Journal of Nutrition and Food Security
Shahid Sadoughi University of Medical Sciences
School of Public Health
Department of Nutrition
Shahid Sadoughi University of Medical Sciences
School of Public Health

eISSN: 2476-7425 pISSN: 2476-7417 JNFS 2025; 10(1): 57-68 Website: jnfs.ssu.ac.ir

Higher Consumption of Carbonated Drinks and Fast Food Related to Depression and Quality of Life in Adolescent Girls

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ARTICLE INFO

ORIGINAL ARTICLE

Article history:
Received: 31 Oct 2023
Revised: 15 Apr 2024
Accepted: 30 Apr 2024

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Keywords:
Whole grain;
Fast food;
Diet;
Depression;
Quality of life;
Adolescent.

ABSTRACT

Background: The association between fast food, whole grain, refined grain and carbonated drink consumption and depression and quality of life (QoL) was evaluated in Iranian adolescent girls. **Methods:** In this cross-sectional study, 733 adolescent girls were included from Mashhad and Sabzevar cities in northeastern Iran. The Beck Depression Inventory (BDI) and SF-12v2 questionnaire were used to assess depression and QoL, respectively. A valid and reliable food frequency questionnaire was used to obtain dietary intakes of the study participants. To explore the association between intake of food groups and depression and QoL. It was used linear and logistic regression in crude and adjusted models. **Results:** There was a significant decreasing trend in the odds of poor QOL and depression across increasing quartile intake of whole grain; but, there was no linear relationship between whole grain intake and depression and QoL score. In addition, participants in the highest quartile of carbonated drink consumption had higher odds of poor QoL compared to the first quartile (OR: 1.33; 95% CI: 1.00–2.32, *P*=0.04). A positive association was found between intake of fast food and depression score (β=0.09). Intake of fast food was inversely associated with QoL score (β=-0.081). However, there was no significant relationship between intake of refined grains and carbonated drinks and depression, and between whole grain and refined grain intake and QoL. **Conclusions:** The results demonstrated an inverse association between fast food intake and depression and QOL. To better conclude, further studies evaluating the association of various food groups with depression and QoL.

Introduction

Recent evidence confirms the growing prevalence as well as socioeconomic costs of mental health disorders (Collins *et al.*, 2011, Murray and Lopez, 1996, Prince *et al.*, 2007). Depression is a common mental health disorder, with two major symptoms including depressed mood and anhedonia, which are often accompanied with several other symptoms (Prince *et al.*, 2007). The lifetime prevalence of depression is estimated to be 15% in the general population (Lépine and Briley, 2011). Many patients suffering from depression experience depressive symptoms during adolescence (Belfer, 2008). The prevalence of depression is affected by gender and is higher

This paper should be cited as: Sangouni AA, Darabi Z, Ghayour-MobarhanM, Khayyatzadeh SS. ***Higher Consumption of Carbonated Drinks and Fast Food Related to Depression and Quality of Life in Adolescent Girls.*** *Journal of Nutrition and Food Security (JNFS)*, 2025; 10 (1): 57-68.

[DOI: 10.18502/jnfs.v10i1.17757]

among adolescent females than males (Bijl *et al.*, 2002, Cyranowski *et al.*, 2000). Obesity, oxidative stress, and inflammation are linked to the development and progression of depressive symptoms (Shafiee *et al.*, 2018, Shafiee *et al.*, 2017, Tayefi *et al.*, 2017). Based on a meta-analysis, the prevalence of depression among Iranian children and adolescents is reported to be 43.5% (Sajjadi *et al.*, 2013).

Several studies have suggested that depression has a negative effect on QoL (Gao *et al.*, 2019, Teles *et al.*, 2018). Quality of life (QoL) is a multidimensional concept (Sivertsen *et al.*, 2015). Based on the World Health Organization (WHO), QoL is defined as follows: "the perception of individuals about their position in life in the context of the culture and value systems which is related to their goals, expectations, standards and concerns" (WHOQOL Group:, 1995).

