

Gastroesophageal Reflux Symptom Burden and Dental Caries Experience Among Adults in Syria: A Cross- Sectional Study

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Abstract

Background

Gastroesophageal reflux disease is associated with several oral manifestations, particularly dental erosion; however, its relationship with dental caries experience remains less clearly established. This study evaluated the association between reflux symptom burden and cumulative dental caries experience among adults in Syria.

Methods

This cross-sectional, questionnaire-based study was conducted in Damascus, Syria, between March and May 2026. A total of 258 adults completed a structured questionnaire. Reflux symptom burden was assessed using the Reflux Symptom Questionnaire 7-day recall (RESQ-7), including frequency, intensity, domain, and overall full scores. Dental caries experience was assessed using a self-reported Decayed, Missing, and Filled Teeth index. Bivariate associations with DMFT score were assessed using non-parametric tests, and multiple linear regression was used to identify factors independently associated with DMFT score.

Results

The median age was 25.0 years, and 53.1% of participants were female. Self-reported diagnosed GERD was reported by 19.0%. The median DMFT score was 7.0, and the median RESQ-7 full score was 16.50. The RESQ-7 demonstrated excellent internal consistency (Cronbach's alpha = 0.936). Higher DMFT was associated with older age, higher BMI, and greater reflux symptom burden, including RESQ-7 total frequency, total intensity, and full scores (all $p < 0.001$). After adjustment, higher RESQ-7 full score remained significantly associated with higher DMFT score ($p = 0.006$).

Discussion

Higher reflux symptom burden was modestly associated with greater self-reported dental caries experience. This association should be interpreted within the multifactorial and cumulative nature of DMFT. Longitudinal studies using objective reflux and oral-health assessments are needed.

Introduction

Gastroesophageal reflux disease (GERD) is a common chronic gastrointestinal disorder that develops when reflux of gastric contents into the esophagus causes troublesome symptoms and/or complications. (1, 2) Its burden varies across populations and is influenced by lifestyle, dietary habits, obesity, symptom perception, and diagnostic approach. (2–4) The typical symptoms of GERD include heartburn and regurgitation; however, the disease may also present with atypical or extra-esophageal manifestations, including chronic cough, laryngitis, hoarseness, sleep disturbance, and dental erosion. (1, 2, 5) Because reflux-related symptoms may occur without prior objective evaluation or formal diagnosis, structured symptom assessment may be useful outside gastroenterology settings.

The oral cavity is increasingly recognized as a relevant site for reflux-related manifestations. Repeated exposure of the oral cavity to gastric acid may reduce oral pH, alter salivary flow and buffering capacity, impair enamel mineral balance, and contribute to hard- and soft-tissue changes. (2, 6–9) Among dental outcomes, dental erosion is the most consistently described reflux-related manifestation. It represents non-bacterial loss of dental hard tissue caused by chemical acid exposure, making it biologically compatible with repeated intrinsic acid reflux. (10–13) However, oral outcomes in GERD are multifactorial and may be modified by diet, oral hygiene, salivary protection, fluoride exposure, bruxism, smoking, and other behavioral or clinical factors.

Compared with dental erosion, the relationship between reflux symptoms and dental caries is less clearly established. Dental caries is a complex, biofilm-mediated, and diet-related disease influenced by socioeconomic, behavioral, environmental, and demographic determinants. The DMFT index provides a standardized measure of cumulative dental caries experience, but it is

also influenced by age, oral hygiene practices, dental care access, smoking, body mass index, and long-term behavioral exposures. (2, 4, 14) Therefore, evaluating reflux symptom burden in relation to DMFT requires careful interpretation within this broader multifactorial framework.

This study aimed to evaluate the association between reflux symptom burden, assessed using the RESQ-7 questionnaire, and dental caries experience, measured by the DMFT index, among adult dental clinic patients in Syria.

Methods

Study design and setting

This cross-sectional, questionnaire-based study was conducted **in Damascus, Syria, between March and May 2026**. The study included adult patients attending dental clinics who completed a structured questionnaire assessing sociodemographic characteristics, clinical history, lifestyle factors, oral-health-related variables, reflux-related symptoms, and the patient-reported impact of reflux symptoms.

Study population and eligibility criteria

The study population included adults aged 18 years or older who provided complete questionnaire data, including reflux symptom assessment and **self-reported dental caries experience**. Participants younger than 18 years, individuals who declined participation, and those with incomplete questionnaire responses or missing dental caries data were excluded. A total of 258 participants were included in the final analysis.

