J Med Sci 2025;45 (6):237-243
DOI: 10.4103/jmedsci.jmedsci_33_25

ORIGINAL ARTICLE

Three-dimensional Morphometrics of Nasal Complex in Orthognathic and Prognathic Maxilla: A Pilot Study

Ananya Madiyal[1], M. S. Ravi[2], Vidya Ajila[1], K. Saidath[2]

[1]*Department of Oral Medicine and Radiology, Nitte (Deemed to be University), AB Shetty Memorial Institute of Dental Sciences,* [2]*Department of Orthodontics and Dentofacial Orthopaedics, Nitte (Deemed to be University), AB Shetty Memorial Institute of Dental Sciences, Mangalore, Karnataka, India*

Background: The nasal septum and surrounding structures play a key role in midface development. Deviations in nasal septal growth can affect adjacent bone morphology and contribute to malocclusion. Malalignment of facial structures plays a crucial role in the physical and psychological well-being of the individual. This pilot study assessed the nasal complex morphology in individuals with orthognathic and prognathic maxilla using cone-beam computed tomography (CBCT). **Aim:** The present study aimed to assess and compare the morphometrics of nasal complex in individuals with prognathic maxilla and orthognathic maxilla. **Methods:** Sixteen CBCT images of individuals aged 18–30 years were analyzed and divided into orthognathic maxilla group and prognathic maxilla group. Nasal bone length, lateral bone width, septal deviation angle, and presence of concha bullosa were measured and compared. Statistical analysis used unpaired *t*-tests, multiple regression tests, Shapiro–Wilk test, and Fisher's exact test ($P < 0.05$). **Results:** No significant differences were observed in nasal bone length, septal deviation angle, or lateral nasal bone width between the groups. However, concha bullosa ($P = 0.01$) and nasal septal deviation ($P = 0.01$) were significantly more prevalent in the orthognathic maxilla group. **Conclusion:** Ethnic variability in nasal bone width was observed, with lower measurements in the Indian population compared to others. Significant differences in concha bullosa and septal deviation suggest that nasal airflow may influence maxillary development. This study provides preliminary normative data for future orthodontic planning.

Key words: Cone-beam computed tomography, malocclusion, nasal complex, orthodontics, well-being

INTRODUCTION

Nasomaxillary complex is situated in the middle third of the facial skeleton and is influenced by bones adjacent to it during its growth phase. Major effects are exerted by the cranium and the soft tissues of the face. Later, the nasal complex, especially the nasal septum, transmits the load of maxillary dentition to the cranial base, thereby demonstrating a morphological and functional relationship between the three structures.[1] Kim *et al*. found that nasal septum continues to grow till the individual reaches teenage.[2] The cartilaginous part of the septum reduces with age while the bony component increases.[1] The septum is made up of parts of the vomer, palatine bone, maxilla, and ethmoid. Therefore, if deviation in growth occurs in the nasal septum, it affects other bones of the midface.[2,3]

Received: February 13, 2025; Revised: May 13, 2025; Accepted: June 03, 2025; Published: September 04, 2025
Corresponding Author: Dr. M. S. Ravi, Department of Orthodontics and Dentofacial Orthopaedics, Nitte (Deemed to be University), AB Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore - 575 018, Karnataka, India. Tel: +91-984-5221386; Fax: +91-824-2204963. E-mail: drmsravi@gmail.com

Orthodontic treatment planning is complex since the mode of treatment mainly depends on the etiology of malocclusion in each patient. Inclination of the cranial base along with anteroposterior relationship of the maxilla and mandible and comprehensive evaluation of other related parameters form the basis of classification of malocclusion.[1] It has been observed that patients who have lost or sustained damage to the nasal septal cartilage during the period of growth show midface anteroposterior hypoplasia.[4] This underscores the importance of nasal septum and its components in the development of midface structures and, by extension, treatment of these malocclusions.

