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Dietary habits and obesity indices in patients with gastro-esophageal reflux disease: a comparative cross-sectional study

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Abstract

Background: Gastro-esophageal reflux disease (GERD) is suggested to be associated with some socio-demographic and lifestyle factors. Although the roles of some factors such as obesity are well documented, evidence on the impact of other factors such as dietary habits are still inconclusive. The aim of this study was to determine the relationship between socio-demographic and lifestyle factors with GERD in participants referred to a teaching hospital in Zahedan, South-East of Iran.

Methods: This comparative cross-sectional study was conducted during 2014–2015. All patients completed a structured questionnaire regarding information on socio-demographic status, lifestyle factors and dietary habits. Anthropometric indices including body mass index (BMI) and waist circumference (WC) were used to determine general and central obesity, respectively. Data were analyzed using SPSS software version 22. Value of $p < 0.05$ was considered as statistically significant.

Results: Five hundred and five participants, including 285 GERD and 220 Non-GERD participants participated in the study. In univariate analysis, being married (OR = 1.57, 95%CI = 1.04, 2.36), general obesity (OR = 1.77, 95%CI = 1.11, 2.81), central obesity (OR = 2.09, 95%CI = 1.46, 3.01) and consumption of citrus fruits between meals (OR = 1.69, 95%CI = 1.04, 2.73) were associated with higher odds of GERD, while higher educational level (OR = 0.53, 95%CI = 0.36, 0.77) and regular physical activity ≥ 2 h/week (OR = 0.53, 95%CI = 0.30, 0.94) were associated with lower odds of GERD. In the adjusted model, central obesity (OR = 1.88, 95%CI = 1.18, 3.01) and consumption of citrus fruits between meals (OR = 2.22, 95%CI = 1.30, 3.81) were positively associated with odds of GERD, while higher educational level (OR = 0.55, 95%CI = 0.33, 0.91) was associated with decreased odds of GERD.

Conclusion: According to the results of the current study, central obesity as determined by WC and citrus fruit intake were independent factors associated with GERD. Therefore, lifestyle modification might have a positive effect in the treatment of GERD in an urban population of Iran.

Keywords: Gastro-esophageal reflux disease, Dietary habits, Central obesity, Waist circumference

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Background

Gastro-esophageal reflux disease (GERD) is one of the most common disorders of the upper digestive tract worldwide. The prevalence of GERD is estimated within the range of 18.1% to 27.8% in North America, 8.8% to 25.9% in Europe, and 8.7% to 33.1% in the Middle East [1]. In Iran, prevalence of GERD is estimated within the range of 1.9 to 52% [2]. GERD is characterized primarily based on typical symptoms of heartburn and regurgitation. In addition to the esophageal manifestations of GERD, its effect on quality of life as well as extra-esophageal presentations such as dry cough, chest pain, sleep difficulties, and teeth decays, have been increasingly recognized among gastroenterologists [3, 4]. Up to now, a combination of lifestyle modifications and anti-reflux medications are recommended for the management of GERD symptoms [5].

There is evidence that several socio-demographic and lifestyle factors are predictors of GERD development. The roles of some risk factors such as obesity are well known in epidemiological studies [6]. However, evidence on other variables particularly dietary habits are still inconclusive. Current guidelines recommend that reflux-triggering foods such as coffee, chocolate, spicy foods, and citrus fruit should not be routinely eliminated in management of GERD [7]. However, some studies revealed that specific dietary choices were related to higher risk of GERD development or the severity of the disease [8, 9]. In recent years, increased awareness of the side effects of medication on the general population shifted attention gradually, from pharmacological therapies to dietary modifications as the first-line management for GERD [10, 11]. Besides, it is proposed that eating habits may contribute to GERD risk through their effect on body weight [12]. Unfavorable eating patterns, which are mainly characterized by frequent consumption of carbonated drinks, fast foods, and large portion-size meals are positively associated with development of obesity [13] which in turn, may contribute to increased GERD risk.

Although, there are many studies in Iran investigating predictors of GERD risk in terms of lifestyle related factors such as smoking and obesity, evidence on the association between dietary habits and GERD are scarce and even inconsistent. A study from North of Iran showed a positive association between lying down after meals, with increased frequency of GERD, however such an association was not found for consumption of beverages and spicy foods [14]. Similarly, a study in South of Iran found no significant association between consumption of tea, coffee, and fast foods, with GERD [15]. High burden of disease in the Iranian population [16], makes it necessary to identify factors associated with GERD in different regions, for implementing prevention programs. Therefore, the aim of the present study was to

determine independent factors associated with GERD in patients referred to a teaching hospital in Zahedan, South-East of Iran.