Sampling and data collection

Participants were recruited using a convenience sampling approach during the study period. Data were collected using a structured Google Form administered through face-to-face interview. The questionnaire collected information on sociodemographic characteristics, medical history, medication use, lifestyle factors, oral-hygiene practices, reflux-related symptoms, and the perceived effect of reflux symptoms on sleep, appetite, work, or studies.

DMFT and RESQ-7 assessment

Dental caries experience was assessed using a self-reported Decayed, Missing, and Filled Teeth index. For each participant, the numbers of decayed, missing, and filled teeth were recorded. The main outcome was the DMFT score, calculated as:

DMFT = number of decayed teeth + number of missing teeth + number of filled teeth.

The DMFT score was interpreted as a self-reported cumulative measure of dental caries experience.

Reflux symptoms were assessed using the Reflux Symptom Questionnaire 7-day recall (RESQ-7), UK-English source version. The RESQ-7 is a validated self-reported questionnaire designed to assess the frequency and intensity of gastroesophageal reflux symptoms during the preceding seven days. (15) The instrument includes 13 symptom items, each assessed for both frequency and intensity, and the items are aggregated into four domains: heartburn, regurgitation, burping, and cough/hoarseness/difficulty swallowing.

The RESQ-7 was used under a formal licence agreement granted to Syrian Private University by AstraZeneca/RWS Life Sciences for the present non-commercial academic study. The questionnaire was administered electronically using Google Forms, in accordance with the licence terms.

Frequency and intensity responses were initially coded from 0 to 5. According to the official RESQ-7 scoring instructions, frequency responses were recoded to reflect the number of symptomatic days during the previous week: 0 for "did not have," 1 for "1 day," 2 for "2 days," 3.5 for "3–4 days," 5.5 for "5–6 days," and 7 for "daily." Intensity responses were not recoded. Domain

scores were calculated as the mean of the corresponding items. Total frequency score, total intensity score, and overall RESQ-7 full score were then calculated. The RESQ-7 full score was interpreted as a measure of reflux symptom burden rather than as a confirmed clinical diagnosis of GERD.

Other study variables

Other collected variables included age, sex, residence, educational level, economic status, body mass index, self-reported previous GERD diagnosis, diagnosed peptic ulcer, history of upper endoscopy, chronic disease, medication use, smoking status, pack-years, caffeine beverage intake, fast-food intake, meal intake within two hours before sleep, tooth brushing before and after sleep, mouthwash use, regular dental check-up, dental visit during the previous month, hoarseness or persistent phlegm, quality-of-life rating, self-rated health, and patient-reported effects of reflux symptoms on sleep, appetite, work, or studies.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 26. Continuous and ordinal score variables were summarized as median and interquartile range, while categorical variables were summarized as frequencies and percentages.

Internal consistency of the RESQ-7 was assessed using Cronbach's alpha across the 26 frequency and intensity items. The RESQ-7 demonstrated excellent internal consistency in the present sample, with a Cronbach's alpha of 0.936 among 258 participants.

Bivariate associations with DMFT score were assessed according to variable type. Spearman correlation was used for continuous and score variables. The Mann–Whitney U test was used for binary categorical variables, and mean ranks were reported. The Kruskal–Wallis test was used for categorical variables with more than two groups, with mean ranks used to describe group differences. The Jonckheere–Terpstra trend test was used for ordered variables where appropriate. Only statistically significant bivariate associations were presented in the supplementary material (Table S1).

Multiple linear regression was performed to identify factors independently associated with DMFT score. The dependent variable was DMFT score. The model included RESQ-7 full score, BMI, smoking status, caffeine beverage intake, fast-food intake, meal intake within two hours before sleep, tooth brushing before and after sleep, and regular dental check-up. Regression coefficients, standard errors, standardized beta coefficients, 95% confidence intervals, p-values, tolerance, and variance inflation factor were reported. Collinearity was assessed using tolerance and variance inflation factor. A two-sided p-value < 0.05 was considered statistically significant.

Ethical considerations

The study protocol was approved by the Research Ethics Committee of the Syrian Private University (SPU), Faculty of Medicine (Approval No. MD-30032026-135). Verbal informed consent was obtained from all participants before enrollment, and participation was voluntary and anonymous.

