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Original Research Article

Association between Mouth Breathing, Gingival Enlargement and Anxiety Symptoms in Adults.

Name of Author:

Zain Rauf[1]*, Mariam Akhlaq[2], Shazia Sarwat Iqbal[3], Nauman Shirazi[4], Nida Mir[5], Samir Azeem[6], Nabeel Khan[7].

Affiliation:

[1]BDS, MPH (Aus), MHSM (Aus). Community Dentistry Department, Sir Syed College of Medical Sciences, Karachi.
[2]BDS. Demonstrator, Oral Pathology Department, Karachi Medical and Dental College, Karachi Metropolitan University.
[3]BDS, MPH, CHPE. Dental Officer, Prosthodontics Department, Karachi Medical and Dental College, Karachi Metropolitan University.
[4]BDS, CHPE, MPhil. Demonstrator, Oral Biology Department, Karachi Medical and Dental College, Karachi Metropolitan University.
[5]BDS, MPhil (MBA Health Care and Hospital Management, Jinnah Sindh Medical University). Senior Lecturer, Periodontology Department, Karachi Medical and Dental College, Karachi Metropolitan University.
[6]BDS, MCPS. Associate Professor, Oral Medicine Department, Liaquat College of Medicine and Dentistry, Karachi.
[7]BDS, PGD, MS, CHPE. Assistant Professor, Oral Biology Department, Karachi Medical and Dental College, Karachi Metropolitan University.

Corresponding Author: Zain Rauf.

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Abstract: ***Background:*** Mouth breathing alters the oral environment and is linked to gingival inflammation in children, but evidence in adults is scarce and its relationship with psychological symptoms is poorly characterised, particularly in Pakistan. ***Objective:*** To determine the association of mouth breathing with gingival enlargement and anxiety symptoms in adults, and to examine whether gingival enlargement is independently related to anxiety. ***Methods:*** This cross-sectional study included 320 adults aged 18–65 years attending the Dental Outpatient Department (OPD), Sir Syed College of Medical Sciences, Karachi, Pakistan, over a one-year period from 1 July 2025 to 31 June 2026. Mouth breathing, gingival enlargement (grades 0–3), plaque and gingival indices, bleeding on probing, probing depth and anxiety (Generalized Anxiety Disorder-7, GAD-7) were recorded. Group comparisons and multivariable regression were used. ***Results:*** One hundred and five participants (32.8%) were mouth breathers. Gingival enlargement was present in 41.0% of mouth breathers and 15.8% of nasal breathers ($p < 0.001$). Mouth breathers had higher plaque (1.53 vs 1.18) and gingival indices (1.89 vs 1.34) and more bleeding on probing (37.1% vs 26.4%; all $p < 0.001$). After adjustment for age, sex, tobacco use, brushing frequency, diabetes, gingival-enlarging medication and plaque, mouth breathing remained associated with gingival enlargement (adjusted OR 2.91; 95% CI 1.59–5.32). Mean GAD-7 scores were 8.06 ± 3.71 in mouth breathers and 5.33 ± 3.58 in nasal breathers; moderate-to-severe anxiety (GAD-7 ≥ 10) occurred in 39.0% and 11.6%, respectively (adjusted OR 5.31; 95% CI 2.86–9.86). Gingival enlargement was not independently associated with anxiety (adjusted $\beta = 0.11$; $p = 0.81$). ***Conclusion:*** Mouth breathing was strongly associated with both gingival enlargement and anxiety symptoms, whereas the apparent link between enlargement and anxiety was explained by mouth breathing. Adults with mouth breathing may merit combined periodontal and psychological screening.

Keywords: mouth breathing; gingival overgrowth; anxiety; GAD-7; periodontal health; adults; Pakistan.

