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Is tooth loss associated with irritable bowel syndrome?

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SUMMARY **Although the relationship between number of teeth and gastric disturbances has been recognised, limited data are available linking tooth loss and irritable bowel syndrome (IBS). This study aimed to investigate the relation between dental status and IBS among Iranian adults. In a cross-sectional study on 4669 Iranian adults, dental status was evaluated using a self-administered questionnaire. Participants were categorised into five main groups: those with full dentition (without denture), those with denture, individual who had lost 1–2 teeth, 3–5 teeth and half of one jaw or more. IBS and its subtypes were defined using Rome III criteria. After adjusting for different confounding variables, those who had lost 1–2 and 3–5 teeth had 1·35 and 1·33 times greater odds for IBS than fully dentate subjects, respectively. After controlling for different confounders, individuals who had denture had 103% greater odds to have constipation-predominant IBS than those with full dentition (95% confidence interval: 1·29–3·21). Neither in crude nor in adjusted models were any significant association between dental status and other subtypes of IBS. In addition, we did not find any association between losing half of one jaw or more and IBS. We found that losing 1–2 or 3–5 teeth might significantly be associated with increased risk of IBS. Having denture might be related to constipation-predominant IBS. There should be further prospective studies to confirm these findings.**

KEYWORDS: **functional gastrointestinal disorders, irritable bowel syndrome, masticatory function, tooth loss**

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Introduction

Irritable bowel syndrome (IBS) is the most prevalent functional gastrointestinal disorder worldwide. Several contributing factors to IBS have been identified including, but not limited to, abnormal motility of intestine, visceral hypersensitivity, inflammation, neurotransmitter imbalance, disturbance of brain–gut interaction, abnormal central processing, autonomic and hormonal events, genetic, environmental and psychosocial factors (1–3). Population-based studies have shown that the prevalence of symptoms compatible with IBS in the community varies from around 5% to more than 20% (1). The prevalence of IBS has been reported to vary from 1·1% to 25% in Iran based on different study populations and diagnostic criteria (3).

Tooth loss is the most frequent cause of deficient masticatory function. Despite the progress in the prevention and early treatment, tooth loss remains highly prevalent worldwide (4). Insufficient breakdown of food and decreased exposure to saliva lead to inadequate pre-fermentation, impaired bolus formation, insufficient secretion of gastric juice acid and, as a result, to digestive disorders and compromised nutritional status (5–7). Findings from animal studies have provided evidence indicating a moderate effect of mastication on food digestion (4). The current evidence in this regard is inconsistent (5–10). In a case–control study of patients in geriatric facilities, it was shown that insufficient masticatory function significantly increased the risk of gastrointestinal dis-

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orders (8). Another study revealed that lag phase and gastric half-emptying time were significantly shortened when the meal was chewed with 50 cycles than with 25 cycles (9). Furthermore, tooth loss may be associated with IBS apart from masticatory function and digestive ability. Previous studies have documented that 10–15% of adults aged 30 years and older have severe periodontitis (11) and the prevalence of severe periodontitis does not increase by age. This group may exhibit more tooth loss as well as a highly active inflammatory response, which makes them more prone to inflammatory disease, such as IBS (12, 13).

Although the relationship between number of teeth and gastric disturbances has been suggested in a few studies (9, 10), very limited data are available linking tooth loss and functional gastrointestinal disorders. The present study aimed to investigate the relation between dental status and IBS among a large group of Iranian adults.

