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ORIGINAL ARTICLE

The relationship between dairy food intake and psychological distress among Iranian adults: results from a large cross-sectional population-based study

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Abstract

Aim Psychological distress is associated with decreased quality of life. The nutritional factor is one of the most important for mental well-being.

Subjects and methods The aim of the present study was to determine the relationship between dairy food intake and psychological distress. In this cross-sectional study, data on the dietary food intake of 4763 participants were collected using a validated FFQ. Also, the Iranian validated version of the GHQ was used to screen psychological distress.

Results Individuals in the highest tertile of total dairy food intake were less likely to have psychological distress (OR 0.80, 95% CI 0.70–0.91, $P = 0.04$) in the final adjusted model. At stratified analysis based on sex, the same findings were obtained only among women. Inversely, individuals in the highest category of high-fat dairy intake had greater odds of suffering from psychological distress (OR 1.45, 95% CI 1.07–1.83, $P = 0.01$). Also, higher intake of high-fat dairy was significantly associated with greater odds of psychological distress among women in models stratified by sex. However, we found a marginally significant inverse association between higher intake of low-fat dairy and psychological distress risk (OR 0.85, 95% CI 0.69–1.01, $P = 0.07$). This association was not significant among men and women in a stratified analysis based on sex.

Conclusions The result showed dairy intake is associated with psychological distress. Further studies are required to confirm these associations.

Keywords Dairy food intake · High-fat dairy · Low-fat dairy · Psychological distress

Introduction

Psychological distress refers to significant emotional upset consisting of anxiety, depression, social dysfunction and loss of confidence. Also, this mental disorder is associated with reduced quality of life (Mitchell et al. 2011; Russ et al. 2015).

Multiple genetic and environmental risk factors have been mentioned as initiating psychological distress. However, it is necessary to consider the key roles of modifiable factors in prevention and optimal intervention (Atkins et al. 2013).

Several studies showed associations among various aspects of diet such as single dietary nutrients, foods or dietary

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patterns with mental distress odds (Haghighatdoost et al. 2016; Hajian 2016; Richard et al. 2015; Uemura et al. 2016).

Some studies found that psychological distress is associated with poor dietary intake (Uemura et al. 2016); on the other hand, greater adherence to a healthy dietary pattern is protectively associated with psychological disorders (Hosseinzadeh et al. 2016).

Recently, diet-disease evidence has indicated that dairy intake might improve some chronic diseases (Pasin and Comerford 2015). Dairy foods have long been recognized as a source of useful nutrients and many important bioactive compounds that confer benefits in some mental disorders (Hsieh et al. 2015; Kalantari et al. 2016; Ozawa et al. 2014). However, the role of dairy food intake in predicting psychological disorders is a relatively unexplored area of inquiry, and studies on confirming this association are rare.

Some studies have reported that only low-fat dairy products could decrease indices of some psychological disorders (Camfield et al. 2011; Crichton et al. 2010). Also, a previous study on dietary assessments revealed that high adherence to healthy dietary habits, including dairy products, is associated with the lowest stress scores (Hwang et al. 2010). Based on an extensive search, we founnd no studies on the association of dairy food intake and psychological distress not only in Iran but also worldwide. However, insufficient dairy food intake as a part of inappropriate dietary habits is prevalent among the Iranian population (Akbari and Azadbakht 2014; Ghasemian et al. 2014). In addition, the rates of psychological distress and stressful life events in Iran are notably higher than in western countries, increasing the need to investigate complicated diet–disease relations in this area (Saneei et al. 2016).

Accordingly, in a large sample, we tested the link between dairy food intake and psychological distress and provided first evidence in this regard based an epidemiological study among the Iranian population. The findings of this study will be used to implement informative interventional programs to prevent psychological distress and develop practical policies to improve diet quality among individuals with psychological distress.

Study participants and methods

Study participants

The current cross-sectional study was conducted within the framework of the cross-sectional SEPAHAN project, a Study on the Epidemiology of Psychological, Alimentary Health and Nutrition, among a large sample of Iranian adults in Isfahan, Iran (Adibi 2012).

The data were collected in two separate phases to increase the accuracy of the quality and response rate. To collect information about demographic variables, medical history, anthropometric measures, lifestyle and nutritional habits and food intake, self-administered questionnaires were distributed among 10,087 subjects in the first phase, and 8691 completed questionnaires were returned (response rate: 86.16%). In the second phase, information regarding gastrointestinal and psychological health was collected (response rate: 64.6%). After matching questionnaires in two phases, we used data on 4763 subjects with completed information in the current analysis. Data for 1606 participants could not be used in the merging process because (1) some did not complete the questionnaires of the first phase and (2) some did not complete their identification code in phase 1 or 2.

Informed consent was obtained from all participants. The study protocol was approved by the regional bioethics committee of IUMS (Adibi 2012).

Measurement

Measurement of dairy food intake and other foods The dietary intakes of participants were evaluated using a 106-item, self-administered, dish-based, semiquantitative food-frequency questionnaire (FFQ), which was designed and validated specifically for Iranian adults. Details about the design, validity of this questionnaire and included foods have been reported previously (Keshteli et al. 2014). It requests information relating to frequency of food intake and beverage items during the last year (Keshteli et al. 2014).

We asked participants (1) about the frequency of dairy food intake as: do you consume dairy food during the week? (never, 1–3 times, 4–6 times, 7–9 times or more than 10 times) and (2) describe the amount of dairy consumed.

