ORIGINAL ARTICLE

The relationship between fruit and vegetable intake with gastroesophageal reflux disease in Iranian adults

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Background: Findings from studies that investigated the relationship between fruit and vegetable intake with gastroesophageal reflux disease (GERD) were inconsistent. We aimed to assess the relationship between fruit and vegetable consumption and GERD among a large group of Iranian adults. **Materials and Methods:** In this cross-sectional study on 3979 adults, a validated food frequency questionnaire was used to assess usual dietary intakes including fruits and vegetables. The presence of heartburn sometimes or more during the past 3 months were considered as having GERD. **Results:** The prevalence of GERD among study population was 23.9%. After adjustment for potential confounding factors, those with the highest consumption of fruits had 25% lower risk for GERD, in comparison to those with the lowest intake (odds ratio [OR] = 0.75, 95% confidence interval [CI]: 0.59–0.97). Vegetable intake was not significantly related to the risk of GERD in crude or multivariable-adjusted models. However, participants with the highest intake of fruits and vegetables had 33% lower risk of GERD (OR = 0.67, 95% CI: 0.51–0.88), after adjustment for confounders. Women with the highest fruit and vegetable intake had 36% lower risk for GERD (OR = 0.64, 95% CI: 0.45–0.91). Overweight/obese participants in the last tertile of fruit consumption had 42% lower risk for GERD, in comparison to the first category (OR = 0.58, 95% CI: 0.42–0.83). Furthermore, participants with body mass index higher than 25 kg/m^2 and higher intake of fruits and vegetables had 53% lower risk for GERD (OR = 0.47, 95% CI: 0.32-0.69). **Conclusion:** We found inverse associations between fruit intake as well as fruit and vegetable intake and risk of GERD among Iranian adults.

Key words: Diet, fruit intake, gastroesophageal reflux disease, vegetable intake

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INTRODUCTION

Gastroesophageal reflux disease (GERD) is one of the most common chronic disorders of upper gastrointestinal tract. It is mostly characterized by an abnormal reflux of the gastric contents into the esophagus, leading to symptoms such as heartburn and/or acid regurgitation.[1,2] The prevalence of GERD in the general population is globally estimated to be 15%–20%.[3] In Asia, GERD has been reported to be less prevalent than the Western countries.[4] The prevalence of GERD in Iran has been reported to be widely ranged between 1.9% and 52%, based on different definition criteria and study populations.[5,6] GERD resulted in economic burdens and reduced quality of life for patients.[7]

The prevalent defects that play significant roles in pathogenesis of GERD are delayed gastric emptying, reduced pressure in the lower esophageal sphincter (LES) and increased number of transient

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LES relaxation episodes.[8,9] Some risk factors for GERD include environmental factors such as obesity,[10,11] smoking, alcoholism,[11] and probable genetic factors.[10] In addition, some specific food items such as high fat diets have been correlated with increased risk of GERD.[11]

The relationship between fruit and vegetable consumption and GERD has been investigated in limited number of studies with conflicting results.[3,11-14] Some studies have indicated that fruit and vegetable consumption and fiber intake have a protective effect on GERD.[3,11-13,15,16] However, higher risk for GERD among fruit and vegetable consumers has been reported by other investigations.[14] As dietary fibers scavenge nitrites in the stomach, which were produced in the gastric acidic environment and make LES relaxed, fiber may have preventative effects against reflux.[7] Due to the high prevalence of GERD and its negative impacts on quality of life and the high costs of treatment, finding modified environmental-based strategies may play an important role in prevention. The association between fruit and vegetable intake and GERD has been less studied in the Middle Eastern area, where dietary intakes are different from other parts of the world.[17] The current study was conducted to investigate the relationship between fruit and vegetable consumption and GERD among a large group of Iranian adults.

MATERIALS AND METHODS

Participants

This project was designed and carried out in the framework of the study on the epidemiology of psychological, alimentary health and nutrition (SEPAHAN). SEPAHAN was a cross-sectional study, on nonacademic staffs of Isfahan University of Medical Sciences (IUMS) working in different centers across Isfahan province. The study design, sample selection, characteristics of study participants as well as details on data collection methods have been presented elsewhere.[18] Using a validated self-administered questionnaire, detailed information on gastrointestinal and lifestyle-related profile of 3979 adults was available for further statistical analysis. The Regional Bioethics Committee affiliated to IUMS approved the study protocol.