Previous studies have proposed that diet can play an important role in the development or preventive of depression (Oddy *et al.*, 2018, Park *et al.*, 2019, Weng *et al.*, 2012). Several studies have investigated the association between dietary patterns, intake of nutrients or specific food groups with depression (Li *et al.*, 2017, Li *et al.*, 2018, Oddy *et al.*, 2018, Park *et al.*, 2019, Weng *et al.*, 2012). Results of some studies reported that intake of copper, iron, zinc and selenium were inversely associated with depressive symptoms (Li *et al.*, 2017, Li *et al.*, 2018). Results of other studies showed that healthy dietary patterns which provide higher amounts of gruel, oatmeal, whole grains, fresh yellow or red vegetables, fruits, soya milk and fish, can decrease risk of depression among adolescents (Oddy *et al.*, 2018, Weng *et al.*, 2012). Unhealthy dietary patterns like western dietary pattern characterized by high intake of red and processed meats, refined foods, saturated fatty acids (SFAs), noodles, white bread and coffee can increase the risk of depression (Park *et al.*, 2019, Weng *et al.*, 2012). Investigations suggested that intake of specific food groups such as vegetables, fruits, nuts and legumes have an inverse association with the risk of depression (Anjom-Shoae *et al.*, 2020, Liu *et al.*, 2016). There are few studies investigating the relationship between specific food groups and depression. A recent systematic review evaluated the relationship between diet and QoL (Carson *et al.*, 2014); the results of the study demonstrated that the lack of evidence needed to understand the effect of dietary interventions on QoL has research and clinical implications that must be considered and addressed. Accordingly, the present study aims to investigate the association between intake of refined grains, whole grains, fast foods and carbonated drinks and depression and QoL in adolescent girls.

Methods and Materials

Study population

This cross sectional study was conducted among 733 adolescent girls (aged 12-18 y) in January 2015. Participants were selected from 24 high schools from six geographical areas of Mashhad and Sabzevar, in northeastern Iran by a random cluster sampling method. Four high schools were randomly chosen from each geographic area by the random selection of one class per grade. The entire process of selecting schools, classes, and students was conducted using computer-generated random numbers.

Adolescents with history of autoimmune diseases, cancer, metabolic bone disease, hepatic or renal failure, cardiovascular disorders, malabsorption or thyroid, parathyroid, adrenal diseases and anorexia nervosa or bulimia were excluded from the study. In addition, the included participants did not receive anti-inflammatory, anti-depressant, antidiabetic, or anti-obesity drugs, vitamin D or calcium supplements, and any hormone therapy within the last 6 months.

Demographic and anthropometric assessments

Demographic variables were assessed using a demographic questionnaire administered by trained interviewers. Demographic variables were age, smoking status, menstruation status, medical history, supplement intake, taking psychological treatment and chronic diseases. Participants' physical activity was assessed using a modifiable activity questionnaire (MAQ) (Momenan *et al.*, 2012). Physical activity level was calculated based

[DOI: 10.18502/jnfs.v10i1.17757]

on metabolic equivalent task minutes per week. Anthropometric variables such as weight, height and waist circumference (WC) were measured by the trained investigators using the standard protocols. Body mass index (BMI) was computed as weight (kg) divided by square of height (m^2).

Dietary assessment

Dietary intakes were estimated by a validated food-frequency questionnaire (FFQ) with 147 food items. The validity and reliability of this FFQ had been confirmed previously (Asghari *et al.*, 2012). To complete the FFQ, a face-to-face interview was performed by a trained dietitian. To evaluate the frequency of food items intake during the last year, the participants answered the questions about their daily, weekly, monthly and yearly intake. The reported portion sizes in the FFQ were converted to grams using household measures, and the energy and nutrient intakes were calculated using the Nutritionist IV software (Pehrsson *et al.*, 2000). Whole grains were defined by total intake of Barley Oat, Sangak bread, and fast food was defined by intake of pizza and fried potato. Refined grain included breads of Lavash, Barbari, Taftoon, Baguette and cooked rice, macaroni, potato, vermicelli, noodle, biscuit, cracker, cake and corn.

Assessment of depression

Depression was assessed via a Persian version of the Beck Depression Inventory (BDI). This questionnaire has 21 items evaluating various symptoms of depression including feelings of guilt, feelings of hopelessness, sadness, crying, sleep disturbance, and fear and loss of appetite over the past 2 weeks. The range of scores for the BDI was between 0 and 63 points. Scores 0-13, 14-19, 20-28 and 29-63 refer to no depression, mild depression, moderate depression, and severe depression respectively. The validity and reliability of this questionnaire were confirmed by previous studies (Ghassemzadeh *et al.*, 2005, Scogin *et al.*, 1988).

QoL assessment

To assess health-related QoL, the SF-12v2 questionnaire was used. This questionnaire is a short form of SF-36 questionnaire and an improved version of SF-12v1 (Cheak-Zamora *et al.*, 2009). The validity and reliability of this questionnaire were approved in Iran (Montazeri *et al.*, 2011). The questionnaire has 12 items which evaluate 8 domains of health including physical functioning, role limitations because of physical problems, bodily pain, general health, vitality, social functioning, role limitations because of emotional problems, and mental health. The range of QoL scores are between 0 (the worst QoL) to 100 (the best QoL). The median of the QoL score is 43. The subjects were categorized as high QoL if their scores were higher than 43.

