Original Article

Relationship between Tooth Loss, Functional Dyspepsia and Gastro-Esophageal Reflux Disorder among Isfahani Adults

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Abstract

Background: Few studies have assessed the relationship between tooth loss and upper gastro-intestinal (GI) disorders including functional dyspepsia (FD) and gastro-esophageal reflux disease (GERD). This study aimed to investigate the relation between dental status and FD, its components and GERD among a large group of Isfahani adults.

Methods: In a cross-sectional study from April to May 2010, the dental status of 4109 Isfahani adults was evaluated using a self-administered questionnaire. Participants were categorized into three main groups: those with full dentition, individual who had lost 1–5 teeth and those who had lost >5 teeth. FD, its components and GERD were defined using Rome III criteria. Multivariable logistic regression was used to examine the relationship between dental status and gastrointestinal disorders.

Results: After adjustment for potential confounders, we found no significant association between dental status, FD and GERD. However, individuals who had lost 1–5 teeth and >5 teeth had 34% and 109% greater odds for early satiation, respectively. In addition, individuals who had lost 1–5 teeth were 24% likely to have postprandial fullness and epigastric pain. Stratified analyses by gender also revealed a significant association between dental status and GERD as well as FD in females; such that those who had lost 1–5 teeth had 33% greater chance for GERD and those who had lost >5 teeth were 101% more likely to have FD compared with those with full dentition.

Conclusion: We found significant positive associations between tooth loss, GERD and FD in women, but not in men. We also found significant relations between tooth loss and components of FD, especially early satiety in the entire population.

Keywords: Functional dyspepsia, gastro-esophageal reflux disorder, masticatory function, tooth loss

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Introduction

Functional dyspepsia (FD) and gastroesophageal reflux disease (GERD) are common disorders in young adults.[1] Dyspepsia is an upper gastrointestinal tract syndrome presenting with epigastric pain and discomfort, fullness sensation, early satiety, nausea, vomiting and belching and usually aggravated by food ingestion.[2] The prevalence of functional dyspepsia has been estimated to be about 44.9% in the US adult population.[3] In Iran, it has been reported that 0.1% to 29.9 % are affected.[4-5] GERD is a chronic disorder related to the retrograde flow of gastroduodenal contents into the esophagus and/or adjacent organs, resulting in a variable spectrum of symptoms, with or without tissue damage.[6-7] It might be associated with esophagitis, esophageal ulcer, upper GI bleeding and Barrett's esophagus.[8] The prevalence of GERD varies from 10% to 38% in the Western population [9] and 1.9% to 52% in Iranians.[10]

The process of chewing prepares food for digestion. The breakdown of food in mouth stimulates the production of saliva which in turn triggers activation of digestive enzymes and the passage of food through the stomach. Tooth loss is the most frequent cause of deficient masticatory function. Individuals with impaired mastication may cope with feeding problems by either adjusting their food choices or swallowing coarse particles both of which cause problems. The first type of behavior is known to induce imbalance in dietary intake, and the second may result in decreased bioavailability of nutrients and gastrointestinal disturbances.[11] Studies have shown a relationship between masticatory performance and malocclusion with gastrointestinal disorders.[12–13]

Few studies have been conducted on the relationship between tooth loss and upper GI disorders including functional dyspepsia and GERD. Some studies have shown an association between masticatory performance and FD but no association was found with the number of occlusal pairs.[14] Furthermore the relationship between dental erosion and halitosis with GERD has been frequently reported,[7] but we are aware of no information indicating the association between tooth loss and GERD.

Given the increasing prevalence of FD and GERD in developing countries along with high prevalence of tooth loss, this study aimed to investigate the relationship between dental status and upper gastrointestinal disorders among a large group of Isfahani adult population.