Obtaining normative data for each ethnicity plays an important role in planning individualized orthodontic, orthognathic, or esthetic treatment. Conventionally,

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Madiyal A, Ravi MS, Ajila V, Saidath K. Three-dimensional morphometrics of nasal complex in orthognathic and prognathic maxilla: A pilot study. J Med Sci 2025;45:237-43.

cephalometric parameters have been used for orthodontic treatment planning.[5] Three-dimensional (3D) imaging modalities such as computed tomography (CT) or cone-beam computed tomography (CBCT) provide much-needed objective data regarding various structures in the head-and-neck region. CBCT, owing to its relatively lesser radiation dose, better hard-tissue resolution, lower cost, and easier setup, is quickly becoming the norm in most diagnostic protocols.[6] Therefore, this pilot study was designed to determine the morphology of the nasal bone, nasal septum, septal deviation, and concha bullosa in individuals with orthognathic and prognathic maxilla.

MATERIALS AND METHODS

The study included 16 CBCT images of individuals recommended for full-volume CBCT analysis from the department of orthodontics and dentofacial orthopedics with an aim to assess and compare the morphology of the nasal bone, nasal septum, septal deviation, and concha bullosa between individuals with orthognathic and prognathic maxilla. The study was conducted in accordance with the Declaration of Helsinki and written informed consent was obtained from each individual. Ethical clearance was obtained from the Institutional Central Ethics Committee, and scientific clearance was obtained from the Central Scientific Committee prior to the start of the study (NU/CEC/2023/488).

The individuals included in the study were aged between 18 and 30 years, with no history of trauma or surgery to the head-and-neck region, no history of orthodontic or orthopedic treatment, no congenital or craniofacial anomalies, and no systemic diseases like osteoporosis. Pregnant individuals and those with conditions contraindicated for radiation exposure were excluded.

CBCT images were obtained under standardized conditions using Planmeca 3D CBCT unit (Planmeca Oy, Helsinki, Finland). Lateral cephalograms were generated from the CBCT scan volumes, and cephalometric landmarks were identified using the Planmeca Romexis Viewer Software (Planmeca Oy, Helsinki, Finland). Images were analyzed for midfacial morphology according to Burstone *et al.*'s analysis based on lateral cephalometric measurement values of Point A to N perpendicular (A-N$\perp$) and angle angle SNA (Sella-Nasion-Point A) [Figure 1].[7]

The individuals were then categorized into two groups based on the values given by Burstone *et al.* in 1978 and Riedel in 1952:[7,8]

- Group 1: Orthognathic maxilla group with A-N$\perp$ = 0 ± 3.7 mm (males), −2 ± 3.7 mm (females) and angle SNA = 82° ± 2°
- Group 2: Prognathic maxilla group with A-N$\perp$ >3.7 mm and angle SNA >88°.

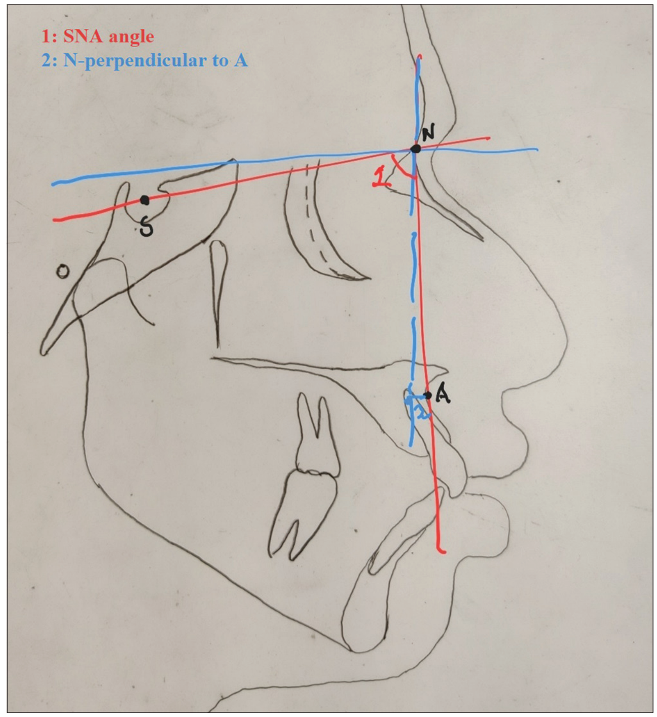

Figure 1: Lateral cephalometric tracing showing Point A to N perpendicular (A-N$\perp$) and Angle SNA

Nasal bone length was measured on sagittal sections from the frontonasal suture to the endpoint of the nasal bone [Figure 2a]. Lateral nasal bone width was measured on axial sections bilaterally at the nasomaxillary suture [Figure 2b]. Concha bullosa was evaluated on coronal sections as pneumatization of the middle turbinate to more than half of its length [Figure 2c]. Nasal septal deviation angle was measured on coronal sections as the angle between the most deviated point in the septum and the midline. Midline was defined as the line joining crista galli and crista nasalis [Figure 2d]. Images without any nasal septal deviation were grouped in the "no nasal septal deviation" group.