Materials and methods

Participants

This cross-sectional study was carried out in the framework of the Study on the Epidemiology of Psychological, Alimentary Health and Nutrition (SEPAHAN) (14). SEPAHAN aimed to investigate the role of different nutritional, psychological and lifestyle factors in the aetiology of functional gastrointestinal disorders in Iranian adults. The study consisted of two main phases using self-administered questionnaires. In the first phase, a detailed questionnaire on socio-demographic factors, dietary behaviours and dental status was used. In the second phase, information on functional gastrointestinal disorders was collected using a modified Persian version of Rome III questionnaire. The Rome criteria is a system developed to classify the functional gastrointestinal disorders, in which symptoms cannot be explained by the presence of structural or tissue abnormality, based on clinical symptoms. After merging data from the first and second phases, the complete information about dental status and IBS on 4669 subjects who were non-academic staff of Isfahan University of Medical Sciences, working in 50 health centres across Isfahan province, was available for the current study. Participants provided signed informed written consents. The study was approved by the Regional Bioethics Committee affiliated to Isfahan University of Medical Sciences, Isfahan, Iran.

Assessment of dental status

Tooth status was evaluated by asking participants the following question: 'How many teeth have you lost?' They were asked to choose one of these choices: 'I have all my teeth, I have lost one tooth, two teeth, three teeth, four teeth, five teeth, half of one jaw, all of one jaw, more than one jaw or I have lost all my teeth'. We also asked participants about having denture: 'Do you have any denture?' They could choose one of these choices: 'I do not have any dentures, I have a removable denture in one jaw, I have a full denture in one jaw, I have removable dentures in two jaws, I have fixed dentures (bridges) or implants'. As the number of subjects responded to some choices was very low, we categorised participants into five main groups: those with full dentition (without denture), those with denture, individual who had lost 1–2 teeth, 3–5 teeth and half of one jaw or more. Removable partial denture in less than one jaw, one jaw, two jaws, as well as fixed denture or implants was considered as having denture in the present study. In order to fit persons with partial dentures to 'have denture' category only, we first coded individuals who indicated having denture, in the denture category and then other subjects were categorised into other groups.

Assessment of IBS

A modified Persian version of Rome III questionnaire to assess IBS was used (14). During the face validation of this questionnaire, it was found that most participants could not discriminate the difference between the descriptors used in the original version of Rome III. Therefore, the descriptors in Rome III questionnaire (never, <1 day a month, 1 day a month, 2–3 days a month, 1 day a week, more than 1 day a week or every day) were modified to a 4-item rating scale (never or rarely, sometimes, often or always) (14). Also, the presence of abdominal pain in the past 3 months was asked instead of questioning patients about the beginning of the symptom in a 6-month or longer period before the evaluation. Irritable bowel syndrome was defined as the presence of

recurrent abdominal pain or discomfort at least sometimes in the last 3 months associated with two or more of the following features: improvement with defecation, pain onset associated with a change in frequency of stool, pain onset associated with a change in form (appearance) of stool. We also defined IBS subtypes according to Rome III criteria: (1) constipation-predominant IBS (IBS-C) was defined as having IBS and both of the following criteria: (i) hard or lumpy stools at least sometimes and (ii) lack of loose, mushy or watery stools; (2) diarrhoea-predominant IBS (IBS-D) was defined as having IBS and both of the following criteria: (i) lack of hard or lumpy stools and (ii) loose, mushy or watery stools at least sometimes; (3) mixed IBS (IBS-M) was defined as having IBS and both of the following criteria: (i) hard or lumpy stools at least sometimes and (ii) loose, mushy or watery stools at least sometimes; and (4) unsubtyped IBS (IBS-U) was defined as having IBS and both of the following criteria: (i) lack of hard or lumpy stools and (ii) lack of loose, mushy or watery stools. It is noteworthy that the 'IBS' group consists of all the other four IBS subtypes together. IBS-M is a combination of diarrhoea and constipation and IBS-U is a kind of IBS that does not fall into any other three categories of IBS.

Assessment of other variables

Data on body weight and height were obtained through the use of a self-reported questionnaire. Body mass index (BMI) was calculated as weight in kg divided by height in metres squared. Obesity was defined as BMI $\geq$ 30 kg m^{-2}.

