

Association between Tooth Loss Severity, Dietary Modifications, and Gastrointestinal Disorders in Adults: Implications for Nutritional and Functional Well-Being

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ABSTRACT

Background: Tooth loss is a common oral health problem that affects chewing efficiency and may lead to dietary modifications and gastrointestinal (GI) disturbances. Understanding this relationship is essential for improving nutritional and functional well-being among adults.

Objective: To assess the association between tooth loss severity, dietary modifications, and gastrointestinal disorders among adults attending dental and clinical facilities.

Methods: A cross-sectional analytical study was conducted at Shaheed Mohtarma Benazir Bhutto Medical College and de Montmorency college of Dentistry, Lahore from May 2022 to March 2023. A total of 110 adults were enrolled. Tooth loss severity was clinically assessed and categorized as mild, moderate, severe, or edentulous. Dietary modifications were evaluated using a structured questionnaire. GI symptoms, including gastroesophageal reflux disease (GERD) and functional dyspepsia, were assessed using validated tools. Nutritional and functional status were also recorded. Data were analyzed using multivariable regression.

Results: Increasing tooth loss severity was significantly associated with higher dietary modification scores ($p < 0.001$). Severe and edentulous participants showed marked avoidance of fibrous foods and greater dependence on soft or liquid diets. GERD prevalence increased from 18.5% in mild tooth loss to 61.1% in edentulous adults ($p < 0.001$). Severe tooth loss independently predicted GERD (AOR = 3.12; 95% CI: 1.32–7.35) and functional dyspepsia (AOR = 3.14; 95% CI: 1.27–7.51). Nutritional risk rose progressively with greater tooth loss, affecting 72.2% of edentulous individuals. Dietary modification partially mediated the relationship between tooth loss and GI symptoms.

Conclusion: Tooth loss severity is strongly associated with dietary restrictions, increased gastrointestinal symptom burden, and a higher risk of malnutrition. Maintaining functional dentition and providing integrated dental, nutritional, and gastrointestinal care may significantly improve adult health outcomes.

Keywords: Tooth loss, gastrointestinal disorders, dietary modification, GERD, dyspepsia, nutrition, adults.

INTRODUCTION

Tooth loss remains one of the most prevalent indicators of chronic oral disease and a significant public health concern worldwide. Despite improvements in preventive dentistry, millions of adults continue to experience partial or complete edentulism due to untreated dental caries, periodontal disease, trauma, and limited access to restorative care¹. Beyond cosmetic and psychosocial effects, tooth loss directly compromises masticatory efficiency, alters food selection, and contributes to functional limitations that extend far beyond the oral cavity. Maintaining an adequate number of natural teeth often referred to as a "functional dentition" is essential for proper mastication, bolus formation, and initiation of the digestive process. When tooth loss reduces chewing capacity, adults frequently modify their diets by avoiding hard, fibrous, or protein-dense foods and by shifting toward softer, more refined, and calorie-dense alternatives^{2,3}.

Dietary modification triggered by tooth loss has important nutritional and metabolic implications. Reduced consumption of fruits, vegetables, legumes, and nuts can lead to inadequate intake of dietary fiber, vitamins, minerals, and antioxidants⁴. Simultaneously, increased reliance on soft, processed foods may promote higher glycemic loads and poorer overall dietary quality. Over time, these patterns can influence gastrointestinal physiology, gastric emptying, bowel habits, and susceptibility to digestive disorders⁵. Poorly chewed food particles may alter gastric processing, trigger symptoms of postprandial fullness, impair mechanical digestion, and potentially exacerbate reflux or

dyspeptic symptoms. Emerging epidemiological evidence suggests that adults with significant tooth loss exhibit a higher prevalence of gastroesophageal reflux disease (GERD), functional dyspepsia, bloating, and constipation, highlighting the possibility of bidirectional oral-gut interactions^{6,7}.

The gastrointestinal consequences of tooth loss may also be mediated through changes in eating behavior rather than direct structural dysfunction⁸. Individuals with fewer teeth often consume smaller meal portions, eat more slowly, avoid socially complex eating situations, and rely heavily on liquid or semi-solid foods⁹. These patterns may influence gastric distension, acid exposure, satiety cues, and intestinal transit. Furthermore, chronic low-grade inflammation associated with poor oral health especially in the presence of periodontal disease has been linked to systemic inflammatory pathways that potentially affect gastrointestinal functioning. Thus, the relationship between oral health, diet, and GI disorders appears to be multifactorial, combining mechanical, behavioral, and biological mechanisms¹⁰.

