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Morphometric Analysis of Nasal Parameters and Their Correlation with Nasofacial and Nasolabial Angle

1. Nilima Singh
(corresponding author email id nilimasingh5126@gmail.com)
P.G student, Rama University, Kanpur
2. Vandana Tewari
Professor, Anatomy Department, Rama University, Kanpur
3. Nilesh Jaybhaye
Assistant Professor, Anatomy Department, Rama University, Kanpur

Abstract

The human nose plays a pivotal role in determining facial aesthetics, symmetry, and functional efficiency, making nasal anthropometry an essential component of anatomical, forensic, and reconstructive studies. This study aimed to perform a detailed morphometric analysis of nasal parameters and evaluate their correlation with nasofacial and nasolabial angles in young adults. A cross-sectional observational study was conducted on 88 healthy undergraduate students aged 18–25 years. Linear nasal parameters including nasal height, nasal width, nasal length, nasal tip projection, and nasal index were measured using a **digital vernier caliper**, while angular parameters were assessed using standardized digital photographic analysis. Statistical analysis revealed significant sexual dimorphism in **nasal height** and **nasal length**, with males exhibiting significantly higher values compared to females ($p<0.05$). Nasal width, nasal tip projection, nasofacial angle, and nasolabial angle showed no statistically significant gender differences. Pearson's correlation analysis demonstrated no significant linear correlation between individual nasal dimensions and facial angles ($p>0.05$). However, **nasal index** showed a highly significant association with both nasofacial and nasolabial angles ($p<0.001$), emphasizing its importance in overall facial proportionality. The findings provide normative anthropometric data for the North Indian population and underscore the clinical relevance of nasal morphometry in **rhinoplasty planning**, forensic identification, orthodontics, and anthropological research. Establishing population-specific nasal parameters can aid surgeons and clinicians in achieving optimal functional and aesthetic outcomes. (3, 2021; 7, 2015; 12, 2021)

Keywords *Nasal Anthropometry, Nasofacial Angle, Nasolabial Angle, Nasal Index, Facial Morphometry*

Introduction

Human facial aesthetics has fascinated philosophers, anatomists, and surgeons since antiquity. Classical concepts of beauty emphasized **symmetry, harmony, and proportion**, principles later refined by Renaissance scholars such as Leonardo da Vinci, whose anatomical studies laid the foundation for modern facial analysis (1, 2019). Among facial structures, the nose occupies a central and dominant position, significantly influencing both appearance and identity. Variations in nasal shape and proportions contribute to ethnic, racial, and individual diversity

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and play a vital role in non-verbal communication (2, 2024). The external nose is a pyramidal structure composed of a complex **osseocartilaginous framework** that determines its contour and functional efficiency. Anatomically, it serves critical physiological roles including air filtration, humidification, olfaction, and speech resonance (5, 2014). Deviations in nasal anatomy can adversely affect airflow dynamics and facial aesthetics, leading to both functional impairment and psychological distress (4, 2023). Nasal anthropometry, a sub-discipline of human anthropometry, focuses on quantifying nasal dimensions and angles to establish normative standards (10, 2021). Parameters such as nasal height, width, length, nasal index, nasofacial angle, and nasolabial angle are routinely assessed to evaluate facial harmony (12, 2021). These measurements are indispensable for **rhinoplasty**, forensic identification, orthodontic diagnosis, and craniofacial reconstruction (8, 2015). Sexual dimorphism in nasal parameters has been widely documented, with males generally exhibiting larger linear dimensions due to differences in skeletal growth and hormonal influences (18, 2014). Conversely, angular facial parameters often demonstrate minimal gender variation, suggesting independent developmental patterns (7, 2015). Environmental and climatic factors further modulate nasal morphology, as reflected by the nasal index, which correlates with temperature and humidity (4, 2023). Despite its clinical importance, region-specific nasal morphometric data remain limited in India, particularly for North Indian populations. Establishing normative datasets is crucial for evidence-based surgical planning and forensic applications (16, 2017). Therefore, the present study was undertaken to analyze nasal parameters and their correlation with nasofacial and nasolabial angles among undergraduate students at Rama University, Kanpur.