Ethical considerations

The ethical committee of Mashhad University of Medical Sciences in Mashhad approved the study with code number: 931188. All methods were performed in accordance with relevant guidelines. The written informed consent form was signed by all participants and their parents before the data collection.

Data analysis

Participants were classified into four groups across quartiles of their food group scores including whole grain, refined grain, carbonated drink, and fast foods. General characteristics and nutrient intake across quartiles of food group score were expressed as means±SDs for continuous variables, and as numbers and percentages for categorical variables. To examine the differences between quartiles, one-way-ANOVA and Chi square test were used for continuous and categorical variable respectively. To investigate the relationship between quartiles of food group scores and depression and poor QoL, multivariate regression was conducted in the crude and adjusted models. Multivariate linear regression was used to explore the association between QoL score and depression and fast food, carbonated drink, whole grain and refined grain intake. Age and energy intake were adjusted in Model I. Additionally, BMI percentile was adjusted in Model II. Finally, physical activity, age, energy intake and BMI percentile were adjusted in model III. All statistical analyses were conducted using the SPSS version 21. P-values less than 0.05 were considered significant.

[DOI: 10.18502/jnfs.v10i1.17757]

Results

General characteristics study participants

The mean age of the participants was 14.5. The prevalence of depression and poor QoL were 24% and 49%, respectively. General characteristics and anthropometric indices of the participants across quartiles of food groups are demonstrated in **Table 1**. Participants in the lowest quartile of whole grain and the highest quartile of refined grain were significantly younger (P=0.02 and P=0.01, respectively). Anthropometric variables and other general characteristics were not different among quartiles of food intake.

Dietary intake of study participants

Dietary intake of study participants across quartiles of food groups are shown in **Table 1**. Participants in the highest quartiles of food groups (whole grain, refined grain, fast food and carbonated drink) compared with the participants who were in the lowest quartile had higher intake of energy, protein and carbohydrate. Vitamin B6 intake was significantly higher among participants in the last quartile of fast food intake (per 1000 kcal) compared to the first quartile (P=0.04). Intake of Vitamin B12 was not significantly different between quartiles of food groups (per 1000 kcal). Participants in the first quartile of carbonated drink as well as fast foods intake had higher intake of folate compare with the fourth quartile (per 1000 kcal, P<0.001). The participants with a greater intake of refined grain had a lower intake of vitamin A (P=0.01), vitamin C (P<0.001), and calcium (per 1000 kcal, P<0.001). Participants in the highest quartile of food groups' intake including fast foods, refined grain and carbonated drink had higher intake of monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFAs) and SFAs.

Association between food groups, depression, and poor QoL

Multi-variable adjusted odds ratios (ORs) for depression and poor QoL categories across quartiles of food intake are represented in **Table 2**. Adolescent girls in the fourth quartile of whole grain intake compared with the subjects in the first quartile had a 40% lower probability of having depressive symptoms (OR: 0.60; 95% CI: 0.37–0.98, P=0.04). This association remained significant after adjustment for age, energy intake, BMI percentile, and physical activity (OR: 0.60; 95% CI:0.36–0.99, P=0.04). There was a significant reduction trend in the odds of poor QoL across increasing quartile intake of whole grain in the crude (OR: 0.87; 95% CI: 0.76–0.99, P_{trend}=0.04). This trend was not significant after adjustment for age, energy intake, BMI percentile, and physical activity (OR: 0.88; 95% CI: 0.76–1.00, P_{trend}=0.06). Intake of refined grain was not associated with odds of depression and poor QoL (OR: 1.01; 95% CI: 0.66–1.52, P=0.95). Participants in the highest quartile of carbonated drink intake had higher odds of poor QoL compared with the subjects in the first quartile (OR: 1.33; 95% CI: 1.00–2.32, P=0.04). This association remained significant after adjustment for age, energy intake, BMI percentile, and physical activity (OR: 1.69; 95% CI: 1.08–2.63, P=0.02). However, intake of carbonated drink was not significantly associated with odds of depression (OR: 0.92; 95% CI: 0.57–1.47, P=0.74). Fast food intake increased odds of poor QoL. The odds of poor QoL increased with higher intake of fast food (OR: 1.14; 95% CI: 1.00–1.37, P_{trend}=0.04); after adjustment for potential confounders, this association remained significant (OR: 1.20; 95% CI: 1.04–1.38, P_{trend}=0.02).