Assessment of fruit and vegetable consumption

Usual dietary intakes during the preceding 12 months were assessed using a validated 106-item self-administered semi-quantitative dish-based food frequency questionnaire (FFQ), especially designed for adults living in Isfahan province.[19] The semi-quantitative FFQ included 36 questions to assess intake of most commonly consumed fruits and vegetables (raw or cooked as mixed dishes). Those fruits and vegetables that are consumed raw are cucumbers, tomatoes, dates, raisins, herbs, dried berries, salad, citrus, apples or pears, cherries, apricot, plum, raw onions, kiwi, strawberries, grapes, pomegranate, mulberry, banana, figs, and all kinds of fruit juice.

Assessment of gastroesophageal reflux disease

A validated self-administered questionnaire was applied to assess the frequency of heartburn in the past 3 months.[18] We used a four-item rating scale for the assessment of symptoms' frequency (never, sometimes, often, or always). In addition, we asked about the severity of heartburn using a four-item rating scale (mild, moderate, severe, and very severe). Participants who reported the presence of heartburn sometimes or more during the past 3 months were considered to be suffering from GERD.

Assessment of other variables

Standard questionnaires were distributed to collect information on age, gender, and educational status. Weight, height, smoking status (nonsmoker, ex-smoker, and current smoker), and the presence of diabetes mellitus (yes/no) were evaluated by means of a self-administered questionnaire. Levels of physical activity of study participants were assessed by the General Practice Physical Activity Questionnaire. This questionnaire is a simple validated screening tool for ranking adult people's physical activity with focusing on current general activities.[20] Participants were classified into four categories: active (>3 h/week), moderately active (1–3 h/week), moderately inactive (<1 h/week), and inactive (no physical activity), based on the type and intensity of their physical activity in work hours and during the weekends. The pattern of tea consumption (never or <1 cup/month, 1–3 cups/month, 1–3 cups/week, 4–6 cups/week, 1 cup/day, 2–4 cups/day, 5–7 cups/day, 8–11 cups/day, or at least 12 cups/day) was also assessed by a pretested questionnaire. Fluid intake was evaluated through questions on the consumption of water, soft drinks, yogurt drink ("dough"), and other beverages, before, after, or during meals, which participants could answer as never, sometimes, often, or always. Regularity of meals was also assessed and quantified as never, sometimes, often, or always having regular meals. Quality of chewing was also evaluated (not very well, well, or very well).

Statistical methods

Participants were categorized based on tertiles of fruit, vegetable, as well as fruit and vegetable intake. Comparison of continuous variables across different categories of fruit, vegetable as well as fruit and vegetable intake was assessed using one-way analysis of variance. Chi-square test was used to examine the distribution of participants in terms of categorical variables across different categories of fruit, vegetable, and fruit and vegetable intake. The relationship between fruit, vegetable, and fruit and vegetable intake and GERD was examined using logistic regression in

different models. First, the relationship was assessed in crude model. Then, age, gender, and energy intake were adjusted for in the first model. We further controlled for smoking, self-reported diabetes, and physical activity in Model II. Dietary behaviors including eating rate, chewing quality, frequency of breakfast, meal regularity, intrameal fluid intake, and frequency of fried food intake were additionally adjusted in the third model. Dietary intakes including fat intake, dairy, nuts and legumes, tea, carbonated drinks, and processed meat were additionally adjusted in Model IV. Further adjustment for body mass index (BMI) was performed in the last model. In all models, participants in the first category of fruit, vegetable, fruit and vegetable intake were considered as the reference category. The Statistical Package for the Social Sciences (SPSS Inc., version 18.0, Chicago, IL, USA) was used for all analyses, and $P < 0.05$ was considered statistically significant.

RESULTS

The prevalence of GERD among 3979 participants of the study was 23.9%. General characteristics of study participants across tertiles of fruit and vegetable intake are specified in Table 1. Food intake of study participants across tertile of fruit and vegetable intake is presented in Table 2. Participants in the last tertiles of fruit, vegetable, fruit and vegetable intake had statistically different intake of energy, fat, carbohydrates, proteins, red meat, processed meat, fruit, vegetables, nuts and legumes, and dairy products, as compared to those in the first tertile of intake.