Methods

Participants

A comparative cross-sectional study was conducted during 2014–2015 at Zahedan, center of Sistan and Baluchestan province in South-East of Iran, which has a referral Gastroenterology and Hepatology clinic in Ali-Ibn-Abi-Talib Hospital. During the clinical interview, a gastroenterologist asked patients about the symptoms of GERD. All participants (20 to 60 years old) with frequent (more than weekly) typical reflux symptoms including heartburn and acid regurgitation with diagnosis of GERD were included in the study. In addition, 220 healthy age- and sex-matched participants with no GERD-related symptoms were regarded as the control group. The control group was chosen from among the relatives of patients who were referred to the gastroenterology unit and other medical specialties clinics in the hospital. Those with a history of upper GI surgery, taking non-steroidal anti-inflammatory drugs (NSAIDs) or anti-reflux therapies in the previous month, and participants with history of other gastrointestinal diseases were excluded. All participants signed a written informed consent. The study protocol was approved by the Ethics Committee of Children and Adolescent Health Research Center, Zahedan University of Medical Sciences, Zahedan, Iran.

Questionnaire and anthropometric measurements

A structured questionnaire was completed by researchers of the study through face-to-face interviews (Additional file 1: The structured questionnaire was developed to obtain information on socio-demographic and lifestyle-related factors in this study.). The first part of the questionnaire consisted socio-demographic information including age, sex, marital status, education, job level, and presence of any concomitant disease (asthma, diabetes, hypertension, hyperlipidemia, chronic kidney disease and/or chronic artery disease. The second part included questions about lifestyle factors including smoking (cigarette or hookah) and substance abuse (opium or nass, which is a combination of tobacco, ash, and lime), physical activity, consumption of large portion-size meals, fast foods (including sausage, fried chicken, pizza, hamburger, French fries, and doughnuts), spicy foods (including chili pepper, turmeric, ginger, cinnamon, and curry), chocolate, tea, coffee, citrus fruit, carbonated drinks, number of meals consumed daily, time interval between the last meals and sleep, and resting immediately after main meals. To assess consumption of large portion-size meals, food photographs were applied. Each photograph was

comprised of foods that were habitually consumed as a main meal (breakfast, lunch, and dinner) in Iranian culture, for example, a photograph of a dish containing “rice, meat, and beans” typically represented a meal for lunch or dinner meal, served by the Iranian population. Food items were presented in their standard portion size which had been proposed by the USDA food guide pyramid (for example one cup, slice, or teaspoon) [17]. Then, participants were asked to estimate whether they consumed a larger portion than what was presented in the past week, and if they responded “yes,” the frequency of consumption was assessed. An intake of large portion-size meals for each participant was recorded by summing up the weekly consumption of these meals.

A trained staff conducted anthropometric measurements. Weight and height were measured with accuracy of 0.1 kg and 0.5 cm respectively, using Seca instruments (Seca, Hamburg, Germany). Body mass index (BMI) was calculated as weight (kg)/height² (m²). Waist circumference (WC) was measured by a non-elastic tape at the midpoint of the last rib margin and iliac crest according to WHO standards [18]. Values of BMI ≥ 30 kg/m² was defined as general obesity. Also, WC ≥ 102 cm in men and WC ≥ 88 cm in women were regarded as central obesity.

Statistical analysis

The Chi-square test was used to assess the differences in socio-demographic and lifestyle factors between GERD and non-GERD participants. Multiple logistic regression model was employed to detect independent factors associated with GERD. Validity of the regression model was checked using the Hosmer–Lemeshow goodness-of-fit test. Multicollinearity between variables in the model was evaluated using the Variance Inflation Factor (VIF). Variables were excluded from the adjusted model if they had showed multicollinearity, which was considered as VIF > 5 [19]. Results were expressed as percentages, crude and adjusted odds ratios (ORs), and 95% confidence intervals (CIs). Data were analyzed using SPSS software version 22 (IBM Corp., Armonk, NY, USA). A value of $p < 0.05$ was considered as statistically significant.

Results

A total of 505 participants consisting of 285 GERD and 220 Non-GERD cases were included. Table 1 compares socio-demographic status and obesity indices between GERD and Non-GERD participants. In comparison with the Non-GERD group, the GERD group had significantly higher percentage of married individuals ($p = 0.02$) as well as the presence of concomitant disease ($p = 0.001$). Level of education ($p = 0.001$) and regular physical activity ≥ 2 h per week ($p = 0.03$) inversely influenced the prevalence of GERD. In addition, the prevalence of general obesity ($p = 0.01$) and central obesity ($p = <0.001$)

Table 1 The association between socio-demographic factors and obesity indices with GERD in study participants