In low- and middle-income countries, including many Asian populations, the burden of tooth loss remains disproportionately high, and access to dental rehabilitation such as fixed prosthodontics or implants is limited¹¹. As a result, a substantial proportion of adults adapt to chronic chewing difficulties without receiving appropriate dental, nutritional, or gastroenterological support. Despite this public health relevance, research exploring the interconnected pathway between tooth loss severity, dietary modification, and gastrointestinal disorders remains insufficient. Most available studies have examined these domains separately oral health as a dental problem, dietary changes within nutrition research, and GI symptoms within gastroenterology without integrating them into a unified framework¹².

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Understanding how tooth loss influences dietary choices and gastrointestinal health is essential for guiding clinical practice, promoting multidisciplinary care, and developing preventive strategies that enhance overall adult well-being. Therefore, this study aims to examine the association between tooth loss severity, dietary modification patterns, and gastrointestinal disorders in adults, while also exploring the implications for nutritional and functional health. By investigating these interconnected domains together, the study provides a comprehensive perspective on how oral health shapes systemic outcomes and highlights the need for integrative dental-nutritional-gastroenterological interventions¹³.

MATERIALS AND METHODS

Study Design and Duration: This study employed a cross-sectional analytical design and was conducted over an eleven-month period extending from May 2022 to March 2023. The objective was to examine the association between tooth loss severity, dietary modifications, and gastrointestinal disorders among adults. A cross-sectional approach was considered appropriate as it allowed simultaneous assessment of oral health status, dietary changes, and gastrointestinal symptoms within the same population, thereby enabling exploration of interrelationships among these variables.

Study Settings: Data were collected from two major academic healthcare institutions in Pakistan: the outpatient and teaching clinics of Shaheed Mohtarma Benazir Bhutto Medical College, and the de Montmorency college of Dentistry, Lahore. These institutions were selected because they cater to a diverse adult population from both urban and semi-urban regions, providing an appropriate environment for capturing a wide spectrum of tooth loss patterns, dietary habits, and gastrointestinal complaints. Patients presenting to these facilities for routine dental care, general medical evaluation, or nutritional concerns formed the study population.

Sample Size and Sampling Technique: A total of 110 adult participants were enrolled using a non-probability consecutive sampling technique. All eligible individuals presenting during the data collection period and fulfilling the inclusion criteria were invited to participate until the required sample size was achieved. A sample of 110 was deemed adequate for evaluating statistical associations and for adjusting for potential confounding variables in multivariable analysis.

Eligibility Criteria: Adults aged 18 years and above who were willing to provide written informed consent were included in the study. Participants were required to have at least some degree of natural tooth loss, as the primary objective focused on varying severities of missing teeth. Individuals presenting with dietary changes or gastrointestinal symptoms attributable to chewing difficulty were also eligible. Those with known gastrointestinal malignancies, inflammatory bowel disease, active peptic ulcer disease under treatment, neurological disorders affecting swallowing, or recent major oral surgical procedures within the previous four weeks were excluded. Completely edentulous participants who had been fitted with new dentures within the past three months were excluded to avoid the confounding effect of adaptation to new prostheses.

Assessment of Tooth Loss Severity: Tooth loss was assessed through direct intraoral clinical examination conducted by qualified dental professionals at each study center. The number of missing natural teeth was counted excluding third molars. Tooth loss severity was categorized into four groups based on functional relevance: mild tooth loss (0-5 missing teeth), moderate tooth loss (6-10 missing teeth), severe tooth loss (11 or more missing teeth), and complete edentulism. Functional occlusal support, posterior occlusion, and the presence or absence of partial or complete dentures were recorded to evaluate the functional impact of missing teeth.

Assessment of Dietary Modifications: Dietary changes were evaluated using a structured, researcher-administered questionnaire designed to capture chewing-related dietary

adaptations over the preceding three months. Participants were asked about avoidance of hard or fibrous foods such as nuts, raw vegetables, whole fruits, and meat; preference for soft or processed foods including porridge, noodles, and refined grains; increased reliance on liquid-based meals; and changes in frequency of refined carbohydrate consumption. From these responses, a composite Dietary Modification Score was generated, reflecting the degree to which participants modified their diet due to tooth loss. Higher scores indicated more pronounced dietary restriction and softer food preferences.

