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The Relationship between Dietary Patterns and Irritable Bowel Syndrome in Adolescent Girls

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ABSTRACT

Background: Dietary factors are associated with the development of irritable bowel syndrome (IBS) in adults, but no studies have ever investigated the relationship between dietary patterns and the risk of IBS among adolescents. **Methods:** In this cross-sectional study a total of 750 adolescent girls aged 12 to 18 years old were recruited using a random cluster sampling method from several schools in different areas of Mashhad city, Iran. A validated food frequency questionnaire (FFQ) and the modified version of Rome III questionnaire were administered to assess the participants' dietary intakes and IBS, respectively. Socio-demographic data and anthropometric variables were also obtained. Factor analysis was performed to identify major dietary patterns. **Results:** The dietary patterns of healthy, mix, and western were identified in this study. An inverse non-significant association was also observed between the healthy dietary pattern and IBS (OR: 0.83; 95% CI: 0.47-1.48). The relationship of IBS prevalence with mix and western dietary patterns was also non-significant. **Conclusions:** No statistically significant associations were found between dietary patterns and IBS among Iranian girl adolescents. Further studies, particularly longitudinal intervention studies with a larger sample size are required in this area.

Keywords: *Dietary patterns; Factor analysis; Gastrointestinal function; Irritable bowel syndrome*

Introduction

Irritable bowel syndrome (IBS) is a prevalent abnormality characterized by abdominal pain and altered bowel habits (Thompson *et al.*, 1999). Health–related quality of life (HRQOL) is impaired in IBS. It causes reduced work performance among IBS (Varni *et al.*, 2006). The prevalence of IBS among children was estimated at approximately 2-24% globally and its prevalence among Asian children ranged from 2.8-25.7% (Devanarayana *et al.*, 2015). A systematic review

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investigated the epidemiology of IBS in Iran and revealed that the IBS prevalence was from 1.1% to 25% (Jahangiri *et al.*, 2012). The global prevalence of IBS in adolescents varied widely from 25.7% in Korea (Son *et al.*, 2009), 19.89% in China (Zhou *et al.*, 2011), and 4.8% in Colombia (Lu *et al.*, 2016). Overall, in western countries, IBS symptoms was present in 22% to 45% of children between the ages of 4 to 18 years (Rasquin *et al.*, 2006). It was also reported that the prevalence of IBS was 1.8 times higher in girls compared to boys (Dong *et al.*, 2005).

Since the etiology of IBS has been unknown, several theories were proposed including: altered gut microbiota function, immunological abnormality, food allergy, changed GI motility, psychological factors, and genetic predisposition (Drossman, 1999). Although it has been previously suggested that diet played an important role in developing IBS (Eswaran *et al.*, 2011, Fedewa and Rao, 2014, Shepherd *et al.*, 2008), little is known about eating habits in adolescent IBS patients; this is a common age at which eating disorders will be developed. The relationship of IBS with foods or nutrients was previously assessed by several studies particularly among adults (Khayyatzadeh *et al.*, 2016). With regard to the synergistic effects of foods on each other and the large variety of foods associated with IBS (Khayyatzadeh *et al.*, 2016), investigating dietary patterns and IBS might be necessary among children and adolescents. Approximately 75% of patients with IBS reported a relationship between specific food ingestion and IBS symptoms (Monsbakken *et al.*, 2006, Simren *et al.*, 2001), especially fatty and starchy foods (Shepherd *et al.*, 2008, Staudacher *et al.*, 2011). Furthermore, different food ingredients were suggested to stimulate IBS symptoms, which included lactose, fructose, wheat, and caffeine. On the other hand, recent studies have shown that dietary manipulation, including a diet low in fermentable carbohydrates, can be beneficial in patients with IBS. The dietary habits of this group of functional gastrointestinal disease patients should be recognized before any dietary alternation (Ross *et al.*, 2016). Since individuals' dietary patterns are different around the world, investigating the association between adherences to major dietary patterns and health outcomes is important. Individuals in different parts of the world have various culture, beliefs, and geography, which can influence dietary patterns. Considering the few number of studies over the association between dietary patterns and IBS, limited data are available about the association between major dietary patterns and gastrointestinal health in all age groups especially among adolescents (Monsbakken *et al.*, 2006, Simren *et al.*, 2001). Therefore, the current study aimed to investigate the association between major dietary patterns and IBS within a sample of Iranian adolescent girls.