The prevalence of GERD across tertiles of fruit and vegetable intake is provided in Figure 1. Higher intake of fruits was associated with a lower prevalence of GERD. Moreover, GERD was significantly less prevalent among individuals in the top tertile of fruit and vegetable intake compared to those in the bottom tertile.

Multivariable-adjusted odds ratio (OR) for GERD across tertiles of fruit and vegetable intake is shown in Table 3. Those with the highest fruit consumption had 22% lower risk for GERD in comparison to those with the lowest intake (OR = 0.78, 95% confidence interval [CI]: 0.65–0.94). After adjustment for confounders, participants who were in the third tertile of fruit consumption had 25% lower risk for GERD in comparison to these in the first tertile (OR = 0.75, 95% CI: 0.59–0.97). Vegetable consumption was not significantly related to the risk of GERD in crude or multivariable-adjusted models. In comparison to these in the first tertile of fruit and vegetable consumption, those who were in the third tertile had a lower risk for GERD, in both crude and adjusted models, such that after adjustment for all confounding factors, participants with the highest intake of fruits and vegetables had 33% lower risk of GERD.

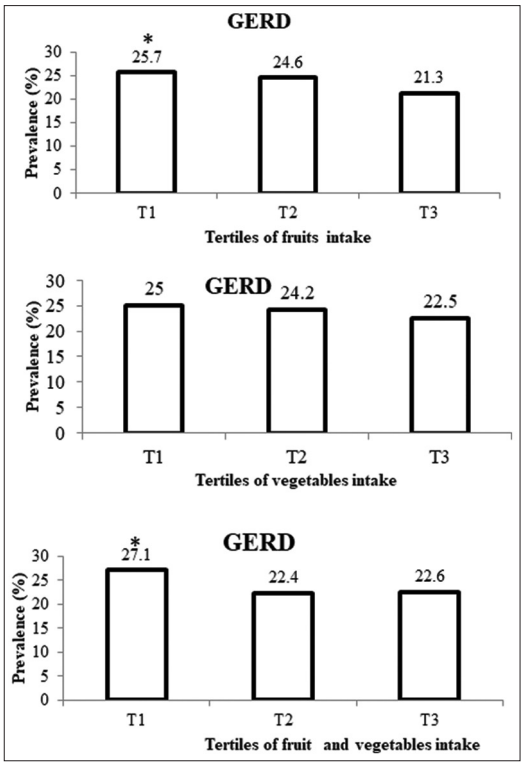

Figure 1: The prevalence of gastroesophageal reflux disease across tertiles of fruit ($P = 0.02$), vegetable ($P = 0.31$), fruit and vegetable intake ($P = 0.003$). Asterisks show significant differences

Stratified analysis by gender showed that there was no significant relation between fruit, vegetable, fruit and vegetable intake, and GERD in men. Women who were in the third tertile of fruit consumption had 32% lower risk for GERD, in comparison to women in the first tertile, in crude model (OR = 0.68, 95% CI: 0.54–0.87). After adjustment for gender, age, energy intake, smoking, self-reported diabetes, and physical activity, this relation remained statistically significant (OR = 0.66, 95% CI: 0.49–0.89). After adjustment for dietary habits, dietary intake, and BMI, the significant relation between fruit consumption and GERD in women disappeared. The risk of GERD did not statistically differ in tertiles of vegetable intake in both men and women.

There were no significant relations between fruit and vegetable intake and GERD in men. However, in women, those who were in the third tertile of fruit and vegetable consumption had lower risk for GERD, in comparison to the first tertile, in both crude and adjusted models, such that after adjustment for all confounders, participants with the highest consumption of fruits and vegetables had 36% lower risk for GERD (OR = 0.64, 95% CI: 0.45–0.91).