Meal pattern regularity was assessed through asking individuals the following question: 'How often do you consume your meals regularly?' Subjects were able to choose one of these choices: never, sometimes, often or always. Individuals who had reported that never consume meals regularly were defined as having irregular meal pattern. Additional information about age, sex, marital status, smoking habits and use of supplements was obtained using a self-administered questionnaire.

Statistical analysis

Comparison of continuous variables across different categories of dental status was assessed using one-way ANOVA which was followed by Bonferroni's *post hoc* comparisons. Chi-square test was used to examine the distribution of participants in term of categorical variables across different categories of dental status. The prevalence of IBS and its subtypes across categories of dental status was evaluated using chi-square. The relationship between dental status and IBS was examined using logistic regression in different models. First, the relationship was assessed in crude model. Then, age (continuous) and sex were adjusted for in the first model. We further controlled for marital status (single, married, divorced or widowed), smoking status (non-smoker, ex-smoker or current smoker), supplement use (yes or no), and obesity status (normal, overweight or obese) in model 2. Meal regularity (never, sometimes, often or always) was additionally adjusted for in the third model. In all models, subjects who had all their teeth were considered as the reference category. Besides the analyses for the whole population, we conducted the stratified analyses by gender. All analyses were performed for IBS and its subtypes separately. Statistical Package for Social Sciences* was used for all analyses and *P*-values <0·05 were considered statistically significant.

Results

From 4669 participants aged 19–70 years old (mean age: 36·5, s.d.: 8·10), 1581 (33·9%) subjects had all of their teeth (without denture), 445 (9·5%) individuals had denture, 1319 (28·3%) ones had lost 1–2 teeth, 1122 (24·0%) people had lost 3–5 teeth, and 202 (4·3%) participants had lost half of one jaw or more. General characteristics of study population according to their dental status are shown in Table 1. Compared with those with full dentition, individuals who had lost half of one jaw or more, were older, had higher weight and BMI, were more likely to be married, female, smokers, obese and had irregular meal pattern.

The prevalence of IBS across categories of dental status is presented in Fig. 1. Irritable bowel syndrome was not significantly different in individuals who had lost 1–2, 3–5 or half of one jaw or more compared with those with full dentition ($P = 0{\cdot}06$). We also did not find a significant difference in terms of the preva-

*version 18.0; SPSS Inc., Chicago, IL, USA

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

	Dental status						
	All (n = 4669)	Full dentition (n = 1581)	Have denture (n = 445)	Lost 1–2 teeth (n = 1319)	Lost 3–5 teeth (n = 1122)	Lost ≥ half of 1 jaw (n = 202)	$P^{\dagger}$
Age (year)	36·5 ± 8·1[‡]	33·3 ± 7·4*	43·2 ± 7·5	35·6 ± 7·4*	38·5 ± 7·5*	42·8 ± 6·7	<0·001
Age range (year)	(19–70)	(19–70)	(25–69)	(20–57)	(19–69)	(28–61)	
Sex							
Females (%)		39·4[§]	7·5	30·4	19·8	2·9	<0·001
Male (%)		26·9	12·1	25·5	29·4	6·1	
Marital status							
Married (%)		30·2	10·1	28·8	25·7	5·2	<0·001
Single (%)		51·7	4·5	27·8	15·7	0·4	
Divorced/widowed (%)		36·1	25·0	25·0	11·1	2·8	
Smoking							
Current smoker (%)		8·9	40·0	4·4	28·9	17·8	<0·001
Ex-smoker (%)		10·4	28·5	19·7	30·6	10·9	
Non-smoker (%)		36·1	7·7	29·4	23·6	3·1	
Weight (kg)	69·9 ± 13·46	66·7 ± 12·8*	70·7 ± 13·1	68·4 ± 12·9*	71·4 ± 14·7	71·9 ± 12·3	<0·001
BMI (kg m^{-2})	25·1 ± 4·67	24·4 ± 4·7*	25·8 ± 4·2	24·9 ± 4·1*	25·7 ± 5·0	26·3 ± 5·9	<0·001
Use of dietary supplements							
Yes (%)		42·4	5·8	32·6	16·1	3·2	<0·001
No (%)		33·2	9·8	27·9	24·7	4·4	
Obesity status							
Normal weight (%)		39·1	8·3	28·9	20·2	3·5	<0·001
Overweight (%)		29·5	10·1	28·5	27·5	4·5	
Obese (%)		22·8	12·8	25·7	31·0	7·7	
Meal regularity							
Never (%)		27·7	11·6	22·8	29·3	8·6	<0·001
Sometimes (%)		32·8	10·1	27·0	25·4	4·9	
Often (%)		36·2	7·9	30·3	22·0	3·6	
Always (%)		33·4	11·4	28·0	23·8	3·4	