Also, information on total dairy intake from all sources was categorized into total dairy, high-fat (ice cream, pizza cheese, cream, butter) and low-fat dairy (milk, cheese, yoghurt, dough, curd).

By using standardized portion sizes commonly used in Iran and the reported frequency and nutrient composition of each product, the daily value was extracted based on the US Department of Agriculture Food Composition Database. Furthermore, the Nutritionist IV program, modified for Iranian foods, was used to subsequently determine the macro- and micronutrient intake of each individual.

Measurement of psychological distress Psychological distress was measured using the 12-item version of the General Health Questionnaire (GHQ-12), a modified shorter version of the original 60-item questionnaire. There is evidence that the GHQ-12 is a consistent, reliable and easy-to-complete instrument when used in general population samples. Regarding the scoring system, each item response category was coded 0-0-1-1, i.e., the first two answers (less than usual, no more than usual) were given 0, and the second two answers (rather more than usual or much more than usual) were given 1 point, with the total score ranging from 0 to 12 points. High scores

Table 1 Distribution of demographic, lifestyle and basic clinical characteristics of study participants in distress and healthy participants

	No presence of psychological distress	Presence of psychological distress	*P* value*
Age (years)	36.36 ± 7.8	35.59 ± 7.5	0.01
BMI	24.91 ± 3.7	24.62 ± 3.9	0.08
Sex			
Male	82.9%	17.1%	< 0.001
Marital status			
Married	77.4%	22.6%	0.250
Single	76%	24%	
Divorced or widowed	68.5%	31.5%	
Educational level			
< Diploma	69.3%	30.7%	0.002
Diploma-master	77.9%	22.1%	
Master or above	79.5%	20.5%	
Physical activity			
Less than 1 h/week	76%	24%	0.002
More than 1 h/week	82.6%	17.4%	
Dairy intake			
Low-fat dairy	338.98 ± 272.37	311.37 ± 264.00	0.03
High-fat dairy	14.85 ± 18.49	15.32 ± 18.46	0.08
Total dairy	353.84 ± 274.94	326.70 ± 268.32	0.01
Intake of antipsychotic drugs			
Yes	48.4%	51.6%	< 0.001
Smoking			
Current smokers	77%	23%	0.91
Non- or ex-smokers	76.8%	23.2.%	
FGIDs [1]			
No	86.4%	13.6%	< 0.001
Yes [2]	67.7%	32.3%	

*Independent t-test for quantitative variables and chi-square test for categorical data. (1)Functional gastrointestinal disorders (FGIDs), (2) suffreing from at least one of the major FGIDs, i.e., IBS, dyspepsia, GERD and constipation

indicate poor psychological well-being. The cutoff point 4 was used to identify a person with psychological distress (Rahmati Najarkolaei et al. 2014).

Measurement of other variables To assess participants' information on age and gender, marital status, educational level and anthropometric measurements, we used a standard self-reported questionnaire. According to a validation study on 200 participants from the same population, the self-reported values of anthropometric indices recorded their measured values with reasonable validity (Saneei et al. 2016). Participants were also classified into three categories, never, <1 h/week or ≥ 1 h/week, according to the type and intensity of their physical activity by using a validated General Practice Physical Activity Questionnaire (GPPAQ) (Saneei et al. 2016). Data on smoking were collected through self-reported responses that evaluated participants' smoking in two domains: "non-smokers or ex-smokers" and "current smokers." Also, functional gastrointestinal disorders (FGIDs) were assessed by a modified validated Persian version of the Rome III Questionnaire (Sorouri et al. 2010). In the current study, suffering from at least one of the four major gastrointestinal disorders, including irritable bowel syndrome (IBS), gastroesophageal reflux disease (GERD), dyspepsia and constipation, was considered a binary variable in the logistic regression model as a confounder.

Statistical analysis

First, individuals were classified based on tertiles of reported dairy food intake. Next, continuous variables were evaluated across different tertiles of dairy food intake using one-way analysis of variance (ANOVA). Also, the distribution of study participants in terms of categorical variables across different tertiles of dairy food intake was compared using the chi-square test. The association

Table 2 Distribution of demographic, lifestyle and psychological characteristics across categories of low-fat, high-fat and total dairy food intake

	Tertile of low-fat dairy food intake				Tertile of high-fat dairy food intake				Tertile of total dairy food intake			
	Tertile 1	Tertile2	Tertile 3	*P* value	Tertile 1	Tertile2	Tertile 3	*P* value	Tertile 1	Tertile2	Tertile 3	*P* value
Age	35.74 ± 7.70	36.48 ± 7.75	36.51 ± 8.12	0.06	36.67 ± 7.60	36.45 ± 8.11	35.07 ± 7.67	< 0.001	35.98 ± 7.793	36.39 ± 7.696	36.44 ± 8.121	0.37
BMI	24.80 ± 3.89	24.86 ± 3.80	25.03 ± 3.79	0.37	25.014 ± 3.89	24.80 ± 3.71	24.65 ± 3.84	0.14	24.88 ± 3.89	24.80 ± 3.75	25.01 ± 3.82	0.44
Male	41.8%	41.8%	41.4%	0.97	39.5%	43.9%	42.2%	0.15	41.9%	42.1%	41.4%	0.93
Married	79.2%	82.8%	82.8%	0.06	82.0%	83.0%	80.1%	0.59	79.5%	83.0%	82.5%	0.09
Diploma or less	43.7%	35.6%	39.2%	0.005	37.6%	38.7%	37.8%	0.73	43.0%	35.5%	39	0.005
Above diploma	56.3%	64.4%	60.9%		62.3%	61.2%	62.2		57%	64.4%	61%	
Current smoker or ex-smoker	17.4%	22%	16.4%	0.42	15.2%	19.4%	17.5%	0.11	17.7%	17.7%	16.6%	0.48
Intake of anti-psychotic drugs	6.8%	5.2%	4.9%	0.14	4.7%	5.8%	5.0%	0.66	6.3%	5.1%	5.1%	0.35
Physical activity < 1 h/week	87.1%	86.2%	87.1%	0.76	88.1%	86.4%	85.1%	0.18	87.1%	86.1%	87.3%	0.66
Presence of FGID	53.1%	50.0%	50.3%	0.29	52.6%	52.5%	48.3%	0.10	53.7%	48.5%	50.8%	0.05
Presence of psychological distress	27.5%	21.5%	21.4%	0.001	22.2%	23.0%	24.4%	0.51	26.1%	22.2%	21.0%	0.01