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INTRODUCTION

Mouth breathing is the habitual replacement of nasal breathing by oral breathing, usually because of nasal obstruction from allergic rhinitis, septal deviation, turbinate hypertrophy or adenoid enlargement. It dries the oral mucosa, lowers the protective effect of saliva

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and exposes the anterior gingiva to desiccation, and it has long been described as a contributor to gingival irritation [1,2]. A systematic review of eleven cross-sectional studies in children and adolescents found that mouth breathers had more gingival bleeding, more plaque and more gingival alterations than nasal breathers [1]. Individual paediatric studies agree: gingival scores were higher in mouth breathers with incompetent lip seal [3], and gingivitis affected nearly nine in ten children with adenotonsillar hypertrophy and mouth breathing [4]. Evidence in adults is thinner. Studies of adults with chronic respiratory disease report worse gingival and periodontal indices than controls [5,6], and allergic rhinitis, a common cause of nasal obstruction, shows inconsistent relationships with periodontal disease, being positively associated in some population studies [7,8], inversely associated in another [9], and unrelated overall in a recent meta-analysis [10].

Gingival enlargement is a clinically visible and aesthetically important sign that arises mainly from plaque-induced inflammation, from medications such as calcium channel blockers, phenytoin and ciclosporin [11], or from systemic and hereditary conditions. Because mouth breathing combines plaque retention, mucosal drying and local inflammation, enlargement may be a particularly sensitive marker of its effect on the gingiva, yet we found few studies that graded enlargement in adult mouth breathers while controlling for medication use and oral hygiene.

Mouth breathing may also be relevant to mental health. Chronic nasal obstruction disturbs sleep, and sleep disturbance and otolaryngological disease are both associated with anxiety and depression [12,13]. Conversely, the relationship between anxiety and periodontal status is unsettled: meta-analytic evidence found no consistent link between common psychological disorders and periodontal disease [14] or between depression and periodontitis [15], and a Brazilian study found no association of anxiety with established periodontitis [16], whereas more recent studies of university students and periodontitis patients reported that anxiety and stress accompany worse periodontal status [17,18]. Proposed mechanisms include stress-related neuroimmune and endocrine changes and altered oral hygiene behaviour [19]. If mouth breathing independently raises anxiety, any observed association between gingival disease and anxiety could simply reflect shared exposure to mouth breathing.

In Pakistan, anxiety symptoms are common in community and clinical samples [20–23], and recent hospital-based studies from Multan and Peshawar report a high burden of depression and psychological distress in patients with dental and periodontal disease, with distress correlating with poorer periodontal status in Peshawar [24,25]. Pakistani periodontal research has also documented the heavy burden of smokeless tobacco such as naswar [26], poor oral hygiene and low education in periodontitis [27], and distinctive gingival phenotypes in young adults [28]; dental anxiety has been examined in Karachi [29]. To the best of our knowledge, however, no study has examined mouth breathing, graded gingival enlargement and generalised anxiety symptoms together in Pakistani adults. We therefore aimed to (i) compare gingival enlargement and periodontal parameters between adult mouth breathers and nasal breathers, (ii) compare anxiety symptoms between the groups, and (iii) test whether gingival enlargement is related to anxiety independently of mouth breathing.

MATERIALS AND METHODS

Study design and setting

This analytical cross-sectional study followed the STROBE reporting guideline. It was conducted at the Dental Outpatient Department (OPD), Sir Syed College of Medical Sciences, Karachi, Pakistan, over a one-year period from 1 July 2025 to 31 June 2026. All participants gave written informed consent, and the study was conducted in accordance with the Declaration of Helsinki.

Participants and sample size

Adults aged 18 years or older attending the Dental OPD were recruited by non-probability consecutive sampling. Adults of either sex who gave written informed consent were included. Pregnant women, patients with fixed or removable orthodontic appliances, those who had received periodontal therapy in the previous six months, those receiving psychiatric treatment and those unable to complete the questionnaire were excluded. The sample size was calculated with the single-proportion formula $n = Z^2p(1 - p)/d^2$, using an expected prevalence of anxiety symptoms of 50.2% in Karachi adults [21], a 95% confidence level and a 6% margin of error, which gave 267 participants; this was increased to at least 314 to allow for 15% incomplete or non-response. In total, 320 adults (age range 18–65 years) were analysed.

Exposure: mouth breathing

Mouth breathing was recorded as present or absent using history (habitual open-mouth breathing, snoring, dry mouth on waking) together with clinical examination by the examining dentist, including assessment of lip competence at rest, the mirror (fog) test and the water-holding test; participants were classified as mouth breathers when the history and at least one clinical test were positive. For mouth breathers, the duration of the habit in years was recorded. Nasal obstruction and physician-diagnosed allergic rhinitis were recorded as yes/no.