Variable	Total N = 505		GERD N = 285		Non- GERD N = 220		P-value*
	N	%	N	%	N	%	
Age (years)							
< 35	292	57.8	160	56.1	132	60	0.38
≥ 35	213	42.2	125	43.9	88	40	
Gender							
Men	156	30.9	78	27.4	78	35.5	0.051
Women	349	69.1	207	72.6	142	64.5	
Marital status							
Single	123	24.4	59	20.7	64	29.1	0.02**
Married	382	75.6	226	79.3	156	70.9	
Education (years)							
< 12 years schooling	328	65	203	71.2	125	56.8	0.001**
≥ 12 years schooling	177	35	82	28.8	95	43.2	
Job							
Unemployed	337	66.7	198	69.5	139	63.2	0.32
Self-employed	97	19.2	51	17.9	46	20.9	
Employee	71	14.1	36	12.6	35	15.9	
Smoking or substance abuse							
Yes	61	12.1	37	13.0	24	10.9	0.47
No	444	87.9	248	87.0	196	89.1	
Physical activity (hours/wk)							
< 2	451	89.3	262	91.9	189	85.9	0.03**
≥ 2	54	10.7	23	8.1	31	14.1	
Concomitant diseases ^a							
Yes	165	32.7	111	38.9	54	24.5	0.001**
No	340	67.3	174	61.1	166	75.5	
BMI							
< 30	407	80.6	219	76.8	188	85.5	0.01**
≥ 30	98	19.4	66	23.2	32	14.5	
WC (cm)							
Men <102; Women <88	272	53.9	131	46.0	141	64.1	<0.001**
Men ≥ 102 ; Women ≥ 88	233	46.1	154	54.0	79	35.9	

BMI body mass index, WC waist circumference. ^aConcomitant diseases, including asthma, diabetes, hypertension, hyperlipidemia, chronic kidney disease and/or chronic artery disease. *p-values was derived from Chi-square test. **Significant at the level of $p < 0.05$

were significantly higher in the GERD group compared to the Non-GERD ones. Dietary habits of participants are presented in Table 2. There were no significant differences in dietary habits between the two groups.

Table 3 shows results of univariate and multiple regression analysis for detection of independent factors associated with GERD development, as the study outcome. In univariate analysis, being married (OR = 1.57, 95%CI = 1.04, 2.36), general obesity (OR = 1.77, 95%CI = 1.11, 2.81), central

Table 2 The association between dietary habits and GERD in study participants

Variable	Total N = 505		GERD N = 285		Non-GERD N = 220		P-value*
	N	%	N	%	N	%	
Numbers of meals consumed daily(meals/d)							
< 3	185	36.6	107	37.5	78	35.5	0.62
≥ 3	320	63.4	178	62.5	142	64.5	
Time interval between the last meal and sleep (hours)							
< 2	247	48.9	146	51.2	101	45.9	0.23
≥ 2	258	51.1	139	48.8	119	54.1	
Resting immediately after the main meals							
Yes	335	66.3	186	65.3	149	67.7	0.56
No	170	33.7	99	34.7	71	32.3	
Large portion-size meals (times/wk)							
< 2	236	46.7	123	43.2	113	51.4	0.06
≥ 2	269	53.3	162	56.8	107	48.6	
Fast foods intake (times/wk)							
< 2	468	92.7	267	93.7	201	91.4	0.32
≥ 2	37	7.3	18	6.3	19	8.6	
Spicy foods intake (times/wk)							
< 2	271	53.7	152	53.3	119	54.1	0.86
≥ 2	234	46.3	133	46.7	101	45.9	
Chocolate intake (times/wk)							
< 2	324	64.2	179	62.8	145	65.9	0.47
≥ 2	181	35.8	106	37.2	75	34.1	
Tea intake							
None	38	7.5	20	7	18	8.2	0.54
Just before meals	109	21.6	67	23.5	42	19.1	
Just after meals	98	19.4	51	17.9	47	21.4	
Between meals	260	51.5	147	51.6	113	51.4	
Coffee intake							
None	474	93.9	272	95.4	202	91.8	0.18
Just before OR after meals	12	2.4	4	1.4	8	3.6	
Between meals	19	3.8	9	3.2	10	4.5	
Citrus intake							
None	360	71.3	195	68.4	165	75	0.08
Just before OR after meals	52	10.3	28	9.8	24	10.9	
Between meals	93	18.4	62	21.8	31	14.1	
Carbonated drinks intake							
None	217	43	127	44.6	90	40.9	0.16
Within meals	234	46.3	134	47	100	45.5	
Between meals	54	10.7	24	8.4	30	13.6	