Values are presented as mean ± SD for quantitative and percent for categorical data. *P* values resulted from ANOVA for quantitative and chi-square test for categorical data

between dairy food intake and psychological distress was evaluated by multivariable logistic regression analysis in different models. Adjustment for demographic variables was done in the first model. Further statistical adjustment was made for lifestyle factors, including physical activity, smoking (nonsmoker, ex-smoker and current smoker) and BMI in the second model. Additional adjustments were made for antipsychotic drug intake (yes/no) and suffering from FGIDs (yes/no) in the third model. In the fourth model, further adjustments were made for energy intake, processed food or palatable food (refined grains, preserved foods, fatty meat, fried foods and sweets), whole plant foods (whole grains, beans, vegetables, fruits, nuts) and low-fat animal foods (fish and lean meat). The results of logistic regression were presented as the odds ratio (OR) and 95% confidence interval (95% CI).

To assess the trend of odds ratios across tertiles of dairy food intake, we applied the Mantel-Haenszel extension chi-square test.

All statistical tests were two-sided, and $P < 0.05$ was considered statistically significant. The Statistical Package for the Social Sciences (SPSS) software (version 15, SPSS Inc., Chicago, IL, USA) was used for all analyses.

Results

The general characteristics of our study population across psychological distress statuses are presented in Table 1.

Distribution of general characteristics and food intake across categories of low-fat, high-fat and total dairy food intake is shown in Tables 2 and 3, respectively. Compared with those who had higher intake of low-fat and total dairy intake, individuals in the lowest intake levels were more distressed and less educated. In addition, greater intake of high-fat dairy intake was more prevalent among young subjects. The distribution of other basic characteristics of study participants across tertiles of dairy food intakes are presented in Table 2. Also, a significant difference was observed in total energy intake of study participants across tertiles of dairy food intake. Higher intake of low-fat, high-fat and total dairy was associated with higher intakes of total energy.

Table 4 shows the crude and multivariable-adjusted odds ratio (OR) of psychological distress across tertiles of low-fat dairy intake in the total sample and sex categories. Individuals who had higher intake of low-fat dairy intake had a 29% lower chance for suffering psychological distress compared with those in the lowest category of low-fat dairy intake (OR 0.71, 95% CI 0.58–0.88, $P = 0.002$). After adjusting the impact of confounding factors, this association remained marginally significant (OR 0.85, 95% CI 0.69–1.01, $P = 0.07$). In models stratified by sex, a higher intake of low-fat dairy food was associated with a lower odds of psychological distress in

Table 3 Distribution of energy and food intake across categories of low-fat, high-fat and total dairy food intake