The correlations between intake of food groups with depression and QoL score are shown in **Table 3**. There was a positive association between intake of fast food and depression score in the crude model (β=0.09; P=0.01). Likewise, this association remained significant after adjustment for age, energy intake, BMI percentile, and physical activity (β= 0.01; P<0.01). Intake of fast food was inversely associated with QoL score in the crude (β=-0.081; P=0.02) and adjusted models (β=-0.090; P=0.02). Carbonated drink, refined grain and whole grain intake were not significantly associated with depression and QoL score.

[DOI: 10.18502/jnfs.v10i1.17757]

Table 1. General characteristics, anthropometric indices, daily macronutrient and some micronutrients intake of study participants by quartiles of food groups.

Variable	Whole grain			Refined grain			Fast food			Carbonated drink		
	Q1	Q4	P-value[b]	Q1	Q4	P-value[b]	Q1	Q4	P-value[b]	Q1	Q4	P value[b]
Age(year)	14.28±1.43[a]	14.75±1.62	0.02	14.62±1.60	14.14±1.36	0.01	14.42±1.46	14.60±1.57	1.00	14.25±1.52	14.66±1.58	0.07
BMI (kg/m^2)	20.81±4.14	21.59±4.12	0.46	21.61±4.15	20.91±3.93	0.68	20.89±4.83	21.46±4.05	1.00	21.14±5.06	21.27±4.15	1.00
Weight(kg)	51.17±11.11	54.11±11.62	0.11	53.86±11.84	52.31±11.05	1.00	52.01±13.91	53.54±11.06	1.00	52.52±14.11	53.14±11.80	1.00
WC (cm)	70.01±9.57	70.53±8.62	1.00	71.41±9.23	70.15±8.45	1.00	69.99±9.87	70.29±8.70	1.00	70.65±10.61	70.60±9.13	1.00
MET(h/week)	44.74±3.39	46.01±3.60	0. 01<	45.27±2.95	45.07±3.80	1.00	45.00±2.71	45.49±3.62	1.00	44.84±2.89	45.68±3.92	0.12
Score of depression	12.23±10.38	10.23±8.66	0.24	11.10±9.18	11.25±9.42	1.00	10.12±9.3	11.27±8.65	1.00	10.60±9.62	11.48±9.80	1.00
Score of QoL	41.34±7.69	42.27±7.69	0.81	41.95±7.72	41.27±1.69	1.00	42.07±8.64	41.89±7.89	1.00	42.50±8.34	40.75±7.67	0.23
Energy (kcal)	2564.82±869.47	2878.28±862.30	0. 01<	2192.65±777.85	3337.90±654.97	0.001<	2287.98±781.87	3166.93±695.43	0.001<	2487.00±857.97	3135.92±797.07	0.001<
Carbohydrate (g)	349.82±127.1	406.27±123.91	0.001<	279.24±100.79	488.93±25.67	0.001<	314.41±116.71	430.19±112.52	0.001<	341.11±123.98	433.11±117.68	0.001<
Carbohydrate(g/1000 kcal)	136.80±18.99	142.02±14.98	0.001<	129.25±20.36	147.50±15.36	0.22	137.98±20.95	135.66±17.04	0.49	137.98±19.31	138.60±17.20	0.34
Protein (g)	86.49±33.31	101.01±31.99	0.001<	74.55±29.83	114.18±25.67	0.001<	78.78±29.57	107.21±29.20	0.001<	88.43±32.35	100.95±31.52	0.01<
Protein (g/1000 kcal)	33.75±5.99	35.36±5.16	0. 01<	34.34±7.00	34.36±4.91	. 01<	34.61±6.57	33.85±5.34	0.49	35.74±5.71	32.90±5.15	0.01<
Fat (g)	97.18±41.63	102.85±40.81	1.00	92.04±4.67	112.17±38.34	0.001<	85.42±40.33	121.28±35.7	0.001<	92.43±42.21	119.58±40.81	0.001<
Fat (g/1000 kcal)	37.63±8.65	35.21±7.10	0.001<	40.94±9.78	33.07±7.28	0.80	36.94±10.31	38.31±7.70	0.41	36.65±9.01	37.91±7.78	0.40
Cholesterol (mg)	229.57±166.75	240.62±112.79	1.00	225.75±150.69	251.55±139.33	0.43	209.24±131.38	269.32±129.35	0.001<	237.71±173.45	245.81±128.88	1.00
Cholesterol (mg/1000 kcal)	91.07±58.86	85.92±37.00	0.69	103.74±52.14	75.60±41.45	0.06	92.56±50.44	85.54±35.32	0.32	95.69±54.64	79.63±37.96	0.01<
Saturated fatty acid (g)	27.78±12.61	30.88±13.00	0.16	28.08±14.49	32.26±11.57	0.01	25.17±12.50	36.81±13.05	0.001<	27.89±14.03	34.07±12.63	0.001<
Saturated fatty acid (g/1000 kcal)	10.83±3.28	10.69±2.97	0. 01<	12.60±3.89	9.55±2.56	0. 48	10.98±3.98	11.67±3.23	0.09	11.10±3.85	10.88±2.92	0.16
Monounsaturated fatty acid (g)	31.44±13.13	32.78±13.72	1.00	28.91±15.06	36.45±14.00	0.001<	27.76±14.58	38.90±12.06	0.001<	30.41±15.10	38.07±14.17	0.001<
Monounsaturated fatty acid (g/1000 kcal)	12.20±3.52	11.25±2.81	0.001<	12.87±3.93	10.74±2.90	0.20	11.96±4.19	12.31±2.88	0.80	12.02±3.61	12.09±3.10	0.83
Polyunsaturated fatty acid (g)	22.55±11.22	22.48±11.98	1.00	19.91±12.91	25.14±11.59	0.001<	19.08±11.91	26.86±10.00	0.001<	20.86±11.38	27.36±12.75	0.001<
Polyunsaturated fatty acid (g/1000 kcal)	8.75±3.05	7.61±2.73	0.001<	8.79±3.78	7.39±2.58	0.15	8.19±3.73	8.50±2.64	0.69	12.02±3.19	8.62±2.98	0.66
Fiber (g)	43.04±23.19	49.23±20.21	0.02	33.51±14.80	58.32±22.72	0.001<	45.01±22.17	48.96±20.19	0. 01<	42.59±19.8	48.53±19.42	0.03
Fiber (g/1000 kcal)	16.80±6.31	17.17±5.19	0.12	15.78±5.93	17.53±5.79	0.001<	45.01±6.78	15.40±5.33	0.001<	17.42±6.25	15.48±4.90	0.01<
Calcium (mg)	1057.57±504.31	1206.66±505.70	0.02	1003.03±517.32	1278.1±422.8	0.001<	980.65±455.67	1299.01±507.63	0.62	1087.95±544.30	1231.45±468.84	0.04
Calcium (mg/1000 kcal)	411.61±132.57	422.84±124.92	1.00	459.20±154.6	382.14±96.18	0.001<	433.94±155.50	410.97±130.75	0.001<	436.94±149.89	395.71±118.71	0.02
Iron (mg)	19.00±7.85	22.40±7.42	0.001<	14.62±5.70	27.35±6.02	0.001<	17.57±7.20	22.66±6.87	0.05	19.22±7.49	21.96±7.37	0.001<
Iron (mg/1000 kcal)	7.39±1.57	7.82±1.23	0.02	6.82±1.64	8.26±1.29	0.001<	7.71±1.74	7.13±1.30	0.001<	7.78±1.50	6.96±1.37	0.001<
Vitamin A (µg)	585.55±984.42	620.80±350.58	0.89	563.69±365.79	604.87±319.04	0. 80	485.48±308.87	469.96±412.86	1.00	576.75±387.80	599.90±322.28	0.94