Stratified analysis by BMI showed that fruit, vegetable, fruit and vegetable intake was not related to the risk of GERD in normal-weight participants (BMI <25 kg/m^2). Overweight or obese participants (BMI ≥25 kg/m^2) in the last tertile of fruit consumption had 32% lower risk for GERD, in

Table 1: General characteristics of study participants across tertiles of fruit and vegetable intake[a]

	Tertiles of fruit consumption			P^b	Tertiles of vegetable consumption			P^b	Tertiles of fruit and vegetable consumption			P^b
	1	2	3		1	2	3		1	2	3	
Age (years)	36.34±7.96	36.61±7.99	36.38±8.16	0.68	35.63±7.55	36.48±8.01	37.21±8.45	<0.001	36.06±7.6	36.55±8.18	36.72±8.26	0.119
Weight (kg)	69.90±13.67	69.17±13.02	67.91±13.3	0.001	68.19±13.11	69.09±13.17	69.74±13.43	0.012	69.40±13.60	68.95±12.92	68.63±13.22	0.336
Body mass index (kg/m^2)	25.24±5.21	24.98±4.12	24.93±4.36	0.198	24.93±4.44	24.99±4.80	25.23±4.50	0.214	25.21±5.19	24.93±4.08	25.01±4.40	0.275
Female (%)	47.2	54.1	64	<0.001	58	55.1	52.1	0.01	50.7	55.9	58.7	<0.001
Married (%)	81.4	82.8	79.6	0.097	80.5	81.5	81.8	0.916	81.1	82.2	80.4	0.22
Education (% greater than or equal to diploma)	82.5	88	89.9	<0.001	87.6	88.3	84.6	0.015	84.3	87.4	88.7	<0.001
Current smoker (%)	15.8	13.8	12.5	0.015	13.8	12.7	15.6	0.03	15	13.7	13.4	0.536
Diabetes (%)	1.8	1.9	1.7	0.959	1.5	1.5	2.4	0.13	1.8	1.4	2.2	0.346
Physically active (% ≥1 h/week)	17	15.9	15.1	0.461	13.1	14.7	20.2	<0.001	14.9	16.6	16.5	0.448
Chewing sufficiency (% little)	15.9	13.4	13.3	0.001	16.3	12.5	13.9	0.003	16.2	12.8	13.7	0.001
Intrameal fluid consumption (%)												
Never	6	6.5	8.2	0.243	6.7	5.9	8.1	0.035	6	6.3	8.4	0.087
Sometimes	41.7	40.1	39.3		42.7	39.6	38.8		42.3	39.9	38.9	
Often	28.6	30.6	30.3		27.3	30.5	31.6		28.3	30.1	31	
Always	23.8	22.8	22.2		23.2	24.1	21.5		23.4	23.7	21.7	
Meal regularity (% Never)	1.5	1.2	0.7	0.124	0.8	1.6	1	0.151	1.4	1.3	0.7	0.151
Frequently fried food intake (% ≥4/week)	17.2	15.6	16.2	0.523	15.4	15.4	18.2	0.087	16.5	15.9	16.6	0.844
Breakfast skippers[c] (%)	25.9	21.7	18.4	<0.001	25.6	21.3	19.3	<0.001	25.6	21.9	18.6	<0.001

[a]All values are means±SD, unless indicated; [b]ANOVA for continuous variables and Chi-square test for categorical variables; [c]Defined as individuals who were eating breakfast <5 times/week. SD = Standard deviation; ANOVA = Analysis of variance

Table 2: Food intake in study participants across tertiles of fruit and vegetable intake[a]

	Tertiles of fruit consumption			P^b	Tertiles of vegetable consumption			P^b	Tertiles of fruit and vegetable consumption			P^b
	1	2	3		1	2	3		1	2	3	
Energy (kcal/days)	2119.90±32.26	2709.17±35.49	3381.45±59.66	<0.001	1820.09±23.44	2625.22±27.17	3766.24±61.08	<0.001	1917.72±27.24	2633.46±29.83	3660.37±60.60	<0.001
Fats (g/days)	90.27±1.38	113.83±1.63	135.78±2.89	<0.001	73.82±0.93	106.87±1.09	159.23±2.97	<0.001	80.56±1.09	109.41±49.04	149.95±2.97	<0.001
Carbohydrates (g/days)	249.81±4.27	328.13±4.44	433.19±6.84	<0.001	229.05±3.44	327.37±4.03	454.83±7.08	<0.001	230.36±3.87	322.22±3.91	458.66±6.88	<0.001
Proteins (g/days)	80.69±1.31	101.34±1.42	122.85±2.42	<0.001	67.87±0.83	97.10±1.02	142.95±2.49	<0.001	71.19±1.01	98.11±1.21	135.61±2.49	<0.001
Red meat (g/days)	64.96±1.49	81.90±1.62	95.71±2.70	<0.001	47.25±0.92	76.65±1.21	118.71±2.88	<0.001	54.60±1.07	79.01±1.49	108.99±2.84	<0.001
Processed meat (g/days)	6.46±0.39	7.87±0.46	9.52±0.92	0.003	4.73±0.26	6.63±0.34	12.50±1	<0.001	5.32±0.32	7.33±0.38	11.20±0.98	<0.001
Fruit (g/days)	77.91±1.26	240.25±1.35	565.43±7.18	<0.001	195.31±5.29	282.53±5.85	405.86±8.29	<0.001	93.38±1.77	247.42±2.48	542.90±7.74	<0.001
Vegetables (g/days)	178.75±3.15	238.49±3.50	321.54±6.07	<0.001	108.45±1.11	215.54±0.78	414.84±5.34	<0.001	135.56±1.80	228.46±2.31	374.80±6.03	<0.001
Nuts and legumes (g/days)	52.99±1.40	64.81±1.50	77.23±2.40	<0.001	38.39±0.82	60.24±1.15	96.40±2.62	<0.001	45.22±1.15	62.34±1.28	87.47±2.56	<0.001
Dairy product (g/days)	295.37±7.75	364.03±7.96	458.50±10.64	<0.001	256.59±6.35	342.15±7.31	519.22±11.22	<0.001	267.80±6.74	354.80±7.71	495.35±11.04	<0.001