[†]Obtained from one-way analysis of variance or chi-square, where appropriate. Statistically significant values as compared with other categories (ANOVA) are marked with *.

[‡]Data are means ± standard deviation unless indicated.

[§]These percentages have been calculated as row percentages.

lence of IBS subtypes across categories of dental status (data not shown).

Multivariable-adjusted odds ratios for IBS across different categories of dental status are provided in Table 2. After adjustment for confounding variables, those who had lost 1–2 teeth had 35% greater odds to have IBS compared with fully dentate people (95% confidence interval: 1·10–1·64). In addition, those who had lost 3–5 teeth had 1·33 times greater odds for IBS than fully dentate ones (95% confidence interval: 1·07–1·66). We did not find any association between losing half of one jaw or more and prevalence of IBS, either in crude or adjusted models. After controlling for different confounders, individuals with dentures had 103% greater odds to have IBS-C than those with full dentition (95% CI: 1·29–3·21). However, we did not find a significant association between losing teeth and IBS-C in the study population. Either in crude or adjusted models, no significant association was seen between dental status and IBS-D, IBS-U or IBS-M.

Stratified analysis by gender revealed a positive significant relationship between loss of 1–2 teeth and IBS among men (Table 3). Women who had lost 3–5 teeth had 34% greater odds of having IBS than those with full dentition. Although losing 1–2 teeth were related to IBS-C in men in adjusted model (OR: 2·15, 95% CI: 1·02–4·56), having denture were

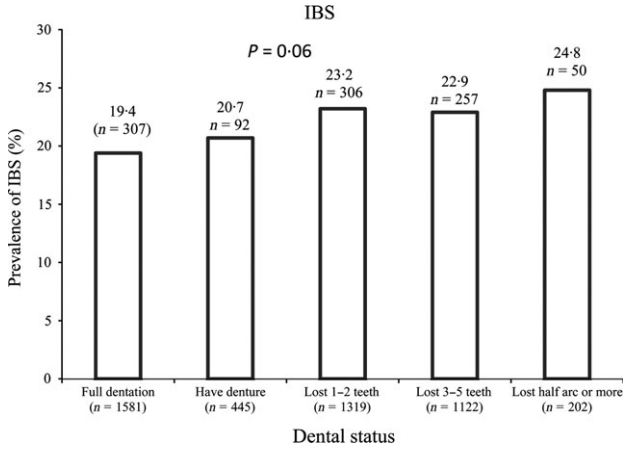

Fig. 1. Prevalence of irritable bowel syndrome (IBS) across categories of dental status in the study population (n = 4669). Irritable bowel syndrome was tended to be more prevalent among individuals who had lost 1–2, 3–5 or ≥ half of 1 jaw compared with those with full dentition (P = 0·06 from chi-square test).

related to IBS-C in women (OR: 2·18, 95% CI: 1·29–3·68). No significant associations were observed between losing teeth and other IBS subtypes in men and women.

Discussion

In the present cross-sectional study, we found that losing 1–2 and 3–5 teeth might be significantly associated with increased risk of IBS. In stratified analyses, this association was seen in men who had lost 1–2 teeth and in women who had lost 3–5 teeth. A positive association was also seen between IBS-C and having denture. To our knowledge, this is the first study examining the association between tooth loss and IBS.