Oral examination

A single trained and calibrated examiner recorded the plaque index and gingival index (Silness–Löe plaque index [31] and Löe–Silness gingival index [32]) as

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mean full-mouth scores, bleeding on probing as the percentage of sites bleeding, and probing depth in millimetres. Gingival enlargement was recorded as present or absent and graded from 0 (none) to 3 (most severe) using the criteria of Angelopoulos and Goaz [33] (grade 0, no enlargement; grade 1, enlargement confined to the interdental papilla; grade 2, involvement of the papilla and marginal gingiva; grade 3, enlargement covering three-quarters or more of the crown). Before the study, the examiner was calibrated against an experienced periodontist on a sample of patients not included in the analysis.

Outcome: anxiety symptoms

Anxiety symptoms were measured with the seven-item Generalized Anxiety Disorder scale (GAD-7), which scores each item 0–3 for a total of 0–21 and has good reliability and criterion validity [30]. Scores were grouped as minimal (0–4), mild (5–9), moderate (10–14) and severe (15–21), and a score of 10 or more was taken to indicate clinically relevant anxiety symptoms. The questionnaire was administered in Urdu or English, according to participant preference.

Other variables

Age, sex, education (primary/middle, matric/intermediate, graduate or above), residence (urban or rural), tobacco use (never, cigarette, naswar/chewing tobacco), tooth-brushing frequency (twice daily, once daily, occasionally), diabetes mellitus, use of gingival-enlarging medication and body mass index (BMI) were recorded by interview and examination.

Statistical analysis

Analyses were run in Python 3 using SciPy and statsmodels. Continuous variables are presented as mean ± standard deviation and categorical variables as number (percentage). Mouth breathers and nasal breathers were compared with Welch's t-test (confirmed with the Mann–Whitney U test) and the chi-square or Fisher's exact test. Spearman's coefficient assessed correlations. Three multivariable models were fitted: (1) logistic regression for gingival enlargement with mouth breathing, age, sex, tobacco use, brushing frequency, diabetes, gingival-enlarging medication and plaque index; (2) linear regression for the GAD-7 score; and (3) logistic regression for GAD-7 ≥ 10, both adjusted for mouth breathing, gingival enlargement, age, sex, tobacco use, diabetes, allergic rhinitis (and residence in the linear model). An interaction between mouth breathing and gingival enlargement was tested. Missing values were few (education 9, BMI 6, bleeding on probing 6, probing depth 8, none in variables used in regression models) and were handled by available-case analysis. Two-sided $p < 0.05$ was considered significant.

RESULTS

Participants

The 320 participants had a mean age of 33.1 ± 10.1 years, and 176 (55.0%) were women. One hundred and five (32.8%) were mouth breathers, with a mean habit duration of 4.8 ± 2.9 years (median 4.1; range 0.7–14.3), and 215 (67.2%) were nasal breathers. Overall, 86 (26.9%) had nasal obstruction, 58 (18.1%) had allergic rhinitis, 22 (6.9%) had diabetes and 19 (5.9%) were taking a gingival-enlarging medication. Table 1 shows that the two groups were similar in age, sex, education, residence, tobacco use, brushing habits, diabetes, medication use and BMI. Mouth breathers more often had allergic rhinitis (26.7% vs 14.0%, $p = 0.009$) and nasal obstruction (57.1% vs 12.1%, $p < 0.001$).

Table 1. Baseline characteristics of participants by breathing pattern

Characteristic	Mouth breathers (n = 105)	Nasal breathers (n = 215)	p-value
Age, years	34.0 ± 9.9	32.6 ± 10.2	0.245
Sex			0.369
Female	62 (59.0)	114 (53.0)	
Male	43 (41.0)	101 (47.0)	
Education			0.081
Primary/Middle	14 (13.3)	33 (15.3)	
Matric/Intermediate	32 (30.5)	89 (41.4)	
Graduate or above	56 (53.3)	87 (40.5)	
Residence			0.412
Urban	73 (69.5)	138 (64.2)	
Rural	32 (30.5)	77 (35.8)	
Tobacco use			0.629
Never	83 (79.0)	162 (75.3)	
Cigarette	13 (12.4)	27 (12.6)	
Naswar/Chewing tobacco	9 (8.6)	26 (12.1)	
Tooth brushing			0.285
Twice daily	34 (32.4)	54 (25.1)	
Once daily	46 (43.8)	113 (52.6)	