	Tertile of low-fat dairy food intake				Tertile of high-fat dairy food intake				Tertile of total dairy food intake			
	Tertile 1	Tertile2	Tertile 3	*P* value	Tertile 1	Tertile2	Tertile 3	*P* value	Tertile 1	Tertile2	Tertile 3	*P* value
Energy	2117.25 ± 822.28	2378.27 ± 790.12	2636.88 ± 784.16	< 0.001	2190.46 ± 798.61	2404.29 ± 760.72	2714.00 ± 793.39	< 0.001	2112.65 ± 817.98	2398.47 ± 778.19	2647.04 ± 786.65	< 0.001
Sangak bread	13.78 ± 40.26	15.90 ± 43.34	16.02 ± 41.96	0.39	14.40 ± 44.04	13.74 ± 34.08	18.51 ± 48.09	0.03	13.72 ± 39.60	15.83 ± 43.34	16.24 ± 42.62	0.31
Banana	26.04 ± 38.23	28.91 ± 37.33	32.28 ± 42.58	0.002	24.27 ± 32.02	30.69 ± 44.46	33.65 ± 40.29	< 0.001	26.05 ± 38.46	28.47 ± 36.50	32.72 ± 42.74	< 0.001
Grapes	43.47 ± 72.49	45.43 ± 74.01	57.87 ± 88.73	< 0.001	49.81 ± 78.88	46.33 ± 71.10	52.34 ± 86.43	0.25	42.59 ± 72.10	45.84 ± 73.15	58.06 ± 89.38	< 0.001
Dates	7.05 ± 17.63	7.60 ± 13.14	11.64 ± 18.05	< 0.001	8.42 ± 14.23	8.23 ± 14.73	9.82 ± 16.50	0.05	7.06 ± 13.66	7.83 ± 13.62	11.40 ± 17.64	< 0.001
Beans	13.86 ± 21.01	13.84 ± 14.31	13.80 ± 14.69	0.99	12.63 ± 21.95	13.99 ± 13.67	14.23 ± 15.79	< 0.001	13.92 ± 20.81	13.91 ± 14.23	13.76 ± 14.38	0.96
Cereal	4.63 ± 6.29	4.43 ± 6.31	4.67 ± 6.69	0.63	4.19 ± 5.76	4.69 ± 6.72	6.60 ± 4.78	0.94	4.56 ± 6.30	4.42 ± 5.90	4.71 ± 7.05	0.56
Onions	38.55 ± 30.09	40.00 ± 27.1	44.93 ± 32.46	< 0.001	37.61 ± 26.96	41.76 ± 29.98	44.69 ± 32.06	< 0.001	38.22 ± 29.82	40.73 ± 27.13	44.63 ± 32.39	< 0.001
Eggplant	7.21 ± 7.84	7.86 ± 7.53	7.12 ± 8.54	0.33	6.57 ± 6.70	7.99 ± 8.41	9.51 ± 9.24	< 0.001	7.13 ± 7.91	7.93 ± 8.38	8.15 ± 7.95	0.08
Tomatoes	40.11± 53.51	51.52 ± 45.39	67.72 ± 66.10	< 0.001	48.53 ± 45.25	52.76 ± 52.86	58.93 ± 60.25	< 0.001	40.62 ± 51.55	52.01 ± 46.34	67.59 ± 65.96	< 0.001
Vegetables	16.70 ± 14.15	17.01 ± 14.19	17.49 ± 14.06	0.44	15.87 ± 13.96	16.69 ± 13.47	19.44 ± 14.93	< 0.001	16.66 ± 14.38	17.16 ± 13.82	14.23 ± 17.44	0.41
Cotyledons	11.69 ± 16.11	12.06 ± 16.91	10.69 ± 15.09	0.11	11.31 ± 16.99	11.38 ± 15.92	11.77 ± 15.22	0.80	11.92 ± 16.15	11.88 ± 16.89	10.81 ± 15.37	0.18
Green beans	10.49 ± 11.47	11.07 ± 11.79	11.23 ± 11.54	0.31	10.37 ± 12.02	10.25 ± 10.53	12.67 ± 11.76	< 0.001	10.57 ± 11.75	11.06 ± 11.70	11.22 ± 11.46	0.38
Lentils	13.74 ± 17.30	13.76 ± 18.50	15.09 ± 18.91	0.14	12.49 ± 14.91	14.39 ± 18.97	16.08 ± 19.47	< 0.001	13.32 ± 16.90	14.10 ± 19.45	15.04 ± 18.35	0.08
Mung beans	1.69 ± 2.32	1.84 ± 2.13	1.77 ± 1.98	0.28	1.73 ± 2.11	1.65 ± 1.99	1.99 ± 2.17	0.001	1.69 ± 2.27	1.86 ± 2.15	1.77 ± 1.97	0.17
Raisins	1.11 ± 3.25	1.06 ± 2.83	1.36 ± 3.33	0.05	1.19 ± 3.46	1.17 ± 2.64	1.32 ± 3.34	0.53	1.10 ± 3.15	1.06 ± 2.89	1.37 ± 3.34	0.04
Dried berries	0.15 ± 0.66	0.15 ± 0.93	0.18 ± 1.21	0.67	0.15 ± 1.00	0.15 ± 0.76	0.19 ± 1.16	0.63	0.14 ± 0.64	0.15 ± 0.96	0.19 ± 1.22	0.53
Lettuce	11.19 ± 13.52	13.58 ± 15.70	15.90 ± 15.62	< 0.001	12.28 ± 13.29	13.66 ± 15.97	15.99 ± 16.57	< 0.001	11.47 ± 13.78	13.38 ± 14.94	16.06 ± 16.35	< 0.001
Cucumbers	25.68 ± 34.79	38.00 ± 38.85	52.72 ± 55.96	< 0.001	36.63 ± 45.16	37.90 ± 42.13	45.11 ± 47.95	< 0.001	26.17 ± 34.01	38.65 ± 39.69	52.58 ± 55.98	< 0.001
Cherries	2.62 ± 5.61	3.30 ± 6.63	4.18 ± 7.51	< 0.001	3.16 ± 6.45	3.26 ± 6.36	4.15 ± 7.65	0.003	2.72 ± 5.90	3.26 ± 6.55	4.20 ± 7.48	< 0.001
Cabbage	2.79 ± 3.38	3.39 ± 3.92	3.97 ± 3.90	< 0.001	3.07 ± 3.32	3.41 ± 3.99	3.99 ± 4.14	< 0.001	2.86 ± 3.44	3.34 ± 3.73	4.01 ± 4.08	< 0.001