Statistical analysis

The data were entered into Microsoft Excel (Microsoft Corporation) and analyzed using SPSS (Statistical Package for Social Sciences, IBM) version 23. The data were subjected to the Shapiro–Wilk test for testing the normality. Homogeneity of variance assumption was tested using Levene's statistic homogeneity of variance. The variables followed a normal distribution. Hence, a parametric evaluation was adopted. The descriptive statistics are expressed as number and percentage for nominal data and as mean and standard deviation for continuous variables. The difference in nasal bone length and nasal septal deviation bone right and left between the two groups was analyzed using unpaired *t*-test. The difference in

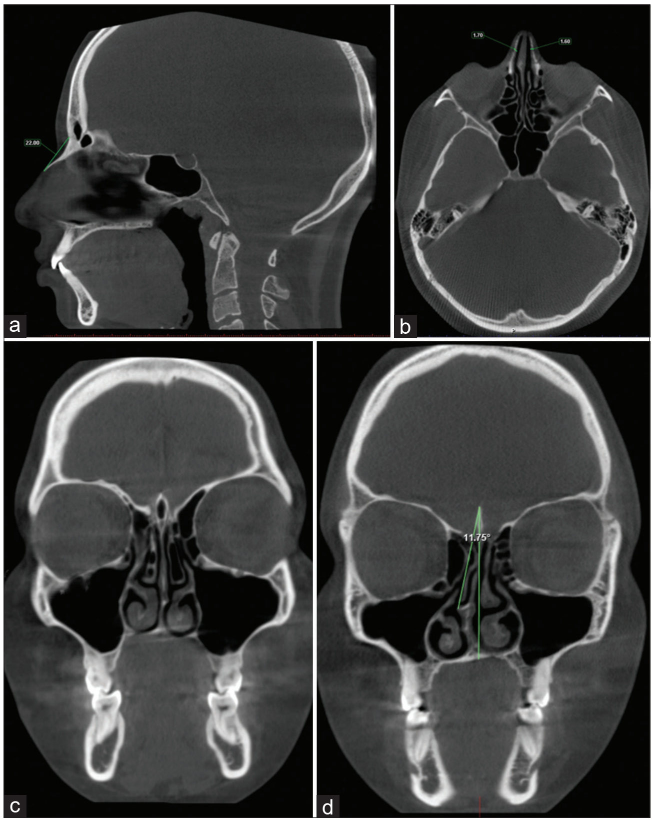

Figure 2: Sections of cone-beam computed tomography showing (a) nasal bone length measurement on sagittal sections from the frontonasal suture to the endpoint of the nasal bone, (b) lateral nasal bone width measurement on axial sections bilaterally at the nasomaxillary suture, (c) concha bullosa evaluation on coronal sections as pneumatization of the middle turbinate to more than half of its length, (d) nasal septal deviation angle measurement on coronal sections as the angle between the most deviated point in the septum and the midline. Midline was defined as the line joining crista galli and crista nasalis

concha bullosa and nasal septal deviation between the two groups was analyzed using the Fisher's exact test. $P < 0.05$ was considered statistically significant. Linear regression and binary logistic regression were used to assess the influence of the independent variables on each of the dependent variables.

RESULTS

The mean age in Group I was 27.13 ± 4.99 years and in Group II was 25.50 ± 5.18 years [Table 1]. When comparing the difference in length of the nasal bone, nasal septal deviation angle, and right and left lateral nasal bone width between the two groups, no significant difference was observed [Table 2]. However, when comparing the presence or absence of concha bullosa, $P = 0.01$ was obtained, which was statistically significant. Similarly, when comparing the presence or absence of nasal septal deviation, the results were significantly different between the groups with $P = 0.01$ [Tables 3 and 4].