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Materials and Methods

Study participants

This cross-sectional study was done in the framework of the Study on the Epidemiology of Psychiatric-Alimentary Health and Nutrition (SEPAHAN),[15] a project that was performed on 10,500 Isfahani adults working in 50 different rural and urban health centers, across the Isfahan province, affiliated with the Isfahan University of Medical Sciences (IUMS). The study was conducted in two main phases. In the first phase in April 2010, a detailed questionnaire on socio-demographic factors, dietary behaviors and dental status was used to examine the related variables. In the second phase, in mid-May 2010, information on functional gastrointestinal disorders (FGID) was collected through the use of a validated Persian version of Rome III questionnaire. All questionnaires were distributed and collected within 2–3 weeks and sent to the project headquarters. In the first and second phases of the study, 8691 (response rate: 86.16%) and 6239 (response rate: 64.64%) people, respectively, returned the completed questionnaires. No significant difference was found between the demographic data of those who returned the completed questionnaires and those who did not. In July 2012, after merging data from the first and second phases, the complete information on 4669 subjects was available for analysis. In this study, we excluded those who had reported using removable denture (n = 450). Also, 110 subjects were excluded due to lack of data. These exclusions resulted in 4109 subjects remaining for the present analysis. Participants provided signed written informed consents. The study was ethically approved by the Medical Research Ethics Committee of the Isfahan University of Medical Sciences, Isfahan, Iran.

Assessment of exposure (dental status)

Tooth loss was evaluated by asking participants the following question: "How many teeth you have lost?" The Subject were able to choose one of these choices: "have all my teeth", "one tooth", "two teeth", "three teeth", "four teeth", "five teeth", "half of one arch", "all of one arch", "more than one arch", "lost all my teeth". As the number of subjects choosing some choices was very low, we categorized participants into three main groups: those with full dentition, individual who had lost 1–5 teeth and those who had lost >5 teeth.

Assessment of outcomes (gastrointestinal health)

To assess functional gastrointestinal disorders, we used the validated Persian version of ROME III questionnaire.[15] During the face validation of this questionnaire, we found that most participants could not discriminate the difference between the descriptors used in Rome III. Therefore, we modified the descriptors in Rome III questionnaire (never, less than one day a month, one day a month, two to three days a month /one day a week, more than one day a week /every day) to a 4-item-rating scale (never or rarely, sometimes, often, always) for each question. We also asked about the presence of each symptom in the past three months instead of questioning patients about the beginning of each symptom in more than 6 months prior to the evaluation, which already exists in the original Rome III questionnaire. This modified Persian version of the Rome III questionnaire, as part of the main comprehensive questionnaire, was used for assessment of FGIDs. Individuals with one or more of the following characteristics were defined as having FD: bothersome postprandial fullness (defined as feeling uncomfortably full after a regular-sized meal, often or always), early satiation (defined as being unable to finish a regular-sized meal, often or always), and/or epigastric pain or epigastric burning (defined as feeling pain or burning in the middle of abdomen, often or always). We defined GERD as the presence of heartburn sometimes, often or always during the three months prior to the study. In addition, we asked about the severity of each gastrointestinal complaint using a 4-item rating scale (mild, moderate, severe and very severe).

Assessment of potential confounders

Data on body weight and height were obtained through a self-reported questionnaire. Body mass index (BMI) was calculated as weight (in kg) divided by height (in meters squared). Obesity was defined as BMI $\geq 25 kg/m^2$. Additional information about age, sex, marital status, smoking habits, prevalence of diabetes, use of dietary supplements and proton-pump inhibitors (PPIs) (such as omeprazole and pantoprazole, which reduce acid production), were obtained with a questionnaire. General Practice Physical Activity Questionnaire (GPPAQ) was used to assess physical activity levels of study participants. Based on this questionnaire, the participants were classified into 4 categories: active (>3 hr/week), moderately active (1–3 hr/week), moderately inactive (<1 hr/week), and inactive (no physical activity). Meal pattern regularity was assessed by asking individuals about the regularity of their meals "Do you consume your meals regularly?" The subjects were able to choose one of these choices: never, sometimes, often, or always. Individuals, who had reported that they never consume their meals regularly, were defined as having an irregular meal pattern.

Statistical analysis

Comparison of continuous variables across different categories of dental status was achieved using one-way ANOVA. The Chi-square test was used to examine the distribution of participants in terms of categorical variables across different categories of dental status. The prevalence of GERD, FD and its components across categories of dental status was evaluated using Chi-square. The relationship between dental status and gastrointestinal disorders was examined using logistic regression in different models. First, the relationship was assessed in crude model. Then, age (continuous), sex (male/female), smoking (non-smoking/ex-smoking/smoking), physical activity (never, <1 hr/w, 1–3 hr/w, >3 hr/w) and diabetes (yes/no), meal regularity (always/often/occasionally/never) were adjusted for in the first model. BMI was additionally adjusted for in the second model. To calculate the trend of odds ratios across categories of dental status, we considered dental status categories as an ordinal variable. In all models, subjects who had all their teeth were considered as reference. All analyses were done for GERD, FD and its components separately. Statistical Package for Social Sciences (SPSS Inc., version 18.0, Chicago, IL) was used for all analyses.