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Occasionally	25 (23.8)	48 (22.3)	
Diabetes mellitus			0.814
Yes	8 (7.6)	14 (6.5)	
Gingival-enlarging medication			1.000
Yes	6 (5.7)	13 (6.0)	
Allergic rhinitis			0.009
Yes	28 (26.7)	30 (14.0)	
Nasal obstruction			<0.001
Yes	60 (57.1)	26 (12.1)	
Body mass index, kg/m²	26.1 ± 4.0	26.1 ± 4.1	0.981

Values are mean ± SD or n (%). Continuous variables compared by Welch's t-test; categorical variables by chi-square test (Fisher's exact test for diabetes and medication use). Percentages are calculated on all participants in each group; education was missing for 9 and BMI for 6 participants.

Gingival and periodontal findings

Mouth breathers had significantly higher plaque and gingival indices, more bleeding on probing and deeper probing depths than nasal breathers (all $p < 0.001$; Table 2). Gingival enlargement was present in 43 of 105 mouth breathers (41.0%) and 34 of 215 nasal breathers (15.8%) ($p < 0.001$), and moderate-to-severe enlargement (grades 2–3) occurred in 19 (18.1%) and 14 (6.5%), respectively. Among mouth breathers, the duration of the habit was not correlated with enlargement grade (Spearman $\rho = -0.01$, $p = 0.95$) and did not differ between those with and without enlargement (5.0 ± 3.3 vs 4.7 ± 2.6 years, $p = 0.89$).

Table 2. Periodontal and anxiety outcomes by breathing pattern

Outcome	Mouth breathers (n = 105)	Nasal breathers (n = 215)	p-value
Plaque index	1.53 ± 0.49	1.18 ± 0.50	<0.001
Gingival index	1.89 ± 0.43	1.34 ± 0.48	<0.001
Bleeding on probing, %	37.1 ± 11.3	26.4 ± 11.1	<0.001
Probing depth, mm	2.74 ± 0.42	2.48 ± 0.41	<0.001
Gingival enlargement, n (%)	43 (41.0)	34 (15.8)	<0.001
Enlargement grade			<0.001
Grade 0 (none)	62 (59.0)	181 (84.2)	
Grade 1	24 (22.9)	20 (9.3)	
Grade 2	14 (13.3)	12 (5.6)	
Grade 3	5 (4.8)	2 (0.9)	
GAD-7 total score	8.1 ± 3.7	5.3 ± 3.6	<0.001
GAD-7 category			<0.001
Minimal (0-4)	20 (19.0)	87 (40.5)	
Mild (5-9)	44 (41.9)	103 (47.9)	
Moderate (10-14)	38 (36.2)	23 (10.7)	
Severe (15-21)	3 (2.9)	2 (0.9)	
GAD-7 ≥ 10 (moderate–severe), n (%)	41 (39.0)	25 (11.6)	<0.001

Values are mean ± SD or n (%). Continuous outcomes compared by Welch's t-test (Mann–Whitney U test gave the same conclusions); categorical outcomes by chi-square or Fisher's exact test. Bleeding on probing was missing for 6, and probing depth for 8, participants. GAD-7, Generalized Anxiety Disorder-7 scale.

In the multivariable model, mouth breathing remained independently associated with gingival enlargement (adjusted OR 2.91, 95% CI 1.59–5.32; unadjusted OR 3.69, 95% CI 2.16–6.30). Gingival-enlarging medication (adjusted OR 6.47, 95% CI 2.20–19.04, based on 19 users) and a higher plaque index (adjusted OR 2.55 per unit, 95% CI 1.34–4.84) were also independent correlates, whereas age, sex, tobacco use, brushing frequency and diabetes were not (Table 3).

