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Evaluation of changes in oral and dental health and deleterious oral habits after adenoidectomy or adenotonsillectomy in children

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Objective: This study aimed to evaluate changes in oral health status and related oral habits in children undergoing adenoidectomy or adenotonsillectomy, focusing on dental indices and mouth breathing-associated symptoms. **Methods:** This prospective observational study included 52 children (mean age: 7.4 ± 2.1 years) who underwent adenoidectomy or adenotonsillectomy. Clinical evaluations included decayed, missing, and filled teeth for primary dentition/decayed, missing, and filled teeth for permanent dentition (dmft/DMFT) scores, plaque index (Silness and Löe), gingival index (Löe and Silness), and unstimulated salivary flow rate. Parents completed structured questionnaires assessing their children's medical and dental history, oral health-related behaviors, and symptoms. Oral health-related quality of life was evaluated using the Early Childhood Oral Health Impact Scale. **Results:** Statistically significant improvements were found in salivary flow rate (from 0.43 ± 0.21 mL/min to 0.75 ± 0.19 mL/min), plaque index (1.58 ± 0.48 to 1.06 ± 0.33), and gingival index (1.28 ± 0.55 to 0.70 ± 0.39) (all P = 0.001). Several mouth breathing-related symptoms, such as snoring, dry mouth, daytime sleepiness, and halitosis, also showed a significant postoperative reduction (P < 0.05). **Conclusions:** Adenoidectomy or adenotonsillectomy significantly improved periodontal parameters and reduced mouth breathing-associated symptoms in children. These findings highlight the importance of interdisciplinary management involving otolaryngologists, pediatric dentists, and orthodontists.

Keywords: Airway, Habit, Adenotonsillar hypertrophy, Oral health-related quality of life

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INTRODUCTION

The tonsils and adenoids, which are components of Waldeyer's lymphatic ring, the body's first line of defense against pathogens in inhaled and ingested air, can hypertrophy due to physiological, allergy, and infectious causes. While adenotonsillar growth continues from early childhood to puberty, a slow involution or atrophy occurs post-puberty.[1,2] Adenotonsillar hypertrophy is defined as a larger area of the nasopharyngeal wall owing to the dimensional enlargement of the adenotonsillar tissue. Studies have reported that adenotonsillar hypertrophy may cause serious problems, such as snoring, obstructive sleep apnea, speech, smell, taste, swallowing difficulties, mouth breathing, and orofacial problems.[3-7]

The term "adenoid face" refers to a distinctive facial appearance that emerges from various dentofacial alterations associated with mouth breathing caused by adenotonsillar hypertrophy. These alterations typically include a V-shaped constriction of the maxillary arch, a low tongue posture, mandibular retrognathia, increased overjet, anterior and posterior crossbites, and an anterior open bite.[8-10] Studies have indicated that dentofacial irregularities resulting from adenotonsillar hypertrophy may regress within the first year following surgical interventions, such as adenoidectomy or adenotonsillectomy.[11,12] There is also an increase in dental caries, halitosis, and periodontal diseases caused by decreased saliva flow rate owing to mouth breathing.[8,9,13] However, the findings on this issue are controversial and have not been sufficiently clarified in the literature. Therefore, our study enabled us to evaluate the preoperative and postoperative oral health status of children who underwent after adenoidectomy or adenotonsillectomy, thus contributing to a subject that requires more research.

MATERIALS AND METHODS

Study design and ethical approval

This prospective observational study was conducted at the Pediatric Dentistry Department of an oral-health and dental-health center. Ethics approval was obtained from the Institutional Clinical Research Ethics Committee (approval no.: 2365/13.06.2023). Written informed consent was obtained from the parents or legal guardians of all participants before enrollment.

Participants and surgical indications

Children aged 4–16 years who were diagnosed with adenoid or adenotonsillar hypertrophy and had symptoms such as snoring, apnea, and nasal obstruction were included in the study. The exclusion criteria were chronic systemic diseases such as diabetes mellitus, lung diseases, renal diseases, autoimmune diseases, asthma, and allergic rhinitis. The indication for adenoidectomy was based on flexible endoscopic evaluation; it was planned if the adenoid gland filled more than two-thirds of the vertical portion of the choana. Tonsillectomy indications were determined by oropharyngeal examination using the Friedman Staging System and planned for patients with grade 3 or 4 tonsils (**Figure 1**).[14] All patients underwent surgery under general anesthesia. Adenoidectomies were performed using adenotomes, and tonsillectomies were performed using the cold dissection method. Hemostasis was initially achieved with tampons and, if needed, bipolar cautery. The patients were reevaluated in the first, second, and fourth weeks post-surgery. Ongoing nasal obstruction or snoring was monitored during the follow-up. If any persistent complaints were noted, the patients were re-examined for residual disease and excluded from the study. Although the study protocol allowed for exclusion in cases of persistent nasal obstruction or snoring, no patients were excluded on this basis. Mild ongoing symptoms were considered part of the natural variability in postoperative recovery.