Results

The general characteristics of our study population by dental status are shown in Table 1. Compared with those with full dentition, individuals who had lost >5 teeth, were older, had higher weight and BMI, were more likely to be married, female, supplement users, smokers, obese and had irregular meal pattern.

Table 1. General characteristics of the study population by categories of dental status.[1]

	Dental status			
	Full dentition (*n* = 1385)	**Lost 1-5 teeth (*n* = 2506)**	**Lost >5 teeth (*n* = 218)**	***P*[2]**
Age (year)	39.2 ± 7.2	36.9 ± 7.6	41.1 ± 7.9	<0.001
Females (%)	67	54	42	<0.001
Married (%)	70	85	91	<0.001
Smokers (%)	11	13	26	<0.001
Weight (kg)	66.3 ± 12.9	69.8 ± 13.9	70.9 ± 12.2	<0.001
BMI (kg/m^2)	24.3 ± 4.4	25.3 ± 4.6	26.1 ± 7	<0.001
Supplement use (%)	9.5	6.8	7.2	0.01
Obesity (%)	6.2	10.8	14.5	<0.001
Milk intolerance (%)	14.6	15	15.4	0.92
Meal regularity (never, %)	6.4	8.1	13.5	<0.001
Prevalence of diabetes (%)	1.0	2.0	3.7	0.001
Physical activity (≥1 hr/w, %)	32.1	32.6	27.6	0.001
Proton-pump inhibitors (PPIs) use[3]	9.3	10.5	15	0.06

[1] Data are means ± standard deviation unless indicated. [2]Obtained from one-way analysis of variance or chi-square, where appropriate. [3] Medications such as omeprazole and pantoprazole, which reduce the production of acid.