Results

Sample characteristics

A total of 258 participants were included. The median age was 25.0 years, and 137 participants were female (53.1%). Most participants lived in urban areas (76.4%) and had a university-level education (68.2%). Self-reported diagnosed GERD was reported by 19.0% of participants. The median BMI was 24.2 kg/m². The median DMFT score was 7.0, with a median of 2.0 decayed teeth and 0.0 missing teeth. (Table 1)

Table 1
Baseline sociodemographic, clinical, lifestyle, and oral health characteristics Overall sample: N = 258

Characteristic	Category / statistic	Overall (N = 258)
Demographic and socioeconomic characteristics		
Age, years	Median (IQR)	25.0 (20.0–44.0)
Sex	Female	137 (53.1)
	Male	121 (46.9)
Residence	Suburbs	61 (23.6)
	Urban	197 (76.4)
Education level	Elementary	30 (11.6)
	High school	52 (20.2)
	University graduate	176 (68.2)
Economic status	Below average	23 (8.9)
	Average	190 (73.6)
	Above average	45 (17.4)
BMI, kg/m ²	Median (IQR)	24.2 (21.9–27.0)
Clinical history and medication use		
Self-reported diagnosed GERD	No	209 (81.0)
	Yes	49 (19.0)
NSAID/analgesic use	No	178 (69.0)
	Yes	80 (31.0)
Diagnosed peptic ulcer	No	240 (93.0)
	Yes	18 (7.0)
History of upper endoscopy	No	225 (87.2)
	Yes	33 (12.8)
Chronic disease	No	212 (82.2)
	Yes	46 (17.8)
Lifestyle factors		
Smoking status	Never	171 (66.3)
	Current	68 (26.4)
	Former	19 (7.4)
Pack-years between current smokers (n = 61)	Median (IQR)	6.0 (3.0–25.0)
Caffeine beverage use	No	40 (15.5)
	Yes	218 (84.5)
Data are presented as median (IQR) for continuous/ordinal score variables and n (%) for categorical variables. IQR indicates interquartile range; BMI , body mass index; GERD , gastroesophageal reflux disease; NSAID , non-steroidal anti-inflammatory drug. NSAID/analgesic use included ibuprofen, aspirin, or diclofenac. Pack-years between smokers was available for 61 participants.		

Characteristic	Category / statistic	Overall (N = 258)
Demographic and socioeconomic characteristics		
Fast-food intake	Rarely	62 (24.0)
	Once weekly	97 (37.6)
	Twice weekly or more	99 (38.4)
Meal within 2 hours before sleep	No	93 (36.0)
	Yes	165 (64.0)
Oral hygiene and dental characteristics		
Brushing teeth before and after sleep	No	95 (36.8)
	Yes	163 (63.2)
Mouthwash use	No	215 (83.3)
	Yes	43 (16.7)
Regular dental check-up	No	160 (62.0)
	Yes	98 (38.0)
Dental visit in the past month	No	193 (74.8)
	Yes	65 (25.2)
Number of decayed teeth	Median (IQR)	2.0 (0.75-5.0)
Number of missing teeth	Median (IQR)	0.0 (0.0–2.0)
DMFT score	Median (IQR)	7 (3–11)
Data are presented as median (IQR) for continuous/ordinal score variables and n (%) for categorical variables. IQR indicates interquartile range; BMI , body mass index; GERD , gastroesophageal reflux disease; NSAID , non-steroidal anti-inflammatory drug. NSAID/analgesic use included ibuprofen, aspirin, or diclofenac. Pack-years between smokers was available for 61 participants.		

Reflux-related symptoms and RESQ-7 scores

Hoarseness or persistent phlegm was reported by 27.9% of participants. Reflux symptoms affected sleep in 42.6%, work or studies in 29.1%, and appetite in 33.3%. The median quality-of-life and self-rated health scores were both 3.0. The median RESQ-7 total frequency score was 8.50, the median total intensity score was 8.00, and the median overall RESQ-7 full score was 16.50. The RESQ-7 demonstrated excellent internal consistency, with a Cronbach's alpha of 0.936 across the 26 frequency and intensity items. (Tables 2–4)

Table 2
Reflux-related symptoms and patient-reported impact *Overall sample: N = 258*

Characteristic	Category / statistic	Overall (N = 258)
Reflux-related symptoms and patient-reported impact		
Hoarseness or persistent phlegm	No	186 (72.1)
	Yes	72 (27.9)
Quality-of-life rating (1–5)	Median (IQR)	3.0 (3.0–4.0)
Health rating (1–5)	Median (IQR)	3.0 (3.0–4.0)
Reflux symptoms affect work/studies	No	183 (70.9)
	Yes	75 (29.1)
Reflux symptoms affect sleep	No	148 (57.4)
	Yes	110 (42.6)
Reflux symptoms affect appetite	No	172 (66.7)
	Yes	86 (33.3)
Data are presented as median (IQR) for ordinal score variables and n (%) for categorical variables. IQR indicates interquartile range.		