Clinical assessment and measurements

Preoperative assessments were performed within 1 week before surgery, and postoperative assessments were conducted 4 months after surgery. All clinical oral-health evaluations were conducted by a calibrated pediatric

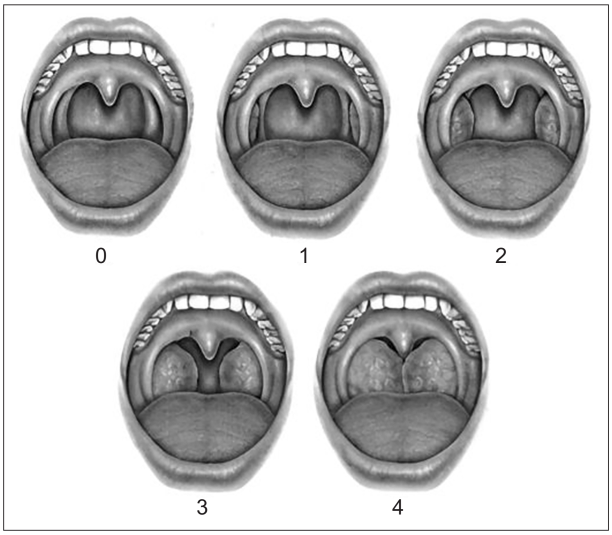

Figure 1. Tonsil size is graded from 0 to 4.
0, surgically removed tonsils; 1, tonsils hidden within the pillars; 2, tonsils extending to the pillars; 3, tonsils are beyond the pillars but not to the midline; 4, tonsils extend to the midline.
Adapted from the article of Lu et al. (Biomed Res Int 2018; 2018:6434872).[14]

dentist. To minimize the influence of external behavioral factors on postoperative oral-health assessments, oral-hygiene instructions or motivations were not provided to participants or their parents during the study period. However, all participants remained under routine dental supervision and urgent dental needs were managed according to standard clinical protocols. After the completion of data collection, individualized oral-hygiene education and preventive guidance were provided to all children and their parents in accordance with ethical standards. Intra-rater reliability was established by repeating assessments on 10% of the sample, achieving a kappa coefficient of > 0.85, which indicated almost perfect agreement. The kappa statistic measures the consistency of repeated assessments by the same examiner, while considering the possibility of chance agreement.

During dental examinations, each child's oral status was assessed using a standardized scoring system. These included the plaque index, scored as 0 = no plaque, 1 = localized deposits, 2 = generalized deposits, and 3 = abundant plaques. The gingival index was also recorded, with scores of 0 indicating healthy gingiva, scores of 1 indicating inflammation without bleeding on probing, scores of 2 indicating inflammation with bleeding on probing, and scores of 3 indicating spontaneous bleeding.[15,16] In accordance with World Health Organization guidelines, dental caries were diagnosed by identifying lesions that had progressed to the cavitation stage. To quantify caries experience, the study employed the following widely recognized indices: decayed, missing, and filled teeth for permanent dentition (DMFT) and decayed, missing, and filled teeth for primary dentition (dmft).[17] To assess the salivary flow rate, unstimulated saliva was collected in 15-mL tubes over a 5-minute period.[18] Mouth breathing, anterior open-bite, lip incompetence, and deep palate were documented through direct clinical observation by a pediatric dentist. The diagnostic criteria were as follows: mouth breathing was identified by habitual open-mouth posture at rest and parental reports; anterior open bite was defined as the lack of vertical overlap between the maxillary and mandibular incisors during occlusion; lip incompetence was recorded when the lips could not be closed at rest without effort; and the deep palate was evaluated subjectively based on palatal height relative to age norms. No radiographic assessment was performed. Malocclusion was evaluated in the vertical, transverse, and sagittal dimensions and was classified using standard orthodontic criteria.[19] The degree of overjet—defined as the horizontal projection of the maxillary anterior teeth beyond the mandibular incisors, typically approximately 3 mm—and overbite—described as the vertical overlap between the maxillary and mandibular anterior teeth, generally approximately 30%—were assessed using a periodontal probe to measure the horizontal and vertical dimensions, respectively.

Questionnaires

To gather extensive information, a detailed questionnaire was designed to capture data on participants' demographic profiles, medical and dental backgrounds, oral-hygiene practices, nutritional patterns, and oral health-related symptoms. The survey included inquiries about parental-education levels, breastfeeding duration, daily frequency of the consumption of sweet snacks between meals, types of foods eaten as snacks, toothbrushing routines, regularity of dental appointments, whether any interventions occurred during these visits, and oral-health issues, such as mouth breathing, xerostomia, snoring, and halitosis (Appendix 1). The criteria for preoperative symptoms and postoperative changes—including sleep-related behaviors, oral breathing patterns, daytime functioning, and behavioral characteristics—were established based on clinical evaluations and parental reports. Symptoms were recorded as present if they were observed by the clinician or reported by the parent at least once per week during the evaluation period. This frequency threshold was selected to distinguish persistent or recurrent symptoms and occasional or incidental symptoms. The intensity of each symptom was not graded numerically but was categorized dichotomously as 'present' or 'absent' for consistency in the statistical analysis. For symptoms subject to subjective interpretation—such as hyperactivity, abnormal breathing, or aggression—evaluations were performed independently by two experienced examiners. In cases of disagreement, a consensus decision was reached after discussion to minimize observer bias and ensure the reliability of the symptom classification.