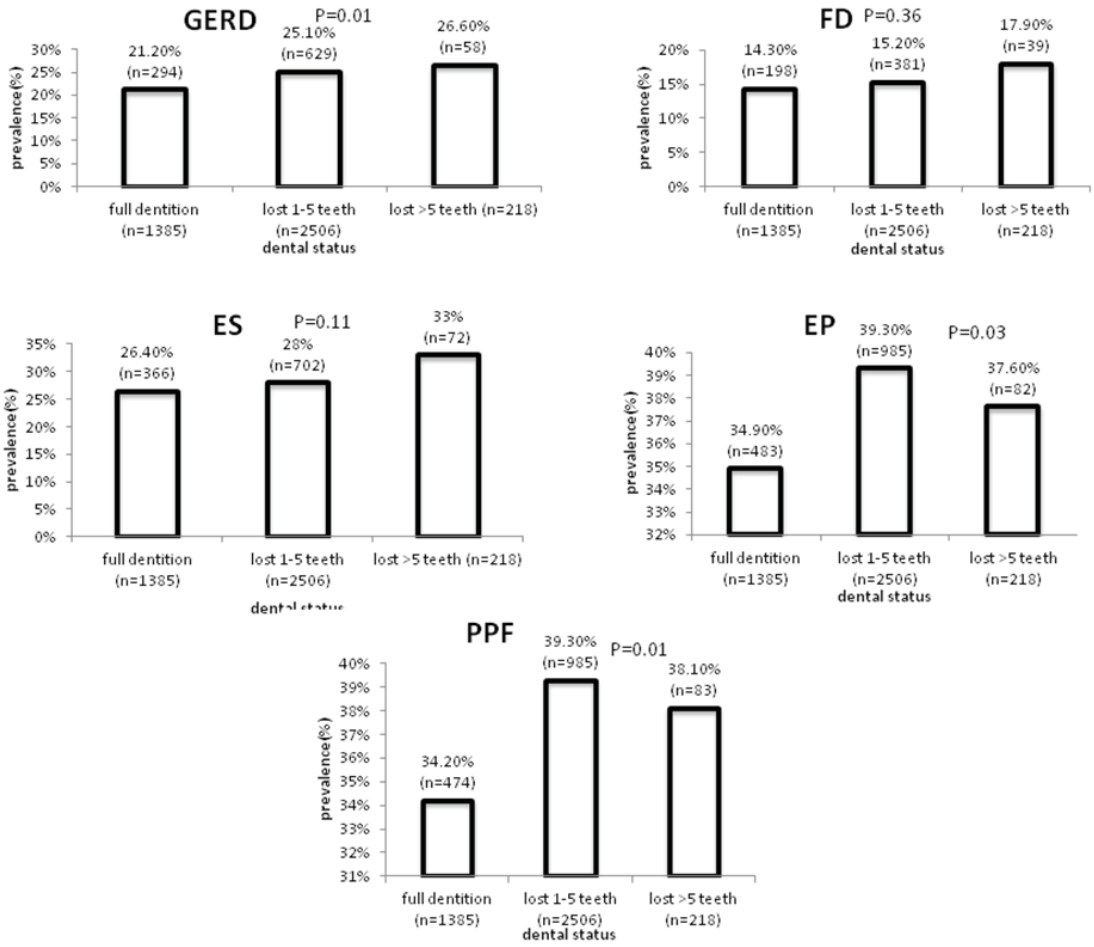

Figure 1. Prevalence of gastroesophageal reflux disease (GERD), Functional dyspepsia (FD) and its components across different categories of dental status. ES = early satiation, PPF = post prandial fullness, EP = epigastric pain.

Table 2. Multivariable-adjusted odds ratios for GERD and FD across different categories of dental status.[1]

	Dental status			
	Full dentition (*n* = 1385)	**Lost 1-5 teeth (*n* = 2506)**	**Lost >5 teeth (*n* = 218)**	P_{trend}[4]
GERD				
Crude	1.00	1.25 (1.06–1.46)	1.35 (0.97–1.87)	0.03
Model 1[2]	1.00	1.12 (0.93–1.35)	1.14 (0.76–1.71)	0.53
Model 2[3]	1.00	1.11 (0.92–1.34)	1.19 (0.79–1.80)	0.50
FD				
Crude	1.00	1.07 (0.89–1.29)	1.30 (0.89–1.90)	0.59
Model 1[2]	1.00	1.16 (0.93–1.46)	1.47 (0.90–2.40)	0.68
Model 2[3]	1.00	1.21 (0.95–1.52)	1.42 (0.86–2.36)	0.59

[1]Data are Odds Ratio and 95% Confidence Interval. [2]Model l: Adjusted for age, sex, physical activity, smoking, diabetes, meal pattern regularity. [3]Model 2: Additional adjustment for BMI. [4]Obtained by the use of categories of dental status as an ordinal variable in the model.

Table 3. Multivariable-adjusted odds ratios for FD components across different categories of dental status.

		Dental status			
		Full dentition (*n* = 1385)	**Lost 1 – 5 teeth (*n* = 2506)**	**Lost > 5 teeth (*n* = 218)**	P_{trend}[3]
Early satiation					
	Crude	1.00	1.08 (0.93–1.25)	1.37 (1.01–1.87)	0.08
	Model 1[1]	1.00	1.27 (1.06–1.52)	2.05 (1.39–3.03)	0.001
	Model 2[2]	1.00	1.34 (1.12–1.61)	2.09 (1.40–3.10)	<0.001
Post prandial fullness					
	Crude	1.00	1.24 (1.08–1.42)	1.18 (0.88–1.58)	0.06
	Model 1[1]	1.00	1.21 (1.03–1.43)	1.14 (0.78–1.65)	0.17
	Model 2[2]	1.00	1.24 (1.04–1.46)	1.18 (0.80–1.72)	0.12
Epigastric pain					
	Crude	1.00	1.20 (1.05–1.38)	1.12 (0.83–1.50)	0.17
	Model 1[1]	1.00	1.22 (1.04–1.44)	1.19 (0.82–1.73)	0.17
	Model 2[2]	1.00	1.24 (1.05–1.46)	1.23 (0.84–1.80)	0.19

[1] Model l: Adjusted for age, sex, physical activity, smoking, diabetes, meal pattern regularity. [2] Model 2: Additional adjustment for BMI.
[3] Obtained by the use of categories of dental status as an ordinal variable in the model.