Irritable bowel syndrome is a chronic condition often with severe consequences. Persons with IBS usually demonstrate impaired health-related quality of life (1–3). Despite the high prevalence of IBS in the general population and its personal and economic impacts, its aetiology remains largely unknown (15). Findings of the present study indicated that tooth loss is associated with the symptoms in IBS patients; however, the pathogenesis and pathophysiology of IBS is complex and not completely understood. Therefore, people should be clinically recommended to improve their tooth health to avoid missing teeth in a hope to decrease the risk of IBS symptoms.

There are several investigations on the relation between dental status and other gastrointestinal disorders, while no study has assessed its association with IBS, yet. Tosello *et al.* (8) reported high prevalence of gastrointestinal pathology (heart burns, precocious satiety, gastroesophageal reflux, transit disorders, regurgitation, epigastric pain, tumoral formation, pancreatitis and vomiting) in partially edentulous subjects. They reported that subjects with a natural set of teeth suffer from less gastrointestinal pathologies than others. In another study, a group of 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 (16). They found a strong degree of inflammation and infection (*Helicobacter pylori*) of the gastric mucosa in patients with severely impaired dental status. New evidence has indicated the oral microbiome harbours transient and permanent members that are potentially pathogenic

Table 2. Multivariable-adjusted odds ratios for irritable bowel syndrome across different categories of dental status[†]

	Dental status				
	Full dentition (n = 1581)	Have denture (n = 445)	Lost 1–2 teeth (n = 1319)	Lost 3–5 teeth (n = 1122)	Lost ≥ half of 1 jaw (n = 202)
IBS					
Crude	Ref.	1·08 (0·83–1·40)[‡]	1·25 (1·05–1·50)*	1·23 (1·02–1·49)*	1·37 (0·97–1·92)
Model 1[§]	Ref.	1·16 (0·86–1·57)	1·30 (1·08–1·58)*	1·28 (1·04–1·57)*	1·42 (0·96–2·12)
Model 2[¶]	Ref.	1·20 (0·88–1·64)	1·30 (1·07–1·59)*	1·29 (1·04–1·61)*	1·43 (0·95–2·16)
Model 3**	Ref.	1·22 (0·89–1·67)	1·35 (1·10–1·64)*	1·33 (1·07–1·66)*	1·44 (0·95–2·18)

[†]Irritable bowel syndrome (IBS) was defined based on Rome III criteria. Significant odds ratios are indicated by *.
[‡]All values are odds ratios (OR) and 95% confidence intervals (CI).
[§]Model 1: Adjusted for age and sex.
[¶]Model 2: Additionally adjusted for married status, smoking, supplement using, obesity.
**Model 3: Further adjusted for meal pattern regularity.

Table 3. Multivariable-adjusted odds ratios (OR) and 95% confidence intervals (CI) for irritable bowel syndrome across different categories of dental status, stratified by gender†

	Dental status (men)					Dental status (women)				
	Full dentition (*n* = 555)	Have denture (*n* = 250)	Lost 1–2 teeth (*n* = 526)	Lost 3–5 teeth (*n* = 606)	Lost ≥ half of 1 jaw (*n* = 126)	Full dentition (*n* = 1026)	Have denture (*n* = 195)	Lost 1–2 teeth (*n* = 793)	Lost 3–5 teeth (*n* = 516)	Lost ≥ half of 1 jaw (*n* = 76)
IBS										
Crude	Ref.	0·97‡ (0·64–1·48)	1·62 (1·19–2·21)*	1·38 (1·02–1·88)*	1·39 (0·85–2·28)	Ref.	1·42 (1·00–2·00)*	1·77 (0·90–1·40)	1·30 (1·02–1·66)*	1·77 (1·07–2·91) *
Model 1§	Ref.	0·92 (0·55–1·52)	1·69 (1·19–2·39)*	1·32 (0·93–1·87)	1·42 (0·80–2·52)	Ref.	1·43 (0·99–2·09)	1·15 (0·91–1·44)	1·27 (0·98–1·65)	1·51 (0·85–2·66)
Model 2¶	Ref.	1·02 (0·61–1·73)	1·81 (1·26–2·61)*	1·35 (0·93–1·96)	1·45 (0·79–2·65)	Ref.	1·38 (0·93–2·06)	1·11 (0·87–1·40)	1·29 (0·98–1·70)	1·44 (0·80–2·60)
Model 3**	Ref.	0·97 (0·58–1·69)	1·86 (1·29–2·68)*	1·37 (0·94–1·99)	1·42 (0·77–2·61)	Ref.	1·44 (0·97–2·16)	1·14 (0·90–1·45)	1·34 (1·02–1·77)*	1·48 (0·82–2·69)