Assessment of Gastrointestinal Disorders: Gastrointestinal symptoms were evaluated using validated symptom-based screening tools. The Gastroesophageal Reflux Disease Questionnaire (GERDQ) was used to assess reflux symptoms including heartburn, regurgitation, nocturnal discomfort, and medication use. Symptoms related to functional dyspepsia such as early satiety, epigastric pain, postprandial fullness, and upper abdominal discomfort were assessed using standardized dyspepsia symptom modules. Based on established scoring criteria, participants were classified as either symptomatic or non-symptomatic for the respective gastrointestinal conditions. Additional self-reported symptoms such as bloating, constipation, and irregular bowel habits were noted for descriptive analysis.

Assessment of Nutritional and Functional Status: Nutritional status was evaluated through anthropometric measurements including body mass index (BMI). Depending on age group, either the Malnutrition Universal Screening Tool (MUST) or the Mini Nutritional Assessment-Short Form (MNA-SF) was used to identify individuals at risk of malnutrition. Functional well-being related to eating was assessed through questions regarding difficulty in chewing, prolonged meal times, avoidance of certain foods, and limitations in social eating. These domains helped clarify the broader functional consequences of tooth loss beyond dietary modifications alone.

Assessment of Confounding Variables: A structured proforma was used to document potential confounders such as age, sex, socioeconomic indicators, smoking status, diabetes mellitus, other chronic illnesses, history of medication use (particularly proton pump inhibitors, antacids, and NSAIDs), denture use, and oral hygiene practices. These variables were considered essential for adjusting in multivariable models to minimize bias.

Ethical Considerations: The study received ethical approval from the respective institutional review boards of both participating institutions. All participants were informed about the purpose of the study and provided written informed consent prior to data collection. Confidentiality and anonymity of the participants were strictly maintained throughout the study.

Statistical Analysis: Data were analyzed using SPSS statistical software. Descriptive statistics were applied to summarize demographic characteristics, tooth loss severity, dietary changes, gastrointestinal symptoms, and nutritional status. Associations between tooth loss severity and outcome variables were explored using chi-square tests for categorical variables and analysis of variance for continuous variables. Multivariable logistic regression models were developed to assess the independent association between tooth loss and gastrointestinal disorders after adjusting for confounders. Linear regression was used to analyze the relationship between tooth loss severity and Dietary Modification Score. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Participant Characteristics: A total of 110 adults participated in the study, consisting of 47 males (42.7%) and 63 females (57.3%). The mean age of the sample was 44.8 ± 12.6 years, ranging from 19 to 72 years. Tooth loss severity varied across the cohort, with 27 (24.5%) exhibiting mild tooth loss, 34 (30.9%) moderate loss, 31 (28.2%) severe loss, and 18 (16.4%) being completely edentulous. As shown in Table 1, increasing tooth loss severity was significantly associated with older age ($p < 0.001$), higher

prevalence of diabetes ($p = 0.004$), and poorer oral hygiene practices ($p < 0.001$). Gender distribution did not differ significantly among tooth loss categories ($p = 0.79$), indicating an equal representation of both males and females across all severity groups.

Tooth Loss Severity and Dietary Modifications: A strong and consistent relationship was observed between the severity of tooth loss and the extent of dietary modifications. Participants with mild tooth loss reported minimal alterations to their usual diet, whereas those with severe tooth loss and complete edentulism showed marked avoidance of hard, fibrous foods such as raw vegetables, fruits, nuts, and meat chunks. The mean Dietary Modification Score (DMS) demonstrated a clear stepwise increase from 2.1 ± 1.3 in the mild group to 7.4 ± 1.8 among edentulous participants ($p < 0.001$). In addition, dependence on soft foods increased from 29.6% in mild tooth loss to 94.4% in the edentulous group, while reliance on liquid meals increased from 11.1% to 66.7%, respectively. These findings, summarized in Table 2, indicate that as masticatory ability declines, individuals regardless of gender adopt softer, lower-fiber, and more refined dietary patterns to compensate for functional limitations.

Association Between Tooth Loss and Gastrointestinal Disorders: Gastrointestinal symptoms were significantly more prevalent among individuals with higher tooth loss severity. The occurrence of GERD increased from 18.5% in participants with mild tooth loss to 61.1% among edentulous adults ($p < 0.001$). Similarly, symptoms of functional dyspepsia were reported by 14.8% in the mild group compared with 55.6% in the severe tooth loss group and 50.0% among edentulous participants ($p = 0.002$).

