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Quantitative assessment of uvula dimensions, airway space, and pharyngeal bursa in children with and without adenoid hypertrophy

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Abstract

This study aimed to investigate the association between adenoid hypertrophy (AH) and upper airway morphology in pediatric patients, with a specific focus on uvula dimensions, pharyngeal bursa characteristics, and nasopharyngeal airway space using sagittal and axial magnetic resonance imaging (MRI). In this retrospective cross-sectional study, MRI scans of 104 pediatric patients aged 1–18 years were analyzed. Uvula height and width, pharyngeal bursa height and width, and the nasopharyngeal airway distance (from the posterior nasal spine to the posterior pharyngeal wall) were measured using calibrated DICOM software. Patients were grouped based on the presence of AH, and anatomical measurements were compared accordingly. Correlations with age and sex were also assessed. Statistical analysis included t-tests, ANOVA, chi-square tests, and Pearson correlation. Children with AH had significantly reduced nasopharyngeal airway space compared to those without AH (mean: 12.05 mm vs. 16.71 mm, $p<0.001$). No significant differences were observed in uvula or bursa dimensions across groups. A strong correlation was found between uvula height and width ($r=0.66$), and both increased significantly with age. Males showed greater pharyngeal bursa height than females ($p=0.001$), while bursa width did not differ significantly by sex. MRI is a valuable non-invasive tool for evaluating pediatric airway anatomy. While AH is associated with airway narrowing, it does not appear to affect uvula or bursa characteristics. Pediatric dentists should consider comprehensive airway assessments, as early detection of obstruction can impact craniofacial development and treatment planning.

Keywords: Adenoid hypertrophy, magnetic resonance imaging, pediatric airway, pharyngeal bursa, uvula

Introduction

Adenoid hypertrophy (AH) represents one of the most prevalent causes of upper airway obstruction in the pediatric population, exerting a multifactorial impact on craniofacial development, occlusion, and oral health status [1,2]. Adenoid tissues undergo physiological proliferation during early childhood, peaking around the age of five, and typically regress during adolescence [3]. However, persistent or pathological hypertrophy can result in partial or complete blockage of the nasopharyngeal airway, contributing to a variety of functional impairments, including snoring, sleep-disordered breathing (SDB), obstructive sleep apnea (OSA), and disturbances in speech, deglutition, and olfaction [4,5].

Habitual mouth breathing is a frequently observed compensatory behavior in children with AH, and has been associated with a spectrum of dentofacial abnormalities, such as maxillary constriction, anterior open bite, lip incompetence, and Class II skeletal patterns [6–8]. These effects underscore the critical role of early diagnosis and interdisciplinary management in preventing long-term craniofacial alterations.

Although conventional diagnostic tools—such as clinical examination, lateral cephalometry, and nasoendoscopy—are commonly employed to evaluate adenoidal obstruction, they each present limitations [9,10]. Lateral cephalometric radiographs offer only two-dimensional insights with limited soft tissue resolution , while nasoendoscopy, despite its dynamic

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visualization capability, is invasive and operator-dependent, often causing discomfort in pediatric patients [11-13].

Magnetic resonance imaging (MRI), by contrast, offers a non-invasive, radiation-free, and reproducible modality with superior soft tissue contrast and multiplanar visualization. These characteristics make MRI particularly suitable for the anatomical assessment of pediatric airway structures, including the nasopharynx and oropharynx [14]. Despite these advantages, MRI remains underutilized in routine pediatric airway evaluation.

An underexplored anatomical feature in this context is the morphology of the soft palate and uvula, which are integral to velopharyngeal function. It is hypothesized that chronic upper airway obstruction due to AH may lead to adaptive changes in uvular features; however, this relationship has not been comprehensively studied in pediatric populations using MRI [9,10]. In addition, the linear distance from the posterior nasal spine (PNS) to the posterior pharyngeal wall has been proposed as an indirect metric of nasopharyngeal patency, yet its diagnostic utility remains unclear [15].

Existing literature has largely focused on cephalometric or endoscopic approaches to evaluate upper airway dimensions, with few studies employing MRI to assess uvula width and height alongside airway space measurements [16–18]. To date, no study has systematically investigated the combined role of uvular and nasopharyngeal metrics in relation to AH using sagittal and axial MRI in children.

Accordingly, the present study aims to quantitatively assess uvula dimensions, nasopharyngeal airway space, and pharyngeal bursa characteristics in pediatric patients with and without AH. By determining whether secondary soft tissue structures reflect underlying airway compromise, this research seeks to advance MRI-based diagnostic approaches in pediatric airway evaluation.

The null hypothesis of this study posits that there are no significant differences in uvula width and height and pharyngeal bursa dimensions between children with and without AH.

Material and Methods

Ethical Approval

This retrospective, cross-sectional study aimed to evaluate the relationship between AH and morphometric parameters of the upper airway in pediatric patients. The study protocol was reviewed and approved by the Non-Interventional Clinical Research Ethics Committee of Kocaeli Health and Technology University (Approval No: 2025-160) on April 21, 2025. The research was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki and its subsequent amendments. All patient data were anonymized prior to analysis to ensure confidentiality and data protection.