Table 1: Demographic data of subjects in Group I and Group II

	Group I	Group II
Age	27.13±4.99	25.50±5.18
Gender (%)		
Male	5 (62.5)	6 (75)
Female	3 (37.5)	2 (25)

A multiple regression was run to predict nasal bone length from group, age, and gender. These variables did not significantly predict nasal bone length, F (3, 12) = 1.049, $R^2 = 0.208$. All three variables did not add statistical significance to the prediction, $P > 0.05$ [Table 5]. A multiple regression was run to predict nasal septal deviation from group, age, and gender. One variable significantly predicted nasal septal deviation, F (3, 12) = 2.152, $R^2 = 0.350$. Among the variables, age added statistical significance to the prediction, $P = 0.033$ [Table 6].

A multiple regression was run to predict right lateral nasal bone width from group, age, and gender. These variables did not significantly predict right lateral nasal bone width, F (3, 12) = 0.879, $R^2 = 0.180$. All three variables did not add statistical significance to the prediction, $P > 0.05$ [Table 7]. A multiple regression was run to predict left lateral nasal bone width from group, age, and gender. These variables did not significantly predict left lateral nasal bone width, F (3, 12) = 1.380, $R^2 = 0.256$. All three variables did not add statistical significance to the prediction, $P > 0.05$ [Table 8].

The original dependent variable, concha bullosa, included multiple categories based on laterality. For analytical simplicity and to enhance statistical power, it was dichotomized into a binary variable (present vs. absent). A logistic regression was performed to ascertain the effects of group, age, and gender on the likelihood that participants have concha bullosa. The logistic regression model was statistically significant, χ^2 (3) = 10.683, $P = 0.014$. The model explained 64.9% (Nagelkerke R^2) of the variance in concha bullosa and correctly classified 87.5% of cases. None of the variables were significantly associated with the variance in concha bullosa [Table 9]. The original dependent variable, nasal septal deviation, included multiple categories based on laterality. For analytical simplicity and to enhance statistical power, it was dichotomized into a binary variable (present vs. absent). A logistic regression was performed to ascertain the effects of group, age, and gender on the likelihood that participants have nasal septal deviation. The logistic regression model was statistically significant, χ^2 (3) = 0.000, $P = 1.000$. The model explained 83.2% (Nagelkerke R^2) of the variance in nasal septal deviation and correctly classified 93.8% of cases. None of the variables

Table 2: Comparison of nasal bone length, lateral nasal bone width, and nasal septal deviation angle between Group I and Group II

Groups	*n*	Mean	SD	SEM	95% CI difference		Mean difference	*t*	*P*
					Lower	Upper			
Nasal bone length (mm)									
Group I	8	22.34	2.55	0.90	−0.92	4.09	1.583	1.354	0.197
Group II	8	20.75	2.11	0.75					
Nasal septal deviation angle (°)									
Group I	8	7.62	2.93	1.08	−3.20	5.74	1.267	0.608	0.553
Group II	8	6.35	5.12	1.81					
Lateral nasal bone (R) (mm)									
Group I	8	1.67	0.62	0.22	−0.84	0.23	−0.303	−1.220	0.243
Group II	8	1.98	0.33	0.11					
Lateral nasal bone (L) (mm)									
Group I	8	1.66	0.59	0.21	−0.92	0.06	−0.427	−1.870	0.082
Group II	8	2.08	0.27	0.09					

SD=Standard deviation; SEM=Standard error of mean; CI=Confidence interval

Table 3: Comparison of presence and absence of concha bullosa between Group I and Group II

	Present	Absent
Group I	7	1
Group II	1	7

Test applied: Fisher's Exact Test (Two-tailed) *P*=0.01

Table 4: Comparison of presence and absence of nasal septal deviation between Group I and Group II

	Present	Absent
Group I	8	0
Group II	3	5

Test applied: Fisher's Exact Test (Two-tailed) *P*=0.01

were significantly associated with the variance in nasal septal deviation [Table 10].