Table 3

Descriptive distribution of RESQ-7 frequency responses and frequency domain scores Values are shown as n (%) for categorical item responses and median (IQR) for continuous scores. N = 258.

Domain	RESQ-7 item / score	Did not have	1 day	2 days	3–4 days	5–6 days	Daily	Median (IQR)
Heartburn domain								
	a. A burning feeling behind the breastbone	156 (60.5%)	29 (11.2%)	24 (9.3%)	23 (8.9%)	7 (2.7%)	19 (7.4%)	—
	b. Pain behind the breastbone	189 (73.3%)	21 (8.1%)	17 (6.6%)	13 (5.0%)	6 (2.3%)	12 (4.7%)	—
	c. A burning feeling in the center of the upper stomach	132 (51.2%)	49 (19.0%)	35 (13.6%)	15 (5.8%)	10 (3.9%)	17 (6.6%)	—
	d. Pain in the center of the upper stomach	160 (62.0%)	37 (14.3%)	27 (10.5%)	17 (6.6%)	9 (3.5%)	8 (3.1%)	—
	m. Heartburn	167 (64.7%)	26 (10.1%)	27 (10.5%)	21 (8.1%)	5 (1.9%)	12 (4.7%)	—
	Heartburn frequency domain score	—	—	—	—	—	—	0.40 (0.00–1.80)
Regurgitation domain								
	e. An acid/sour taste in the mouth	159 (61.6%)	42 (16.3%)	29 (11.2%)	16 (6.2%)	6 (2.3%)	6 (2.3%)	—
	k. A bitter taste in the mouth	181 (70.2%)	30 (11.6%)	18 (7.0%)	10 (3.9%)	7 (2.7%)	12 (4.7%)	—
	f. Unpleasant movement of material upward from the stomach	141 (54.7%)	50 (19.4%)	30 (11.6%)	20 (7.8%)	10 (3.9%)	7 (2.7%)	—
	l. Stomach contents moving upward to the throat or mouth	141 (54.7%)	56 (21.7%)	21 (8.1%)	13 (5.0%)	14 (5.4%)	13 (5.0%)	—
	Regurgitation frequency domain score	—	—	—	—	—	—	0.50 (0.00–1.62)
Burping domain								
	g. Burping	124 (48.1%)	41 (15.9%)	33 (12.8%)	28 (10.9%)	13 (5.0%)	19 (7.4%)	—
	Burping frequency domain score	—	—	—	—	—	—	1.00 (0.00–2.00)
Cough/hoarseness/difficulty swallowing domain								
	h. Hoarseness	188 (72.9%)	30 (11.6%)	10 (3.9%)	17 (6.6%)	6 (2.3%)	7 (2.7%)	—
	i. Cough	139 (53.9%)	43 (16.7%)	29 (11.2%)	25 (9.7%)	9 (3.5%)	13 (5.0%)	—
	j. Difficulty swallowing	174 (67.4%)	32 (12.4%)	17 (6.6%)	19 (7.4%)	6 (2.3%)	10 (3.9%)	—
	Cough/hoarseness/difficulty swallowing frequency domain	—	—	—	—	—	—	0.33 (0.00–

Abbreviations and notes: RESQ-7, Reflux Symptom Questionnaire 7-day recall; IQR, interquartile range. Frequency response categories reflect the number of symptomatic days over the previous 7 days. Domain scores are presented after the corresponding items within each RESQ-7 domain.

Domain	RESQ-7 item / score	Did not have	1 day	2 days	3–4 days	5–6 days	Daily	Median (IQR)
Heartburn domain								
	score							1.21)
	Total RESQ-7 frequency score	—	—	—	—	—	—	8.50 (2.00–22.00)
Abbreviations and notes: RESQ-7, Reflux Symptom Questionnaire 7-day recall; IQR, interquartile range. Frequency response categories reflect the number of symptomatic days over the previous 7 days. Domain scores are presented after the corresponding items within each RESQ-7 domain.								

Table 4

Descriptive distribution of RESQ-7 intensity responses and intensity domain scores Values are shown as *n (%)* for categorical item responses and median (*IQR*) for continuous scores. *N* = 258.