Materials and Methods

A cross-sectional observational study was conducted in the Department of Anatomy, Rama Medical College, Kanpur, after obtaining approval from the Institutional Ethics Committee (2, 2020). The study included 88 healthy undergraduate students aged 18–25 years, with equal representation of males and females. Participants with congenital facial anomalies, history of facial trauma, nasal surgery, or systemic disorders affecting craniofacial growth were excluded. All measurements were performed in a standardized environment with subjects seated in the **Frankfort horizontal plane**. Linear nasal parameters were measured using a calibrated digital vernier caliper (accuracy 0.01 mm). Angular measurements were obtained from standardized frontal and lateral photographs using digital software. Three readings were taken for each parameter, and the mean value was recorded to minimize observer error. Linear parameters included nasal height (nasion to subnasale), nasal width (alar to alar), nasal length (nasion to pronasale), nasal tip projection (Goode's method), and nasal index (nasal width/nasal height ×100). Angular parameters assessed were the nasofacial angle and nasolabial angle. Data were analyzed using SPSS version 22 and Jamovi software. Descriptive statistics, independent t-tests, Pearson correlation coefficients, and ANOVA were applied, with $p<0.05$ considered statistically significant (11, 2019).

Linear Nasal Parameters:

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- Nasal Height: (nasion to the subnasale)
- Nasal Width: (alar to alar)
- Nasal Length: (nasion to the pronasale)
- Nasal Tip Projection: (pronasale to alar plane)
- Nasal index: (It was calculated by dividing the nasal breadth by nasal height multiplied by 100.)

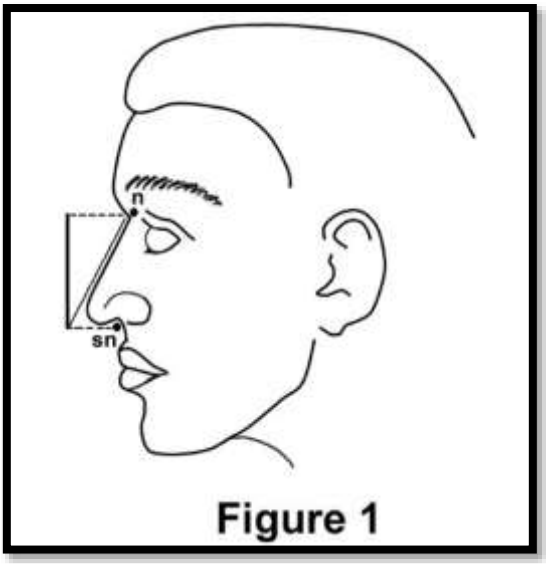

Figure 1

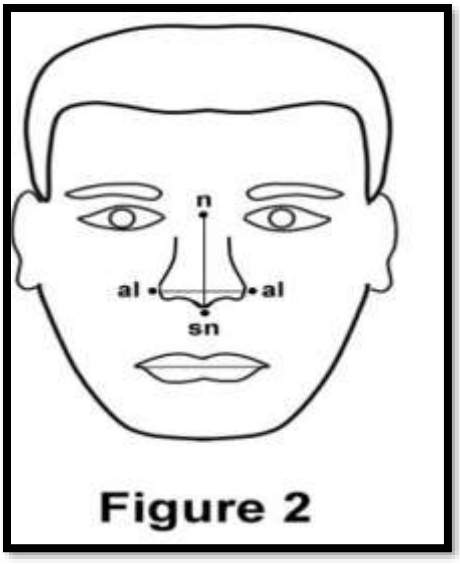

Figure 2

Nose measurements:

- Nasal Height: It was the distance measured from the nasion to the subnasale
- Nasal Width: Measured from ala to ala (most lateral points on each alar contour)
- Nasal Length it was the distance measured from the nasion to the pronasale
- Nasal Tip Projection by Goode's Method (pronasale to alar plane)
- Nasal index : It was calculated by dividing the nasal breadth by nasal height multiplied by 100

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Photograph no.6 showing digital vernier caliper

Photograph No. 7 Showing measurement of nasal height of male by using digital vernier caliper

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Photograph No. 8 Showing measurement of nasal width of male by using digital vernier caliper

Photograph No. 9 Showing measurement of nasal length of female by using digital vernier caliper

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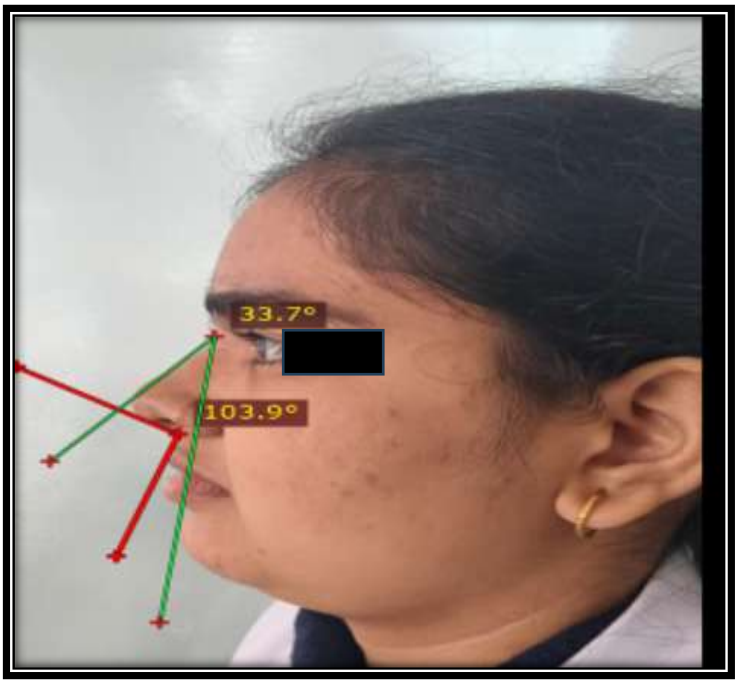
Photograph No. 10 Showing measurement of nasal tip projection for Goode's method of female by digital vernier caliper



Photograph No.11 Showing measurement of nasofacial and nasolabial angle of female

Results

The study population comprised 44 males and 44 females. Males demonstrated significantly greater **nasal height** and **nasal length** compared to females ($p<0.05$). Nasal width, nasal tip projection, nasofacial angle, and nasolabial angle showed no significant gender differences. Pearson's correlation analysis revealed no significant correlation between individual nasal

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parameters and facial angles. However, nasal index exhibited a highly significant association with both nasofacial and nasolabial angles ($p<0.001$), highlighting its role in facial proportionality (9, 2023).

Interpretation of Table 1

The nasal parameters and facial angles of males and females (n = 44 each) are compared by gender in the table. Both nasal height and length were significantly higher in males than in females, with nasal height showing a highly significant difference ($p = 0.004$). Males had slightly greater nasal width and nasal tip projection, but these differences were not statistically significant. Nasofacial and nasolabial angles also did not significantly differ between the sexes. In general, linear nasal dimensions were the main indicator of sexual dimorphism, whereas angular facial parameters were essentially unchanged between males and females.

Overall, the findings showed that nasal width, nasal tip projection, and facial angles seem to be sex-independent, nasal morphology in undergraduate students is primarily influenced by gender in terms of nasal length and height. These results offer useful baseline anthropometric information and have significant ramifications for forensic identification, orthodontic evaluation, aesthetic facial surgery, and anthropological studies.