Materials and Method

Study population: The present cross-sectional study was conducted in 2015 with the aim of assessing the relationship between IBS and dietary patterns among 750 adolescent girls in Mashhad city and Sabzevar city, northeastern of Iran. All participants were 12-18 year-old students. The selected study population was recruited using a random cluster sampling method from 20 schools in five areas of Mashhad city and 5 schools in two areas of Sabzevar city. The participants had no history of chronic diseases (colitis, diabetes, cardiovascular diseases, cancer, and hepatitis).

Dietary assessment: In order to collect dietary information, a 168-item food frequency questionnaire (FFQ) was developed for the Tehran Lipid and Glucose Study. The validity and reliability of this FFQ were reported in a previous study (Hosseini Esfahani *et al.*, 2010). The FFQ has nine multiple-choice frequency response categories varying from "never or <1/mo" to "_12/d". Daily nutrient intakes for each participant were calculated using the US Department of Agriculture's (USDA) national nutrient databank (Pehrsson *et al.*, 2000). In order to minimize the influence of under- and over-reporting of energy intakes, we omitted the participants whose reported total energy intakes were not within the range of 800 to 4200 kcal/day (Azadbakht *et al.*, 2005) (n = 80). As a result, data from 670 student girls were finally included in the statistical analysis. To identify dietary patterns, we determined 40 predefined food groups (**Table 1**). Certain food groups were created based on the similarity of nutrients and their association with IBS.

Assessment of IBS: We used a version of Rome III questionnaire translated into Persian, as a part of the original questionnaire in order to assess the participants' Functional gastrointestinal disorders (FIGDs). The validation of this questionnaire was reported in a previous study (Sorouri *et al.*, 2010). According to the Rome III criteria, IBS is characterized by: Recurrent abdominal pain or discomfort at least 3 days/month in the last 6 months associated with two or more of the following: Improvement with defecation, onset associated with a change in frequency of stool, and onset associated with a change in form (appearance) of stool.

Assessment of other variables: General demographic information including age, smoking status, menstruation status, medical history, and drug use was obtained by expert interviewers. Anthropometric parameters were measured by standard protocols. Weight was measured while participants were minimally clothed and not wearing shoes. Height was measured using a tape measure while the individuals were standing and not wearing shoes. Body mass index (BMI) was calculated as weight (in kg) divided by height squared (in meters). Dietary habits including regular meal pattern, chewing sufficiency, fluid consumption, and breakfast consumption were assessed by pretested questionnaire.

Data analysis: Principal component analysis was used to identify the major dietary patterns based on the 40 food groups and factors rotated by varimax rotation. We determined three factors with regard to Eigen values > 1.5 and interpretation of scree plot. Therefore, three major dietary patterns were diagnosed and then labeled based on our interpretation of the data and of the previous studies. For all participants, factor scores of each derived pattern were obtained by summing intakes of foods weighed by their factor loadings. We categorized individuals by quartiles of dietary pattern scores. We used one-way analysis of variance to examine the significant differences in continuous variables (age, weight, BMI) across quartile categories of dietary pattern scores. In addition, chi-squared test was performed for assessing the categorical variables (passive smoker, menstruation, regular meal pattern, chewing insufficiency, fluid consumption, and breakfast consumption) across quartiles of dietary pattern in participants. Energy-adjusted intakes of foods and nutrients were examined by covariance analyses across quartiles of dietary patterns. Logistic regression in various models was also applied to investigate the relationship between dietary patterns and IBS. In the first model, we controlled the confounding variables of age and energy. In the second model, further adjustments were done for passive smoking, BMI, and menstruation. Additional adjustments were also performed for regular meal pattern, chewing sufficiency, breakfast consumption, and fluid consumption. We examined overall trends for the odds ratios by increasing quartiles of the dietary patterns scores using Mantel- Haenszel extension. A P-value < 0.05 was defined as statistically significant. All statistical analyses were performed using SPSS version 15.0 (SPSS Inc, Chicago, IL, USA).