Domain	RESQ-7 item / score	Did not have	Very mild	Mild	Moderate	Moderately severe	Severe	Median (<i>IQR</i>)
Heartburn domain								
	a. A burning feeling behind the breastbone	150 (58.1%)	28 (10.9%)	30 (11.6%)	25 (9.7%)	15 (5.8%)	10 (3.9%)	—
	b. Pain behind the breastbone	184 (71.3%)	18 (7.0%)	16 (6.2%)	18 (7.0%)	13 (5.0%)	9 (3.5%)	—
	c. A burning feeling in the center of the upper stomach	144 (55.8%)	33 (12.8%)	28 (10.9%)	31 (12.0%)	6 (2.3%)	16 (6.2%)	—
	d. Pain in the center of the upper stomach	154 (59.7%)	33 (12.8%)	27 (10.5%)	23 (8.9%)	13 (5.0%)	8 (3.1%)	—
	m. Heartburn	163 (63.2%)	32 (12.4%)	23 (8.9%)	21 (8.1%)	8 (3.1%)	11 (4.3%)	—
	Heartburn intensity domain score	—	—	—	—	—	—	0.60 (0.00–1.60)
Regurgitation domain								
	e. Acid/sour taste in the mouth	158 (61.2%)	41 (15.9%)	29 (11.2%)	20 (7.8%)	7 (2.7%)	3 (1.2%)	—
	k. Bitter taste in the mouth	179 (69.4%)	24 (9.3%)	22 (8.5%)	18 (7.0%)	6 (2.3%)	9 (3.5%)	—
	f. Unpleasant movement of material upward from the stomach	146 (56.6%)	39 (15.1%)	39 (15.1%)	22 (8.5%)	10 (3.9%)	2 (0.8%)	—
	l. Stomach contents moving upward to the throat or mouth	147 (57.0%)	40 (15.5%)	34 (13.2%)	18 (7.0%)	6 (2.3%)	13 (5.0%)	—
	Regurgitation intensity domain score	—	—	—	—	—	—	0.50 (0.00–1.50)
Burping domain								
	g. Burping	136 (52.7%)	38 (14.7%)	38 (14.7%)	19 (7.4%)	16 (6.2%)	11 (4.3%)	—
	Burping intensity domain score	—	—	—	—	—	—	0.00 (0.00–2.00)
Cough/hoarseness/difficulty swallowing domain								
	h. Hoarseness	188 (72.9%)	34 (13.2%)	12 (4.7%)	14 (5.4%)	6 (2.3%)	4 (1.6%)	—
	i. Cough	145 (56.2%)	41 (15.9%)	25 (9.7%)	32 (12.4%)	8 (3.1%)	7 (2.7%)	—
	j. Difficulty swallowing	171 (66.3%)	35 (13.6%)	18 (7.0%)	15 (5.8%)	8 (3.1%)	11 (4.3%)	—

Abbreviations and notes: RESQ-7, Reflux Symptom Questionnaire 7-day recall; IQR, interquartile range. Intensity response categories reflect symptom severity. Domain scores are presented after the corresponding items within each RESQ-7 domain. The overall RESQ-7 full score is presented descriptively and should be interpreted as reflux symptom burden, not as a confirmed GERD diagnosis.

Domain	RESQ-7 item / score	Did not have	Very mild	Mild	Moderate	Moderately severe	Severe	Median (IQR)
Heartburn domain								
	Cough/hoarseness/difficulty swallowing intensity domain score	—	—	—	—	—	—	0.33 (0.00–1.00)
	Total RESQ-7 intensity score	—	—	—	—	—	—	8.00 (2.00–19.00)
	Overall RESQ-7 full score	—	—	—	—	—	—	16.50 (5.38–42.62)
Abbreviations and notes: RESQ-7, Reflux Symptom Questionnaire 7-day recall; IQR, interquartile range. Intensity response categories reflect symptom severity. Domain scores are presented after the corresponding items within each RESQ-7 domain. The overall RESQ-7 full score is presented descriptively and should be interpreted as reflux symptom burden, not as a confirmed GERD diagnosis.								