Saifi spices	27.48 ± 41.95	31.81 ± 45.21	36.60 ± 42.03	< 0.001	29.23 ± 34.83	31.88 ± 46.67	35.89 ± 47.36	0.04	28.36 ± 43.26	31.06 ± 43.53	36.90 ± 42.72	< 0.001
Citrus fruits	41.84 ± 45.30	49.38 ± 48.18	56.02 ± 50.29	< 0.001	47.50 ± 45.12	48.40 ± 48.26	50.54 ± 47.63	0.36	42.63 ± 46.29	48.66 ± 46.96	56.71 ± 50.69	< 0.001
Apples	31.89 ± 32.32	36.24±29.84	42.35 ± 39.65	< 0.001	35.60 ± 33.13	36.41 ± 34.86	38.94 ± 35.08	0.09	31.90 ± 31.68	36.23 ± 30.12	42.62 ± 39.53	< 0.001
Kiwis	5.23 ± 9.10	5.73 ± 9.27	6.94 ± 10.96	< 0.001	5.18 ± 9.25	6.07 ± 9.33	6.67 ± 9.84	0.003	5.16 ± 8.94	5.83 ± 9.40	6.96 ± 10.97	< 0.001
Apricots	6.33 ± 16.38	8.64 ± 21.20	10.32 ± 23.57	< 0.001	8.32 ± 21.36	20.74 ± 20.14	8.99 ± 8.29	0.71	6.95 ± 18.27	8.23 ± 20.31	10.41 ± 23.47	< 0.001
Plums	5.11 ± 10.80	6.28 ± 12.28	7.80 ± 14.47	< 0.001	6.25 ± 12.62	6.62 ± 12.95	6.81 ± 12.95	0.63	5.33 ± 11.16	6.13 ± 12.10	7.89 ± 14.54	< 0.001
Peas	0.51 ± 1.83	0.48 ± 1.00	0.44 ± 0.91	0.45	0.39 ± 0.90	0.47 ± 0.87	0.57 ± 1.07	< 0.001	0.49 ± 1.72	0.48 ± 1.05	0.45 ± 0.09	0.66
Carrots	5.16 ± 4.56	5.87 ± 5.16	6.58 ± 4.95	< 0.001	5.28 ± 4.27	5.96 ± 4.98	6.83 ± 5.62	< 0.001	5.20 ± 4.53	5.87 ± 5.04	6.62 ± 5.15	< 0.001
Baked potatoes	20.07 ± 26.74	20.81 ± 24.89	21.03 ± 24.41	0.66	17.80 ± 21.05	20.90 ± 24.29	23.82 ± 26.23	< 0.001	19.68 ± 25.88	20.84 ± 24.95	21.37 ± 24.88	0.27
Fresh figs	2.08 ± 5.19	2.28 ± 5.51	2.59 ± 5.65	0.10	2.32 ± 5.29	2.12 ± 5.17	2.42 ± 5.67	0.46	2.11 ± 5.26	2.29 ± 5.48	2.56 ± 5.61	0.15
Fish	14.30 ± 19.83	13.96 ± 17.72	13.97 ± 15.22	0.88	12.00 ± 14.47	14.64 ± 19.64	17.21 ± 19.03	< 0.001	14.11 ± 19.30	13.94 ± 17.39	14.14 ± 15.98	0.96
Eggs	25.01 ± 21.39	25.82 ± 20.77	24.31 ± 19.04	0.20	23.72 ± 19.85	25.34 ± 20.14	27.09 ± 20.91	0.002	24.84 ± 21.32	25.95 ± 20.66	24.37 ± 19.11	0.17
Chicken	48.42 ± 39.80	49.96 ± 42.05	52.17 ± 42.02	0.11	45.86 ± 39.10	50.76 ± 40.60	57.94 ± 43.29	< 0.001	48.08 ± 40.40	50.99 ± 42.69	52.14 ± 41.74	0.06
Oil	40.19 ± 18.66	41.34 ± 17.88	40.80 ± 17.69	0.33	37.74 ± 17.20	41.26 ± 17.20	46.11 ± 18.71	< 0.001	39.93 ± 18.57	41.76 ± 17.91	40.86 ± 17.69	0.05
Mayonnaise	3.73 ± 7.97	3.74 ± 5.93	4.89 ± 12.06	0.002	3.12 ± 5.36	4.08 ± 8.39	5.49 ± 11.08	< 0.001	3.76 ± 7.83	3.65 ± 5.76	4.93 ± 12.04	0.001
Barbari bread	9.16 ± 29.85	11.81 ± 38.85	13.35 ± 39.69	0.02	11.78 ± 42.60	11.25 ± 33.96	12.96 ± 36.65	0.61	9.23 ± 30.06	11.95 ± 39.85	13.46 ± 39.60	0.02
Cake	10.32 ± 16.26	11.90 ± 17.76	12.22 ± 17.14	0.03	9.56 ± 14.15	10.80 ± 16.12	15.75 ± 20.81	< 0.001	10.20 ± 16.17	11.79 ± 17.42	12.52 ± 17.64	0.005
Pastry	2.10 ± 4.72	2.25 ± 4.23	2.32 ± 4.90	0.54	1.84 ± 3.56	2.26 ± 5.46	2.99 ± 4.66	< 0.001	2.04 ± 4.54	2.24 ± 4.24	2.4 ± 4.97	0.17
Baguette bread	0.35 ± 0.69	0.30 ± 0.62	0.28 ± 0.66	0.08	0.17 ± 0.39	0.35 ± 0.65	0.49 ± 0.90	< 0.001	0.34 ± 0.68	0.29 ± 0.59	0.29 ± 0.68	0.16
Cream	1.38 ± 6.50	1.38 ± 3.36	1.57 ± 5.92	0.63	0.50 ± 0.73	1.13 ± 2.13	3.51 ± 9.86	< 0.001	1.27 ± 6.08	1.49 ± 4.22	1.61 ± 5.92	0.33
Taro (Gooshfill)	0.19 ± 1.31	0.22 ± 2.49	0.20 ± 1.67	0.95	0.20 ± 2.97	0.22 ± 1.44	0.27 ± 1.38	0.73	0.17 ± 1.23	0.24 ± 2.63	0.20 ± 1.67	0.73
Tamarisk	1.18 ± 4.01	1.04 ± 2.43	1.12 ± 3.01	0.57	0.95 ± 2.84	1.26 ± 3.24	1.34 ± 3.89	0.03	1.13 ± 3.81	1.06 ± 2.48	1.13 ± 3.00	0.82
Jam	4.78 ± 13.98	5.99 ± 15.58	5.44 ± 13.49	0.15	4.55 ± 11.68	5.86 ± 16.25	6.71 ± 15.44	0.006	5.02 ± 14.86	5.83 ± 14.94	5.51 ± 13.49	0.41
Sugar	4.22 ± 7.54	4.52 ± 7.89	4.37 ± 7.48	0.67	3.77 ± 7.13	4.77 ± 8.11	4.95 ± 7.44	0.001	4.00 ± 7.39	4.74 ± 8.04	4.38 ± 7.47	0.07