The prevalence of GERD and FD among the study population was 23.9% (n = 981) and 15.0% (n = 618), respectively. The prevalence of GERD and FD and its components across different categories of dental status are shown in Figure 1. GERD, FD and early satiation were highly prevalent among individuals who had lost 1–5 or >5 teeth compared with those with full dentition. Individuals who had lost 1–5 teeth had a higher prevalence of post prandial fullness and epigastric pain.

Multivariable-adjusted odds ratios for GERD and FD across different categories of dental status are presented in Table 2. Although individuals who had lost 1–5 teeth had 25% greater chance for GERD compared with those with full dentition, adjustment for confounding factors attenuated this association. After additional controlling for BMI, no significant association was observed between dental status and GERD. After adjustment for potential confounders, individuals who had lost >5 teeth were 42% more likely to have FD compared with those with full dentition; however, this relation was not statistically significant.

Multivariable-adjusted odds ratios for FD components across different categories of dental status are presented in Table 3. A significant association was observed between tooth loss and early satiation; such that after adjustment for all confounders including BMI, individuals who had lost 1–5 teeth, had 34% and those who lost >5 teeth, had 109% greater odds for early satiation. In addition, tooth loss was significantly associated with postprandial fullness and epigastric pain; such that after adjustment for potential confounders, individuals who had lost 1–5 teeth were 24% likely to have these conditions. However, no significant association was found between losing >5 teeth and either postprandial fullness or epigastric pain.

Stratified analyses based on gender revealed no significant association between dental status and GERD or FD in males (Table 4). However, among females, we found that those who had lost 1–5 teeth had 33% greater chance for GERD than those with full dentition. After adjustment for confounders, we found that losing >5 teeth was not significantly associated with GERD in women.

Table 4. Multivariable-adjusted odds ratios for GERD and FD across different categories of dental status, stratified by gender.

		Male				Female			
		Dental status				Dental status			
		Full dentition (n = 458)	Lost 1-5 teeth (n = 1154)	Lost >5 teeth (n = 139)	P_{trend} [3]	Full dentition (n = 927)	Lost 1-5 teeth (n = 1352)	Lost >5 teeth (n = 79)	P_{trend} [3]
GERD									
	Crude	1.00	1.16 (0.89–1.51)	1.25 (0.80–1.96)	0.49	1.00	1.34 (1.10–1.64)	1.59 (0.96–2.64)	0.01
	Model 1[1]	1.00	0.81 (0.59–1.13)	0.69 (0.39–1.22)	0.09	1.00	1.31 (1.05–1.65)	1.73 (0.92–3.25)	0.03
	Model 2[2]	1.00	0.79 (0.57–1.10)	0.75 (0.42–1.33)	0.11	1.00	1.33 (1.05–1.68)	1.63 (0,86–3.11)	0.04
FD									
	Crude	1.00	0.98 (0.70–1.36)	1.20 (0.69–2.09)	0.89	1.00	1.20 (0.96–1.51)	1.75 (1.01–3.02)	0.14
	Model 1[1]	1.00	0.95 (0.61–1.48)	1.00 (0.47–2.09)	0.13	1.00	1.26 (0.97–1.65)	2.01 (1.01–3.99)	0.13
	Model 2[2]	1.00	1.06 (0.67–1.68)	0.99 (0.46–2.14)	0.17	1.00	1.28 (0.98–1.68)	1.81 (0.89–3.68)	0.15

[1]Model l: Adjusted for age, physical activity, smoking, diabetes, meal pattern regularity. [2]Model 2: Additional adjustment for BMI. [3]Obtained by the use of categories of dental status as an ordinal variable in the model.

Table 5. Multivariable-adjusted odds ratios for GERD and FD across different categories of dental status stratified by BMI status

		BMI<25				BMI≥25			
		Dental status				Dental status			
		Full dentition (n = 831)	Lost 1–5 teeth (n = 1201)	Lost > 5 teeth (n = 90)	P_{trend} [2]	Full dentition (n = 497)	Lost 1–5 teeth (n = 1203)	Lost > 5 teeth (n = 115)	P_{trend} [2]
GERD									
	Crude	1.00	1.05 (0.84–1.30)	1.52 (0.93–2.47)	0.88	1.00	1.44 (1.13–1.85)	1.34 (0.84–2.14)	0.02
	Model 1[1]	1.00	0.93 (0.72–1.20)	1.66 (0.91–3.03)	0.54	1.00	1.38 (1.03–1.85)	1.04 (0.58–1.87)	0.11
FD									
	Crude	1.00	1.10 (0.86–1.41)	1.76 (1.04–2.99)	0.45	1.00	1.15 (0.85–1.57)	0.93 (0.50–1.73)	0.53
	Model 1[1]	1.00	1.14 (0.85–1.53)	2.25 (1.15–4.41)	0.68	1.00	1.37 0.92–2.03)	0.83 (0.37–1.89)	0.76

[1] Model l: Adjusted for age, sex, physical activity, smoking, diabetes, meal pattern regularity. [2] Obtained by the use of categories of dental status as an ordinal variable in the model.