Bivariate associations with DMFT score

Higher DMFT score was significantly associated with older age and higher BMI (both $p < 0.001$). DMFT was also positively associated with reflux symptom burden, including RESQ-7 total frequency score, total intensity score, and overall RESQ-7 full score (all $p < 0.001$). At the domain level, significant positive associations were observed with heartburn frequency ($p < 0.001$), regurgitation frequency ($p = 0.007$), cough/hoarseness/difficulty swallowing frequency ($p = 0.008$), heartburn intensity ($p < 0.001$), regurgitation intensity ($p = 0.003$), and cough/hoarseness/difficulty swallowing intensity ($p = 0.003$). Lower quality-of-life rating was also associated with higher DMFT score ($p = 0.004$). (Table S1)

Categorical factors associated with DMFT score

Several categorical factors were significantly associated with DMFT score, including residence ($p < 0.001$), chronic disease status ($p = 0.007$), smoking status ($p = 0.003$), tooth brushing before and after sleep ($p = 0.001$), education level ($p < 0.001$), economic status ($p < 0.001$), fast-food intake ($p < 0.001$), and reflux symptoms affecting sleep ($p = 0.011$). (Table S1)

Multiple linear regression for DMFT score

The multiple linear regression model was statistically significant ($p < 0.001$) and explained 22.5% of the variance in DMFT score. After adjustment, higher RESQ-7 full score remained significantly associated with higher DMFT score ($p = 0.006$). Higher BMI ($p < 0.001$) and current/former smoking ($p = 0.014$) were also associated with higher DMFT score, whereas brushing before and after sleep was associated with lower DMFT score ($p = 0.020$). Fast-food intake showed inverse adjusted associations with DMFT score, both for once-weekly intake ($p = 0.005$) and twice-or-more-weekly intake ($p < 0.001$). Eating within two hours before sleep also showed an inverse adjusted association with DMFT score ($p = 0.046$). Collinearity diagnostics were acceptable for all model variables. (Table 5)

Table 5
Multiple linear regression model for DMFT score *Dependent variable: DMFT score*

Variable	B	SE	β	t	p	95% CI for B	Tolerance	VIF
Constant	3.069	2.158	—	1.422	.156	-1.181 to 7.319	—	—
Fast-food intake: once/week vs rarely	-2.600	0.910	-0.205	-2.856	.005	-4.392 to -0.808	0.606	1.651
Fast-food intake: twice or more/week vs rarely	-4.802	0.941	-0.380	-5.103	< 0.001	-6.655 to -2.949	0.563	1.777
Smoking: current/former vs never	1.984	0.802	0.142	2.473	.014	0.404 to 3.564	0.943	1.060
RESQ-7 full score	0.040	0.014	0.170	2.792	.006	0.012 to 0.068	0.842	1.188
Caffeine beverage intake: yes vs no	1.384	0.996	0.082	1.390	.166	-0.578 to 3.346	0.907	1.102
Meal within 2 hours before sleep: yes vs no	-1.453	0.724	-0.114	-2.007	.046	-2.879 to -0.027	0.976	1.025
Brushing before and after sleep: yes vs no	-1.807	0.774	-0.142	-2.335	.020	-3.331 to -0.283	0.846	1.182
Regular dental check-up: yes vs no	-0.411	0.766	-0.032	-0.537	.592	-1.920 to 1.098	0.853	1.172
BMI	0.278	0.075	0.215	3.689	< 0.001	0.130 to 0.426	0.917	1.090
Note. B is the unstandardized coefficient; SE is the standard error; β is the standardized coefficient; t and p test whether each coefficient differs from zero. CI, confidence interval; DMFT, Decayed, Missing, and Filled Teeth; RESQ-7, Reflux Symptom Questionnaire 7-day recall; VIF, variance inflation factor.								
Model diagnostics: $R^2 = 0.225$ and adjusted $R^2 = 0.197$; overall model $F(9,248) = 8.014$, $p < 0.001$. Collinearity was acceptable for all predictors (tolerance > 0.56 and VIF < 1.78).								