Ethical considerations: Written informed consent forms were filled by all individuals before beginning of the study. This study was approved by the Ethics Committee of Mashhad and Sabzevar Universites of Medical Sciences.

Results

Identified major dietary patterns: After performing factor analysis, three different dietary patterns of healthy, mix, and western were determined in our sample population to identify the food patterns. In healthy dietary patterns, intakes of all kinds of vegetables, tomatoes, garlic, fruits, olives, egg, yoghurt, and legumes were higher than other patterns. The mix dietary pattern contained high intakes of potatoes, hydrogenated fats, vegetables oil, sugar, salt, spices, and tea. Western dietary pattern was high in intakes of refined grains, snacks, red meat, poultry, fish, organ meat, pizza, fruits, fruit juice, industrial juice and compote, mayonnaises, nuts, soft drinks, sweets, and deserts. The factor-loading matrixes for three dietary patterns are presented in **Table 2**.

General characteristics and dietary habits of study participants: General characteristics and dietary habits of the study participants across quartiles of the dietary pattern scores are presented in Table 3. No significant differences were observed between the participants' age, weight, menstruation status, and regular meal pattern across all quartiles. However, participants in the healthy dietary pattern group were more likely to be passive smokers in the lowest quartile compared to the highest quartile (P = 0.01). Furthermore, in the lowest quartile of this pattern, participants consumed more fluids than the highest quartile (P = 0.003), although in the highest quartile of the healthy pattern individuals consumed breakfast more regularly than those in the lowest quartile (P = 0.02). In addition, BMI was higher in the mix pattern than the lowest quartile in comparison with the highest quartile (P = 0.03). In the western pattern category, fluid consumption was higher among those in the highest quartile compared to the lowest one (P = 0.04). Age and energy-adjusted intakes of food groups and nutrients across quartile categories of dietary pattern scores are shown in **Table 4**. Red meat, low and high fat dairies, fruits, legumes, coffee, and spices were more eaten by participants in the fourth quartile of the healthy dietary pattern in comparison to those in the first quartile. Energy, protein, total carbohydrates, total fiber, sucrose, fat, total SFAs, total MUFAs, total PUFAs, cholesterol, vitamin C, vitamin E, and vitamin A were consumed more frequently in participants of the highest quartile of healthy dietary pattern compared to those in the lowest quartile. However, refined grain was consumed less by participants of the highest quartile of healthy pattern than compared with the individuals in the lowest quartile. In comparison to the participants in the first quartile of the mix dietary pattern, vegetable oil, spices, nuts, and salt were consumed more frequently by those in the fourth quartile. Similarly, significant differences were observed between the lowest and highest quartiles regarding intake of energy, total carbohydrates, total fiber, sucrose, fat, total MUFAs, total PUFAs, vitamin C, and vitamin E. Individuals in the highest quartile of western dietary pattern consumed more red meat, processed meat, high fat dairy, fruits, legumes, coffee, refined grain, and nuts compared to the participants in the lowest quartile. Similarly, consumption of energy, protein, total carbohydrates, total fiber, sucrose, fat, total SFAs, total MUFAs, total PUFAs, cholesterol, vitamin C, vitamin E, and vitamin A were significantly higher among participants of the fourth quartile of western dietary pattern in comparison to the first quartile.