Patient Selection

This retrospective study involved the analysis of randomly selected MRI data to evaluate the presence of AH, height and width of uvula, and the distance between the PNS and posterior wall of the nasopharynx, width and height of the pharyngeal bursa in pediatric patients. MRI scans were obtained from the Radiology Department of Kocaeli City Hospital between 2022 and March 2024. This study included pediatric patients aged between 1 and 18 years at the time of imaging, availability of MRI scans that clearly depicted the nasopharyngeal region in axial and sagittal planes, images acquired for non-neoplastic clinical indications (e.g., headache, suspected sinusitis, or SDB), no prior surgical intervention involving the nasopharynx or oropharynx, and sufficient image quality without significant motion artifacts or anatomical distortion. Patients were excluded if they had any of the following; inadequate image quality or incomplete coverage of the target anatomical structures, a history of head and neck surgery, including adenoidectomy, tonsillectomy, or cleft palate repair, known or suspected craniofacial syndromes or congenital anomalies affecting the nasopharynx (e.g., cleft palate, Pierre Robin sequence, Down syndrome), evidence of nasopharyngeal tumors, infections, or other mass-like lesions, or if they were older than 18 years of age. Only initial MRI scans were included to prevent duplication from follow-up examinations in the same individual. All included scans were reviewed to confirm the visibility of the adenoids, uvula, pharyngeal bursa, and surrounding reference structures required for the planned measurements. A total of 104 patients (54 males, 50 females; mean age: 10.21 ± 5.16 years) met the criteria and were included in the final analysis. The presence or absence of AH was confirmed based on radiological appearance.

Imaging Protocols

All MRI examinations were performed using a 3.0T scanner equipped with a dedicated head and neck coil (device model and manufacturer to be specified if available). The imaging protocol included axial and coronal Fast Spin Echo (FSE) T1-weighted and T2-weighted sequences, as well as T2-weighted Fluid-Attenuated Inversion Recovery (FLAIR) sequences for enhanced soft tissue contrast. For FSE T1-weighted images, typical parameters were as follows: repetition time (TR) ranging from 400 to 700 ms, echo time (TE) between 10 and 20 ms, slice thickness of 3–4 mm, inter-slice gap of 0.3–1 mm, field of view (FOV) of 180–240 mm, and a matrix size of 256 × 192 or higher. T1-weighted images were acquired in both axial and coronal planes for optimal anatomical coverage. FSE T2-weighted images were acquired with a TR of 3000–6000 ms and a TE of 80–120 ms. The slice thickness and FOV parameters were kept consistent with T1-weighted sequences to ensure measurement comparability, and images were obtained in both axial and coronal planes.

For the T2-weighted FLAIR sequences, a TR of 8000–10000 ms, TE of 90–140 ms, and an inversion time (TI) of approximately 2200–2500 ms were used. These sequences were primarily acquired in the axial plane, with a slice thickness of 3–5 mm and an inter-slice gap of 0.5–1 mm. The matrix was set to a minimum of 256 × 192 to ensure high spatial resolution.

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All images were reviewed and measurements were performed on DICOM files using a standardized workstation with appropriate calibration, ensuring consistency across patients and timepoints.

Morphometric and Classification Parameters

Morphometric evaluations were performed using axial and sagittal FSE and FLAIR MRI sequences. Coronal plane images were not included in the evaluation because routine pediatric MRI protocols at our institution do not consistently acquire coronal sequences in all cases. This approach is used to minimize total scan duration and reduce motion artefacts in children, ensuring better standardization and measurement reproducibility across the study population. All measurements were conducted on high-resolution images using a standardized DICOM viewer, and anatomical landmarks were consistently applied to ensure intra-study uniformity. The parameters assessed included nasopharyngeal airway width, uvula height and width, adenoid thickness (if present), and pharyngeal bursa dimensions.

Airway Measurement

The nasopharyngeal airway was evaluated on midline sagittal FSE T1-weighted images. The measurement was defined as the shortest linear distance between the PNS—identified as the most posterior point of the hard palate—and the posterior wall of the nasopharynx, typically at the level of the anterior surface of the cervical vertebral body (C1 or C2, depending on individual anatomy) (Figure 1).