†Irritable bowel syndrome (IBS) was defined based on Rome III criteria. Significant odds ratios are indicated by *.
‡All values are odds ratios (OR) and 95% confidence intervals (CI).
§Model 1: adjusted for age and sex.
¶Model 2: Additionally adjusted for married status, smoking, supplement using, obesity.
**Model 3: Further adjusted for meal pattern regularity.

for the gastrointestinal system (17, 18). For instance, the oral microbiome might function as a reservoir for *H. pylori*, which then can re-infect the stomach upon reaching clinical gastric health after long-time use of several antibiotics simultaneously. On the other hand, the presence of teeth and the number of functional teeth can affect masticatory function. The relation between masticatory function and gastrointestinal disorders was also evaluated in several studies (5, 8–10). Tooth loss has been associated with increased risk of upper gastrointestinal tract cancers especially non-cardia gastric cancer (19). In a cross-sectional study conducted in four nursing homes in Germany, a self-perceived impaired masticatory ability (stated chewing problems, discomfort with dentures and loose fit of dentures) was interrelated with the number of reported digestive complaints (constipation, diarrhoea, flatulence, heartburn, lack of appetite, vomiting and nausea as well as stool frequency) (20). A link between masticatory insufficiency and gastrointestinal disturbances, as expressed by the presence of diarrhoea and constipation, was also seen in elderly (21). However, Carretero *et al.* (22) 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. In addition, Hattori *et al.* (23) reported that gastrointestinal digestive function was not influenced by the reduction in food trituration caused by shortening the dental arch.

In this study, we found a significant relationship between losing 1–2 teeth and IBS-C in men, but no association was found between losing 1–2 or 3–5 teeth and IBS-D, IBS-M and IBS-U. The effect of chewing on digestive functions is not clear (23). Pera *et al.* (9) found that gastric emptying rate is significantly influenced by masticatory efficiency. They reported that adequate mastication decreased the time needed by the stomach to comminute food particles to a diameter small enough to pass through the pylorus. It has also been suggested that autonomic nervous activity is reduced in patients who are unable to masticate and swallow food, resulting in adverse effects on gastric motor function and excretion function (10). Not being able to identify a significant association between dental status and IBS-D,

IBS-M and IBS-U might be explained by the fact that the prevalence of these IBS subtypes was too low in the study population. We expected to find stronger association between greater tooth loss and IBS, but lack of such association might be explained by the low number of subjects who had lost half of one jaw or more ($n = 50$). Such a small number might lead to wider confidence intervals and non-significant results.

In the present study, we found that having denture, in the whole study population and particularly in women, was associated with increased odds of IBS-C. Previous investigators have also documented that subjects who had only a few teeth and more or less suitable dentures were preferentially exposed to reduced masticatory function and gastrointestinal pathologies (8). Reduced selection of foods rich in fibre, which are hard to chew, could provoke constipation in these subjects with deficient masticatory function (21).