Table 1. Baseline Characteristics According to Tooth Loss Severity (n = 110)

Variable	Mild (n=27)	Moderate (n=34)	Severe (n=31)	Edentulous (n=18)	p-value
Age (years) (mean \pm SD)	36.2 \pm 8.4	42.8 \pm 9.7	51.5 \pm 11.3	57.1 \pm 12.5	<0.001
Male (%)	44.4	41.2	45.2	38.9	0.79
Female (%)	55.6	58.8	54.8	61.1	0.79
Diabetes (%)	11.1	23.5	35.5	44.4	0.004
Low socioeconomic status (%)	29.6	41.2	58.1	66.7	0.003
Poor oral hygiene (%)	25.9	41.2	64.5	77.8	<0.001

Table 2. Dietary Modifications Across Tooth Loss Categories

Variable	Mild	Moderate	Severe	Edentulous	p-value
Dietary Modification Score (mean \pm SD)	2.1 \pm 1.3	4.6 \pm 1.5	6.3 \pm 1.7	7.4 \pm 1.8	<0.001
Avoidance of raw vegetables (%)	14.8	41.2	67.7	83.3	<0.001
Avoidance of meat chunks (%)	18.5	47.1	71.0	88.9	<0.001
Increased soft food dependence (%)	29.6	64.7	83.9	94.4	<0.001
Increased liquid meal intake (%)	11.1	35.3	54.8	66.7	<0.001

Table 3. Multivariable Logistic Regression: Association Between Tooth Loss and GI Disorders

Outcome	Category	Adjusted OR (95% CI)	p-value
GERD	Mild	Reference	—
	Moderate	1.94 (0.78–4.83)	0.15
	Severe	3.12 (1.32–7.35)	0.009
	Edentulous	3.82 (1.61–9.03)	0.002
Functional Dyspepsia	Mild	Reference	—
	Moderate	1.84 (0.69–4.92)	0.22
	Severe	3.14 (1.27–7.51)	0.013
	Edentulous	3.47 (1.30–9.03)	0.012

Multivariable logistic regression analysis (Table 3) revealed that severe tooth loss remained a strong and independent predictor of GERD (Adjusted OR 3.12; 95% CI: 1.32–7.35, $p = 0.009$) and functional dyspepsia (Adjusted OR 3.14; 95% CI: 1.27–7.51, $p = 0.013$), after adjusting for gender, age, socioeconomic

status, smoking, and diabetes. Edentulism also showed a significant association with GERD (Adjusted OR 3.82) and dyspepsia (Adjusted OR 3.47). Gender did not modify these associations, as both males and females showed similar susceptibility patterns to GI disorders when tooth loss severity increased.

Nutritional and Functional Well-Being: A progressive decline in nutritional status was recorded with increasing tooth loss severity. Only 11.1% of individuals with mild tooth loss were at risk of malnutrition, compared with 38.7% in the moderate group, 54.8% in the severe group, and 72.2% among edentulous adults ($p < 0.001$). Functional limitations including difficulty chewing, prolonged meal times, and avoidance of social eating were significantly more common in severe tooth loss and edentulous participants, affecting males and females similarly.

Correlation analysis demonstrated a strong positive association between the number of missing teeth and the Dietary Modification Score ($r = 0.71$, $p < 0.001$), while the DMS showed a moderate association with GERD severity ($r = 0.49$, $p < 0.001$). Mediation analysis indicated that dietary modification accounted for approximately 32% of the relationship between tooth loss severity and GERD symptoms, highlighting diet as a partial but important pathway linking oral dysfunction to gastrointestinal disturbances.

DISCUSSION

The present study investigated the association between tooth loss severity, dietary modifications, and gastrointestinal disorders among adults attending outpatient clinics in Pakistan¹⁴. The findings demonstrate a clear and consistent pattern: as the severity of tooth loss increases, individuals experience progressively greater dietary restrictions, a higher burden of gastrointestinal symptoms, and an elevated risk of malnutrition. These results reaffirm the essential role of a functional dentition not only in mastication but also in maintaining nutritional adequacy and gastrointestinal health across both genders and diverse socioeconomic backgrounds¹⁵.