In addition, females who had lost >5 teeth were 101% more likely to have FD compared with those with full dentition. Adjustment for BMI attenuated this association.

The relation between dental status and upper gastrointestinal disorders across different categories of BMI is shown in Table 5. No significant association was found between dental status and GERD in normal-weight participants. However, overweight subjects who lost 1–5 teeth had greater chance for GERD. With regards to FD, we found that normal-weight individuals who had lost > 5 teeth were at greater chance of FD than those with full dentition; while in overweight participants, no significant relation was observed between dental status and FD.

Discussion

In this cross-sectional study among a large group of Isfahani adults, we did not find a significant association between tooth loss, GERD and FD in the whole population. However, gender separated analysis revealed a significant association between losing 1–5 teeth and GERD as well as between losing >5 teeth and FD in women. A significant link was also seen between tooth loss and early satiety. To the best of our knowledge, this study is the first examining the association between tooth loss and functional upper gastrointestinal disorders.

Dyspepsia is a highly prevalent chronic condition. Several factors might affect its pathophysiology, including diet, socio-cultural factors and gastrointestinal infections.[2] Patients with GERD may have extra-esophageal manifestations including oral manifestations such as enamel erosion, temporomandibular disorders, xerostomia, halitosis and mucositis.[16] Although some studies have reported a relation between dental status and other GI disorders, we are aware of no studies that have examined the relationship between tooth loss and FD and GERD. It was documented that tooth loss leads to impaired masticatory function,[11] which can in turn result in a high frequency of gastrointestinal disorders. Gastritis and ulcers have long been reported in subjects with impaired masticatory function.[13] Previous investigations in Iran have documented a linkage between GERD, dental erosion and dental hygiene.[17–19] A cross-sectional study among three groups of Iranian healthy adults, those who were suspected for GERD, and positive GERD patients showed that the prevalence of dental erosion in GERD patients (22.6%) was higher than the suspected (5.3%) and the healthy (7%) individuals.[17] Another observational study among Iranian children revealed a positive significant correlation between GERD and dental erosion. This study suggested posterior occlusal surface erosions in milk teeth as an indicator of GERD.[18] Another investigation among Iranian population has suggested that a high prevalence of GERD might be associated with the history of unpurified water consumption, poor sanitary conditions in childhood, number of missing teeth, and smoking.[19]

We found a significant association between losing 1–5 teeth and GERD as well as between losing >5 teeth and FD in women. Tosello *et al.* have reported a high prevalence of gastrointestinal pathology in partially edentulous subjects.[20] Prior investigations have shown that in elderly edentulous subjects, the reduction of chewing efficiency affected nutrient intake and led to the high prevalence of gastrointestinal disorders.[12] In another study, investigators compared the gastric mucosa of patients with dyspepsia among partially and totally edentulous people suffering from poor masticatory function and those whose dentition was in good condition; they found a strong degree of inflammation and infection of the gastric mucosa (with *Helicobacter pylori*) in patients with severely impaired dental status.[21] A systematic review has shown that the presence of GERD contributes significantly to increased risk of dental erosion in affected individuals.[7] However, data are inconsistent. For instance, Hattori *et al.* reported that reduction in food trituration caused by shortening of the dental arch did not significantly influence gastrointestinal digestive function.[22] Carretero *et al.* reported that in spite of the strong correlation between the number of occlusal pairs and masticatory performance, only the latter was associated with the presence of non-ulcerative functional dyspepsia. Thus, the comminution capacity would be a more important factor to consider in patients with dyspepsia than the number of occlusal pairs.[14]