Table 3 (continued)

	Tertile of low-fat dairy food intake				Tertile of high-fat dairy food intake				Tertile of total dairy food intake			
	Tertile 1	Tertile2	Tertile 3	*P* value	Tertile 1	Tertile2	Tertile 3	*P* value	Tertile 1	Tertile2	Tertile 3	*P* value
Dried sugar	1.18 ± 5.29	1.43 ± 3.75	1.23 ± 2.90	0.30	1.13 ± 5.57	1.41 ± 3.40	1.55 ± 3.35	0.09	1.15 ± 5.01	1.49 ± 3.88	1.22 ± 2.88	0.11
Macaroni	8.63 ± 9.66	10.17 ± 11.84	9.13 ± 9.72	0.002	8.36 ± 9.03	10.0 ± 11.01	10.91 ± 12.01	< 0.001	8.83 ± 10.18	10.08 ± 11.41	9.31 ± 10.13	0.02
Lavash	74.25 ± 139.8	87.30 ± 152.93	84.59 ± 147.68	0.002	82.65 ± 148.94	84.09 ± 148.39	74.99 ± 125.85	0.33	73.48 ± 139.80	88.44 ± 152.87	84.77 ± 147.42	0.04
Fried onions	0.80 ± 0.90	0.95 ± 1.10	0.85 ± 0.90	0.10	0.78 ± 0.84	0.93 ± 1.02	1.01 ± 1.12	< 0.001	0.82 ± 0.95	0.94 ± 1.06	0.87 ± 0.94	0.02
French fries	29.92 ± 22.69	30.86 ± 22.20	31.34 ± 22.80	0.34	28.02 ± 21.92	30.57 ± 21.50	35.53 ± 22.92	< 0.001	29.55 ± 22.95	31.26 ± 21.75	31.43 ± 22.84	0.09
Field	4.11 ± 5.49	4.44 ± 6.71	4.46 ± 4.95	0.31	3.90 ± 5.60	4.48 ± 6.06	4.99 ± 6.33	< 0.001	4.06 ± 5.46	4.46 ± 6.82	4.51 ± 5.01	0.13
Rice	230.64 ± 151.80	242.00 ± 150.23	234.81 ± 140.98	0.18	234.85 ± 158.63	238.80 ± 148.82	242.41 ± 134.73	0.54	230.98 ± 151.71	245.41 ± 151.45	233.86 ± 140.41	0.05
Meat	66.87 ± 46.33	67.16 ± 39.26	68.95 ± 41.90	0.36	60.65 ± 41.39	43.67 ± 41.08	78.29 ± 68.95	< 0.001	65.94 ± 45.50	68.194 ± 39.37	68.86 ± 41.61	0.23

Values are presented as mean ± SD, and *P* values resulted from analysis of variance (ANOVA)

Table 4 Multivariable-adjusted odds ratios and 95% CIs for association of psychological distress and low-fat dairy food intake

	Tertiles of low-fat dairy food intake			
	Tertile 1	Tertile2	Tertile 3	*P* value
Total sample				
Crude	1.00	0.72(0.59–0.88)	0.71(0.58–0.88)	0.002
Model 1	1.00	0.78(0.62–0.97)	0.74(0.59–0.93)	0.01
Model 2	1.00	0.82(0.65–1.03)	0.76(0.60–0.96)	0.02
Model 3	1.00	0.85(0.65–1.07)	0.78(0.61–0.99)	0.04
Model 4	1.00	0.89(1.13–0.70)	0.85(0.695–1.01)	0.07
Male				
Crude	1.00	0.74(0.53–1.05)	0.67 (0.47–0.96)	0.03
Model 1	1.00	0.97(0.65–1.43)	0.80(0.53–1.22)	0.31
Model 2	1.00	1.01(0.67–1.53)	0.74(0.48–1.16)	0.19
Model 3	1.00	0.71(0.45–1.13)	0.92(0.60–1.41)	0.15
Model 4	1.00	0.95(0.62–1.47)	0.78(0.49–1.25)	0.30
Female				
Crude	1.00	0.70(0.55–0.90)	0.73(0.57–0.94)	0.01
Model 1	1.00	0.71(0.54–0.92)	0.71(0.54–0.93)	0.01
Model 2	1.00	0.77(0.59–1.02)	0.75(0.57–0.99)	0.04
Model 3	1.00	0.82(0.62–1.09)	0.80(0.60–1.07)	0.14
Model 4	1.00	0.88(0.66–1.17)	0.78(0.61–1.08)	0.16

Model 1: adjusted for age, marital status, sex and education (in stratified analysis adjustment for sex was not made). Model 2: model 1 + further adjustment for physical activity, smoking and BMI. Model 3: model 2 + further adjustment for anti-psychotic drug intake and suffering from at least one of the main functional gastrointestinal disorders, i.e., IBS, dyspepsia, GERD and constipation. Model 4: model 3 + further adjustment for energy intake, low-fat animal food, whole-plant food and processed foods or palatable food

men and women in the crude model (OR 0.67; 95% CI: 0.47–0.96; $P = 0.03$ and OR 0.73; 95% CI: 0.57–0.94; $P = 0.01$, respectively). However, after adjusting cofounders' impact, although higher levels of low-fat dairy intake had a protective role against psychological distress, the associations were not significant among men and women (OR 0.78; 95% CI: 0.49–1.25; $P = 0.30$ and OR 0.78; 95% CI: 0.61–1.08; $P = 0.16$).