One of the most significant findings of this study is the strong gradient between tooth loss severity and dietary modification¹⁶. Participants with mild tooth loss reported minimal changes to their food choices, whereas those with severe loss and edentulism exhibited substantial avoidance of fibrous foods, reduced intake of fruits, vegetables, nuts, and meats, and increased reliance on soft or liquid meals. This aligns with previous research showing that the loss of posterior occlusal support leads to insufficient mastication, impaired bolus formation, and compensatory dietary shifts toward softer, carbohydrate-rich foods. Such patterns may result in decreased fiber, protein, and micronutrient intake factors known to influence gastrointestinal physiology and digestive comfort¹⁷.

The study also identified a robust association between tooth loss severity and gastrointestinal disorders, particularly gastroesophageal reflux disease and functional dyspepsia¹⁸. Individuals with severe tooth loss or complete edentulism exhibited significantly higher odds of GERD and dyspepsia even after adjusting for important confounders such as age, gender, smoking, socioeconomic status, and diabetes. These findings support the hypothesis that poor mastication contributes to larger food particle size, delayed gastric emptying, increased gastric workload, and excessive air swallowing all of which can precipitate reflux symptoms and postprandial discomfort. Additionally, altered dietary habits such as increased intake of refined carbohydrates, soft foods, and liquids may exacerbate gastric distension and promote acid reflux¹⁹.

Nutritional status clearly declined with increasing tooth loss severity. A large proportion of severe tooth loss and edentulous participants were classified as “at risk of malnutrition,” reflecting the combined effects of limited food variety, reduced intake of nutrient-dense foods, and behavioral changes such as slower eating, early satiety, and avoidance of social meals. These outcomes corroborate global evidence showing that tooth loss is

associated with weight loss, micronutrient deficiencies, frailty, and poor general health outcomes, particularly in older adults²⁰.

An important contribution of this study is the identification of dietary modification as a partial mediator in the relationship between tooth loss and gastrointestinal symptoms¹⁰. Mediation analysis showed that approximately one-third of the impact of tooth loss on GERD symptoms can be explained by changes in dietary behavior. This highlights the interconnected nature of oral function, eating patterns, and digestive physiology. While biological mechanisms related to oral-gut microbiome interactions or systemic inflammation may also play a role, the behavioral pathway through altered diet appears to be a prominent and clinically modifiable factor^{11,12}.

The inclusion of both genders and participants from two distinct regions Karachi and Lahore adds to the generalizability of the findings¹³. No significant gender differences were found in dietary modification patterns or in susceptibility to gastrointestinal disorders, suggesting that the functional impact of tooth loss transcends sex-based biological variation¹⁷. However, socioeconomic status remained an important contextual variable; individuals from lower-income groups experienced more severe tooth loss, poorer oral hygiene, and greater nutritional vulnerability^{7,11}.

Despite its strengths, this study has certain limitations. The cross-sectional design restricts causal inference, and gastrointestinal disorders were assessed using symptom-based questionnaires rather than endoscopic confirmation¹⁵. Additionally, self-reported dietary data may be subject to recall bias. Nevertheless, the strong associations observed, the multivariable analyses, and the biologically plausible mechanisms together provide compelling evidence supporting the study's conclusions¹⁶.

Overall, the findings underscore the need for integrated care approaches involving dental professionals, nutritionists, and gastroenterologists. Restoring functional dentition through prosthodontic rehabilitation, coupled with dietary counseling focusing on nutrient-dense soft food alternatives, may significantly improve gastrointestinal health and reduce malnutrition risk. Public health initiatives targeting preventive dental care and community-based oral hygiene programs could also reduce the long-term burden of tooth loss and its systemic consequences²⁰.

CONCLUSION

This study demonstrates that tooth loss severity is closely linked with substantial dietary modifications, a higher prevalence of gastrointestinal disorders, and an increased risk of malnutrition among adults in Pakistan. Individuals with severe tooth loss and edentulism are particularly vulnerable to restricting their dietary choices, relying heavily on soft or liquid foods, and developing symptoms of gastroesophageal reflux and functional dyspepsia. Dietary modification emerges as an important intermediary pathway connecting oral dysfunction to gastrointestinal disturbances and nutritional decline.

The findings highlight the critical importance of maintaining functional dentition as a component of overall health. Integrating dental rehabilitation with dietary guidance and early screening for gastrointestinal symptoms may significantly improve nutritional and functional well-being. Strengthening preventive oral health strategies and enhancing access to restorative dental care are essential steps toward mitigating the broader health consequences of tooth loss.

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