Oral health-related quality of life assessment

To evaluate oral health-related quality of life (OHRQoL), the study employed the Turkish adaptation of the Early Childhood Oral Health Impact Scale (ECOHIS), a tool that has been previously validated and shown to possess high reliability. The Turkish version of the ECOHIS (T-ECOHIS) comprises 13 items organized into two principal domains: the child impact section (CIS) and the family impact section (FIS) (Appendix 2). The CIS is further subdivided into four areas, namely child symptoms, functional limitations, psychological aspects, and self-image/social interactions. The FIS includes two subdomains: parental distress and family functioning. Responses are recorded on a straightforward 5-point Likert scale, ranging from 0 (never), 1 (hardly ever), 2 (occasionally), 3 (often), to 4 (very often), with an additional option of 5 for "don't know." The aggregate score ranges from 0 to 52, with a possible range of 0 to 36 for the child section and 0 to 16 for the family section. Higher scores signify a more pronounced negative effect on OHRQoL.[20]

In this study, all participating parents completed not only the T-ECOHIS but also additional surveys assessing oral hygiene practices, oral-health behaviors, and dietary patterns.

Statistical analysis

A power analysis was conducted before data collection. Based on an expected effect size of 0.5, a significance level (α) of 0.05, and a 95% power (1−β = 0.95), the required minimum sample size was calculated as 34. This study included 52 children who met the adequacy criteria for statistical reliability. Statistical analyses were performed using the IBM SPSS Statistics 22 (IBM Corp., Armonk, NY, USA). Normality was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Descriptive statistics for qualitative variables are expressed as frequencies (%). Wilcoxon signed-rank and McNemar's tests were used for nonparametric comparisons. Statistical significance was set at $P < 0.05$.

RESULTS

In total, 52 children (24 girls, 28 boys; mean age 7.4 ± 2.1 years) participated in the study. Most children had regular mealtimes (73.1%) and consumed sugar between meals 1–2 times per day (63.5%). Approximately 34.6% of children had never visited a dentist and 38.5% brushed their teeth less than once daily. Detailed demographic and behavioral data are summarized in **Table 1**.

Table 2 outlines the preoperative symptoms, with snoring and sleeping with an open mouth (92.3%) being the most commonly observed. Tongue thrusting was the least frequently observed symptom (1.9%).

Table 3 provides descriptive statistics related to dentofacial findings, such as dentition period, V-shaped narrowing in the maxillary arch, adenoid face, teeth crowding, enlarged tongue appearance, open-mouth posture, anterior and lower tongue position, dry-chapped lips, mandibular position, anterior tooth occlusion, sagittal-transverse-vertical relationship, and crossbite.

In the preoperative assessment (**Table 4**), the mean unstimulated salivary flow rate was 0.43 ± 0.21 mL/min; the plaque index was 1.58 ± 0.48, the gingival index was 1.28 ± 0.55, the mean number of dmft was 5.49 ± 3.92, and the DMFT score for permanent teeth was 2.15 ± 1.54. These indices were used to evaluate the cumulative dental caries experience in both dentitions.

CIS scores ranged between 0 and 25, with a mean score of 8.08 ± 6.17 and a median score of 6.5. FIS scores ranged between 0 and 14, with a mean of 3.62 ± 3.43 and a median score of 3. Total T-ECOHIS scores

Table 1. Descriptive statistics related to demographic parameters, oral-health behaviors, and dietary habits

	n	%
Mother's education level		
Primary school	15	28.8
Middle school	9	17.3
High school	18	34.6
University	10	19.2
Father's education level		
Primary school	9	17.3
Middle school	11	21.2
High school	21	40.4
University	11	21.2
Regular mealtimes		
Yes	38	73.1
No	14	26.9
Snacks		
Once a day	16	30.8
1–3 times a day	31	59.6
More than 3 times a day	5	9.6
Duration of breastfeeding		
Less than 6 months	13	25.0
6–12 months	12	23.1
More than 12 months	27	51.9
Foods consumed between meals		
Bread and sandwich	17	32.7
Fruit	14	26.9
Biscuits and wafers	7	13.5
Candy and chocolate	10	19.2
Other	4	7.7
Sugar consumption during the day between meals		
More than 3 times a day	4	7.7
1–2 times a day	33	63.5
Only for meals	7	13.5
Nothing	8	15.4
Visiting the dentist		
Yes	34	65.4
No	18	34.6
Treatment status if visiting a dentist*		
Yes	22	64.7
No	12	35.3

*Treatment status was assessed only among participants who reported visiting a dentist; therefore, the total number of respondents for this item is lower than the overall sample size.