*p-values was derived from Chi-square test

obesity (OR = 2.09, 95%CI = 1.46, 3.01), and consumption of citrus fruits between meals (OR = 1.69, 95%CI = 1.04, 2.73) were significantly associated with higher odds of GERD, while higher level of education (OR = 0.53, 95%CI = 0.36, 0.77) and regular physical activity ≥ 2 h/week (OR = 0.53, 95%CI = 0.30, 0.94) were associated with lower odds of GERD. Based on the Hosmer-Lemeshow goodness-of-fit test, the regression model showed a good calibration (Chi-square 7.52; degrees of freedom = 8; p -value = 0.48). Also, no sign of multicollinearity was observed between variables, as all variables had $VIF \leq 2$ and thus, all independent variables were included in the regression model. In the multiple regression model, central obesity (OR = 1.88, 95%CI = 1.18, 3.01) and consumption of citrus fruits between meals (OR = 2.22, 95%CI = 1.30, 3.81) were associated with increased odds of GERD, while higher level of education (>12 years) (OR = 0.55, 95%CI = 0.33, 0.91) was associated with decreased odds of GERD.

Discussion

The aim of the present study was to assess dietary habits, lifestyle, and socio-demographic status of GERD patients in South-East of Iran. Although central obesity and citrus fruit intake were independent factors associated with GERD, such an association was not found for other dietary habits, BMI, and socio-demographic status. Previous researches have indicated that high BMI, an index of general obesity, is a risk factor for GERD development and severity of symptoms [20, 21]. In this study, central obesity, determined by high WC was an independent predictor of GERD. Although high BMI was associated with higher odds of GERD in the univariate analysis, this association remained non-significant in the adjusted model analysis. Excess abdominal fat can increase the risk of GERD through several mechanisms including increased intra-gastric pressure, decreased lower esophageal sphincter (LES) pressure, and increased frequency of transient lower esophageal sphincter relaxation (TLRSR), which results in acid reflux [22]. Similarly, a study on 2457 GERD patients reported that central obesity as determined by WC was one of risk factors inducing erosive esophagitis [23]. Another study by Crews et al. reported that central obesity based on high values of waist-to-hip ratio (WHpR), was an independent risk factor of erosive esophagitis [24]. It should be noted that differences in obesity indices in predicting GERD risk have been reported in other chronic disorders. A previous study found that central obesity determined by high WC was a strong predictor of adverse cardiometabolic profile, compared to BMI or WHpR [25]. In contrast, Gunji et al. found that BMI was a predictor of erosive esophagitis, while such an association was not found for central obesity measured by visceral adipose tissue and waist girth [26]. Moreover, some studies have

Table 3 Factors related to GERD development as the outcome variable by univariate analysis and multiple regression analysis (N = 505)

Variable	B	Univariate OR			Adjusted OR		
		OR	95% CI		OR	95% CI	
			Lower	Upper		Lower	Upper
Age (years)							
< 35 ^a	-0.30	1			1		
≥ 35		1.17	0.82	1.67	0.734	0.466	1.15
Gender							
Men ^a	0.02	1			1		
Women		1.45	0.99	2.13	1.02	0.53	1.97
Marital status							
Single ^a	0.19	1			1		
Married		1.57*	1.04	2.36	1.21	0.75	1.97
Education (years)							
< 12 years schooling ^a	-0.59	1			1		
≥ 12 years schooling		0.53*	0.36	0.77	0.55*	0.33	0.91
Job							
Unemployed ^a		1			1		
Self-employed	0.07	0.77	0.49	1.22	1.08	0.52	2.22
Employee	0.19	0.72	0.43	1.20	1.21	0.57	2.53
Smoking or substance abuse							
No ^a	0.33	1			1		
Yes		1.21	0.70	2.10	1.40	0.76	2.56
Physical activity (h/wk)							
< 2 ^a	-0.38	1			1		
≥ 2		0.53*	0.30	0.94	0.67	0.34	1.32
BMI (kg/m ²)							
< 30 ^a	0.27	1			1		
≥ 30		1.77*	1.11	2.81	1.32	0.76	2.29
WC (cm)							
Men <102; Women <88 ^a	0.63	1			1		
Men ≥102; Women ≥88		2.09*	1.46	3.01	1.89*	1.18	3.01
Numbers of meals consumed daily (meals/d)							
< 3 ^a	-0.16	1			1		
≥ 3		0.91	0.63	1.31	0.85	0.56	1.27
Time interval between the last meal and sleep (hours)							
< 2 ^a	-0.16	1			1		
≥ 2		0.80	0.56	1.15	0.84	0.57	1.24
Resting immediately after the main meals							
No ^a	0.004	1			1		
Yes		0.89	0.61	1.30	1.004	0.66	1.51
Large portion-size meals (times/wk)							
< 2 ^a	0.32	1			1		
≥ 2		1.39	0.97	1.98	1.38	0.94	2.04

Table 3 Factors related to GERD development as the outcome variable by univariate analysis and multiple regression analysis (N = 505) (Continued)