DISCUSSION

Nasal bone varies in morphology based on gender, ethnicity, and age.[6] The concept of an "ideal nose" varies according to ethnicity, gender, and societal norms.[9] Nasal inflammation due to allergic rhinitis, chronic rhinitis, sinusitis, and adenoid hypertrophy can cause a significant decrease in nasal airflow. Behavioral habits such as mouth breathing, inadequate chewing, and ineffective swallowing can have negative effects on the growth and development of facial structures.[10] Obtaining objective data through clinical examination alone is challenging, making 3D radiological investigation crucial for diagnosis in orthodontics, maxillofacial surgery, reconstructive surgery, and esthetic dentistry.[6] Performing osteotomies without the prior knowledge of nasal bone morphometrics may result in untoward surgical results such as asymmetry, destabilization, soft-tissue injury with ecchymosis, and hemorrhage.[11] Fragmentation during intentional fracturing can lead to unsatisfactory esthetic results.[12] Rhinoplasty has been reported to have a complication rate of 5% to 15%, including but not limited to bleeding, infection, and dysfunction.[13] Malaligned facial structures play a major role in the physical, social, and psychological well-being of the individual. Choosing the thinner nasal bone for osteotomies can help prevent these complications.[12]

Zamani Naser and Panahi Boroujeni found that the mean nasal bone width in Iranian population was 1.79 mm, with no difference between the genders.[6] Lee *et al.* found that in CT sections of Asian population, the lateral nasal bone measured 2.75 ± 0.76 mm at the lateral osteotomy line, necessitating a larger osteotome to minimize trauma to soft tissues in this ethnicity.[3] The present study consisted entirely of Indian population where lateral nasal bone width measurements of 0.22 ± 0.62 mm on the right side and 0.21 ± 0.59 mm on the left side were obtained in individuals with orthognathic maxilla. In the prognathic maxilla group, the measurements were 0.11 ± 0.33 mm (right) and 0.09 ± 0.27 mm (left). These measurements were considerably less when compared to similar studies by Serifoglu *et al*., Lee *et al*., and Zamani Naser and Panahi Boroujeni, indicating potential ethnic variation in the Indian skull when compared to other population such as Turkish, Korean, and Iranian.[6,11,12]

Table 5: Multiple regression model for nasal bone length

Model (nasal bone length)	Unstandardized coefficients		Standardized coefficients; Beta	*t*	Significant	95.0% CI for *B*	
	B	SE				Lower bound	Upper bound
1							
Constant	22.320	4.491		4.970	0.000	12.536	32.105
Group	−1.535	1.223	−0.330	−1.255	0.233	−4.201	1.130
Age	0.110	0.126	0.229	0.879	0.397	−0.163	0.384
Gender	−1.046	1.302	−0.208	−0.804	0.437	−3.883	1.790

SE=Standard error; CI=Confidence interval

Table 6: Multiple regression model for nasal septal deviation

Model (nasal septal deviation)	Unstandardized coefficients		Standardized coefficients; Beta	*t*	Significant	95.0% CI for *B*	
	B	SE				Lower bound	Upper bound
1							
Constant	23.401	6.913		3.385	0.005	8.338	38.464
Group	−2.118	1.883	−0.268	−1.125	0.283	−6.221	1.985
Age	−0.466	0.193	−0.569	−2.410	0.033	−0.887	−0.045
Gender	−0.747	2.004	−0.088	−0.373	0.716	−5.114	3.620

SE=Standard error; CI=Confidence interval

Table 7: Multiple regression model for right lateral nasal bone width

Model (lateral nasal bone width-right side)	Unstandardized coefficients		Standardized coefficients; Beta	*t*	Significant	95.0% CI for *B*	
	B	SE				Lower bound	Upper bound
1							
Constant	2.331	0.962		2.424	0.032	0.235	4.426
Group	0.245	0.262	0.250	0.934	0.369	−0.326	0.816
Age	−0.028	0.027	−0.272	−1.024	0.326	−0.086	0.031
Gender	−0.113	0.279	−0.107	−0.407	0.691	−0.721	0.494

SE=Standard error; CI=Confidence interval

Nasopalatine complex is influenced by muscles of the face as well as nasal airflow. Therefore, obstruction to nasal airflow produces changes in the facial skeleton giving rise to "adenoid facies" comprising malar hypoplasia, Angle's class II malocclusion, narrow maxilla, and short posterior facial pattern.[13] The curvature of the nasal septum increases resistance to airflow. The septum determines midfacial appearance as well as the size and shape of the nose, thereby playing an important part in facial appearance.[3] This is one of the reasons that the present study compared the morphometrics of nasal complex between individuals with orthognathic and prognathic maxilla.