In the present study, we used Rome III criteria to assess IBS. 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 or always) through consultation with experts. We also decided to ask about the presence of each symptom in the past 3 months, as participants did not clearly remember symptoms in the last 6 months. Both of these decisions were checked and confirmed with experts (N. Tally, personal communication).

In the present study, we did not collect information on 'functioning dentition', having at least 20 teeth or more and the number of occluding pairs of teeth left in the upper and lower jaws could reach each other or masticate. The pattern of tooth loss is usually more or less distributed in both sides of the dental jaw. So, having lost all teeth in a jaw cannot provide helpful information, as it simply means that at least eight teeth are missing. If one half of a jaw is missing, many more teeth may be missing and affect masticatory function. Therefore, we suggest for future investigations to consider these points.

Several mechanisms can explain the association between tooth loss and IBS. Masticatory efficiency is affected by the presence of teeth, the number of functional teeth and the use of prostheses, which influence the food choice (6, 24). Impaired masticatory function may lead to inadequate food intake and might alter nutrient intake (25). Individuals who lose their teeth may choose to eat industrially processed rather than natural foods that are low in fibre, have a low nutrient density and might have softened form (26, 27). They choose to eliminate crunchy foods such as raw vegetables and fresh fruits (6, 21). The poor functional characteristic leads to a semisolid or soft consistency of the alimentary bolus (10); therefore, insufficiently masticated food is released as whole or incompletely digested from the gastrointestinal tract (4). Masticatory efficiency may be related to fibre intake and food consistency, and therefore, impaired mastication can be considered as an indirect risk factor for some gastrointestinal diseases. Additionally, tooth loss might result in more psychological stress and consequently greater risk of IBS. On the other hand, tooth loss may be related to IBS, not via the masticatory function or digestive ability. Middle age subjects who have lost teeth due to severe periodontitis may also be expected to have IBS. These individuals may exhibit a highly active inflammatory response when exposed to the same level of infection/dental plaque, compared to those with moderate or mild periodontitis (12, 13). It is high likely that these hypersensitive individuals also are sensitive and allergic to agents and have IBS (12, 13). However, the mechanisms that relate tooth loss with gastrointestinal complications are not clear yet and further studies should be conducted to investigate possible mechanisms.

Our study has several strengths and potential limitations. The sample size in this study was substantially larger than previous studies on IBS. In addition, most previous studies in this field have been carried out on geriatric population, while the current study is among the first studies investigating the association between masticatory dysfunction and common gastrointestinal disorders. The study population consisted of a medical university non-academic staff, including crews, employees and managers.

Although the socio-economic status of the study population was representative of general Iranian population, extrapolating the findings to other populations might be made cautiously. Lack of having 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. In this study, the presence of severe malocclusion and position of teeth in the dental arch was not verified. Unfortunately, we did not gather data about decayed teeth and periodontal disease, which might be associated with pain and sensitivity that subsequently would affect the dietary choices. Also, the validity of the self-reported responses might be low for each response category, as the way of asking greatly influences the quality of the responses and hence the usability of collected data. 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. However, the previous findings from the questionnaire in this population have shown that self-reported values provided a reasonable information on dental status in these individuals (28). Also, a misclassification in dental status might happen in the present study, as we did not gather information on wisdom teeth. Many individuals are congenitally missing any number of the four-third molars, so the absence or presence of these teeth makes a big difference in the responses to the question. Some people might have had their up to four-third molars removed, but even though they would be included in the response regarding number of teeth lost, that should not count as having lost any teeth in conjunction with how many teeth are left to chew with.

It is concluded that losing 1–2 and 3–5 teeth might be significantly associated with increased risk of IBS. A positive association was seen between constipation-predominant IBS and having denture, particularly in women. Also losing 1–2 teeth might be linked to IBS-C in men, but not in women. Because of the young age and low number of individuals with IBS in this study, it was not possible to deduct any firm conclusions regarding the association between tooth loss and IBS. The results of the present study advocate performing further studies to investigate how dental status could affect gastrointestinal complaints.

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