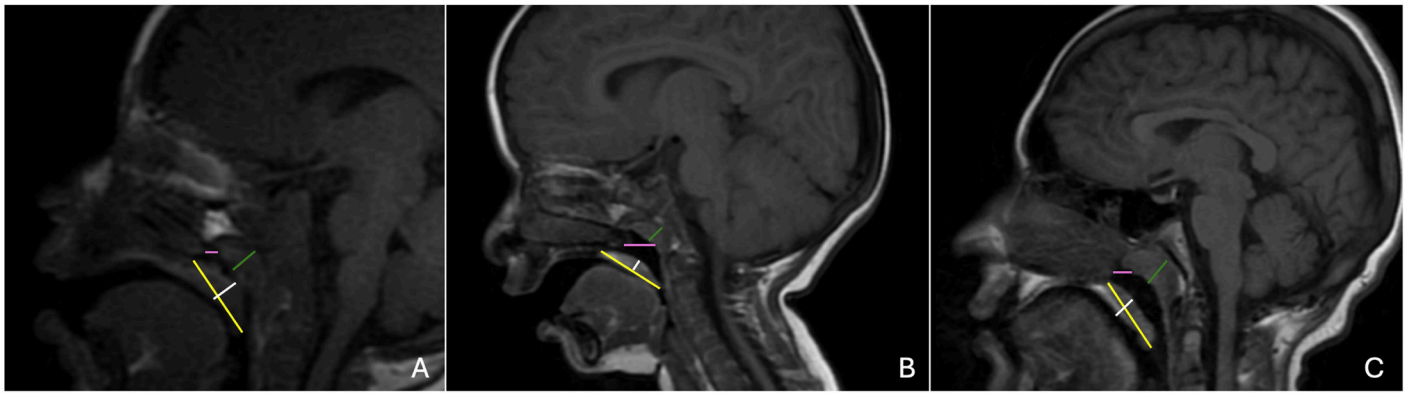

Figure 1. Sagittal T1 FLAIR magnetic resonance images of pediatric patients demonstrating morphometric parameters. (A) 1-year-old male, (B) 3-year-old male, and (C) 13-year-old male. Uvula width (white line) and height (yellow line), adenoid hypertrophy (green line), and nasopharyngeal airway distance from the posterior nasal spine to the posterior pharyngeal wall (pink line) are annotated

Uvula Height and Width

The uvula was also assessed on mid-sagittal FSE T1-weighted images. Uvula height was measured from the tip of the uvula vertically to the soft palate base, at the point of uvular origin. Uvula width was measured at the widest transverse portion of the uvula visible in the sagittal section (Figure 1). Uvula measurements were performed on mid-sagittal MRI images because this plane provides the most accurate visualization of the uvula's full length and width, allowing clear identification of the uvular tip and its anatomical attachment in a single section. Axial and coronal planes were not utilized for these measurements, as their orientation does not consistently capture the uvula in its maximal dimension, potentially increasing measurement variability.

Adenoid Hypertrophy and Thickness

AH was diagnosed based on MRI criteria, defined as anteroposterior protrusion of lymphoid tissue into the nasopharyngeal airway with contact or convex indentation toward the posterior choanal region, resulting in measurable airway narrowing. The presence of adenoid tissue was noted when visible in the posterior nasopharyngeal wall on sagittal FSE T1- and T2- weighted images. If present, adenoid thickness was measured as the maximum anteroposterior dimension of the adenoid tissue protruding into the nasopharyngeal airway space. The measurement was taken perpendicular to the airway, typically at the level of maximal bulging toward the posterior choanae (Figure 2).

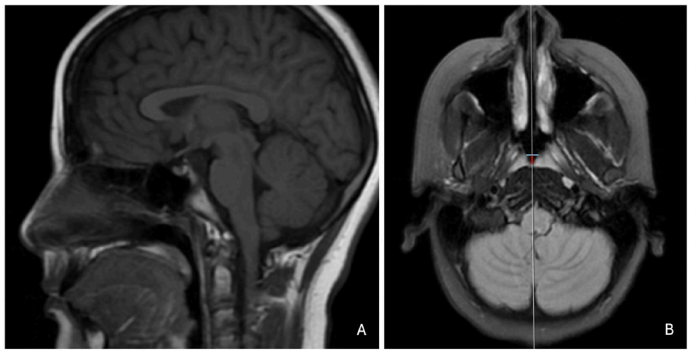

Figure 2. Sagittal and axial T1 FLAIR magnetic resonance images of a 10-year-old female patient. (A) Sagittal view demonstrating absence of Adenoid hypertrophy (AH). (B) Axial view showing the pharyngeal bursa with annotated width (blue line) and height (red line). These images highlight normal nasopharyngeal anatomy and the visualization of the pharyngeal bursa in the absence of adenoid enlargement

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Pharyngeal Bursa Dimensions

The pharyngeal bursa, a midline recess of the posterior nasopharyngeal wall, was evaluated using axial FLAIR T2-weighted images. Bursa height (depth) was defined as the maximum craniocaudal dimension from the most superior to the most inferior point of the visible recess. Bursa width was defined as the widest mediolateral dimension at the base of the bursa, measured perpendicular to the depth axis (Figure 3).

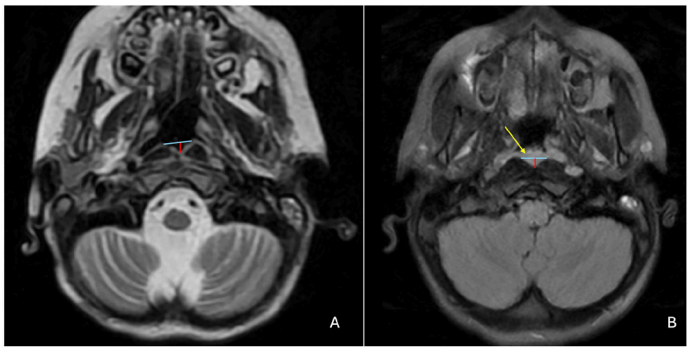

Figure 3. Axial T2-weighted MR images illustrating pharyngeal bursa in pediatric patients. (A) Axial T2 Fast Spin Echo (FSE) image of a 3-year-old male without Adenoid hypertrophy (AH), and (B) axial T2 FLAIR image of a 12-year-old male with evident AH (arrow). Pharyngeal bursa width (blue line) and height (red line) are annotated in both cases, demonstrating the presence and absence of adenoid tissue