Discussion

Principal findings and study context

In this cross-sectional study of 258 dental clinic patients, reflux symptom burden assessed using the RESQ-7 was associated with dental caries experience measured by the DMFT index. The cohort was relatively young, with a median age of 25.0 years, yet showed a clinically relevant dental burden, with a median DMFT score of 7.0 and a median number of decayed teeth of 2.0. Although only 19.0% reported a previous GERD diagnosis, the median RESQ-7 full score was 16.50, suggesting that symptom-based assessment captured a broader reflux burden than formal diagnostic history alone. This distinction is important because GERD is heterogeneous, and symptom instruments may identify patients with clinically meaningful reflux complaints who have not undergone objective evaluation. (1, 16) Previous evidence on GERD and caries-related outcomes has been mixed. In the Iranian PERSIAN Guilan Cohort Study of 10,520 individuals, GERD was diagnosed in 13.2%, but mean DMFT did not differ significantly between GERD and non-GERD groups (14.41 ± 8.47 vs 14.59 ± 8.82 ; $p = 0.49$). (4) Conversely, an Indian case-control study of 350 young adults aged 18–35 years reported higher DMFT among GERD patients. (14) Broader Asian and international literature also links GERD with oral manifestations, including dental erosion, soft-tissue changes, periodontal findings, xerostomia, and altered salivary protection. (2, 9, 11, 13, 17) Therefore, our findings fit within a heterogeneous literature and support considering reflux symptom burden as one component of a broader oral-health risk profile.

Reflux symptom burden and patient-reported impact

Reflux-related symptoms were frequent and functionally relevant despite the relatively low prevalence of self-reported diagnosed GERD. Symptoms affected sleep in 42.6% of participants, appetite in 33.3%, and work or studies in 29.1%, while hoarseness or persistent phlegm was reported by 27.9%. The RESQ-7 also showed a measurable symptom burden, with median total frequency and intensity scores of 8.50 and 8.00, respectively. Symptoms extended beyond classic heartburn to include regurgitation, burping, cough, hoarseness, and difficulty swallowing, suggesting a multidimensional reflux profile in dental clinic patients. This pattern is consistent with a Nigerian study of 647 undergraduate students, where GERD symptoms were reported in 32.8% and extra-esophageal manifestations included dysphagia, nocturnal cough, xerostomia, halitosis, and dental erosion. (3) Broader GERD literature similarly recognizes chronic cough, laryngeal symptoms, halitosis, xerostomia, dental erosion, and quality-of-life impairment as relevant extra-esophageal or oral manifestations. (2, 5) Thus, RESQ-7 may be particularly useful in dental settings because it captures reflux as a graded symptom burden rather than a binary diagnosis. (1, 16)

Bivariate associations between reflux symptoms and DMFT

In bivariate analyses, higher reflux symptom burden was consistently associated with greater DMFT. The RESQ-7 full score, total frequency score, and total intensity score were all positively associated with DMFT (all $p < 0.001$). Similar domain-level associations were observed for heartburn frequency ($p < 0.001$), regurgitation frequency ($p = 0.007$), cough/hoarseness/difficulty swallowing frequency ($p = 0.008$), heartburn intensity ($p < 0.001$), regurgitation intensity ($p = 0.003$), and cough/hoarseness/difficulty swallowing intensity ($p = 0.003$). These findings are directionally consistent with evidence linking reflux-related disorders to acidic exposure, reduced oral pH, enamel demineralization, impaired salivary buffering, and erosive tooth wear. (6, 10, 13, 18) Supporting this biological plausibility, longitudinal and pH-impedance studies have linked reflux burden with dental erosion progression and tooth erosion severity. (7, 8) Similarly, an adult meta-analysis reported substantially higher dental erosion among GERD patients than controls. (11) Nevertheless, because DMFT reflects cumulative caries experience rather than erosion alone, these associations should be interpreted cautiously, especially given the stronger bivariate associations of DMFT with age, BMI, and lower quality-of-life rating (all $p \leq 0.004$).

Multivariable regression and independent association

After adjustment, reflux symptom burden remained independently associated with DMFT. The multiple linear regression model was significant ($p < 0.001$) and explained 22.5% of the variance in DMFT. Higher RESQ-7 full score was associated with higher DMFT after adjustment for BMI, smoking, caffeine intake, fast-food intake, late meals, tooth brushing, and regular dental check-up ($p = 0.006$), although the effect size was modest and should be interpreted as an additional correlate rather than a dominant determinant of caries experience. This finding fits within the mixed GERD–DMFT literature: the Iranian cohort found no overall GERD–DMFT difference but identified age, education, BMI, smoking, alcohol use, wealth index, and tooth brushing as DMFT-related factors within the GERD group, (4) whereas Indian case-control evidence reported higher DMFT among GERD patients. (14) Other studies from Korea, Japan, India, and Russia suggest that reflux-related oral outcomes may overlap with periodontal disease, oral hygiene status, salivary changes, and broader oral manifestations. (9, 19–21) Overall, the adjusted results support an association between reflux symptom burden and DMFT, but within a broader network of demographic, behavioral, dietary, and oral-hygiene determinants.