[a]All values are means±SE; [b]ANOVA was used for comparison. SE = Standard error; ANOVA = Analysis of variance

Table 3: Multivariable-adjusted odds ratio for gastroesophageal reflux disease across tertiles of fruit and vegetable intake[a]

	Tertiles of fruit consumption			*P* trend[b]	Tertiles of vegetable consumption			*P* trend[b]	Tertiles of fruit and vegetable consumption			*P* trend[b]
	1	2	3		1	2	3		1	2	3	
GERD												
Crude	1	0.94 (0.78–1.12)	0.78 (0.65–0.93)	0.008	1	0.96 (0.80–1.14)	0.87 (0.72–1.04)	0.133	1	0.77 (0.64–0.92)	0.76 (0.63–0.90)	0.002
Model I	1	0.93 (0.77–1.13)	0.72 (0.59–0.89)	0.002	1	0.95 (0.78–1.16)	0.85 (0.68–1.06)	0.149	1	0.76 (0.63–0.92)	0.69 (0.56–0.85)	0.001
Model II	1	0.93 (0.75–1.14)	0.71 (0.56–0.89)	0.003	1	0.96 (0.78–1.19)	0.86 (0.67–1.10)	0.227	1	0.77 (0.62–0.96)	0.67 (0.53–0.85)	0.001
Model III	1	1.04 (0.83–1.30)	0.79 (0.61–1.01)	0.066	1	0.92 (0.73–1.16)	0.88 (0.67–1.14)	0.322	1	0.82 (0.65–1.03)	0.71 (0.55–0.92)	0.01
Model IV	1	1.02 (0.82–1.28)	0.77 (0.60–0.99)	0.05	1	0.90 (0.72–1.14)	0.84 (0.64–1.10)	0.199	1	0.81 (0.64–1.01)	0.69 (0.53–0.90)	0.005
Model V	1	1.03 (0.82–1.29)	0.75 (0.59–0.97)	0.031	1	0.89 (0.71–1.13)	0.80 (0.61–1.07)	0.128	1	0.80 (0.63–1.00)	0.67 (0.51–0.87)	0.003

[a]GERD was defined as the presence of heartburn sometimes or more during the 3 months. Model I = Adjusted for age, gender, and energy intake; Model II = Further adjustment for smoking, self-reported diabetes, and physical activity; Model III = Further adjustment for eating rate, chewing quality, frequency of breakfast, meal regularity, intrameal fluid intake, and frequency of fried food; Model IV = Further adjustment for dietary intakes (fat intake, dairy, nuts and legumes, tea, carbonated drinks, and processed meat); Model V = Further adjustment for BMI; [b]Obtained by the use of categories of fried food intake as an ordinal variable in the model. GERD = Gastroesophageal reflux disease

comparison to the first category in crude model (OR = 0.68, 95% CI: 0.54–0.87) and adjustment model (OR = 0.58, 95% CI: 0.42–0.83). Participants with BMI higher than 25 kg/m^2 and higher intake of fruits and vegetables had 53% lower risk for GERD after adjustment for all confounding variables (OR = 0.47, 95% CI: 0.32–0.69), compared to those in the reference category.