All morphometric measurements were recorded in millimeters using a calibrated DICOM viewer. Measurements were performed by a single observer with expertise in head and neck radiology, trained in the anatomical landmarks and measurement protocols described in this study. To minimize variability, the observer adhered to a standardized workflow and measurement template. Importantly, the observer was blinded to the patients' AH status during all evaluations to reduce assessment bias. To assess intraobserver reliability, a randomly selected subsample of 14 MRI scans was re-evaluated by the same observer seven days after the initial measurements. The repeated assessments were conducted under identical conditions and blinded to the first set of values to reduce recall bias. Intraclass Correlation Coefficients (ICC) were calculated using a two-way random-effects model with absolute agreement, single rater form—denoted as ICC (2,1)—which is appropriate for assessing consistency of measurements when both subjects and raters are considered random effects. The ICC values were interpreted based on conventional thresholds, where values above 0.90 indicate excellent reliability. The resulting intraobserver agreement was found to be excellent across all measured parameters; Uvula dimensions (height and width): ICC (2,1)=0.9824, Airway measurement (PNS to posterior nasopharyngeal wall): ICC (2,1)=0.9812, Pharyngeal bursa dimensions (height and width): ICC (2,1)=0.9975.

Statistical Analysis

All statistical analyses were conducted using Python 3.11 within the Jupyter Notebook environment. The following libraries were employed: pandas for data handling and descriptive statistics, scipy.stats for inferential statistical tests, statsmodels for post hoc comparisons, and seaborn and matplotlib for data visualization. Descriptive statistics were used to summarize the distribution of continuous variables, including age, uvula height and width, nasopharyngeal airway dimension (distance from the PNS to the posterior pharyngeal wall), pharyngeal bursa height and width, and adenoid diameter. Measures reported include the mean, standard deviation (SD), minimum, and maximum values. To assess differences in continuous variables between two independent groups (e.g., based on adenoid presence or gender), independent samples t-tests were conducted. Variables compared included as following; age by adenoid presence, Uuula height and width by adenoid presence and by gender, airway measurements by adenoid presence and by gender, pharyngeal bursa height and width by adenoid presence and by gender. Prior to applying t-tests, Levene's test for equality of variances was used to assess homogeneity of variance, particularly for age distributions across adenoid subgroups. Associations between categorical variables, such as gender and adenoid presence, were evaluated using the Chi-square test of independence. To evaluate differences across more than two groups, one-way analysis of variance (ANOVA) was performed for uvula dimensions, airway, and pharyngeal bursa measurements. When statistically significant differences were detected, Tukey's Honestly Significant Difference (HSD) post hoc test was applied to identify specific group-level differences. The strength and direction of linear relationships between continuous variables were assessed using the Pearson correlation coefficient (r). Correlation analyses examined the associations between age and each anatomical measurement. Additionally, bivariate correlations were computed between uvula height and width, bursa dimensions, and airway size. A p-value<0.05 was considered indicative of statistical significance.

Result

Demographic Characteristics

The study included a total of 104 pediatric patients ranging from 1 to 18 years of age. The mean age was 10.21 years (SD=5.16). The sample was composed of 50 females (48.08%) and 54 males (51.92%) (Table 1).

Table 1. Demographic characteristics of the study population

Variable	Value
Mean age (years)	10.21
Age range (years)	1–18
Standard deviation	5.16
Female (%)	50 (48.08)
Male (%)	54 (51.92)
Adenoid hypertrophy present (%)	50 (48.08)
Adenoid hypertrophy absent (%)	54 (51.92)

AH was present in 50 children (48.08%), while 54 (51.92%) (Table 2) showed no radiological evidence of adenoid tissue enlargement. Levene's test confirmed the homogeneity of age distribution variances between the two groups, with and without AH (p=0.455).

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Table 2. Adenoid hypertrophy by age and gender

Group	Average age (years)	Female n (%)	Male n (%)	Total (n)
Adenoid present	9.52	32 (64.00)	18 (36.00)	50
Adenoid absent	10.85	18 (33.33)	36 (66.67)	54

When stratified by adenoid status, the average age of children without AH was 10.85 years, compared to 9.52 years among those with hypertrophy. This difference was not statistically significant (p=0.187). Significant positive correlations were found between age and several anatomical features. Uvula height (r=0.675, p<0.001), uvula width (r=0.598, p<0.001), and airway size (r=0.410, p<0.001) all increased with age, reflecting growth-dependent anatomical changes. However, pharyngeal bursa height (r=0.076, p=0.446) and width (r=0.132, p=0.181) did not demonstrate significant correlations with age, suggesting these structures may not follow typical growth-related patterns in the pediatric population.