Variable	B	Univariate OR			Adjusted OR		
		OR	95% CI		OR	95% CI	
			Lower	Upper		Lower	Upper
Fast foods intake (times/wk)							
< 2 ^a	-0.13	1			1		
≥ 2		0.71	0.36	1.39	0.87	0.42	1.82
Spicy foods intake (times/wk)							
< 2 ^a	-0.02	1			1		
≥ 2		1.03	0.72	1.46	0.97	0.66	1.45
Chocolate intake (times/wk)							
< 2 ^a	0.19	1			1		
≥ 2		1.14	0.79	1.65	1.21	0.80	1.82
Tea intake							
None ^a		1			1		
Just before meals	0.14	1.43	0.68	3.02	1.16	0.51	2.60
Just after meals	-0.15	0.97	0.46	2.06	0.85	0.37	1.94
Between meals	-0.03	1.17	0.59	2.31	0.96	0.45	2.04
Coffee intake							
None ^a		1			1		
Just before/ after meals	-0.53	0.37	0.11	1.25	0.58	0.15	2.18
Between meals	-0.19	0.66	0.26	1.67	0.82	0.29	2.3
Citrus intake							
None ^a		1			1		
Just before/after meals	0.35	0.98	0.55	1.76	1.42	0.73	2.76
Between meals	0.80	1.69*	1.04	2.73	2.22*	1.30	3.81
Carbonated drinks intake							
None ^a		1			1		
Within meals	-0.07	0.95	0.65	1.38	0.92	0.61	1.39
Between meals	-0.57	0.56	0.31	1.03	0.56	0.28	1.10

BMI body mass index, WC waist circumference, OR odds ratio, CI confidence interval

^aReference group. *Significant at the level of $p < 0.05$

shown that general obesity is a risk factor for severity of GERD symptoms alongside its development. However, it should be noted that the prevalence of general obesity was lower than that of central obesity in our study (19.4% vs. 46.1%), which may be suggestive of the differences between the BMI in our study compared with that of others.

The association between diet and GERD has been an issue of interest in epidemiological studies. In the present study, citrus fruit intake was the only dietary factor that might be associated with higher odds of GERD. Up to now, results on diet-GERD relationship are inconsistent among various studies. Several studies reported that consumption of caffeinated beverages (coffee and tea), carbonated drinks, citrus fruit, chocolate, spicy foods, and large-volume meals, were related to higher risk of GERD or triggering symptoms [8, 9, 27–29]. It is proposed that

these foods can decrease LES pressure and/or slow gastric emptying which may result in development of GERD symptoms [27]. In addition, the association between coffee and GERD is still unclear. Shimamoto et al. found no association between coffee intake and GERD among 8103 healthy Japanese individuals [30]. Moreover, results of a meta-analysis reported no association between coffee intake and GERD [31]. In our study, about 90% of participants did not consume coffee. Therefore, it seems that any possible relationship between coffee and GERD may not be obvious in this study. In terms of tea consumption and GERD, several epidemiological surveys had regarded tea as a risk factor of GERD [27, 32], although, this relationship varied depending on the type of tea consumed, such as green tea, strong tea or peppermint tea [27, 33, 34], as well as quantity of tea intake [32]. In this study, no

significant association was found between the timing of tea intake and risk of GERD, which is in line with the finding of previous epidemiological reports [35, 36]. Also, we found no association between carbonated beverages and GERD. Similarly, a systematic review demonstrated that carbonated beverages were neither related to GERD development, nor exacerbation of GERD complication [37]. It should be noted that in this study, the amount of the liquid intake was not recorded. Some studies have shown that intake of large volumes of liquid may be associated with GERD development or disease severity [8, 28]. Moreover, it is proposed that this association may vary, depending on whether or not the liquid is consumed with meals. Accordingly, a study reported that intake of coffee alone had no significant changes on LES pressure, while consumption of coffee after a lunch meal significantly reduced LES pressure [38]. However, this topic seems to be still inconclusive and more researches with an emphasis on both quantity and timing of liquid intake are needed.

In terms of socio-demographic status and GERD, being married was associated with higher odds of GERD in univariate analysis. While, higher educational level was associated with lower odds of GERD in both univariate and adjusted analysis. Similarly, previous studies reported lower educational level or being married as risk factors of GERD [39, 40]. It has been suggested that the above-mentioned factors may be indirectly related to GERD through their effects on lifestyle conditions including eating habits, psychosocial stress, and hygiene practices [41]. However, other studies have demonstrated otherwise [42, 43]. It should be noted that this association could not be simply explained due to this cross-sectional design, warranting further researches in this field.