Table 1. Continued

	n	%
Frequency of tooth brushing		
Less than once per day	20	38.5
Once a day	27	51.9
2–3 times a day	5	9.6
Helping of family members to brush their teeth		
Yes	36	69.2
No	16	30.8

n, number of participants.

Table 2. Preoperative symptoms of children

Symptom	n	%
Snoring	48	92.3
Open mouth during sleep	48	92.3
Salivating on the pillow during sleep	38	73.1
Halitosis	28	53.8
Thirsty awakening at nights	27	51.9
Dry mouth	26	50.0
Allergy status	24	46.2
Bruxism	19	36.5
Attention deficit	18	34.6
Hyperactivity	18	34.6
Abnormal breathing	18	34.6
Nail biting	17	32.7
Difficulty in swallowing	16	30.8
Impact on school performance	16	30.8
Headache	14	26.9
Daytime sleepiness	13	25.0
Bedwetting	8	15.4
Difficulty with smell, taste, and speech	8	15.4
Lip biting	8	15.4
Lip sucking	4	7.7
Aggression	3	5.8
Tongue thrusting	1	1.9

n, number of participants.

ranged between 0 and 39; the mean score was 11.69 ± 8.80, and the median score was 11 (Table 5).

In the evaluation of postoperative symptoms as compared to the preoperative symptoms: the decreases in the findings of snoring, open mouth during sleep, salivating on the pillow during sleep, waking up thirsty at night, dry mouth, headache, abnormal breathing, difficulty swallowing, and teeth grinding were statistically

Table 3. Descriptive statistics related to dentofacial findings

	n	%
Dentition period		
Primary dentition	14	26.9
Mixed dentition	35	67.3
Permanent dentition	3	5.8
V-shaped narrowing in the maxillary arch		
Yes	28	53.8
No	24	46.2
Adenoid face		
Yes	28	53.8
No	24	46.2
Teeth crowding (≥ 2 mm)		
Yes	23	44.2
No	29	55.8
Enlarged tongue appearance		
Yes	31	59.6
No	21	40.4
Open mouth posture		
Yes	18	34.6
No	34	65.4
Anterior and lower tongue position		
Yes	43	82.7
No	9	17.3
Mandible		
Normal	26	50.0
Prognathic	3	5.8
Retrognathic	23	44.2
Position of maxillary anterior teeth*		
Normal	30	57.7
Prominent	22	42.3
Position of mandibular anterior teeth†		
Normal	25	48.1
Retrognathic	27	51.9
Dry, chapped lips		
Yes	18	34.6
No	34	65.4
Transversal relationship/posterior crossbite		
Unilateral	5	9.6
Bilateral	7	13.5
No	40	76.9
Vertical relationship		
Normal overbite (vertical overlap of incisors 0–3 mm)	34	65.4
Anterior open bite (no vertical overlap < 0 mm)	3	5.8
Deep bite (vertical overlap > 3 mm)	15	28.8

n, number of participants.
Anterior open bite was defined as a negative overbite value (< 0 mm). Positive values indicated vertical overlap.
*The position of the maxillary anterior teeth was classified as normal (overjet 0–3 mm) or prominent (overjet > 3 mm).
†The position of the mandibular anterior teeth was classified based on overjet values: normal = 0–3 mm; retrognathic > 3 mm.

significant (P = 0.001). Decreases in smell, taste, and speech difficulties (P = 0.016) as well as daytime sleepiness, and halitosis were also statistically significant (P = 0.039; **Table 6** and **Figure 2**).

The postoperative increase in salivary flow rate compared with the preoperative salivary flow rate was statistically significant (P = 0.001). The postoperative decrease according to the preoperative plaque index level was statistically significant (P = 0.001). The postoperative decrease in gingival indices relative to preoperative gingival indices was statistically significant (P = 0.001; **Table 7** and **Figure 3**).

DISCUSSION

Adenotonsillar hypertrophy is one of the most common causes of airway obstruction in children.[21,22] The symptoms observed in our study closely align with previous findings. Among the 52 children evaluated preoperatively, the most frequent symptoms were snoring and sleeping with an open mouth (92.3%), while the least common symptom was tongue thrusting (1.9%). Postoperative assessments revealed notable improvements in snoring, mouth breathing, daytime sleepiness, drooling during sleep, dry mouth, headache, abnormal breathing, dysphagia, olfactory and gustatory difficulties, speech issues, teeth grinding, and halitosis. These findings support the efficacy of after adenoidectomy or adenotonsillectomy in alleviating symptoms of upper-airway obstruction. Improvements in smell, taste, and speech after adenoidectomy or adenotonsillectomy can be attributed to the restoration of nasal airflow and the reduction of chronic inflammation in the upper airway. These changes enhance olfactory receptor exposure, normalize intraoral pressure, and improve tongue and soft palate mobility, thereby contributing to improved articulation.[23,24]

Our results corroborated those of previous studies. For instance, a study of 76 children aged 3–12 years with adenotonsillar hypertrophy reported significant postoperative improvements in snoring, mouth breathing, sleep apnea, and daytime sleepiness, except for bedwetting.[25] Similarly, a clinical study of 59 children aged 1.5–12.0 years found snoring to be the most improved symptom, and daytime sleepiness to be the least improved.[12] Our findings reflected the same trend, with snoring showing the greatest improvement, and halitosis and daytime sleepiness showing the least improvement.