Table 1. Descriptive Statistics of Nasal Parameters and Facial Angles with Gender-wise Comparison (Mean ± SD, *t* and *p* values)

Parameter	**Males (n = 44) Mean ± SD**	**Females (n = 44) Mean ± SD**	***t* value**	**p-value (independent t-test)**
Nasal Length (mm)	41.52 ± 5.86	36.78 ± 2.43	2.26	**0.042**
Nasal Height (mm)	48.44 ± 5.23	39.50 ± 4.77	3.50	**0.004**
Nasal Width (mm)	33.95 ± 0.94	32.01 ± 2.06	2.18	0.070
Nasal Tip Projection (mm)	1.46 ± 0.23	1.43 ± 0.10	0.41	0.686
Nasofacial Angle (°)	34.88 ± 3.20	34.72 ± 3.93	0.09	0.933
Nasolabial Angle (°)	102.85 ± 5.95	102.32 ± 15.74	0.08	0.939

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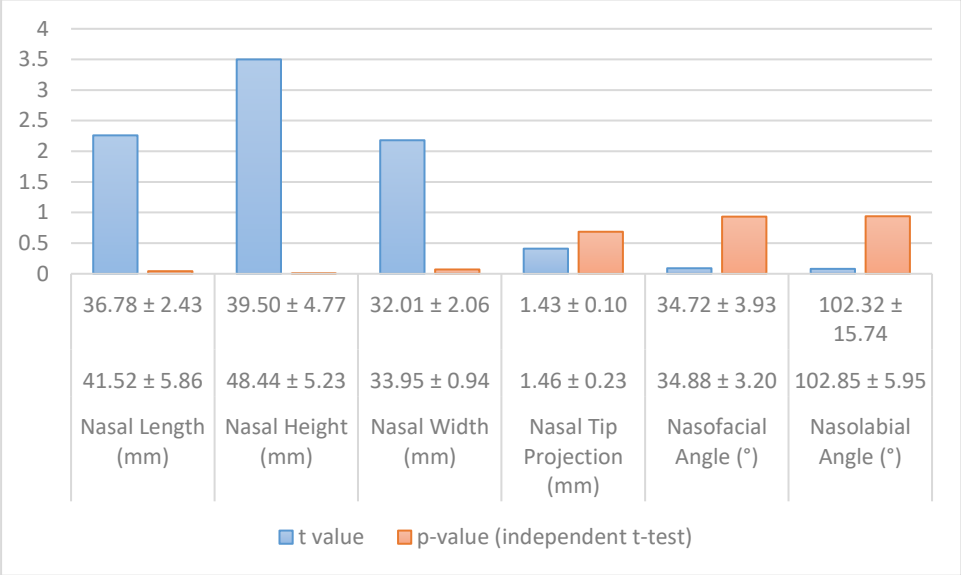

Figure no.1 Bar graph showing statistical comparison of nasal dimensions and facial angles.

Interpretation of table 2

The Pearson's correlation between facial angles and nasal parameters is displayed in the table. The nasofacial or nasolabial angle did not show any statistically significant correlation with any of the nasal parameters ($p > 0.05$). Nasal height and nasal tip projection showed weak positive correlations with the nasofacial angle, whereas nasal length and nasal width showed weak negative correlations, though these relationships were insignificant. Nasal height exhibited a weak negative correlation with the nasolabial angle, while nasal length and nasal tip projection showed weak positive correlations.

Overall, the results show that there is no significant linear correlation between facial angles and nasal dimensions in the population under study.

Table 2. Pearson's Correlation Between Nasal Parameters and Facial Angles

Nasal Parameter	**Nasofacial Angle (*r*)**	***p* value**	**Nasolabial Angle (*r*)**	***p* value**
Nasal Length (mm)	−0.062	0.820	0.247	0.357
Nasal Height (mm)	0.112	0.662	−0.184	0.471
Nasal Width (mm)	−0.205	0.417	0.091	0.721
Nasal Tip Projection (mm)	0.068	0.793	0.134	0.599