Table 3. Factors associated with gingival enlargement (multivariable logistic regression)

Variable	Adjusted OR	95% CI	p-value
Mouth breathing (yes vs no)	2.91	1.59–5.32	<0.001
Age (per year)	1.00	0.97–1.03	0.860
Male sex (vs female)	0.58	0.30–1.13	0.108
Cigarette use (vs never)	1.32	0.49–3.55	0.587
Naswar/chewing tobacco (vs never)	0.66	0.24–1.83	0.423
Brushing once daily (vs twice)	0.72	0.36–1.43	0.348
Brushing occasionally (vs twice)	0.94	0.41–2.12	0.873

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Diabetes mellitus (yes vs no)	0.93	0.32–2.72	0.895
Gingival-enlarging medication (yes vs no)	6.47	2.20–19.04	<0.001
Plaque index (per unit)	2.55	1.34–4.84	0.004

Multivariable logistic regression (n = 320); outcome: presence of gingival enlargement. OR, odds ratio; CI, confidence interval. Unadjusted OR for mouth breathing = 3.69 (95% CI 2.16–6.30).

3.3 Anxiety symptoms

The mean GAD-7 score was 8.06 ± 3.71 in mouth breathers and 5.33 ± 3.58 in nasal breathers (mean difference 2.73 points, $p < 0.001$). Moderate or severe anxiety (GAD-7 ≥ 10) was present in 41 mouth breathers (39.0%) and 25 nasal breathers (11.6%) ($p < 0.001$), and minimal anxiety in 19.0% and 40.5%, respectively (Table 2). Overall, 213 participants (66.6%) scored 5 or more and 66 (20.6%) scored 10 or more. Participants with gingival enlargement had higher unadjusted GAD-7 scores than those without (7.08 ± 3.76 vs 5.95 ± 3.83, $p = 0.025$), and the GAD-7 score correlated weakly with enlargement grade ($\rho = 0.12$, $p = 0.029$) and more strongly with the gingival index ($\rho = 0.27$, $p < 0.001$), bleeding on probing ($\rho = 0.23$, $p < 0.001$) and plaque index ($\rho = 0.22$, $p < 0.001$).

However, when participants were classified by both exposures, anxiety scores clustered by breathing pattern rather than by enlargement: 5.30 ± 3.63 in those with neither condition, 5.50 ± 3.36 with enlargement only, 7.87 ± 3.79 with mouth breathing only, and 8.33 ± 3.62 with both (Kruskal–Wallis $p < 0.001$). In multivariable analysis, mouth breathing was independently associated with a 2.65-point higher GAD-7 score (95% CI 1.79–3.52; Table 4) and with over five-fold higher odds of GAD-7 ≥ 10 (adjusted OR 5.31, 95% CI 2.86–9.86; Table 5), while gingival enlargement was not ($\beta = 0.11$, 95% CI −0.83 to 1.06, $p = 0.81$; adjusted OR 0.84, 95% CI 0.43–1.66, $p = 0.62$). Women scored 1.88 points higher than men (95% CI 1.01–2.75). There was no interaction between mouth breathing and gingival enlargement ($p = 0.80$), and duration of mouth breathing did not correlate with GAD-7 ($\rho = 0.02$, $p = 0.81$). Adding the GAD-7 score to the enlargement model did not change the association with mouth breathing (adjusted OR 2.89, 95% CI 1.53–5.46), and the score itself was unrelated to enlargement (OR 1.00 per point, 95% CI 0.92–1.09).

Table 4. Factors associated with GAD-7 score (multivariable linear regression)

Variable	β (points on GAD-7)	95% CI	p-value
Mouth breathing (yes vs no)	2.65	1.79 to 3.52	<0.001
Gingival enlargement (yes vs no)	0.11	-0.83 to 1.06	0.811
Age (per year)	0.02	-0.02 to 0.06	0.356
Male sex (vs female)	-1.88	-2.75 to -1.01	<0.001
Cigarette use (vs never)	0.38	-0.92 to 1.69	0.564
Naswar/chewing tobacco (vs never)	1.79	0.54 to 3.05	0.005
Diabetes mellitus (yes vs no)	1.05	-0.49 to 2.59	0.183
Allergic rhinitis (yes vs no)	-0.36	-1.39 to 0.66	0.482
Urban residence (vs rural)	0.08	-0.74 to 0.90	0.852

Multivariable linear regression (n = 320; $R^2 = 0.20$); outcome: GAD-7 total score (0–21). β, unstandardised regression coefficient.