Another concern is the lack of a clear association between smoking and GERD. While previous studies have indicated smoking as an independent predictor of GERD development [21, 26, 29, 44], others could not confirm such an association [24, 35, 40], in the present study, smoking was not associated with GERD development. This is inconsistent with findings of the study conducted by Esmailzadeh et al., which showed that in Iranian adult men, smoking was not a significant predictor for GERD [45]. A similar population-based cohort study in Norwegian population clarified that cessation of smoking was associated with improvement of GERD from severe to no or minor complaints, only among individuals within normal range of BMI but not among overweight individuals [46]. Although, smoking has a stimulatory effect on acid exposure, only 4% of the variations in GERD symptoms are attributed to acid exposure [47, 48]. Besides, the inconsistency among studies might be due to differences in the socio-demographic status of study populations, sample sizes, criteria for diagnosis of

GERD, and definition of smoking status. Of note is that in this study, similar to that of Esmailzadeh et al. (7.8% of the study participants were smokers) [45], prevalence of smoking was low, making it difficult to draw a significant relationship between smoking with GERD.

There are some limitations of our study, worth mentioning. First, we cannot ignore the effect of recall bias on our investigation, although trained staff were responsible for data collection, to reduce any possible errors which might be influenced in the results. Second, dietary intake from other food groups such as dairy products, meats, grains, and fats, as well as total energy and nutrient intake were not investigated. A study by Wu et al. found that intake of meat, oil, salt, and calcium were related to an increased risk of GERD, while intake of carbohydrate, protein, vitamin C, starches, egg, and fruits were inversely associated with GERD development [49]. However, the present study focused on those specific dietary sources which have mostly known for their refluxogenic effect. We suggest that future studies should focus on the diet-GERD relationship in the context of dietary patterns, rather than of specific nutrients, food items, or food groups. This approach therefore, will assess the combined effect of various dietary components, and as a result, provide a more comprehensive and precise information on the diet-GERD relationship.

Conclusions

To our knowledge, this study provides the first evidence on predictors of GERD in the Sistan and Baluchistan province. Central obesity as determined by WC and citrus fruit intake were independent factors associated with GERD development in the study population. Due to increasing prevalence of GERD in Iran, detection of risk factors for GERD can assist health professional to promote preventive programs in this region.

Additional file

Additional file 1: The structured questionnaire was developed to obtain information on socio-demographic and lifestyle-related factors in this study. (DOCX 16 kb)

Abbreviations

BMI: Body mass index; CIs: Confidence intervals; GERD: Gastro-esophageal reflux disease; GI: Gastrointestinal; LES: Lower esophageal sphincter; NSAIDs: Non-steroidal anti-inflammatory drugs; ORs: Odds ratios; TLSR: Transient lower esophageal sphincter relaxation; USDA: US Department of Agriculture; WC: Waist circumference; WHO: World Health Organization; WHpR: Waist-to-hip ratio

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Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available since we assured our participants to keep their data in secret, but are available from the corresponding author on reasonable request.

Authors' contributions

OE drafted the manuscript; MSh developed the study protocol and revised the manuscript; AB and TSh provided assistance in data collection and revised the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

This study was performed in accordance to the principles of the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of Children and Adolescent Health Research Center, Zahedan University of Medical Sciences, Zahedan, Iran. Also, a written informed consent was given of all participants.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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References