The relationship between major habitual dietary patterns and IBS in whole population: **U**ltivariable-adjusted odds ratio (OR) for IBS across quartiles of the dietary pattern scores are presented in Table 5. No significant association was observed between dietary pattern scores and IBS using crude or adjusted models. Individuals in the fourth quartile of the healthy dietary patterns had less OR for IBS (OR: 0.83; 95% CI: 0.47-1.48) than those in the first quartile, although this correlation was not significant. Compliance with the mix and western dietary patterns increased the risk of IBS by 42% (OR: 1.42; 95%CI; 0.83-2.43) and 22% (OR: 1.22; 95%CI; 0.71-2.1) in participants at the highest and lowest quartiles, respectively; although these correlations were not statistically significant. After adjusting for the potential confounders (model1, model 2, and model 3), individuals in the healthy dietary pattern group had a lower, but a non-significant OR for IBS, in contrast to the participants of the mix and western dietary patterns.

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	Dough
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

Table 2. Food loading matrix for major dietary patterns

Food groups	Dietary patterns		
	Healthy pattern	**Mix pattern**	**Western pattern**
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	-	-
Green leafy vegetables	0.61	-	-
garlic	0.33	-	-
Fruits	0.32	-	0.27
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

*Values less than 0.20 are not reported.

Table 3. General characteristics of study participants by quartiles (Q) categories of dietary pattern score

Variables	Healthy pattern		P-value	Mix pattern		P-value	Western pattern		P-value[a]
	Q1	Q4		Q1	Q4		Q1	Q4	
Age (y)	14.6±1.5[b]	14.6±1.5	0.29	14.3±1.61	14.6±1.5	0.23	14.4±1.4	14.5±1.5	0.4
Weight (kg)	51.6±12.6	53.8±12.5	0.29	54.4±13.7	52.9±14.1	0.15	52.6±13.9	53.7±11.6	0.13
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	0.18
Passive smoker (%)	33	30.4	0.01	28.3	35.3	0.16	31.3	31.7	0.99
Menstruation(%)	89.4	89.2	0.62	86	86.3	0.6	87.6	88.7	0.71
Regular meal pattern (%)									
Never	11.5	13	0.1	7.7	11.2	0.67	10.4	11.8	0.91
Sometimes	41.2	42.4		39.6	42.8		43.4	37.6	
Often	32.4	21.7		33	32.1		29.1	31.2	
Always	14.8	22.8		19.8	13.9		17	19.4	
Chewing sufficiency (%)									
Little	15.3	11.4	0.62	9.1	14.4	0.21	11.4	9.8	0.72
Moderately	75.4	78.3		78	78.6		77.2	78.8	
A lot	9.3	10.3		12.9	7		11.4	11.4	
Fluid consumption (%)									
Never	3.9	10.2	0.003	6.6	4.3	0.61	5.5	5.4	0.04
Sometimes	29.3	37.6		38.8	33		45.4	27.6	
Often	29.8	22.6		27.3	29.2		23	33	
Always	37	29.6		27.3	33.5		26.2	34.1	
Breakfast consumption (%)									
Never or 1 day	18.8	13.6	0.02	13.6	14.6	0.99	3.9	10.2	0.36
2-4 days	31.5	20.1		27.2	25.9		29.3	37.6	
5-6 days	14.4	15.2		15.8	17.3		29.8	22.6	
Every day	35.4	51.1		43.5	42.2		37	29.6	

[a]: Obtained from one-way ANOVA; [b]: All values are mean ± SD

Table 4. Dietary intakes of study participants by quartiles (Q) categories of dietary pattern scores