Also, crude and multivariable-adjusted ORs of psychological distress across tertiles of high-fat dairy intake in the total sample and in sex categories are illustrated in Table 5. Compared with those who had the highest intake of high-fat dairy food, individuals with the lowest intake were 45% more likely to have psychological distress (OR 1.45, 95% CI: 1.07–1.83, $P = 0.04$) in the fully adjusted model. Although stratified analysis based on gender revealed no significant associations between high-fat dairy intake and psychological distress in men in both the crude and adjusted models, higher intake of high-fat dairy food was associated with greater odds of psychological distress among women in the fully adjusted model (OR 1.40, 95% CI: 1.01–1.93, $P = 0.03$).

Table 5 Multivariable adjusted odds ratios and 95% CIs for association of psychological distress and high-fat dairy food intake

	Tertiles of high-fat dairy food intake			
	Tertile 1	Tertile2	Tertile 3	*P* value
Total sample				
Crude	1.00	1.04(0.84–1.30)	1.13(0.91–1.13)	0.25
Model 1	1.00	1.19(0.94–1.51)	1.25(0.98–1.59)	0.06
Model 2	1.00	1.17(0.91–1.49)	1.25(0.97–1.60)	0.07
Model 3	1.00	1.14(0.88–1.47)	1.29(1.00–1.68)	0.04
Model 4	1.00	1.16(0.90–1.51)	1.40(1.07–1.83)	0.01
Male				
Crude	1.00	1.02(0.69–1.49)	1.18(0.81–1.72)	0.37
Model 1	1.00	1.22(0.79–1.89)	1.41(0.91–2.19)	0.11
Model 2	1.00	1.12(0.71–1.77)	1.33(0.84–2.10)	0.21
Model 3	1.00	1.07(0.66–1.71)	1.39(0.87–2.23)	0.16
Model 4	1.00	1.062(0.66–1.70)	1.43(0.88–2.32)	0.14
Female				
Crude	1.00	1.10(0.84–1.45)	1.13(0.86–1.48)	0.36
Model 1	1.00	1.21(0.90–1.61)	1.19 (0.89–1.59)	0.22
Model 2	1.00	1.20(0.89–1.62)	1.22(0.90–1.64)	0.18
Model 3	1.00	1.18(0.88–1.61)	1.26(0.92–1.72)	0.13
Model 4	1.00	1.23(0.90–1.68)	1.40(1.01–1.93)	0.03

Model 1: adjusted for age, marital status, sex and education (in stratified analysis adjustment for sex was not made). Model 2: model 1 + further adjustment for physical activity, smoking and BMI. Model 3: model 2 + further adjustment for anti-psychotic drug intake and suffering from at least one of the main functional gastrointestinal disorders, i.e., IBS, dyspepsia, GERD and constipation. Model 4: model 3 + further adjustment for energy intake, low-fat animal food, whole-plant food and processed foods or palatable food

Table 6 Multivariable-adjusted odds ratios and 95% CIs for the association of psychological distress and total dairy food intake

	Tertiles of total dairy food intake			
	Tertile 1	Tertile2	Tertile 3	*P* value
Total sample				
Crude	1.00	0.80(0.66–0.98)	0.75(0.61–0.92)	0.006
Model 1	1.00	0.88(0.70–1.09)	0.76(0.61–0.95)	0.01
Model 2	1.00	0.91(0.73–1.14)	0.77(0.61–0.97)	0.02
Model 3	1.00	0.96(0.76–1.71)	0.79(0.62–0.99)	0.04
Model 4	1.00	0.97(0.95–1.26)	0.80(0.70–0.91)	0.04
Male				
Crude	1.00	0.75(0.59–0.96)	0.76 (0.59–0.97)	0.03
Model 1	1.00	1.14(0.78–1.68)	0.82(0.54–1.23)	0.35
Model 2	1.00	1.20(0.80–1.78)	0.75(0.49–1.16)	0.20
Model 3	1.00	1.12(0.74–1.70)	0.73(0.46–1.50)	0.17
Model 4	1.00	1.16(0.76–1.76)	0.79(0.50–1.26)	0.33
Female				
Crude	1.00	0.92(0.66–1.29)	0.71(0.50–1.02)	0.06
Model 1	1.00	0.78(0.60–1.01)	0.74(0.57–0.96)	0.02
Model 2	1.00	0.81(0.62–1.06)	0.76(0.60–0.96)	0.03
Model 3	1.00	0.90(0.68–1.19)	0.81(0.61–0.98)	0.04
Model 4	1.00	0.94(0.71–1.25)	0.80(0.62–0.98)	0.04

Model 1: adjusted for age, marital status, sex and education (in stratified analysis adjustment for sex was not made). Model 2: model 1 + further adjustment for physical activity, smoking and BMI. Model 3: model 2 + further adjustment for anti-psychotic drug intake and suffering from at least one of the main functional gastrointestinal disorders, i.e., IBS, dyspepsia, GERD and constipation. Model 4: model 3 + further adjustment for energy intake, low-fat animal food, whole-plant food and processed foods or palatable food