Mouth breathing due to adenotonsillar hypertrophy has been linked to reduced salivary flow, increased *Can-*

Table 4. Preoperative assessment of caries index, plaque index, gingival index, and salivary flow rate

	n	Minimum	Maximum	Mean ± SD	Median
Salivary flow rate (mL/min)	52	0.1	1.0	0.43 ± 0.21	0.4
dmft (score)	49	0	17.0	5.49 ± 3.92	5.0
DMFT (score)	34	0	6.0	2.15 ± 1.54	2.5
Plaque index (score)	52	0.43	3.03	1.58 ± 0.48	1.7
Gingival index (score)	52	0	3.07	1.28 ± 0.55	1.3

Preoperative period was defined as the assessment conducted within 1 week prior to surgery.
dmft, decayed, missing, and filled teeth for primary dentition; DMFT, decayed, missing, and filled teeth for permanent dentition; n, number of participants; SD, standard deviation.

Table 5. Descriptive statistics for T-ECOHIS scores

	Minimum	Maximum	Mean ± SD	Median
Child impact section (CIS)	0	25	8.08 ± 6.17	6.5
Child symptoms	0	4	1.35 ± 0.97	1.0
Child function	0	11	3.54 ± 2.97	3.0
Child psychology	0	7	2.00 ± 1.96	2.0
Child self-image and social interaction	0	7	2.00 ± 1.96	2.0
Family impact section (FIS)	0	14	3.62 ± 3.43	3.0
Parental distress	0	8	1.90 ± 2.00	2.0
Family function	0	7	1.71 ± 1.84	2.0
Total T-ECOHIS	0	39	11.69 ± 8.80	11.0

T-ECOHIS, Turkish version of the Early Childhood Oral Health Impact Scale; SD, standard deviation.

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Table 6. Evaluation of postoperative changes compared to the preoperative period

	Preoperative	Postoperative	*P* value
Snoring	48 (92.3)	3 (5.8)	0.001***
Open mouth during sleep	48 (92.3)	7 (13.5)	0.001***
Daytime sleepiness	13 (25.0)	6 (11.5)	0.039*
Salivating on the pillow during sleep	38 (73.1)	8 (15.4)	0.001***
Thirsty awakening at nights	27 (51.9)	8 (15.4)	0.001***
Dry mouth	26 (50.0)	6 (11.5)	0.001***
Bedwetting	8 (15.4)	7 (13.5)	1.000
Headache	14 (26.9)	2 (3.8)	0.001***
Aggression	3 (5.8)	4 (7.7)	1.000
Attention deficit	18 (34.6)	14 (26.9)	0.125
Hyperactivity	18 (34.6)	17 (32.7)	1.000
Abnormal breathing	18 (34.6)	3 (5.8)	0.001***
Difficulty in swallowing	16 (30.8)	3 (5.8)	0.001***
Difficulty with smell, taste, and speech	8 (15.4)	1 (1.9)	0.016*
Impact on school performance	16 (30.8)	11 (21.2)	0.063
Allergy status	24 (46.2)	21 (40.4)	0.375
Bruxism	19 (36.5)	8 (15.4)	0.001***
Nail biting	17 (32.7)	17 (32.7)	1.000
Lip biting	8 (15.4)	8 (15.4)	1.000
Tongue thrusting	1 (1.9)	1 (1.9)	1.000
Lip sucking	4 (7.7)	4 (7.7)	1.000
Halitosis	28 (53.8)	21 (40.4)	0.039*

Values are presented as number of participants (%). McNemar's test.
Preoperative period was defined as the assessment conducted within 1 week prior to surgery; postoperative assessments were performed 4 months after surgery.
$^{*}P < 0.05$, $^{***}P \leq 0.001$.

dida and *Lactobacilli* presence, lower plaque pH, and heightened caries risk.[26-28] Mouth breathing can reduce salivary gland stimulation due to decreased lip sealing and reduced orofacial muscle activity, which lowers the mechanical stimulation of the salivary glands. In addition, the absence of nasal breathing results in mucosal dehydration and reduced parasympathetic stimulation of the salivary flow.[29,30] Previous studies have reported that children with chronic tonsillitis have higher dental-caries indices.[9,31] While some studies found no difference in salivary flow between mouth and nasal breathers,[13,32] our study observed a significant postoperative increase in the salivary flow rate ($P = 0.001$).