Age, oral hygiene, behavioral findings, and clinical interpretation

DMFT should be interpreted as a cumulative and behaviorally influenced outcome. Age showed the strongest bivariate association with DMFT ($\rho = 0.521$, $p < 0.001$), supporting its role as a lifetime measure of caries experience rather than current disease alone. In the adjusted model, brushing before and after sleep was associated with lower DMFT ($B = -1.807$; 95% CI, -3.331 to -0.283; $p = 0.020$), whereas current/former smoking ($B = 1.984$; 95% CI, 0.404 to 3.564; $p = 0.014$) and BMI ($B = 0.278$; 95% CI, 0.130 to 0.426; $p < 0.001$) were associated with higher DMFT, consistent with evidence that age, smoking, BMI, oral hygiene, periodontal status, and salivary or mucosal changes influence oral outcomes in GERD-related contexts. (2, 4, 9, 19–21) The inverse associations for fast-food intake and late meals should be interpreted cautiously, as these variables may poorly capture total sugar intake, acidic beverages, snacking patterns, fluoride exposure, or age-related behavioral clustering. Clinically, these findings do not support dental diagnosis of GERD or a causal interpretation; rather, they suggest that structured reflux symptom questioning may help identify patients who could benefit from preventive counseling, fluoride strategies, dietary review, guidance on brushing after acid exposure, and medical referral when symptoms are persistent or functionally impairing. (2, 10, 12, 22)

Strengths and limitations

This study has several strengths, including the use of RESQ-7 as a graded measure of reflux symptom burden, assessment of DMFT as a cumulative caries index, and adjustment for relevant behavioral and oral-hygiene factors. However, its cross-sectional design precludes causal or temporal inference, and GERD was assessed symptomatically rather than by objective testing such as endoscopy or pH monitoring. DMFT was self-reported and cumulative, limiting distinction between active and previous caries experience. In addition, dental erosion, salivary parameters, fluoride exposure, detailed dietary acidity and sugar intake, xerostomia-inducing medications, and brushing technique were not fully assessed. Because age showed the strongest bivariate association with DMFT but was not included in the final regression model, residual confounding cannot be excluded. Future longitudinal studies using objective reflux testing and detailed oral-environment assessment are needed.

Conclusion

In conclusion, higher RESQ-7 reflux symptom burden was modestly associated with greater DMFT burden among dental clinic patients. Although this association persisted after adjustment for BMI, smoking status, selected dietary behaviors, tooth brushing, and regular dental check-up, its modest magnitude and the strong bivariate role of age indicate that reflux-related symptoms represent only one component within a broader multifactorial caries framework. These findings support the potential value of structured reflux symptom assessment in dental settings, particularly among patients with high caries burden or functionally impairing reflux complaints. Future longitudinal studies using objective GERD assessment, active caries measures, dental erosion indices, salivary parameters, fluoride exposure, and detailed dietary data are needed to clarify the temporal and mechanistic relationship between reflux symptoms and oral health outcomes.

Declarations

Human Ethics and Consent to Participate declarations

The study protocol was approved by the Research Ethics Committee of the Syrian Private University (SPU), Faculty of Medicine (Approval No. MD-30032026-135). This was a cross-sectional, questionnaire-based study conducted among adults in Damascus, Syria, between March and May 2026. The study was conducted in accordance with the Declaration of Helsinki. Verbal informed consent was obtained from all participants before enrollment, and participation was voluntary and anonymous.

Consent for publication

Not applicable. The manuscript contains no identifiable personal data from any participant.

Availability of data and materials

De-identified data and analysis outputs are available from the corresponding author on reasonable request.

Clinical trial number

not applicable.

Competing interests

The authors declare no competing interests.

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Author Contributions

Mohamad Malaz AL Habal: Conceptualized the study and developed the initial research idea, contributed to participant recruitment and data collection.

Mohamad Adel Hammoudeh: Contributed to participant recruitment and data collection.

Ibrahim Alkhatib: Drafted the original manuscript and contributed to the intellectual framing of the study, performed the statistical analysis and interpreted the analytical findings.

Mohammad Alaa Aldakak: Contributed to manuscript writing, statistical review, and interpretation of the results, critically revised the manuscript for clarity and intellectual content.

Omran Alkhatib: Contributed to literature review, manuscript editing, and critical revision of the manuscript for important intellectual content.

Ayman F Ali: Supervised the study and provided academic and methodological oversight, critically reviewed and approved the final manuscript.

All authors read and approved the final version of the manuscript.

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