1.47	5.9 ± 2.3	0.001	5.77 ± 2.64	4.56 ± 1.34	< 0.001
Vitamin A (μg)	139 ± 74.7	296 ± 130.8	< 0.001	264 ± 438.6	195.3 ± 105.3	0.02	218 ± 116	238 ± 429	0.7
Folic acid (μg)	539 ± 211	708 ± 185	< 0.001	553 ± 222	573 ± 231	0.1	511 ± 177	539 ± 199	0.1

SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acid.
* All values are mean ± SD and adjusted for energy intake.
[a] obtained from one-way ANOVA.

4. Discussion

In this study in Iranian adolescent girls, adherence to a healthy dietary pattern was associated with a lower prevalence of depressive symptoms. This dietary pattern was characterized by a high intake of fruits, vegetables, fish and dairy products. However, no significant associations were found between Traditional and Western dietary patterns and depression score. To the best of our knowledge, this is the first study conducted with Iranian adolescent girls investigating the association between major dietary patterns and depression symptoms.

In line with our results, several previous studies have found significant associations between healthy dietary pattern scores and depression disorders/symptoms among different populations (Kim et al., 2016; Nanri et al., 2010; Rashidkhani et al., 2013). Rashidkhani et al. examined the associations between healthy and unhealthy dietary patterns and depression in 45 women with major depression and 90 healthy individuals. After adjusting for confounders, the authors found that higher scores in healthy dietary pattern was associated with lower odds of major depression. However, similar to our findings, the odds of major depression showed no significant association with unhealthy dietary pattern score (Rashidkhani et al., 2013). In another study, Kim and colleagues observed a significant inverse association between

Table 6
Multivariate adjusted odds ratios (95% CIs) for depression (Q) across quartiles of dietary pattern scores.

	Crude	Model I*	Model II[b]	Model III[c]
Healthy pattern				
Q1	1	1	1	1
Q2	1.25 (0.82–1.9)	1.21 (0.8–1.84)	1.18 (0.77–1.82)	1.18 (0.76–1.82)
Q3	0.97 (0.64–1.48)	0.92 (0.6–1.41)	0.98 (0.63–1.53)	1.00 (0.64–1.56)
Q4	0.63 (0.4–0.97)	0.55 (0.34–0.88)	0.55 (0.34–0.89)	0.56 (0.35–0.92)
P trend[d]	0.02	0.009	0.01	0.02
Traditional pattern				
Q1	1	1	1	1
Q2	0.83 (0.55–1.27)	0.82 (0/53–1.26)	0.82 (0.53–1.28)	0.8 (0.51–1.24)
Q3	0.75 (0.49–1.15)	0.72 (0.47–1.12)	0.71 (0.45–1.12)	0.67 (0.42–1.06)
Q4	0.9 (0.59–1.37)	0.86 (0.55–1.35)	0.86 (0.54–1.37)	0.81 (0.56–1.29)
P trend[d]	0.55	0.43	0.43	0.3
Western pattern				
Q1	1	1	1	1
Q2	0.91 (0.59–1.4)	0.82 (0.5–1.35)	0.9 (0.58–1.4)	0.94 (0.6–1.46)
Q3	0.94 (0.61–1.44)	0.76 (0.47–1.21)	0.92 (0.58–1.45)	0.91 (0.57–1.44)
Q4	1.14 (0.75–1.74)	0.80 (0.51–1.24)	1.15 (0.7–1.9)	1.19 (0.72–1.96)
P trend[d]	0.51	0.47	0.6	0.57

* Adjusted for age and energy intake.
[a] Additionally adjusted for passive smoking, physical activity and menstruation.
[b] Additionally adjusted for BMI.
[c] Resulted from Mantel-Haenszel extension c2 test.

healthy dietary pattern scores and depression score after adjustment for covariates in women but not in men. Similarly, no significant association was found between western dietary pattern and depression in both men and women (Kim et al., 2016). Moreover, in a study investigating the association between major dietary patterns and depressive symptoms in Japanese adults, Nanri et al. found that a healthy Japanese dietary pattern characterized by high intakes of fruits, vegetables and soy products was associated with less severe depressive symptoms. However, other dietary patterns including animal food pattern and westernized breakfast pattern were not appreciably associated with depressive symptoms (Nanri et al., 2010). Furthermore, in a case-control study on 849 Korean adolescent girls, Kim et al. reported that the risk of depression was negatively associated with the intake of green vegetables and 1–3 servings/day of fruits, after adjusting for menstrual regularity and energy intake (Kim et al., 2015).