Mummolo et al.[32] compared the plaque index values of 40 mouth-breathing and nasal-breathing patients and found that the plaque indexes of mouth-breathing patients were higher. Effects of after adenoidectomy or adenotonsillectomy on periodontal health were evaluated in 15 healthy individuals and 20 patients with adenotonsillar hypertrophy; gingival health was found to be improved after adenoidectomy or adenotonsillectomy.[33] In another study involving 60 children in the deciduous dentition period, mouth-breathing children had higher gingival index values and a higher risk of periodontal disease development than nasal-breathing children.[34] In our study, there was a significant decrease in postoperative plaque and gingival index values compared with the preoperative values ($P = 0.001$). The high preoperative plaque index and gingival index scores can be attributed to mouth-breathing habits, which reduce salivary flow and contribute to poor oral hygiene. These conditions promoted plaque accumulation and gingival inflammation. The observed postoperative improvements in these indices suggest that after adenoidectomy or adenotonsillectomy not only addresses airway obstruction but also contributes to better periodontal outcomes by promoting nasal breathing.

Consistent with previous literature, our findings dem-

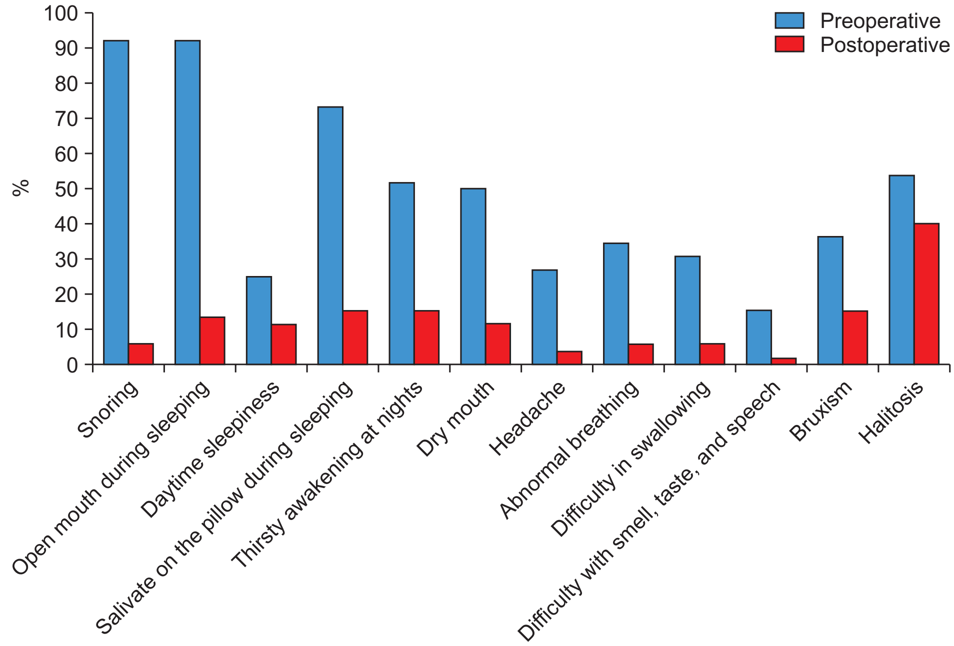

Figure 2. Preoperative and postoperative values of symptoms showing significant changes. Preoperative period was defined as the assessment conducted within 1 week prior to surgery; postoperative assessments were performed 4 months after surgery.

Table 7. Evaluation of postoperative salivary flow rate, plaque index and gingival index changes compared to the preoperative period

	Preoperative	Postoperative	*P* value
Salivary flow rate (mL/min)	0.43 ± 0.21 (0.4)	0.75 ± 0.19 (0.7)	0.001***
Plaque index (score)	1.58 ± 0.48 (1.7)	1.06 ± 0.33 (1.1)	0.001***
Gingival index (score)	1.28 ± 0.55 (1.3)	0.70 ± 0.39 (0.6)	0.001***

Values are presented as mean ± standard deviation (median). Wilcoxon signed-rank test.
Preoperative period was defined as the assessment conducted within 1 week prior to surgery; postoperative assessments were performed 4 months after surgery.
***$P \leq 0.001$.

onstrated significant postoperative reductions in plaque and gingival indices (P = 0.001), supporting the role of after adenoidectomy or adenotonsillectomy in improving periodontal health.[13,32-34] Halitosis, which is influenced by multiple oral-health factors and is frequently linked to adenoid hypertrophy, also showed a significant postoperative reduction,[35-38] although some studies did not find this association.[39]

Oral behaviors and functions such as chewing, swallowing, and speech are often compromised in children with mouth breathing.[27] In our study group, teeth grinding (36.5%), nail biting (32.7%), and speech difficulties (15.4%) were commonly observed, indicating the behavioral impact of chronic mouth breathing.