[DOI: 10.18502/jnfs.v10i1.17757]

Vitamin A (µg/1000 kcal)	231.92±449.62	219.36±115.93	1.00	259.11±142.31	181.71±90.12	0. 01	214.49±129.77	218.56±116.54	0. 01<	232.61±127.26	194.14±3.79	0.77
Vitamin C (mg)	85.74±62.80	101.37±58.86	0.05	93.16±66.08	96.52±50.31	0. 01<	71.43±58.55	120.20±61.68	0.02	87.90±64.50	114.49±64.29	0.001<
Vitamin C (mg/1000 kcal)	33.64±22.90	35.59±19.30	1.00	42.23±25.79	29.00±14.77	0.001<	31.73±24.42	37.98±17.86	0.001<	35.75±21.35	37.12±21.89	1.00
Folate (µg)	587.74±216.72	647.42±212.75	0. 01<	466.72±157.72	789.15±192.24	0.001<	547.46±201.34	673.33±184.03	0.001<	582.14±215.49	660.29±196.71	0.001<
Folate (µg/1000 kcal)	233.89±51.36	227.86±45.22	1.00	221.2±58.22	239.02±47.39	0.01<	243.80±55.62	214.34±41.4	0.001<	239.17±53.07	213.15±44.78	0.001<
Vitamin B6 (mg)	1.78±0.64	2.08±0.65	0.001<	1.55±0.63	2.34±0.50	0.001<	1.57±0.60	2.31±0.61	0.04	0.63.1.79	2.16±0.64	0.001<
Vitamin B6 (mg/1000 kcal)	0.70±0.13	0.73±0.12	0.15	0.71±0.15	0.70±0.10	1.00	0.69±0.82	0.73±0.12	0.001<	0.72±0.12	0.69±0.12	0.08
Vitamin B12 (µg)	4.41±9.66	4.30±2.42	0.91	3.80±2.52	4.13±2.22	0.61	3.23±2.07	5.04±2.80	1.00	3.82±2.55	4.37±3.82	0.57
VitaminB12 (µg/1000 kcal)	1.78±4.55	1.52±0.77	1.00	1.73±0.88	1.24±0.60	0.24	1.43±0.82	1.59±0.77	0. 01<	1.53±0.85	1.40±0.66	1.00