A statistically significant association was observed between gender and adenoid presence (p=0.003), with AH more common among female patients (64%) than males (36%). Analysis of gender differences revealed no statistically significant differences in uvula height (p=0.235), uvula width (p=0.062), or airway size (p=0.489) between male and female patients. However, a significant difference was observed in pharyngeal bursa height, which was greater in males (mean=3.92 mm) than females (mean=2.56 mm) (p=0.001). No gender-related differences were noted for bursa width (p=0.218) (Table 3).

Table 3. Age and gender-based differences in anatomical measurements

Measurement	Gender difference (p-value)	Age correlation (r, p-value)
Uvula height	0.235	0.675, <0.001
Uvula width	0.062	0.598, <0.001
Airway	0.489	0.410, <0.001
Pharyngeal bursa height	0.001	0.076, 0.446
Pharyngeal bursa width	0.218	0.132, 0.181

Abbreviations: r, Pearson correlation coefficient; p, significance level

Uvula Height and Width

Measurements of uvula height and width revealed no statistically significant differences between patients with and without AH. The mean uvula height was 28.18 mm (SD=5.12) in the adenoid group and 27.71 mm (SD=6.75) in the non-adenoid group (p=0.682). The uvula width averaged 7.32 mm (SD=1.69) in children with adenoids and 7.88 mm (SD=1.88) in those without (p=0.110) (Table 4). Among children with hypertrophy, the mean adenoid thickness was 11.00 mm (SD=3.92), with values ranging from 5.20 mm to 19.12 mm. Pearson correlation analyses were conducted to explore relationships between measured anatomical parameters. A moderate to strong positive correlation was found between uvula height and width (r=0.66) (Table 5).

Nasopharyngeal Airway Dimensions

The airway dimension, defined as the distance from the PNS to the posterior nasopharyngeal wall, was significantly smaller in children with AH (mean=12.05 mm, SD=5.21) compared to those without (mean=16.71 mm, SD=5.31) (p<0.001) (Table 4). This represents a highly significant difference and supports the role of adenoid tissue in upper airway narrowing. airway measurements (defined as the distance from the PNS to the posterior nasopharyngeal wall) demonstrated weak or negligible correlations with uvula and bursa parameters (r<0.15) (Figure 4) (Table 5).

Pharyngeal Bursa Dimensions

The pharyngeal bursa height and width did not differ significantly between groups. The bursa height averaged 3.31 mm (SD=2.80) in the adenoid group and 3.23 mm (SD=1.52) in the non-adenoid group (p=0.869). Similarly, bursa width was 7.07 mm (SD=4.57) in those with adenoids and 6.87 mm (SD=3.84) in those without (p=0.809) (Table 4).

However, gender-based analysis showed a significant difference in bursa height (p=0.001), with males exhibiting greater pharyngeal bursa height (mean=3.92 mm) compared to females (mean=2.56 mm). No significant gender differences were observed in bursa width (p=0.218) (Table 3). A moderate correlation was observed between pharyngeal bursa height and width (r=0.48), suggesting dimensional consistency within the bursal anatomy (Table 5) (Figure 5).

Table 4. Morphometric measurements by adenoid hypertrophy status

Measurement	Adenoid present (Mean ± SD)	Adenoid absent (Mean ± SD)	p-value
Uvula height (mm)	28.18 ± 5.12	27.71 ± 6.75	0.682
Uvula width (mm)	7.32 ± 1.69	7.88 ± 1.88	0.110
Airway size (mm)	12.05 ± 5.21	16.71 ± 5.31	<0.001
Pharyngeal bursa height (mm)	3.31 ± 2.80	3.23 ± 1.52	0.869
Pharyngeal bursa width (mm)	7.07 ± 4.57	6.87 ± 3.84	0.809

Abbreviations: SD: standard deviation, r: Pearson correlation coefficient, p: significance level, mm: millimeter

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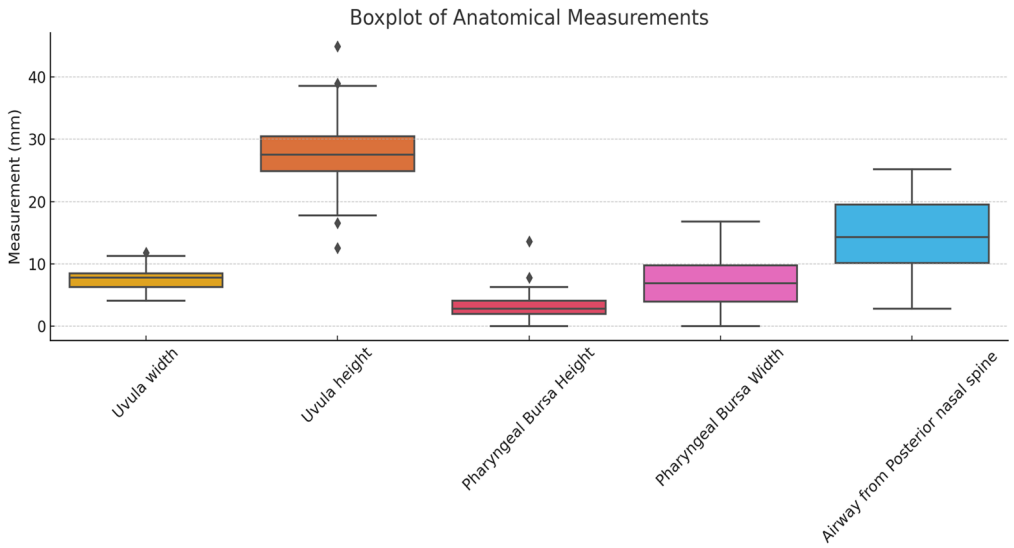