- El-Serag HB, Sweet S, Winchester CC, Dent J. Update on the epidemiology of gastro-oesophageal reflux disease: a systematic review. *Gut*. 2014;63:871–80.
- Fazel M, Keshteli AH, Jahangiri P, Daneshpajouhnejad P, Adibi P. Gastroesophageal reflux disease in Iran: SEPAHAN systematic review No. 2. *Int J Prev Med*. 2012;3(Suppl1):10–7.
- Masoumi SJ, Khademolhosseini F, Mehrabani D, Moradi F, Mostaghni AA, Zare N, et al. Correlation of quality of life with gastroesophageal reflux disease amongst Qashqai nomads in Iran. *Arch Iran Med*. 2012;15:747–50.
- Nwokediuko SC. Current trends in the management of gastroesophageal reflux disease: a review. *ISRN Gastroenterol*. 2012;2012:391631.
- Kang JH, Kang JY. Lifestyle measures in the management of gastro-oesophageal reflux disease: clinical and pathophysiological considerations. *Ther Adv Chronic Dis*. 2015;6:51–64.
- Chang P, Friedenberg F. Obesity and GERD. *Gastroenterol Clin N Am*. 2014;43:161–73.
- Katz PO, Gerson LB, Vela MF. Guidelines for the diagnosis and management of gastroesophageal reflux disease. *Am J Gastroenterol*. 2013;108:308–28.
- Al Saadi T, Idris A, Turk T, Alkhatib M. Epidemiology and risk factors of uninvestigated dyspepsia, irritable bowel syndrome, and gastroesophageal reflux disease among students of Damascus University, Syria. *J Epidemiol Glob Health*. 2016;6:285–93.
- Song JH, Chung SJ, Lee JH, Kim Y-H, Chang DK, Son HJ, et al. Relationship between Gastroesophageal reflux symptoms and dietary factors in Korea. *J Neurogastroenterol Motil*. 2011;17:54–60.
- Sethi S, Richter JE. Diet and gastroesophageal reflux disease: role in pathogenesis and management. *Curr Opin Gastroenterol*. 2017;33:107–11.
- Yu EW, Bauer SR, Bain PA, Bauer DC. Proton pump inhibitors and risk of fractures: a meta-analysis of 11 international studies. *Am J Med*. 2011;124:519–26.
- Esmailzadeh A, Keshteli AH, Feizi A, Zaribaf F, Feinle-Bisset C, Adibi P. Patterns of diet-related practices and prevalence of gastro-esophageal reflux disease. *Neurogastroenterol Motil*. 2013;25:831–e638.
- Li M, Dibley MJ, Sibbritt DW, Yan H. Dietary habits and overweight/obesity in adolescents in Xi'an City, China. *Asia Pac J Clin Nutr*. 2010;19:76–82.
- Mansour-Ghanaei F, Joukar F, Atshani SM, Chaghavand S, Souti F. The epidemiology of gastroesophageal reflux disease: a survey on the prevalence and the associated factors in a random sample of the general population in the northern part of Iran. *Int J Mol Epidemiol Genet*. 2013;4:175–82.
- Saber-Firoozi M, Khademolhosseini F, Yousefi M, Mehrabani D, Zare N, Heydari ST. Risk factors of gastroesophageal reflux disease in shiraz, southern Iran. *World J Gastroenterol*. 2007;13:5486–91.
- Delavari A, Moradi G, Elahi E, Moradi-Lakeh M. Gastroesophageal reflux disease burden in Iran. *Arch Iran Med*. 2015;18:85–8.
- Shaw A, Fulton L, Davis C, Hogbin M. Using the food guide pyramid: a resource for nutrition educators. US Department of Agriculture, Center for Nutrition Policy and Promotion. 1996.
- WHO 2011. Waist circumference and waist-hip ratio: report of a WHO expert consultation. Geneva: World Health Organization; 2008.
- Vatcheva KP, Lee M, McCormick JB, Rahbar MH. Multicollinearity in regression analyses conducted in epidemiologic studies. *Epidemiology (Sunnyvale)*. 2016;6:227.
- Hallan A, Bomme M, Hveem K, Moller-Hansen J, Ness-Jensen E. Risk factors on the development of new-onset gastroesophageal reflux symptoms. A population-based prospective cohort study: the HUNT study. *Am J Gastroenterol*. 2015;110:393–400.
- Sharma PK, Ahuja V, Madan K, Gupta S, Raizada A, Sharma MP. Prevalence, severity, and risk factors of symptomatic gastroesophageal reflux disease among employees of a large hospital in northern India. *Indian J Gastroenterol*. 2011;30:128–34.
- Nadaletto BF, Herbella FA, Patti MG. Gastroesophageal reflux disease in the obese: Pathophysiology and treatment. *Surgery*. 2016;159:475–86.
- Kang MS, Park DI, Oh SY, Yoo TW, Ryu SH, Park JH, et al. Abdominal obesity is an independent risk factor for erosive esophagitis in a Korean population. *J Gastroenterol Hepatol*. 2007;22:1656–61.
- Crews NR, Johnson ML, Schleck CD, Enders FT, Wongkeesong LM, Wang KK, et al. Prevalence and predictors of Gastroesophageal reflux complications in community subjects. *Dig Dis Sci*. 2016;61:3221–8.
- Shahraki T, Shahraki M, Roudbari M, Gargari BP. Determination of the leading central obesity index among cardiovascular risk factors in Iranian women. *Food Nutr Bull*. 2008;29:43–8.
- Gunji T, Sato H, Iijima K, Fujibayashi K, Okumura M, Sasabe N, et al. Risk factors for erosive esophagitis: a cross-sectional study of a large number of Japanese males. *J Gastroenterol*. 2011;46:448–55.
- Jaroszk M, Taraszewska A. Risk factors for gastroesophageal reflux disease: the role of diet. *Prz Gastroenterol*. 2014;9:297–301.
- Kubo A, Block G, Quesenberry CP Jr, Buffler P, Corley DA. Dietary guideline adherence for gastroesophageal reflux disease. *BMC Gastroenterol*. 2014;14:144.
- Matsuki N, Fujita T, Watanabe N, Sugahara A, Watanabe A, Ishida T, et al. Lifestyle factors associated with gastroesophageal reflux disease in the Japanese population. *J Gastroenterol*. 2013;48:340–9.
- Shimamoto T, Yamamichi N, Kodashima S, Takahashi Y, Fujishiro M, Oka M, et al. No association of coffee consumption with gastric ulcer, duodenal ulcer, reflux esophagitis, and non-erosive reflux disease: a cross-sectional study of 8,013 healthy subjects in Japan. *PLoS One*. 2013;8:e65996.
- Kim J, Oh SW, Myung SK, Kwon H, Lee C, Yun JM, et al. Association between coffee intake and gastroesophageal reflux disease: a meta-analysis. *Dis Esophagus*. 2014;27:311–7.
- Chang CH, Wu CP, Wang JD, Lee SW, Chang CS, Yeh HZ, et al. Alcohol and tea consumption are associated with asymptomatic erosive esophagitis in Taiwanese men. *PLoS One*. 2017;12:e0173230.
- Du J, Liu J, Zhang H, Yu CH, Li YM. Risk factors for gastroesophageal reflux disease, reflux esophagitis and non-erosive reflux disease among Chinese patients undergoing upper gastrointestinal endoscopic examination. *World J Gastroenterol*. 2007;13:6009–15.
- Murao T, Sakurai K, Mihara S, Marubayashi T, Murakami Y, Sasaki Y. Lifestyle change influences on GERD in Japan: a study of participants in a health examination program. *Dig Dis Sci*. 2011;56:2857–64.
- Chen T, Lu M, Wang X, Yang Y, Zhang J, Jin L, et al. Prevalence and risk factors of gastroesophageal reflux symptoms in a Chinese retiree cohort. *BMC Gastroenterol*. 2012;12:161.