The present study indicates that oral-health conditions in children have only a mild negative impact on OHRQoL, as measured by T-ECOHIS (mean total 11.69 ± 8.80; CIS 8.08 ± 6.17; FIS 3.62 ± 3.43). The similarity between the mean and median values suggests a relatively consistent effect across the cohort, with most children experiencing only a modest impairment. Although clinical features, such as mouth breathing and associated dentofacial alterations, were evident, their perceived impact on daily functioning and family well-being was limited. Notably, the effects of mouth breathing may not always be captured by the T-ECOHIS as these effects can be masked by coexisting factors, including dental caries, trauma, sociodemographic variables, and parental perceptions. These findings are consistent with those of previous studies. In a controlled clinical study of children with adenotonsillar hypertrophy and mouth breathing, no significant differences in T-ECOHIS scores were observed compared to postoperative or healthy nasal-breathing controls, except for a minor variation in the

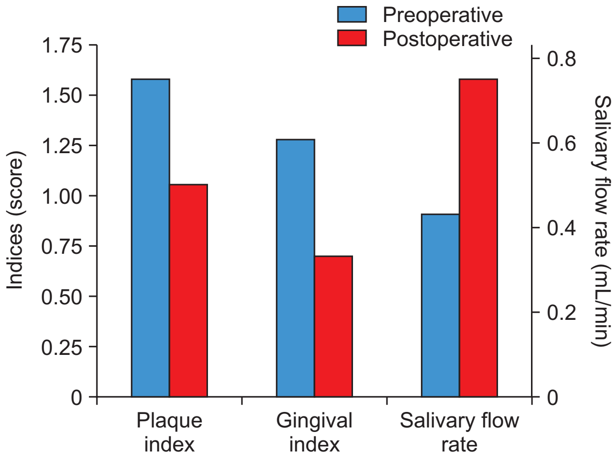

Figure 3. Preoperative and postoperative salivary flow rates, plaque indices, and gingival indices showing significant changes. Preoperative period was defined as the assessment conducted within 1 week prior to surgery; postoperative assessments were performed 4 months after surgery.

self-image/social interaction domain.[9]

The association between adenotonsillar hypertrophy and dentofacial anomalies is well documented.[8,10,26,40,41] In our cohort, 82.7% patients exhibited anterior-inferior tongue positioning, 53.8% had V-shaped maxillary arches and adenoid faces, 44.2% had crowding, and 34.6% had an open-mouth posture. These findings reflected the craniofacial implications of chronic mouth breathing. Our findings contribute to the understanding of how adenotonsillar hypertrophy may affect craniofacial development by altering the breathing patterns. Chronic mouth breathing associated with adenotonsillar obstruction has been widely linked to dentofacial anomalies, such as anterior open bite, lip incompetence, and a high-arched palate. In some patients, these features may persist even after surgery. Therefore, interdisciplinary collaboration with orthodontic specialists is essential for the long-term follow-up and early management of potential malocclusion and growth disturbances. Comparable studies, such as those by Yildirim and Aktören,[39] have reported increased frequencies of these anomalies in mouth-breathing children. Another study reported a significant association between malocclusion and nasal resistance.[41]

It is important to note that the orthodontic findings in our study were not accompanied by standardized cephalometric or three-dimensional (3D) imaging analyses, which limited our ability to precisely define skeletal changes. Furthermore, although a broad classification of orthodontic findings was presented, clearer diagnostic criteria would benefit future studies. Additionally, our study did not include a second postoperative orthodontic evaluation and changes in dentofacial features following after adenoidectomy or adenotonsillectomy were not measured longitudinally. Moreover, because of the ethical constraints related to radiation exposure in pediatric patients, cephalometric or 3D imaging techniques were not employed in this study. This limitation restricted the ability to assess skeletal changes associated with surgical intervention.

Crucially, these craniofacial anomalies often persist despite surgical intervention. After adenoidectomy or adenotonsillectomy may resolve the airway obstruction but may not sufficiently address associated structural or functional concerns. Multidisciplinary management—particularly orthodontic and myofunctional therapy—is essential for the comprehensive care and improvement of long-term oral health.

This study has some limitations. The absence of a separate healthy control group limits the ability to interpret the prevalence of dentofacial anomalies such as anterior-inferior tongue posture or V-shaped maxilla. Although preoperative values served as an internal reference, comparisons with healthy children without adenotonsillar hypertrophy would have strengthened our findings. While intra-rater reliability was established, inter-rater calibration was not conducted, which could impact the consistency of the clinical assessments. The overall oral hygiene status of the study population was suboptimal, which could be a confounding factor, particularly in the assessment of parameters such as halitosis. This study was not designed to include radiographic evaluations, such as cephalometric or three-dimensional imaging; however, patients presenting with dentofacial alterations suggestive of skeletal discrepancies were referred to the orthodontic clinic for further assessment.

Additionally, the study did not perform a separate comparison between children undergoing adenoidectomy and those undergoing after adenoidectomy or adenotonsillectomy because of the limited sample size. The absence of a nonsurgical control group in this study limited our ability to determine whether the observed changes in gingival or plaque indices were attributable to the Hawthorne effect or to the surgical intervention itself. This may obscure potential differences in outcomes, particularly considering that tonsillar hypertrophy may exert a stronger influence on conditions such as mouth breathing and halitosis.

CONCLUSIONS

This study demonstrated that various oral health-related symptoms caused by mouth breathing owing to adenotonsillar hypertrophy can significantly improve following after adenoidectomy or adenotonsillectomy.

Improvements were also observed in the periodontal parameters. However, symptoms such as harmful oral habits, attention deficit, hyperactivity, and bedwetting did not show notable improvement.