Several recent systematic reviews and meta-analyses also confirmed an association between adherence to a high-quality diet and the risk of depressive symptoms (Lai et al., 2014; Molendijk et al., 2018; Rahe et al., 2014). In a dose-response meta-analysis of prospective studies, Molendijk and colleagues showed that adherence to a high-quality diet, regardless of type, was associated with a lower risk of depressive symptoms over time. However, the authors found no significant association between adherence to low quality diets and depression incidence (Molendijk et al., 2018). Lai et al. conducted a meta-analysis of thirteen observational studies to examine the association between dietary patterns and depression. In agreement with our observations, the healthy diet pattern was observed to be significantly associated with reduced odds of depression. Moreover, no statistically significant association was found between the Western diet and depression (Lai et al., 2014). A systematic review of observational studies also suggested a protective effect of healthy dietary patterns as well as a potential positive association of Western patterns and depression (Rahe et al., 2014).

It is now clear that depression is substantially associated with systemic inflammation upregulation and alterations in prooxidant-antioxidant balance (Shafiee et al., 2018a, 2017; Tayefi et al., 2017). As mentioned earlier, we found no significant association between adherence to Western dietary pattern and depression. This could be partly explained by the anti-inflammatory and antioxidant properties of some foods items such as fish, coffee and nuts (Natella et al., 2002; Torabian et al., 2009; Wall et al., 2010), which were identified as part of Western dietary pattern. In this regard, increasing evidence suggest that dietary fish meat and oil consumption protects against depression (Grosso et al., 2014; Timonen et al., 2004). On the other hand, some foods items such as refined grains, snacks, pizza, mayonnaise, soft drinks, sweets and desserts, which were identified as part of Western dietary pattern, has been shown to have negative effects on mental health in previous studies (Dipnall et al., 2015; Jacka et al., 2010b; Liu et al., 2007; Shi et al., 2010; Williams, 2012). Therefore, combining these positive and negative effects of various food items may result in a neutral impact on depression.

Furthermore, several mechanisms may be responsible for the observed negative association between adherence to healthy dietary pattern and depression score. As mentioned earlier, due to the oxidative and inflammatory nature of depression, higher dietary intake of antioxidants which are abundant in healthy dietary patterns (i.e., healthy/prudent or Mediterranean) may partly alleviate the severity of symptoms (Gautam et al., 2012; Xu et al., 2014). Moreover, a recent meta-analysis reported that fruit and vegetable consumption might be inversely associated with the risk of depression (Liu et al., 2016). Additionally, a low dietary folate intake, which is plentiful in vegetables and fruits, has been shown to be a risk factor for severe depression (Tolmunen et al., 2004). Finally, it has been shown that antioxidant, fruit, and vegetable intakes are lower in older adults with depression (Payne et al., 2012).

The strengths of our study include a relatively large sample of adolescent girls, a group with a high prevalence of depressive disorders, and using a standardized tool for assessment of depression symptoms. Moreover, we collected extensive data on potential confounders, including personal characteristics (age), anthropometric and physiological factors (BMI and menstruation), lifestyle habits (physical activity), and other risk factors (passive smoking). All of these factors were considered as potential confounders, and adjustment was made for them in the multivariate regression models to exclude confounding as a potential explanation for the findings. We also acknowledge the limitations in our study including: (a) the use of self-administered tool instead of more accurate face-to-face interviews; (b) the inability to measure reliable parental income; and (b) the fact that we have assessed both depression symptoms and dietary patterns at baseline and no longitudinal assessment was performed. Moreover, it should be noted that maximal information is obtained when analyses are conducted at the levels of nutrients, foods, food groups.

4.1. Conclusion

Our results indicate that adherence to a healthy dietary pattern is associated with a lower probability of having depressive symptoms among a large population of Iranian adolescent girls. However, no significant association was found between adherence to either the Traditional or Western dietary patterns and depression score among studied subjects. Further studies, particularly longitudinal or interventional studies, may be required to clarify the effects of major dietary patterns on psychological disorders such as depression among adolescents.

Conflict of interest

The authors state that there is no conflict of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2018.12.164.

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