Lateral nasal wall contains three projections called "conchae" of variable sizes. One of the most common variations is pneumatization of these conchae, known as concha bullosa. The middle nasal concha is most commonly pneumatized.[14,15] In the present study, the presence of concha bullosa was defined as pneumatization of the middle concha to more than half its length. Seven of the eight individuals of the orthognathic maxilla group and only one individual in the prognathic maxilla group showed the presence of concha bullosa in the present study. A dome-shaped, high-arched palate is another feature seen in patients with nasal obstruction. This dome shape of the palate induces

Table 8: Multiple regression model for left lateral nasal bone width

Model (lateral nasal bone width-left side)	Unstandardized coefficients		Standardized coefficients; Beta	*t*	Significant	95.0% CI for *B*	
	B	SE				Lower bound	Upper bound
1							
Constant	0.984	0.894		1.101	0.293	−0.963	2.931
Group	0.434	0.243	0.454	1.784	0.100	−0.096	0.965
Age	0.017	0.025	0.176	0.698	0.498	−0.037	0.072
Gender	−0.172	0.259	−0.167	−0.664	0.519	−0.737	0.392

SE=Standard error; CI=Confidence interval

Table 9: Multiple regression model for concha bullosa

Concha bullosa	*B*	SE	Wald	df	Significant	EXP (*B*)	95% CI for EXP (*B*)	
							Lower	Upper
Step								
Group	4.305	1.822	5.581	1	0.018	74.096	2.082	2636.469
Age	−0.122	0.180	0.464	1	0.496	0.885	0.622	1.258
Gender	−0.384	1.701	0.051	1	0.821	0.681	0.024	19.111
Constant	1.340	4.608	0.085	1	0.771	3.817		

SE=Standard error; CI=Confidence interval

Table 10: Multiple regression model for nasal septal deviation dichotomized into a binary variable (present vs absent)

Nasal septal deviation	*B*	SE	Wald	df	Significant	EXP (*B*)	95% CI for EXP (*B*)	
							Lower	Upper
Step								
Group	38.410	18,353.661	0.000	1	0.998	4.801	0.000	-
Age	−4.392	1595.719	0.000	1	0.998	0.012	0.000	-
Gender	−6.749	18,112.946	0.000	1	1.000	0.001	0.000	-
Constant	134.115	56,879.212	0.000	1	0.998	1.759	0.000	-

SE=Standard error; CI=Confidence interval

stress on the nasal septum causing deviation of the septum.[16] Shetty *et al*. found a greater degree of nasal septal deviation in patients with concha bullosa.[17] Orhan *et al.* found that maxillary sinus volumes were decreased on the same side as the septal deviation compared to the contralateral side.[14] In the present study, no significant correlation was found between the presence of concha bullosa and nasal septal deviation which could be attributed to it being a pilot study with a small sample size. However, a significant difference was found between the two study groups for the presence of concha bullosa and nasal septal deviation, supporting the theory that prognathism of the maxillary bone may be influenced by nasal airflow during the period of development.

This pilot study included a small sample size, which limits the generalizability of its findings. Cross-population comparisons should be interpreted with caution, as some results were descriptive in nature and not supported by formal statistical analyses due to the limited sample size and lack of access to individual-level data from published studies. Future research with larger, more representative samples and standardized datasets is needed to validate these preliminary observations and to explore the relationship between nasal morphology and maxillary development in a statistically robust manner. Such studies could have important implications for diagnosis and treatment planning in orthodontics and maxillofacial surgery.

CONCLUSION

This study was designed to obtain normative data of the nasal complex, including nasal bone length, lateral nasal bone width, concha bullosa, and nasal septal deviation in individuals with orthognathic maxilla and prognathic maxilla. The results show significant differences in the presence of concha bullosa and nasal septal deviation between the two groups, suggesting that nasal airflow and associated factors may play a role in maxillary development. However, no significant differences were observed in nasal bone length and width between the groups, highlighting the influence of ethnic variability.