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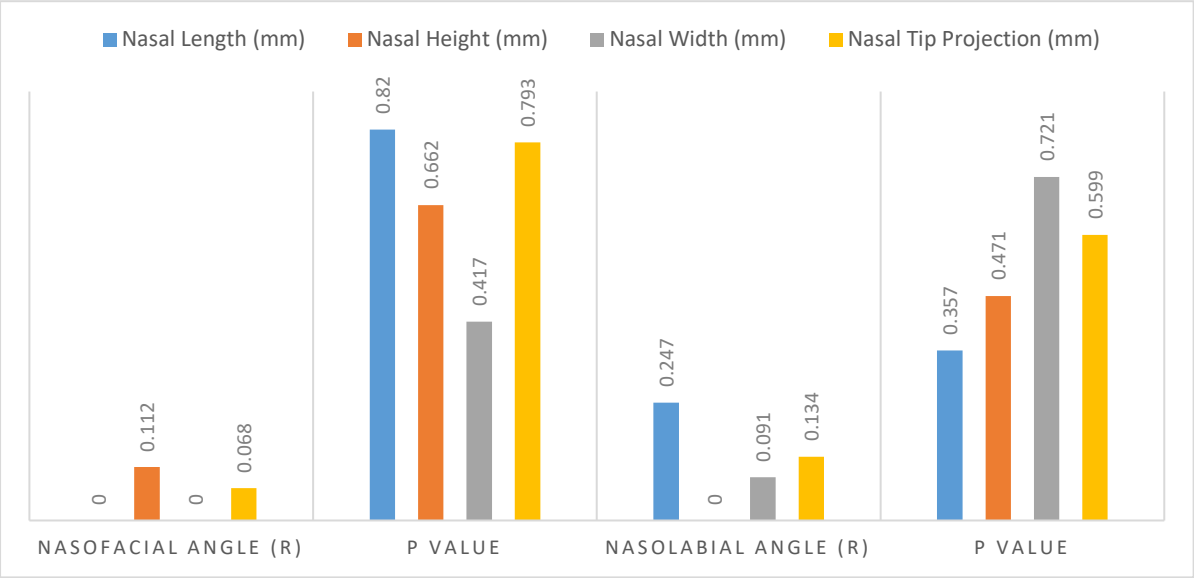

Figure no.2 Bar graph showing the correlation (r) and p-Values of nasal parameters with nasofacial and nasolabial Angles.

Interpretation of Table 3

In this study, a total of 88 participants were evaluated to determine the relationship between the nasal index and facial angles. The average nasal index recorded was 77.621 ± 8.061, and the average nasofacial angle was 36.005 ± 3.344. ANOVA analysis revealed a highly significant correlation between the nasal index and the nasofacial angle ($p < 0.001$).

In a similar vein, the average nasolabial angle measured was 100.214 ± 8.783, and its relationship with the nasal index was also found to be highly significant ($p < 0.001$). These results suggest that differences in the nasal index are significantly associated with both nasofacial and nasolabial angles within the studied group.

Table 3. Corelation of Nasal index with Nasofacial and nasolabial angle.

	n	Mean±SD	p-value (ANOVA)
Nasal Index	88	77.621±8.06	<0.001
Nasofacial Angle	88	36.005±3.34	
Nasal Index	88	77.621±8.06	<0.001
Nasolabial angle	88	100.214±8.78	

A significant difference was also observed between nasofacial and nasolabial angles ($p < 0.001$), indicating distinct morphometric relationships among the parameters.

Discussion

The present study confirms significant sexual dimorphism in linear nasal dimensions while demonstrating relative stability of facial angles across genders. The strong association between nasal index and facial angles underscores its relevance in aesthetic and forensic evaluation.

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These findings are consistent with previous anthropometric studies conducted in Indian populations (17, 2011; 22, 2023).

Summary

This study establishes normative nasal anthropometric data for young adults in North India. Significant gender differences were observed in nasal height and length, whereas facial angles remained largely consistent. The nasal index emerged as a key determinant of facial proportionality. These findings have important implications for **clinical anatomy**, forensic science, and facial reconstructive surgery.

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