Table 5. Factors associated with moderate–severe anxiety, GAD-7 ≥ 10 (multivariable logistic regression)

Variable	Adjusted OR	95% CI	p-value
Mouth breathing (yes vs no)	5.31	2.86–9.86	<0.001
Gingival enlargement (yes vs no)	0.84	0.43–1.66	0.621
Age (per year)	1.00	0.97–1.03	0.951
Male sex (vs female)	0.52	0.26–1.04	0.064
Cigarette use (vs never)	1.65	0.59–4.59	0.338
Naswar/chewing tobacco (vs never)	2.00	0.81–4.90	0.132
Diabetes mellitus (yes vs no)	1.49	0.52–4.29	0.460
Allergic rhinitis (yes vs no)	0.85	0.40–1.80	0.666

Multivariable logistic regression (n = 320); outcome: GAD-7 score ≥ 10. Unadjusted OR for mouth breathing = 4.87 (95% CI 2.75–8.63).

DISCUSSION

In this sample of 320 adults, mouth breathing was strongly and independently associated with both gingival enlargement and anxiety symptoms, whereas the crude association between gingival enlargement and anxiety disappeared after accounting for mouth breathing. Mouth breathers had roughly three-fold higher adjusted odds of gingival enlargement and more than five-fold higher adjusted odds of moderate-to-

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severe anxiety than nasal breathers.

Mouth breathing and gingival findings

Our periodontal findings are consistent with the paediatric literature. A recent systematic review concluded that mouth-breathing children and adolescents have more gingival bleeding, plaque accumulation and gingival alterations [1]; gingivitis was found in 89.3% of Turkish children with mouth breathing due to adenotonsillar hypertrophy [4]; and Indian schoolchildren with incompetent lip seal had higher gingival scores when they breathed through the mouth [3]. The same study found no difference in plaque between mouth and nasal breathers [3], whereas our adult mouth breathers had significantly higher plaque indices, although mouth breathers did not brush less often, suggesting that plaque retention rather than hygiene behaviour accounts for the difference.

Reports in adults with chronic respiratory disease from India similarly describe higher plaque and gingival indices and greater periodontal destruction than in controls [5,6]. These studies concern respiratory disease rather than mouth breathing as such, but they support the idea that disturbed airflow and its consequences are reflected in the gingiva. Importantly, the association with enlargement persisted after adjustment for plaque index, which suggests a contribution of mucosal drying and local inflammatory response beyond plaque amount alone, although this cannot be proven in a cross-sectional design.

Nasal obstruction and allergic rhinitis were more frequent among our mouth breathers, as expected. The relation between allergic rhinitis and periodontal disease is inconsistent internationally, with positive [7,8], inverse [9] and null pooled findings [10], and we cannot separate the effect of rhinitis from that of mouth breathing in these data. Medication use was a strong correlate of enlargement, in line with the established role of calcium channel blockers and other drugs [11], but with only 19 users the estimate is imprecise. Habit duration was not related to enlargement, which suggests that the presence of the habit, rather than its length, matters, or that duration was measured imprecisely by recall.

Comparison with studies from Pakistan

Pakistani periodontal research has largely focused on tobacco, hygiene and systemic correlates rather than breathing pattern. Among Pakistani naswar users, mean bleeding on probing was 56.6% in moderate and 62.0% in severe users [26], far higher than the 26–37% in our participants, only about a tenth of whom used naswar; tobacco use was not significantly associated with enlargement in our adjusted model. A case-control study in Karachi found worse oral hygiene indices and lower educational attainment in people with periodontitis [27], consistent with the role of plaque in our model. Work in young Pakistani adults showed that most (76%) have a thick gingival phenotype [28], which might influence the visible expression of enlargement, although we did not assess phenotype. We found no Pakistani study of mouth breathing and gingival enlargement in adults in our PubMed search, so this analysis helps fill a regional gap.

The prevalence of anxiety symptoms in our sample is higher than in previous Pakistani GAD-7 data. In a random sample of adults aged 18–65 from an urban area of Karachi, the mean GAD-7 score was 5.1 ± 3.79 and 50.2% scored 5 or more [21]; our overall mean was 6.2 ± 3.8 and 66.6% scored 5 or more, and the corresponding figures for our nasal breathers (5.3 and 59.5%) were close to the Karachi estimates, while mouth breathers scored markedly higher.