Further studies with larger sample sizes and a gender-wise distribution across various ethnic populations are essential for developing normative data. Such data will help clinicians optimize surgical and orthodontic interventions, providing more individualized and accurate treatment planning for patients.

Data availability statement

The data that support the findings of this study are available from the corresponding author, [MSR], upon reasonable request.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Kasai E, Kondo S, Kasai K. Morphological characteristics of nasomaxillary complex and cranial base in maxillary retrognathism. Int J Oral Med Sci 2019;18:27-35.
2. Kim JH, Jung DJ, Kim HS, Kim CH, Kim TY. Analysis of the development of the nasal septum and measurement of the harvestable septal cartilage in Koreans using three-dimensional facial bone computed tomography scanning. Arch Plast Surg 2014;41:163-70.
3. Lee HJ, Park JH, Seo HY, Choi SK, Chang NY, Kang KH, *et al*. A CBCT evaluation of nasal septal deviation and related nasofacial structures after maxillary skeletal expansion. Appl Sci (Switzerland) 2022;12:9949-72.
4. Bjork A, Skeller V. Postnatal growth and development of the maxillary complex. In: McNamara A Jr., editor. Factors Affecting the Growth of the Midface. Ann Arbor, Michigan: Center for Human Growth/Development, University of Michigan; 1976. p. 115-25.
5. Perović TM, Blažej Z, Jovanović I. The influence of antero-posterior dentoskeletal pattern on the value of nasal soft tissue angles: A cephalometric study. Folia Morphol (Warsz) 2021;80:657-64.
6. Zamani Naser A, Panahi Boroujeni M. CBCT evaluation of bony nasal pyramid dimensions in Iranian population: A comparative study with ethnic groups. Int Sch Res Notices 2014;2014:819378.
7. Burstone CJ, James RB, Legan H, Murphy GA, Norton LA. Cephalometrics for orthognathic surgery. J Oral Surg 1978;36:269-77.
8. Riedel RA. The relation of maxillary structures to cranium in malocclusion and in normal occlusion. Angle Orthod 1952;22:142-5.
9. Jankowska A, Janiszewska-Olszowska J, Grocholewicz K. Nasal morphology and its correlation to craniofacial morphology in lateral cephalometric analysis. Int J Environ Res Public Health 2021;18:3064.
10. Fujiwara Y, Hironaka S, Ishizaki A, Yamaguchi S, Utsumi A, Ota C, *et al*. Factors associated with nasal airway resistance in young children. Pediatr Dent J 2024;34:8-13.
11. Lee HM, Kang HJ, Choi JH, Chae SW, Lee SH, Hwang SJ. Rationale for osteotome selection in rhinoplasty. J Laryngol Otol 2002;116:1005-8.
12. Serifoglu I, Oz İİ, Damar M, Buyukuysal MC, Tosun A, Tokgöz Ö. Relationship between the degree and direction of nasal septum deviation and nasal bone morphology. Head Face Med 2017;13:3.
13. Rouientan A, Khodaparast MB, Safi Y. Evaluation of diagnostic accuracy of cone beam computed tomography and multi-detector computed tomography for detection of anatomical variations in rhinoplasty. Head Face Med 2024;20:1.
14. Orhan I, Ormeci T, Aydin S, Altin G, Urger E, Soylu E, *et al*. Morphometric analysis of the maxillary sinus in patients with nasal septum deviation. Eur Arch Otorhinolaryngol 2014;271:727-32.
15. Dalili Kajan Z, Khademi J, Nemati S, Niksolat E. The effects of septal deviation, concha bullosa, and their combination on the depth of posterior palatal arch in cone-beam computed tomography. J Dent (Shiraz) 2016;17:26-31.
16. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. London: Mosby, Elsevier; 2007. p. 751.
17. Shetty SR, Al Bayatti SW, Al-Rawi NH, Kamath V, Reddy S, Narasimhan S, *et al*. The effect of concha bullosa and nasal septal deviation on palatal dimensions: A cone beam computed tomography study. BMC Oral Health 2021;21:607.