Figure 4. Boxplot of anatomical measurements in the pediatric population. The figure illustrates the distribution of uvula width, uvula height, pharyngeal bursa height, pharyngeal bursa width, and nasopharyngeal airway distance (from the posterior nasal spine to the posterior pharyngeal wall). Among these parameters, the airway dimension shows the widest range and variability. Outliers are indicated by black diamonds. The data shows the variability in soft tissue structures, with notable anatomical distinctions across measured features

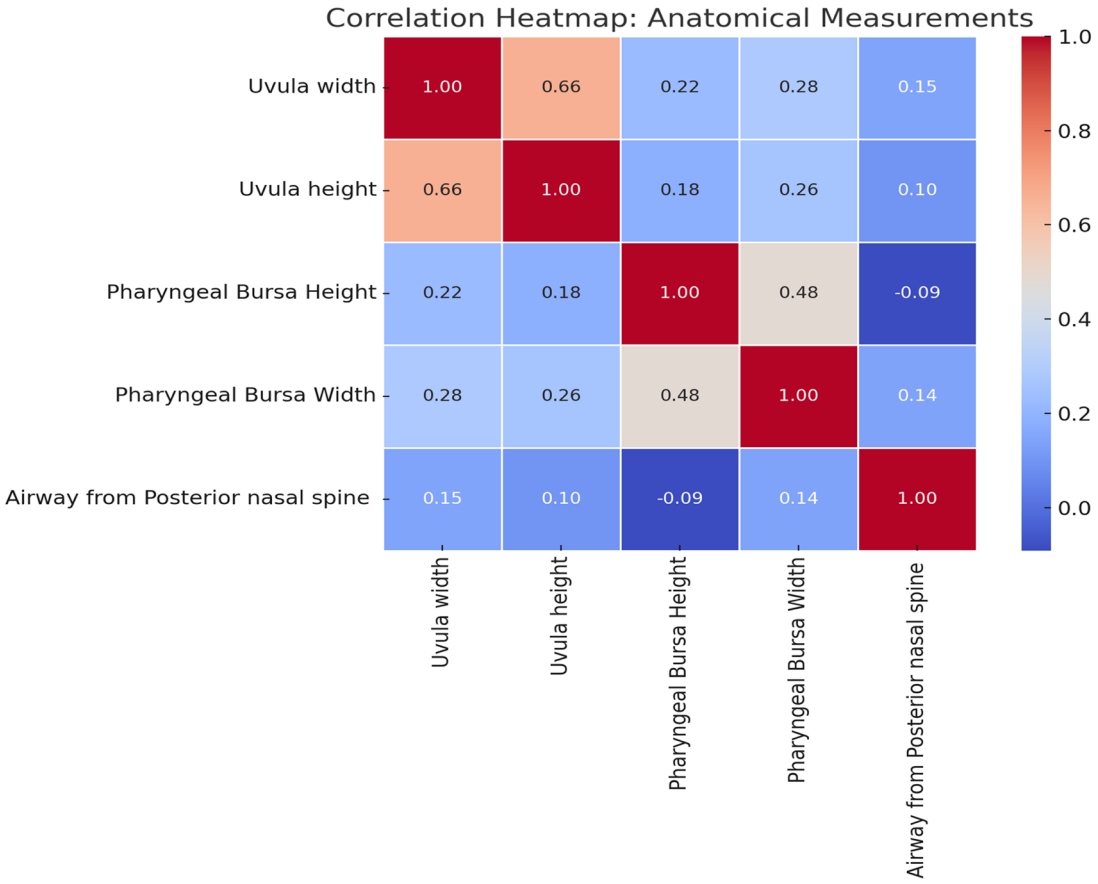

Figure 5. Correlation analysis between anatomical measurements of the nasopharyngeal region. A moderate-to-strong positive correlation was observed between uvula height and width ($r \approx 0.66$), suggesting proportional morphological development. Pharyngeal bursa height and width demonstrated a moderate correlation ($r \approx 0.48$), indicating some internal dimensional consistency. In contrast, airway measurements (posterior nasal spine to posterior pharyngeal wall) showed weak correlations with all other features ($r < 0.15$), suggesting that airway size is largely independent of surrounding soft tissue dimensions. Weak and non-significant correlations were also noted between uvula and bursa parameters, implying limited shared anatomical variability

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Table 5. Pearson correlation coefficients between anatomical parameters

Parameters	Pearson r
Uvula height & uvula width	0.66
Bursa height & bursa width	0.48
Airway & uvula height	<0.15
Airway & uvula width	<0.15
Airway & bursa height	<0.15
Airway & bursa width	<0.15
Uvula & bursa (range)	0.18–0.28