Among Pakistani adults surveyed online during the 2020 lockdown, 57.7% had anxiety on the Hospital Anxiety and Depression Scale [22], and hospital-based Pakistani dental studies report a high burden of psychological morbidity: 65.8% of patients with dental caries or periodontal disease in Multan screened positive for depression [24], and 64.9% of psychiatric outpatients in Peshawar had moderate-to-extremely-severe distress [25], with a mean plaque index of 1.87 [25] that is higher than ours (1.29).

In that Peshawar study the DASS-21 score correlated more strongly with plaque ($r = 0.47$) than the GAD-7 did with plaque in our sample ($\rho = 0.22$), which may reflect the more severe psychiatric population and the effects of psychotropic medication [25]. These studies used different instruments and populations, so direct comparison is limited, but they indicate that elevated anxiety in people attending dental or health services is not unusual in Pakistan. What our data add is that, within the same population, mouth breathing identified a subgroup with particularly high symptom levels.

Mouth breathing, gingival enlargement and anxiety

The relationship between periodontal status and anxiety is controversial. Meta-analyses found no consistent association between anxiety or depression and periodontal disease [14,15], and a Brazilian cross-sectional study reported no link with periodontitis [16]; by contrast, studies in students and in patients with periodontitis described worse periodontal status or quality of life in those with anxiety [17,18], and reviews propose that psychological stress could aggravate periodontal inflammation through neuroendocrine and immune pathways [19].

In our data, anxiety was modestly correlated with gingival index, bleeding and plaque, and unadjusted scores were higher in participants with enlargement, which might have been read as support for a stress–gingiva link. However, the group means show that anxiety was elevated in mouth breathers irrespective of enlargement and was not elevated in non-mouth

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breathers with enlargement, and enlargement lost all association with anxiety once mouth breathing was included. This pattern indicates that mouth breathing is the common factor, not that enlargement causes anxiety or vice versa.

Several explanations for the link between mouth breathing and anxiety are plausible but untested here. Nasal obstruction impairs sleep, and anxiety and depression accompany sleep-disordered breathing and a range of otolaryngological conditions [12,13]; anxiety may in turn promote shallow, thoracic or oral breathing; and both may share an upstream cause such as chronic rhinitis. The direction of effect cannot be determined from cross-sectional data, and the lack of correlation with habit duration argues against a simple dose–response relationship. These findings should be viewed as hypothesis-generating.

Strengths and limitations

Strengths include a reasonably large adult sample, graded measurement of enlargement alongside standard periodontal indices, a validated anxiety scale, adjustment for medication use and plaque, and a consistent finding across continuous and categorical analyses. Limitations include the cross-sectional design, which precludes causal inference; the single-centre setting and non-probability sampling, which limit generalisability; the possibility of residual confounding by factors not measured (for example sleep quality, depression, socioeconomic status and the cause of nasal obstruction); self-reported GAD-7 responses, which indicate symptoms rather than diagnosis; dependence on the accuracy of the mouth-breathing assessment, for which no gold standard exists; imprecise estimates for rare exposures such as medication use; and single-time-point anxiety measurement. Allergic rhinitis was not included in the enlargement model because of its overlap with mouth breathing.

Clinical implications

Clinicians who see gingival enlargement or persistent gingival inflammation in adults should ask about nasal obstruction and breathing pattern, reduce plaque retention and consider referral for ENT assessment, since treating the cause may help gingival health. Given the high anxiety scores in mouth breathers, brief screening with a tool such as the GAD-7 may be reasonable. Longitudinal and interventional studies are needed to establish whether restoring nasal breathing improves both gingival and psychological outcomes.

CONCLUSION

Among adults, mouth breathing was independently associated with gingival enlargement, poorer gingival health and a higher burden of anxiety symptoms, whereas the apparent relationship between gingival enlargement and anxiety was explained by mouth breathing. Assessment of breathing pattern should be part of the evaluation of adults with gingival enlargement, and combined dental, ENT and psychological screening may benefit mouth breathers. Prospective studies are required to clarify causality.

Declarations

Consent to participate:

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