	Healthy pattern			Fast food pattern			Western pattern		
	Q1	**Q4**	**P- value[a]**	**Q1**	**Q4**	**P- value**	**Q1**	**Q4**	**P- value**
Food groups (g/d)									
Red meat[b]	10.5 ± 11.5	16.2 ± 14.9	0.002	13.01 ± 12.7	12.4 ± 12.5	0.07	7.1 ± 7.2	21.9 ± 21.8	<0.001
Processed meat	4.6 ± 6.6	6.2 ± 9.9	0.07	4.9 ± 9.1	4.7 ± 5.7	0.88	2.3 ± 0.1	11.4 ± 0.83	<0.001
Low fat dairy	115.7 ± 113.5	323.3 ± 262.9	<0.001	202.1 ± 178.5	226.8 ± 232.3	0.6	197.2 ± 211.8	221.4 ± 188.1	0.51
High fat dairy	94.1±91.8	254.6 ± 221.0	<0.001	165.2 ± 172.7	162.6 ± 152.0	0.72	115.2 ±122.0	205.2 ± 161.7	<0.001
Fruit	140.2 ± 117.6	301.0 ± 219.5	<0.001	198.7 ± 194.6	220.9 ± 191.1	0.26	149.3 ± 120.4	273.8 ± 231.8	<0.001
Vegetables oil	4.5 ± 7.2	5.8 ± 7.1	0.06	3.0 ± 3.9	7.1 ± 9.1	<0.001	5.3 ± 8.1	5.3 ± 6.5	0.49
Legumes	63.4 ± 52.5	110.1 ± 85.6	<0.001	76.3 ± 74.3	87.1 ± 65.2	0.19	75.2 ± 60.5	94.2 ± 74.3	0.03
Coffee	5.4 ± 17.7	12.5 ± 33.6	0.01	11.4 ± 33.2	8.2 ± 22.5	0.07	3.6 ± 12.9	16.2 ± 36.7	<0.001
Whole grains	186.5 ± 181.7	203.8 ± 159.9	0.42	188.7 ± 173.5	207.5 ± 184.2	0.52	208.5 ± 194.2	194.6 ± 162.7	0.57
Refined grains	321.7 ± 237.6	256.9 ± 122.5	0.004	284.5 ± 200.8	272.5 ± 149.3	0.41	209.6 ± 109.0	350.3 ± 230.7	<0.001
Spices	2.6 ± 3.3	3.2 ± 3.6	0.01	1.1 ± 1.1	4.8 ± 4.9	<0.001	2.7 ± 3.6	3.1 ± 3.1	0.2
Nuts	12.7 ± 27.6	20.2 ± 27.9	0.09	11.3 ± 19.9	19.7 ± 37.1	0.01	9.1 ± 16.1	27.8 ± 44.4	<0.001
Salt	2.7 ± 2.7	3.2 ± 3.06	0.19	1.2 ± 1.3	5.0 ± 4.3	<0.001	2.9 ± 3.1	2.9 ± 2.9	0.68
Nutrients									
Energy (Kcal/d)	2364 ± 840	3180 ± 702	<0.001	2304 ± 859	3131 ± 757	<0.001	2191 ± 793	3381 ± 648	<0.001
Protein (g/d)	73.9 ± 26.4	113.0 ± 29.2	<0.001	87.1 ± 35.6	95.1 ± 30.0	0.07	73.9 ± 28.5	112.8 ± 27.8	<0.001
Total carbohydrates (g/d)	338.6 ± 132.8	418.2 ± 101.1	<0.001	326.7 ± 129.7	410.0 ± 116.3	<0.001	293.5 ± 110.0	464.2 ± 105.1	<0.001
Total fiber (g/d)	41.7 ± 24.4	50.7 ± 18.7	<0.001	41.6 ± 23.5	49.1 ± 21.0	0.003	39.6 ± 18.8	44.7 ± 20.4	<0.001
Sucrose (g/d)	20.1 ± 15.6	26.7 ± 12.7	<0.001	13.7 ± 10.9	33.4 ± 16.6	<0.001	18.0 ± 12.9	28.0 ± 16.9	<0.001
Fat (g/d)	85.0 ± 39.7	126.0 ± 40.3	<0.001	77.9 ±35.0	131.8 ± 43.9	<0.001	86.4 ± 45.5	127.7 ± 35.7	<0.001
Total SFAs (g/d)	22.7 ± 10.4	39.0 ± 14.2	<0.001	25.1 ± 12.9	35.8 ± 14.3	<0.001	24.5 ± 12.8	37.8 ± 12.8	<0.001
Total MUFAs (g/d)	27.9 ± 14.2	39.9 ± 14.8	<0.001	24.8 ± 12.3	43.4 ± 16.9	<0.001	29.2 ± 17.6	40.2 ± 12.1	<0.001
Total PUFAs (g/d)	21.1 ± 12.1	26.1 ± 12.0	<0.001	15.7 ± 7.6	32.0 ± 14.9	<0.001	20.8 ± 14.6	27.9 ± 10.4	<0.001
Cholesterol (mg/d)	151.9 ± 76.3	331.5 ± 169.8	<0.001	229.6 ± 168.0	250.6 ± 144.6	0.31	189.1 ± 116.2	292.1 ± 146.6	<0.001
Vitamin C (mg/d)	60.6 ± 41.8	149.5 ± 69.9	<0.001	87.9 ± 67.3	106.4 ± 62.0	0.01	71.1 ± 55.5	131.0 ± 69.6	<0.001
Vitamin E (mg/d)	11.9 ± 6.8	16.2 ± 7.0	<0.001	9.5 ± 4.8	18.6 ± 8.7	<0.001	13.1 ± 8.9	15.4 ± 5.5	<0.001
Vitamin A (mcg/d)	312.7 ± 170.6	921.7 ± 403.5	<0.001	605.8 ± 953	608.6 ± 364.3	0.46	480.7 ± 321.0	771.8 ± 943.1	<0.001