Abbreviations: r: Pearson correlation coefficient

Discussion

This study utilized sagittal and axial MRI to evaluate upper airway morphology in pediatric patients, with a focus on uvula dimensions, nasopharyngeal airway space, and pharyngeal bursa anatomy in the context of AH. The findings demonstrate a significant reduction in nasopharyngeal airway space among children with AH, confirming the obstructive impact of adenoidal tissue. However, no significant differences were observed in uvula width and height or pharyngeal bursa dimensions between children with and without AH, thus supporting the null hypothesis. A key strength of the present methodology lies in the use of sagittal and axial MRI, which provides superior soft-tissue contrast and radiation-free imaging compared with lateral cephalometry or CT. By obtaining uvula and airway measurements in the mid-sagittal plane, we ensured clear visualization of anatomical landmarks and maximized measurement reproducibility.

The statistically significant decrease in airway space in the AH group (mean: 12.05 mm vs. 16.71 mm, $p<0.001$) aligns with previous studies that identify adenoid enlargement as a key contributor to nasopharyngeal narrowing and upper airway obstruction in children [3,15]. This confirms that sagittal MRI is a sensitive modality for detecting changes in airway patency, providing a valuable alternative to ionizing methods such as lateral cephalometry or computed tomography. [10,13].

Despite expectations, uvula height and width did not vary significantly based on adenoid status. This finding contradicts earlier hypotheses suggesting that chronic airflow resistance caused by AH might lead to compensatory soft tissue adaptations in the uvula. The lack of observed changes may reflect developmental factors, the relatively mild-to-moderate hypertrophy in the sample, or the anatomical resilience of the velopharyngeal structures during early growth phases [12]. These findings highlight the limitations of using uvula width and height alone as an indirect marker of airway compromise in pediatric imaging [14].

Similarly, the pharyngeal bursa showed no significant dimensional differences between groups. Although a moderate correlation was observed between bursa height and width ($r=0.48$), no association with adenoid status or airway size was evident. Interestingly, a significant sex-based difference in bursa height was identified, with males exhibiting larger values. This may point to subtle anatomical dimorphism, but further studies with larger, balanced cohorts are needed to validate this observation.

Age was strongly and positively correlated with uvula size and airway dimension, which is consistent with expected growth-related anatomical expansion during childhood. In contrast, pharyngeal bursa dimensions did not correlate with age, suggesting that the bursa may reach structural maturity earlier or exhibit limited developmental plasticity [13]. These findings reinforce the need for age-adjusted normative values in pediatric airway assessment.

The moderate correlation between uvula height and width ($r=0.66$) suggests proportional morphological growth, aligning with prior concepts of velopharyngeal maturation. Meanwhile, airway measurements showed weak correlations with uvula and bursa parameters ($r<0.15$), indicating structural independence of these features.

From a methodological perspective, MRI proved to be a robust modality for static morphometric evaluation of upper airway anatomy in children. Unlike CT, which provides superior bone detail but involves ionizing radiation, MRI offers multiplanar soft tissue visualization suitable for repeated use in pediatric settings [15]. However, its static nature limits dynamic functional assessment, such as velopharyngeal closure or airway collapse, which could be better evaluated with dynamic MRI or endoscopy in future studies.

The findings of this study also warrant consideration from a pediatric dental perspective. Despite the significant airway narrowing observed in children with AH, the lack of concurrent changes in uvula or pharyngeal bursa characteristics suggests that these soft tissue adaptations may not be as predictive of functional compromise as previously hypothesized. However, the established relationship between chronic mouth breathing and dentofacial alterations—such as maxillary constriction, anterior open bite, and Class II skeletal patterns—remains clinically relevant for pediatric dentists [2,11]. While MRI is not commonly utilized in dental settings, its ability to noninvasively assess nasopharyngeal airway dimensions may provide adjunctive insight, particularly in cases where conventional clinical findings alone do not fully explain the etiology of craniofacial discrepancies [14]. Importantly, the dissociation between adenoid volume and uvular dimensions in this study reinforces the need for comprehensive assessment strategies that integrate anatomical imaging with clinical evaluation [19]. Early recognition of airway obstruction by dental professionals, as recommended by the American Academy of Pediatric Dentistry, may guide timely interdisciplinary referral and prevent long-term skeletal adaptations during growth [20]. Thus, these findings contribute to the growing body of evidence advocating for airway-focused screening in pediatric dental practice.

Several limitations of the present study should be acknowledged. First, its retrospective and cross-sectional design precludes the

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evaluation of causal relationships or developmental progression. Second, dynamic airway function could not be assessed due to the static nature of MRI; future studies employing dynamic imaging or functional endoscopy may yield additional insights. Third, all morphometric measurements were performed by a single observer, although intraobserver reliability was excellent (ICC>0.98). Finally, while the sample size was adequate for group comparisons, further validation in larger, multicenter cohorts is warranted.