36. Nocon M, Labenz J, Willich SN. Lifestyle factors and symptoms of gastro-oesophageal reflux – a population-based study. *Aliment Pharmacol Ther.* 2006;23:169–74.
37. Johnson T, Gerson L, Hershovici T, Stave C, Fass R. Systematic review: the effects of carbonated beverages on gastro-oesophageal reflux disease. *Aliment Pharmacol Ther.* 2010;31:607–14.
38. Salmon PR, Fedail SS, Wurzner HP, Harvey RF, Read AE. Effect of coffee on human lower oesophageal function. *Digestion.* 1981;21:69–73.
39. Pourhoseingholi A, Pourhoseingholi MA, Moghimi-Dehkordi B, Barzegar F, Safaee A, Vahedi M, et al. Epidemiological features of gastro-oesophageal reflux disease in Iran based on general population. *Gastroenterol Hepatol Bed Bench.* 2012;5:54–9.
40. Wang HY, Leena KB, Plymoth A, Hergens MP, Yin L, Shenoy KT, et al. Prevalence of gastro-oesophageal reflux disease and its risk factors in a community-based population in southern India. *BMC Gastroenterol.* 2016;16:36.
41. Nasser-Moghaddam S, Mofid A, Ghotbi MH, Razjouyan H, Nouraie M, Ramard AR, et al. Epidemiological study of gastro-oesophageal reflux disease: reflux in spouse as a risk factor. *Aliment Pharmacol Ther.* 2008;28:144–53.
42. Bor S, Lazebnik LB, Kitapcioglu G, Manannikof I, Vasiliev Y. Prevalence of gastroesophageal reflux disease in Moscow. *Dis Esophagus.* 2016;29:159–65.
43. Cohen E, Bolus R, Khanna D, Hays RD, Chang L, Melmed GY, et al. GERD symptoms in the general population: prevalence and severity versus care-seeking patients. *Dig Dis Sci.* 2014;59:2488–96.
44. Cela L, Kraja B, Hoti K, Toci E, Muja H, Roshi E, et al. Lifestyle characteristics and gastroesophageal reflux disease: a population-based study in Albania. *Gastroenterol Res Pract.* 2013;2013:936792.
45. Esmailzadeh A, Keshteli AH, Tabesh M, Feizi A, Adibi P. Smoking status and prevalence of upper gastrointestinal disorders. *Digestion.* 2014;89:282–90.
46. Ness-Jensen E, Lindam A, Lagergren J, Hveem K. Tobacco smoking cessation and improved gastroesophageal reflux: a prospective population-based cohort study: the HUNT study. *Am J Gastroenterol.* 2014;109:171–7.
47. Kadakia SC, Kikendall JW, Maydonovitch C, Johnson LF. Effect of cigarette smoking on gastroesophageal reflux measured by 24-h ambulatory esophageal pH monitoring. *Am J Gastroenterol.* 1995;90:1785–90.
48. Zimmerman J. Irritable bowel, smoking and oesophageal acid exposure: an insight into the nature of symptoms of gastro-oesophageal reflux. *Aliment Pharmacol Ther.* 2004;20:1297–303.
49. Wu P, Zhao XH, Ai ZS, Sun HH, Chen Y, Jiang YX, et al. Dietary intake and risk for reflux esophagitis: a case-control study. *Gastroenterol Res Pract.* 2013;2013:691026.

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