[a]: Obtained from one-way ANOVA; [b]: All values are mean ± SD

Table 5. Multivariate adjusted odds ratios (95% CIs) for IBS (Q) across categories of dietary pattern scores

	Crude	Model I[a]	Model II[b]	Model III[c]
Healthy pattern				
Q1	1	1	1	1
Q2	1.08 (0.62-1.86)	1.09 (0.62-1.92)	1.06 (0.59-1.9)	1.12 (0.61-2.04)
Q3	1.3 (0.77-1.48)	1.38 (0.79-2.39)	1.28 (0.72-2.28)	1.46 (0.8-2.6)
Q4	0.83 (0.47-1.48)	0.97 (0.52-1.8)	0.95 (0.5-1.79)	0.99 (0.5-1.9)
P-trend	0.75	0.8	0.93	0.77
Mix pattern				
Q1	1	1	1	1
Q2	1.39 (0.81-2.39)	1.44 (0.82-2.52)	1.42 (0.8-2.51)	1.42 (0.79-2.54)
Q3	0.79 (0.43-1.44)	0.84 (0.45-1.58)	0.75 (0.39-1.45)	0.65 (0.32-1.29)
Q4	1.42 (0.83-2.43)	1.63 (0.9-2.94)	1.54 (0.84-2.82)	1.53 (0.82-2.85)
P-trend	0.52	0.3	0.43	0.5
Western pattern				
Q1	1	1	1	1
Q2	0.97 (0.55-1.7)	1.02 (0.58-1.8)	1.02 (0.57-1.83)	0.99 (0.55-1.8)
Q3	1.13 (0.65-1.96)	1.19 (0.67-2.1)	1.19 (0.65-2.17)	1.18 (0.64-2.2)
Q4	1.22 (0.71-2.1)	1.31 (0.68-2.5)	1.23 (0.63-2.4)	1.07 (0.53-2.16)
P-trend	0.38	0.36	0.47	0.84

[a]: Adjusted for age and energy intake; [b]: Additionally adjusted for passive smoking, BMI and menstruation; [c]: Additionally adjusted for regular meal pattern, chewing sufficiency, breakfast consumption, fluid consumption

Discussion

Healthy, mix, and western dietary patterns were found in the studied sample of Iranian adolescent girls using principal components' factor analysis. Healthy dietary pattern correlated non-significantly with lower risk of IBS though mix and western dietary patterns associated non-significantly with higher risk of IBS. To the best of our knowledge, this was the first study evaluating the association between adherence to dietary pattern and IBS in adolescents.