DISCUSSION

Our study provides some novel insights into the involvement of fruit and vegetable consumption in GERD symptoms in Iranian adults. We found a significant protective association between fruit consumption and risk of GERD. In addition, participants with the highest intake of fruits and vegetables had a lower risk of GERD. Stratified analysis by sex and weight status revealed that more intakes of fruits and vegetables in women as well as in overweight or obese participants were associated to lower risk of GERD. These favorable associations were independent of several lifestyle-related variables.

Given the high prevalence of GERD in Iran and its adverse effects on patients' quality of life, it is highly important to identify the factors that help to prevent this disorder. This study provides evidence that fruit and vegetable consumption as a lifestyle-related and modifiable factor might decrease the risk of GERD. It might reduce proton-pump inhibitor consumption in GERD patients.

Although a few studies have confirmed the association between fruit and vegetable intake with GERD symptoms, the results have remained inconsistent. We observed no significant association between vegetable intake and GERD; this nonsignificant association might be the result of the limited range of vegetable intake in our study population; participants in the top and first tertile of vegetable intake consumed 321.54 and 178.75 g vegetable/d, respectively. In epidemiological studies, a wide range of intakes is more likely to provide significant relations. Nocon *et al*. conducted a cross-sectional study on a representative sample of 7124 adult German population. They documented that the frequent consumption of fruits may have a protective effect on symptoms while vegetable consumption had no significant association.[12] El-Serag *et al*. performed a study on 915 participants in the USA and found an inverse association between fiber intake and the risk of GERD symptoms in fully adjusted models while they found no significant independent associations between fruit and vegetable consumption and GERD symptoms.[3] In a case–control study among 3153 individuals, Nilsson *et al*. have documented that consuming bread with high dietary fiber content was related to reduce the risk of reflux.[7] Mostaghni *et al*. have conducted a cross-sectional

study in Iranian population to detect the risk factors of GERD. In contrast to our findings, they have found a higher prevalence of reflux symptoms in those who more frequently consumed fruits and vegetables.[14] However, Saberi-Firoozi *et al*. reported protective effects of fruit and vegetable intake on reflux symptoms in Shiraz, a city in Southern Iran.[13] Kumar *et al*. have also showed that low consumption of fresh fruits was a significant risk factor for the development of GERD, but fresh vegetable consumption was not a protective factor.[11] A prospective study shows that green vegetables were protective for gastroesophageal reflux symptoms during pregnancy.[16] The Mediterranean diet that characterized by a high intake of vegetables, legumes, fruits, and whole grains was also healthful and provides protective effects in the occurrence of GERD.[15] Different findings in the previous investigations could be due to variations in studied populations, study designs, using different tools to assess dietary intakes, and considering various confounders in the studies. Further studies, particularly with prospective design, are required to shed a light on the relationship between fruit and vegetable intake and GERD symptoms.

A few physiological mechanisms have explained the probable correlation between fruit and vegetable consumption with GERD symptom reduction. In the acidic environment of the stomach, large amounts of nitric oxide are nonenzymatically produced from nitrites in the diet. Nitric oxide has a potent relaxing effect on the LES and may promote reflux. Dietary fibers are well known to scavenge nitrites in the stomach, thereby decreasing the availability of the substrate for nonenzymatic nitric oxide synthesis.[7] Furthermore, fruits and vegetables are the source of Vitamins A and C, which prevent the development of the GERD.[21]

Our study has some strength. First, it consisted of a large number of participants. Second, we took into consideration various confounding factors, including lifestyle factors. However, some limitations should be discussed. We cannot prove any cause-and-effect relationships because of the cross-sectional design of our study. Using self-administered questionnaires is another limitation of this study. The study population consisted of medical university nonacademic staffs, including crews, employees, and managers. Despite the wide range of socioeconomic status covered by the study population, extrapolating our findings to other populations might be done cautiously. Finally, there may be other confounding factors besides those evaluated in the present study.

CONCLUSION

The present study confirmed inverse associations between fruit intake as well as fruit and vegetable intake and risk of GERD among Iranian adults. Increasing fruit and vegetable intake may, therefore, be an important strategy in prevention and management of GERD in clinical settings.

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Conflicts of interest

There are no conflicts of interest.

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