To address persistent dentofacial changes after surgery, orthodontic treatment is recommended after a minimum of 1 year of follow-up, if indicated. To enhance childhood oral health, identifying and eliminating risk factors, providing oral hygiene education to children and their families, and implementing preventive strategies are crucial. Because adenotonsillar hypertrophy may pose a risk factor for dental caries and periodontal diseases, a collaborative, interdisciplinary approach involving otolaryngologists, pediatricians, and orthodontists is essential for effective treatment and long-term outcomes. Orthodontic evaluation is recommended for patients with persistent craniofacial changes following after adenoidectomy or adenotonsillectomy to ensure timely intervention for developing dentofacial anomalies.

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AUTHOR CONTRIBUTIONS

Conceptualization: EAM, GYD, SKD. Data curation: EAM, GYD. Formal analysis: EAM, GYD, SKD. Methodology: All authors. Project administration: EAM, SKD, ST. Supervision: EAM, SKD, ST. Visualization: SKD. Writing–original draft: EAM, GYD, SKD. Writing–review & editing: EAM, GYD.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Appendix 1. Questionnaire.

1. Mother's education level:
   1) Primary school   2) Middle school   3) High school   4) University

2. Father's education level:
   1) Primary school   2) Middle school   3) High school   4) University

3. Does the child have regular mealtimes (breakfast, lunch, dinner)?
   1) Yes   2) No

4. How often does he/she have snacks?
   1) Once a day   2) 1–3 times a day   3) More than 3 times a day

5. How long should breastfeeding last?
   1) Less than 6 months   2) 6–12 months   3) More than 12 months

6. Between meals, what kind of foods does he/she usually consume?
   1) Bread and sandwich   2) Fruit   3) Biscuits and wafers   4) Candy and chocolate   5) Other

7. How much sugar does he/she consume throughout the day between meals? (including fruit juice, carbonated drinks, and sugary medicines)
   1) More than 3 times a day   2) 1–2 times a day   3) Only for meals   4) Nothing

8. Has your child been to the dentist before?
   1) Yes   2) No

9. If they visited the dentist, could they be treated?
   1) Yes   2) No

10. How many times a day does your child brush their teeth?
    1) Less than once per day   2) Once a day   3) 2–3 times a day

11. Do family members help with brushing teeth?
    1) Yes   2) No

12. Does your child snore?
    1) Yes   2) No

13. Does your child sleep with their mouth open?
    1) Yes   2) No

14. Is there salivating on the pillow during sleep?
    1) Yes   2) No

15. Have you noticed halitosis in your child?
    1) Yes   2) No

16. Does your child wake up thirsty at night?
    1) Yes   2) No

17. Does your child have dry mouth?
    1) Yes   2) No

18. Is there an allergy?
1) Yes 2) No

19. Does your child grind their teeth (bruxism)?
1) Yes 2) No

20. Is there attention deficit?
1) Yes 2) No

21. Is there hyperactivity?
1) Yes 2) No

22. Is there abnormal breathing?
1) Yes 2) No

23. Does your child bite their nails?
1) Yes 2) No

24. Is there difficulty swallowing?
1) Yes 2) No

25. Is school performance affected?
1) Yes 2) No

26. Does your child have headaches?
1) Yes 2) No

27. Is there daytime sleepiness?
1) Yes 2) No

28. Does your child wet the bed?
1) Yes 2) No

29. Is there difficulty smelling, tasting, and speaking?
1) Yes 2) No

30. Does your child bite their lips?
1) Yes 2) No

31. Does your child suck their lips?
1) Yes 2) No

32. Is there aggression?
1) Yes 2) No

33. Does your child push their tongue out?
1) Yes 2) No

Appendix 2. Turkish version of the Early Childhood Oral Health Impact Scale (T-ECOHIS).

The T-ECOHIS was used to assess the impact of oral-health problems on the quality of life of the children and their families. The items were scored by the parents on a 5-point Likert scale ranging from 0 (never) to 4 (very often).

1. Child impact section (CIS)

Domain	Item
1. Child symptoms	1. Has your child had pain in the teeth, mouth, or jaws?
2. Child function	2. Has your child had difficulty drinking hot or cold beverages because of dental problems? 3. Has your child had difficulty eating some foods because of dental problems? 4. Has your child had difficulty pronouncing any words because of dental problems? 5. Has your child missed preschool, daycare, or school because of dental problems?
3. Child psychology	6. Has your child been irritable or frustrated because of dental problems? 7. Has your child had trouble sleeping because of dental problems?
4. Child self-image/social interaction	8. Has your child avoided smiling or laughing because of dental problems? 9. Has your child avoided talking with other children because of dental problems?

2. Family impact section (FIS)

Domain	Item
1. Parental distress	10. Have you or another family member been upset because of your child's dental problems? 11. Have you or another family member felt guilty because of your child's dental problems?
2. Family function	12. Has your child's dental health affected the family's sleeping habits? 13. Has your child's dental health caused financial difficulties for your family?