The IBS is a complex bio-psychosocial illness widespread in 10-15% of adults and adolescents (Wald, 2012) that causes substantial reduction in quality of life (Wilson *et al.*, 2004). Longitudinal studies indicated that symptom experience will continue in adulthood in most of children and adolescents with IBS or recurrent abdominal pain (Campo *et al.*, 2001, Vlieger *et al.*, 2007, Walker *et al.*, 1998). More dramatically, a limiting number of therapeutic options exist for this group of patients with persisting abdominal complains (Vlieger *et al.*, 2007, Weydert *et al.*, 2003). In addition to pain and other physical discomfort, IBS is associated with psychological disorders particularly depression and anxiety among students (Hyams, 1997). Therefore, identifying the potential risk factors associated with this condition is crucial especially during childhood. Most of the previous studies examined the relationship between certain foods and IBS, while few studies focused on the dietary patterns (Khayyatzadeh *et al.*, 2016).

In the present study, non-significant protective effect of healthy dietary pattern on IBS was seen. All kinds of vegetables, tomatoes, garlic, fruits, olives, egg, yoghurt, and legumes were consumed in high amounts in this pattern. It should be noted that previously, most studies examined the effect of dietary fibers on IBS and a few studies considered the effectiveness of fruits and vegetables on IBS (Khayyatzadeh *et al.*, 2016). Generally, the effect of fruits and vegetables on IBS was inconclusive. Certain fruits and vegetables, which contained high amounts of fermentable short-chain carbohydrates, disaccharides, mono saccharides, polyols, and insoluble fibers are announced as foods, which were found to cause alleviation in IBS symptoms previously (Mazzawi *et al.*, 2013). Intake of high fermentable oligo-, di-, and monosaccharides, as well as polyols (FODMAPs), due to low absorption in the small intestine, may increase the GI lumen osmolality (Ong *et al.*, 2010) and enhance gas production in GI tract (Ong *et al.*, 2010), which both aggravate the IBS symptoms. Reduction in IBS symptoms of about 86% of patients was previously seen following a low FODMAP diet (Shepherd and Gibson, 2006, Staudacher *et al.*, 2011). Similarly, results of some previous studies indicated that dietary fibers did not have a positive role in decreasing the IBS symptoms (Akehurst and Kaltenthaler, 2001, Bijkerk *et al.*, 2004). Furthermore, it was shown that certain vegetables, such as onion, contain indigestible fermentable fructo-oligosaccharides named fructan (Ong *et al.*, 2010) and fruits containing a high amount of fructose have a positive association with IBS symptoms (Shepherd and Gibson, 2006, Staudacher *et al.*, 2011). However, although insoluble fibers exacerbated the IBS symptoms, soluble fibers alleviated them (Akehurst and Kaltenthaler, 2001, Bijkerk *et al.*, 2004). Moreover, earlier studies declared that consumption of legumes worsen IBS symptoms due to the gas production in the GI lumen (Chirila *et al.*, 2012, Friedman, 1989).

Based on our results, it seems that yogurt may have a protective role against IBS symptoms. Similarly, results of a previous cross-sectional study showed that low intake of dairy products such as yogurt was correlated with IBS (Ligaarden *et al.*, 2012). Nevertheless, some earlier studies indicated that milk products may aggravate IBS symptoms duo to the lactose content of milk (Vernia *et al.*, 1995, Vesa *et al.*, 1998). Different designs of these studies might explain the discrepancy in their findings.

As results of this study showed, eliminating or decreasing consumption of the fruits, vegetables, legumes, and dairy products is not recommended to improve IBS symptoms. These healthy foods have high amounts of soluble fibers and a variety of nutrients, which may protect against IBS symptoms by forming a gel and mucus on the GI lumen and supporting several health benefits.