*[a]: Means±SD; [b]: Obtained from one-way ANOVA; **MET**: Metabolic equivalent task; **QoL**: Quality of life. WC: Waist circumference; **BMI**: Body mass index.*

[DOI: 10.18502/jnfs.v10i1.17757]

Table 2. Multivariable-adjusted odds ratio of the associations between depression, poor quality of life and food groups.

Variable	Q1	Q2	Q3	Q4	P value[a]	P_{trend}
			Quartiles of whole grain intake			
Depression						
Crude	1.00	0.74 (0.47-1.18)	0.81 (0.50-1.29)	0.60 (0.37-0.98)	0.04	0.06
Model1	1.00	0.75 (0.47-1.19)	0.81 (0.51-1.30)	0.61 (0.37-1.00)	0.05	0.08
Model2	1.00	0.75 (0.47-1.18)	0.82 (0.51-1.32)	0.61 (0.37-1.01)	0.05	0.09
Model3	1.00	0.74 (0.47-1.18)	0.80 (0.50-1.29)	0.60 (0.36-0.99)	0.04	0.07
Poor quality of life						
Crude	1.00	0.89 (0.59-1.34)	0.71 (0.46-1.09)	0.67 (0.47-1.03)	0.07	0.04
Model1	1.00	0.87 (0.58-1.32)	0.70 (0.46-1.07)	0.66 (0.43-1.01)	0.05	0.03
Model2	1.00	0.87 (0.58-1.32)	0.71 (0.46-1.09)	0.66 (0.43-1.02)	0.06	0.03
Model3	1.00	0.88 (0.58-1.33)	0.73 (0.48-1.12)	0.69 (0.45-1.07)	0.10	0.06
			Quartiles of refined grain intake			
Depression						
Crude	1.00	0.69 (0.43-1.13)	0.81 (0.50-1.30)	1.02 (0.65-1.62)	0.48	0.76
Model1	1.00	0.72 (0.44-1.18)	0.88 (0.54-1.46)	1.21 (0.70-2.07)	0.48	0.43
Model2	1.00	0.72 (0.44-1.17)	0.87 (0.53-1.43)	1.20 (0.70-2.05)	0.50	0.46
Model3	1.00	0.71 (0.44-1.17)	0.87 (0.53-1.43)	1.21 (0.70-2.08)	0.47	0.44
Poor quality of life						
Crude	1.00	0.73 (0.48-1.01)	0.86 (0.57-1.30)	1.01 (0.66-1.52)	0.95	0.76
Model1	1.00	0.75 (0.49-1.14)	0.91 (0.59-1.40)	1.14 (0.70-1.85)	0.57	0.48
Model2	1.00	0.74 (0.48-1.12)	0.89 (0.57-1.37)	1.12 (0.69-1.82)	0.62	0.53
Model3	1.00	0.74 (0.49-1.13)	0.89 (0.57-1.38)	1.10 (0.67-1.78)	0.62	0.60
			Quartiles of carbonated drink intake			
Depression	**Q1**	**Q2**	**Q3**	**Q4**		
Crude	1.00	0.92 (0.57-1.47)	0.86 (0.54-1.38)	0.92 (0.57-1.47)	0.74	0.85
Model1	1.00	0.78 (0.48-1.26)	0.88 (0.55-1.41)	0.98 (0.60-1.60)	0.94	0.96
Model2	1.00	0.79 (0.49-1.27)	0.88 (0.55-1.42)	0.98 (0.60-1.60)	0.94	0.96
Model3	1.00	0.78 (0.48-1.26)	0.87 (0.54-1.40)	0.97 (0.59-1.59)	0.91	0.99
Poor quality of life						
Crude	1.00	0.87 (0.57-1.31)	1.03 (0.68-1.56)	1.33 (1.00-2.32)	0.04	0.03
Model1	1.00	0.86 (0.57-1.31)	1.04 (0.69-1.58)	1.62 (1.04-2.52)	0.03	0.02
Model2	1.00	0.87 (0.57-1.32)	1.05 (0.69-1.59)	1.63 (1.05-2.53)	0.02	0.02
Model3	1.00	0.88 (0.58-1.34)	0.69 (0.72-1.67)	1.69 (1.08-2.63)	0.02	0.01
			Quartiles of fast food intake			
Depression						
Crude	1.00	1.16 (0.71-1.89)	1.37 (0.85-2.20)	1.20 (0.74-1.98)	0.46	0.36
Model1	1.00	1.21 (0.74-2.98)	1.46 (0.89-2.39)	1.35 (0.79-2.28)	0.26	0.19
Model2	1.00	1.23 (0.75-2.02)	1.49 (0.91-2.43)	1.37 (0.81-2.32)	0.23	0.17
Model3	1.00	1.23 (0.75-2.01)	1.47 (0.90-2.42)	1.36 (0.80-2.31)	0.24	0.18
Poor quality of life						
Crude	1.00	0.85 (0.56-1.29)	1.42 (0.94-2.15)	1.33 (0.88-2.01)	0.17	0.04
Model1	1.00	0.88 (0.57-1.33)	1.51 (0.98-2.32)	1.46 (0.93-2.22)	0.09	0.01
Model2	1.00	0.89 (0.59-1.37)	1.55 (1.01-2.38)	1.49 (0.95-2.34)	0.07	0.01
Model3	1.00	0.90 (0.59-1.38)	1.59 (1.03-2.45)	1.51 (0.96-2.38)	0.07	0.01