Also, crude and multivariable-adjusted ORs of psychological distress across tertiles of total dairy intake in the total sample and in sex categories are reported in Table 6. The current study provides evidence of an inverse association between total dairy food intake and psychological distress risk in the crude model (OR 0.75, 95% CI: 0.61–0.92, $P = 0.006$). After adjustment for multiple potential confounders, participants in the highest tertile of total dairy food had 20% lower odds for psychological distress compared with those in the lowest tertile (OR 0.80, 95% CI: 0.70–0.91, $P = 0.04$). Stratified models based on sex also showed a significant association between total dairy intake and psychological distress in the fully adjusted model only among women (OR 0.80, 95% CI: 0.62–0.98, $P = 0.04$).

Discussion

Our study provides the first evidence about the association between dairy food intake and psychological distress using a comprehensive multivariable analysis in a large sample of adult population. In the current study, although a marginally inverse association was found between low-fat dairy food intake and psychological distress in the fully adjusted model, we found a prominent association between a higher intake of high-fat dairy food and psychological distress risk after adjustments for many potential confounders. Conversely, higher total dairy food intake was significantly associated with a lower risk of psychological distress. In line with our findings, Crichton et al. have shown that the intake of whole-fat and low-fat dairy food is associated with increased and decreased risk of some psychological disorders, respectively (Crichton et al. 2010). However, in previous studies high-fat dairy food as a single food (Lang et al. 2015) or as a part of a dietary pattern (Hosseinzadeh et al. 2016) has been suggested to be involved in mental disorder risk.

However, in the stratified analysis based on sex, the mentioned associations were significant only among women. In some studies, sex-specific associations between dairy food intake and health conditions were also seen (Huth and Park 2012; Michaelsson et al. 2014). As hormones are possibly responsible for sexual differences in terms of emotional and behavioral

aspects as well as brain responses to stress (Mendoza et al. 2016), the presence of hormones in dairy products, which are able to mediate specific physiological functions, might be involved in such discrepancies (Malekinejad and Rezabakhsh 2015). A lower prevalence of psychological distress and intake of dairy products in men compared with women in the current study could be considered another possible reason.

There is theoretical biological plausibility for causality in that dairy foods might decrease the risk of psychological distress. These foods have long been recognized as a source of nutrients and important bioactive compounds that confer many benefits in patients with psychological disorders (Hill and Newburg 2015; Oddo and Mabli 2015).

On the other hand, psychological distress has been hypothesized to be associated with adverse biological states such as higher oxidative stress and inflammation (Hagan et al. 2015; Shahreza 2016; Sturgeon et al. 2016). The effect of dairy products as high-value nutritional foods on modulating inflammatory processes in humans has been documented (Da Silva and Rudkowska 2015a). Besides, greater intake of high-fat dairy can influence the fatty acid profile and consequently affect the oxidation rate (Gonzalez et al. 2003). Also, the adverse effects of whole-fat dairy food on mental disorders might be due to binding of minerals in dairy products with fatty acids in the small intestine. These forms of minerals are insoluble and cannot be absorbed (Alonso et al. 2005; Perez-Cornago et al. 2015; Vaskonen 2003). Moreover, whole dairy products are the contributors to trans-fatty acid (de Souza et al. 2015) and saturated fatty acid (SFA) intake (Morio et al. 2016), which have an adverse effect on brain function and mental health (Ginter and Simko 2016; Lim et al. 2016). It should be mentioned that inflammation also can be promoted by SFA. Therefore, high-fat dairy products may possess proinflammatory properties (Da Silva and Rudkowska 2015). Therefore, low-fat dairy products can offset these harmful effects. It should be kept in mind, when interpreting the results, that milk fat is modified by the cow's feed. For example, rapeseed cake feeding can result in a decreased and increased SFA and unsaturated fatty acid content of milk, respectively, which may have different effects on long-term health (Seidel et al. 2005).

Our study has several strengths. There are few studies on the association of psychological distress and dairy food intake. Second, we have examined this relationship based on individual intake data in a large community-dwelling general sample with a wide age span. Third, the magnitude of the observed associations is not negligible after controlling for many relevant demographic, lifestyle and clinical variables as confounding factors.

However, several limitations should be considered when interpreting our findings. Given the cross-sectional nature of the study, we were unable to predict the effects of dairy food intake on psychological distress risk. Although we used validated FFQ (Keshteli et al. 2014) and GHQ-12 (Rahmati Najarkolaei et al. 2014) questionnaires that have been previously examined among the Iranian population, they are subjected to possible measurement errors and misclassification of foods and psychological distress cases. Furthermore, our findings cannot be extrapolated to the entire Iranian general population because it contains a general sample from the center of Iran. Finally, although we controlled many important potential confounding factors, residual confounding due to the genetic background, dietary habits and socioeconomic disparities could not be excluded; therefore, a cautious interpretation of the results is recommended.

Conclusion

In conclusion, we found evidence indicating that greater intake of high-fat dairy food was associated with an increased risk of psychological distress, whereas higher low-fat and total dairy food intake was related to a lower risk of this disorder. These findings need to be confirmed with longitudinal and well-designed diet intervention studies to investigate the impact of dairy products on psychological distress development with more focus on the each dairy food and dietary habit.

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Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

Ethical approval The study protocol was approved by the regional bioethics committee of IUMS (Adibi 2012).

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