In the current study, we found that IBS had a non-significant association with mix and western dietary patterns. Foods containing high amounts of fat such as hydrogenated fats, vegetables oil, snacks, red meat, poultry, fish, organ meat, pizza, mayonnaises, nuts, sweets, and deserts were greatly loaded in these dietary patterns. Several review articles indicated that high intakes of fat and fatty foods were associated with IBS and reduced fat content of diet improved IBS symptoms (Drossman *et al.*, 2002, Friedman, 1991, Horwitz and Fisher, 2001). Indeed, it was proposed that fatty meals caused increasing and prolonging secretion of cholecystokinin in IBS, which might be resulted in intestinal dysmotility in IBS patients (Sjölund *et al.*, 2009). Furthermore, slowing the small bowel motility, decreased gas movement, and increased intestinal sensitivity were related to fat consumption in the IBS patients (Friedman, 1991, Serra *et al.*, 2002, Simrén *et al.*, 2007). In a previous case control study, it was shown that intake of fatty food, coffee, and hot spices caused aggravating symptoms among IBS patients (Simren *et al.*, 2001). Recurrent symptoms were observed in 18% to 28% of IBS patients after consuming tea (Heizer *et al.*, 2009). Nuts, tuna fish, some of food additives, diet beverages, fruit juices, fast foods, and fried foods were considered as foods that induce IBS symptoms (Heizer *et al.*, 2009, MacDermott, 2007). In another cross-sectional population-based study, IBS was correlated with high intake of water, tea, carbonated beverage, vegetable, and potato as well as low intake of dairy products (Ligaarden *et al.*, 2012). Altogether, high intakes of potatoes, hydrogenated fats, vegetable oil, salt, spices, and tea in mix dietary pattern and high consumption of snacks, pizza, sweets, and deserts containing high amounts of fat, as well as intake of high amounts of fruit juice, industrial juice, and nuts in western dietary pattern might explain the positive association of these pattern with IBS. However, the non-significance odds ratios found in the current study might be duo to the role of other important factors in developing IBS symptoms. These factors could be prior gastroenteritis, genetics, luminal irritants, changes in the microbial flora, mucosal inflammation or local immune activation, disorders of evacuation of stool or gas, and certain transmitters and transporters (Camilleri and Di Lorenzo, 2012), which we were unable to control them.

This study has several limitations. First of all, like other cross-sectional studies, determining the cause and effect relationship was not possible in the present study. Second, our population was selected among adolescents of Mashhad province, in the north eastern part of Iran. Since dietary intake and lifestyle of adolescents in other parts of Iran may be different from our participants, generalizing these results to all Iranian adolescents' population is impossible. Third, we used self-report FFQ to obtain dietary intakes of the study participants, which shows measurement bias and misclassification. Next, several subjective or arbitrary decisions emerged in factor analysis that are considered as its limitations (Martinez *et al.*, 1998). Finally, similar to other observational studies, our study had several unmeasured confounders that we could not control them.

To the best of our knowledge, this was the first study that examined the relationship between dietary patterns and aggression presence. Regarding the strength points of our research, controlling a wide range of potential confounders and conducting high-quality data collection were mentioned.

Conclusion

In conclusion, no statistically significant relationships were found between dietary patterns and IBS among Iranian girl adolescents. However, it seems that following a diet greatly loaded by fruits, vegetables, legumes, and yogurt might be protective against IBS. Further studies, particularly longitudinal studies with a larger sample size are required in this area.

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Authors' contribution

The current manuscript was derived from an extensive study and therefore several persons were involved in it. The paper was drafted by Banazadeh V and Jaberi N with contributions from all authors. Ghayour-Mobarhan M and Khayyatzadeh SS designed the study. Banazadeh V, Jaberi N, and Hoseinkhani F participated in field implementation and sampling. Moreover, Khayyatzadeh SS, Bagherniya M, and Ghayour-Mobarhan M were involved in clinical examination and patient confirmation. Khayyatzadeh SS and Bagherniya M contributed to statistical analyses. Ghayour-Mobarhan M and Khayyatzadeh SS supervised the study. All authors contributed in development of the manuscript by reading and approving its final version.

Conflict of interest statement

The authors have no conflict of interest to disclose.

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