Conclusion

Sagittal and axial MRI represent reliable and non-invasive modalities for the quantitative assessment of upper airway structures in pediatric patients. Although AH is significantly associated with a reduction in nasopharyngeal airway space, neither uvula nor pharyngeal bursa features constitutes a sufficient indicator of airway obstruction. These findings emphasize that uvula and pharyngeal bursa features alone are not sufficient markers of airway obstruction, and highlight the necessity of comprehensive airway evaluation in pediatric clinical practice. Consequently, a comprehensive evaluation of the upper airway that integrates anatomical imaging findings with detailed clinical assessment remains essential for accurate diagnosis and appropriate management of pediatric airway compromise.

Ethical Approval
The study was approved by the Non-Interventional Clinical Research Ethics Committee of Kocaeli Health and Technology University (Approval No: 2025-160; Date: April 21, 2025).

Patient Consent
Due to the retrospective design of the study, informed consent was waived by the ethics committee.

Conflict of Interest
The authors declare no conflict of interest.

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References

1. Góis EGO, Ribeiro-Júnior HC, Vale MPP, et al. Influence of nonnutritive sucking habits, breathing pattern and adenoid size on the development of malocclusion. Angle Orthod. 2008;78:647–54.
2. Ballıkaya E, Guciz Dogan B, Onay O, Uzamış Tekçiçek M. Oral health status of children with mouth breathing due to adenotonsillar hypertrophy. Int J Pediatr Otorhinolaryngol. 2018;113:11–5.
3. Zaffanello M, Pietrobelli A, Zoccante L, et al. Insights into pediatric sleep disordered breathing: exploring risk factors, surgical interventions, and physical and scholastic performance at follow-up. Children. 2024;11:388.
4. Nosetti L, Zaffanello M, De Bernardi F, et al. Age and upper airway obstruction: a challenge to the clinical approach in pediatric patients. Int J Environ Res Public Health. 2020;17:3531.
5. Padmanabhan V, Kavitha PR, Hegde A. Sleep disordered breathing in children—a review and the role of a pediatric dentist. J Clin Pediatr Dent. 2010;35:15–21.
6. Lin L, Zhao T, Qin D, et al. The impact of mouth breathing on dentofacial development: a concise review. Front Public Health. 2022;10:929165.
7. Kanehira T, Takehara J, Takahashi D, et al. Prevalence of oral malodor and the relationship with habitual mouth breathing in children. J Clin Pediatr Dent. 2004;28:285–8.
8. Alqutami J, Elger W, Grafe N, et al. Dental health, halitosis and mouth breathing in 10–15-year-old children: a potential connection. Eur J Paediatr Dent. 2019;20:274–79.
9. Feştilă D, Ciobotaru CD, Suciu T, et al. Oral breathing effects on malocclusions and mandibular posture: complex consequences on dentofacial development in pediatric orthodontics. Children. 2025;12:72.
10. Iwasaki T, Sugiyama T, Yanagisawa-Minami A, et al. Effect of adenoids and tonsil tissue on pediatric obstructive sleep apnea severity determined by computational fluid dynamics. J Clin Sleep Med. 2020;16:2037–44.
11. Tripathy M, Anekar J, AC R, et al. A digital cephalometric study on the morphometric evaluation of soft palate in oral submucous fibrosis. Asian Pac J Cancer Prev. 2020;21:2169–76.
12. Verma P, Verma KG, Kumaraswam KL, et al. Correlation of morphological variants of the soft palate and Need's ratio in normal individuals: a digital cephalometric study. Imaging Sci Dent. 2014;44:193–98.
13. Smriti K, Kodali MVRM, Nayak P, et al. Morphological analysis of soft palate using MRI in healthy individuals. J Med Chem Sci. 2024;2:14.
14. Perry JL, Kuehn DP, Sutton BP, et al. Anthropometric analysis of the velopharynx and related craniometric dimensions in three adult populations using MRI. Cleft Palate Craniofac J. 2016;53:e1–13.
15. Li Y, Yi S, Zhang J, et al. The hyoid bone position and upper airway morphology among children with and without adenotonsillar hypertrophy: a cross-sectional study. BMC Oral Health. 2024;24:1365.
16. Peker K, Uysal Ö, Bermek G. Cross-cultural adaptation and preliminary validation of the Turkish version of the Early Childhood Oral Health Impact Scale among 5–6-year-old children. Health Qual Life Outcomes. 2011;9:118.
17. Grippaudo C, Paolantonio EG, Antonini G, et al. Association between oral habits, mouth breathing and malocclusion. Acta Otorhinolaryngol Ital. 2016;36:386–94.
18. Ferry AM, Wright AE, Ohlstein JF, et al. Efficacy of a pediatric sleep questionnaire for the diagnosis of obstructive sleep apnea in children. Cureus. 2020;12:e12244.
19. Huang CC, Wu PW, Chiu CH, Lee TJ. Assessment of sleep-disordered breathing in pediatric otitis media with effusion. Pediatr Neonatol. 2022;63:25–32.
20. American Academy of Pediatric Dentistry. Policy on obstructive sleep apnea (OSA). In: The Reference Manual of Pediatric Dentistry. Chicago (IL): American Academy of Pediatric Dentistry; 2024:139–42.