In our study, we found a significant association between tooth loss and FD components, especially early satiety. Subjects with FD may adapt to this occlusal state by increasing the number of masticatory cycles, swallowing larger-size food particles or by applying other strategies to compensate for their occlusal deficiency.[23] The delayed passage of inadequately chewed and larger than normal-size food particles through the stomach prolongs the period of gastric digestion with potential detrimental consequences for the gastric mucosa. Thus, the altered gastric motor function in patients with decreased masticatory performance could be a possible explanation for functional dyspepsia.[24] An experimental study, indicating the importance of mastication in gastric motility, reported that food remains longer in the stomach with abnormal mastication as the secretion of gastric acid and the motility of the digestive tract were reduced.[25] According to previous studies, these individuals showed a slow masticatory rhythm with unilateral vertical and rotational movements, and remain in the oral cavity after mastication,[14] which could lead to early satiety in these subjects. Our study has shown a relation between losing 1–5 teeth and GERD, while after adjustment for confounding factors, the association weakened. The pH of reflected content in gastric reflux is below 2.0; and repeated exposure to persistent acid regurgitation can cause dental erosion. Some studies have also reported that the severity of dental erosions might depend on the frequency of regurgitation and duration of GERD.[26] On the other hand, impaired dentition status is associated with poor nutritional intake. The results of longitudinal studies have supported significant associations between tooth loss and detrimental changes in dietary intakes, including less consumption of dietary fiber, vitamin B12 and whole fruits along with excessive consumption of fats,[27] which could contribute to increased risk of developing GERD.

In our study, tooth loss was related to FD in women; but after adjustment for BMI, this association disappeared. This finding suggests that the relationship between FD and tooth loss might be mediated through obesity in the population. It remains unknown if tooth loss is associated with weight gain or not. Further studies are required to examine this association. However, tooth loss may lead to insufficient breakdown of food and reduced exposure to saliva which may result in inadequate pre-fermentation, impaired bolus formation, insufficient secretion of gastric juice and, finally, digestive disorders such as early satiation, postprandial fullness and epigastric pain.[13]

In the present study, we used Rome III criteria to assess FGIDs. This questionnaire was introduced as a standard tool to diagnose and classify functional gastrointestinal disorders. Although earlier studies have applied the Rome criteria in Iranian population, the

questionnaire was not originally developed for Iranians. Therefore, we first performed a pilot study based on the consultation with one of the principal investigators of the ROME criteria (Nicholas Talley).[14] As in our pilot study, most participants could not discriminate the difference between the rating scales used in the original Rome III questionnaire, we modified the rating scale to a 4-item-rating scale (never or rarely, sometimes, often, always) through consultation with experts. We also decided to ask about the presence of each symptom in the past three months, as participants did not clearly remember symptoms in the last 6 months. Both of these decisions were checked and confirmed with experts (N. Talley).

Our study has several strengths and potential limitations. The sample size in this study was substantially larger than previous studies. In addition, most previous studies in this field have been conducted on the geriatric population, while the current study is amongst the first investigating the association between masticatory dysfunction and common gastrointestinal disorders in middle-age adults. However, due to the cross-sectional design of the study, a causal relationship cannot be inferred. In addition, this cross-sectional study might be susceptible to recall bias due to low response and misclassification. Selection bias might also be resulted as we were not able to have a comprehensively representative sample of the Iranian population. The study population consisted of a medical university nonacademic-staff, including crews, employees and managers. Although the socio-economic status of the study population was representative of the general Iranian population, extrapolating the findings to other populations must be done cautiously. A non-representative population can be harmful or beneficial depending on the study question and context. The important point is that the distortions may be in any direction (which is unpredictable). In that respect, our findings may be subject to selection bias. The presence of severe malocclusion and position of teeth in the dental arch were also not verified. Furthermore, the prevalence of tooth loss and its related risk factors was examined using a self-administrated questionnaire which can subsequently affect the results due to probable misclassifications; although the previous findings from the questionnaire in this population have shown that self-reported values provided reasonable information on dental status in these individuals.[28] Finally, we examined multiple statistical tests to understand the changes in our findings in subgroups by gender and BMI. Although performing these tests could be the strength of the study, it might be simultaneously considered as a potential pitfall that should be taken into account in the interpretation of the findings.

In conclusion, we found significant positive associations between tooth loss, GERD and FD in women, but not in men. We also found significant relations between tooth loss and components of FD, especially early satiety in the entire population.

Disclosure statement

The authors declare that they have no conflict of interests.

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