[a]: *Fourth quartile compared to first quartile;* ***Model 1****: Adjusted for age and energy intake;* ***Model 2****: additionally, adjusted for body mass index percentile;* ***Model 3****: Adjusted for age, energy intake, body mass index percentile, and physical activity.*

[DOI: 10.18502/jnfs.v10i1.17757]

Table 3. The association between score of depression and quality of life with food groups

Food intake	Score of depression		Score of quality of life	
	в	P-value[a]	в	P-value[a]
Intake of whole grain				
Crude	-0.021	0.57	0.022	0.55
Model1	-0.021	0.57	0.025	0.51
Model2	-0.021	0.57	0.025	0.51
Model3	-0.022	0.56	0.019	0.61
Intake of refined grain				
Crude	0.003	0.93	0.004	0.90
Model1	0.012	0.78	0.004	0.92
Model2	0.011	0.79	0.005	0.91
Model3	0.013	0.73	0.012	0.79
Intake of carbonated drink				
Crude	0.021	0.56	-0.063	0.08
Model1	0.022	0.57	-0.063	0.10
Model2	0.021	0.58	-0.063	0.10
Model3	0.020	0.59	-0.065	0.09
Intake of fast food				
Crude	0.090	0.015	-0.081	0.02
Model1	0.101	0.009	-0.088	0.02
Model2	0.102	0.009	-0.089	0.02
Model3	0.102	0.009	-0.090	0.02

[a]*: Obtained from linear regression;* ***Model 1****: Adjusted for age and energy intake;* ***Model 2****: additionally, adjusted for body mass index percentile;* ***Model 3****: additionally, adjusted for physical activity.*

Discussion

The high prevalence of depression and its outcomes like suicide ideation and suicide attempts in adolescents are important challenges for public health (Collins *et al.*, 2011, Kessler *et al.*, 2007, Turecki and Brent, 2016). Modifying behaviors such as smoking, drinking, using drugs, physical activity, and diet may reduce the risk of depression and improve the QoL (Dowdy *et al.*, 2013, Lowry *et al.*, 2014, Michael *et al.*, 2020). Thus, evaluating the association of these modifiable factors with depression and QoL can be helpful for public health organizations, physicians, and patients for the management of depression and increasing QoL. To the best of the researchers' knowledge, the present study was the first cross-sectional study evaluating the association between specific food groups and depression and QoL among adolescent females.

The authors demonstrated that higher consumption of fast foods was positively associated with depression score. In addition, although based on the logistic regression analysis, a higher intake of whole grain was associated with lower odds of depression (at a slightly significant level with P=0.04), according to linear regression analysis, there was no association between whole grain intake and depression. Unlike linear regression analysis, in logistic regression analysis, individuals are categorized based on their intakes, and the linear relationship is not examined. Therefore, this finding must be interpreted with caution. However, no significant relationship between intake of refined grain and carbonated drink with risk of depression was found. There was no cross-sectional study examining the association between depression and the above-mentioned food groups among adolescents. A cross-sectional study conducted in adults showed an inverse relationship between frequency of healthy food groups such as fruits and vegetables consumption and odds of depression (Bishwajit *et al.*, 2017). This study used logistic regression analysis, but not linear regression analysis. Moreover, a study found that subjects without depression consumed more legumes, fruits, and vegetables compared to patients with depression (Grases *et al.*, 2019). In addition, it has been shown that intake of non-refined grain was associated with lower odds of depression/anxiety disorders (Gibson-Smith *et al.*,

[DOI: 10.18502/jnfs.v10i1.17757]

2020); but, high intake of refined grains was associated with a higher risk of depression (Moludi *et al.*, 2020). Some inconsistencies between the results of mentioned studies and the findings of this study may be due to the differences in design, statistical analysis, methodology of the studies as well as age of participants. The findings showed that subjects in the highest quartile of fast food and refined grain intake had higher energy intake which can induce obesity. Some studies confirmed that fast foods and refined grains as the important components of unhealthy dietary patterns can induce obesity, oxidative stress and inflammation (Biobaku *et al.*, 2019, Guallar-Castillón *et al.*, 2007, Lang *et al.*, 2015, Siracusa *et al.*, 2019). Several investigations revealed the association between obesity, inflammation and oxidative stress with depression (Anderson *et al.*, 2007, Shafiee *et al.*, 2018, Shafiee *et al.*, 2017, Tayefi *et al.*, 2017). In addition, O'neil (O'neil *et al.*, 2014) and Adjibade (Adjibade *et al.*, 2018) showed adherence to the healthy dietary patterns containing fruits, vegetables, and whole grains can reduce risk of depression.

On the other hand, the present study found that fast food consumption was inversely associated with the QoL score. Fast food is a component of unhealthy dietary patterns that can induce obesity, inflammation as well as oxidative stress (Biobaku *et al.*, 2019, Guallar-Castillón *et al.*, 2007, Siracusa *et al.*, 2019), and subsequently increase the risk of depression (Shafiee *et al.*, 2018, Shafiee *et al.*, 2017, Tayefi *et al.*, 2017). As mentioned, depression had a negative effect on QoL. Moreover, the logistic regression analysis showed higher carbonated drink consumption was associated with lower odds of poor QoL. However, linear model analysis demonstrated that there was no relationship between carbonated drink consumption and QoL score. As mentioned, unlike linear regression analysis in the logistic regression analysis, subjects were categorized based on their intakes which cannot demonstrate the linear association. The results should be interpreted with caution. In addition, there was no significant association between intake of whole grain and refined grain with QoL score. There was no similar study in this field. A systematic review conducted by Govindaraju (Govindaraju *et al.*, 2018) confirmed that adherence to the healthy dietary patterns containing higher amounts of whole grains, fruits and vegetables as well as lower amounts of carbonated drinks and refined foods and fast food was directly associated with QoL score.

Some important strengths of this study were as follows: 1) The first study evaluating the association between specific food groups and depression among a relatively large sample of adolescents; 2) The first investigation examining the relationship between specific food groups and QoL; 3) High quality of data collection; and 4) Modulating the effects of various important confounding factors. The present study also had some limitations. Due to design of the study, the authors could not show the causality. Furthermore, this study was conducted only among adolescent females. Finally, low response and misclassification are common in cross-sectional studies, which could have increased the probability of recall bias.

Conclusions

The authors demonstrated an inverse association between fast food intake and depression and QOL. However, there was no significant relationship between intake of refined grain and carbonated drink and depression. Furthermore, no association was found between intake of whole grain and refined grain with QoL. Due to inconsistent findings based on utilizing different analyses, the associations between intake of whole grain and depression as well as consumption of carbonated drink and QoL remained unclear.

Acknowledgements

The authors would like to thank all participants without whom this study was impossible.

Authors' contributions

SS Khayyatzadeh conceived the idea. Z Darabi and SS Khayyatzadeh prepared the proposal. SS Khayyatzadeh and M Ghayour-Mobarhan obtained ethical approvals, applied for funding, and

[DOI: 10.18502/jnfs.v10i1.17757]

provided data collection, and Z Darabi and AA Sangouni wrote the manuscript. Authors read and approved the final manuscript.

Conflict of interests

The authors declared no conflict of interests.

Funding

The present study was supported by a grant provided by Shahid Sadoughi University of Medical Sciences (SSUMS).

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[DOI: 10.18502/jnfs.v10i1.17757]