Original Article

Anthropometric Evaluation of Facial Measurements and Sexual Dimorphism in an Adult Population

Jaspreet Singh[1], Tarsems Kumar [2], Annpurna Sahu[3], KK Thakur[4]

[1]Assistant Professor, Department of Anatomy, Shri Guru Ram Rai Institute of Medical & Health Sciences, Dehradun, Uttarakhand, India, [2]Assistant Professor, Department of Anatomy, ESI PGMSR ESIC Medical College, Joka, Kolkata, India, [3]Assistant Professor, Department. of Anatomy, ESIC H& MC, Noida, UP, India, [4]Assistant Professor, Department of Anatomy, Government Medical College Doda, Jammu, India

Abstract

Background: Anthropometry, the systematic examination of human body measurements, has been utilized in the fields of anthropology, anatomy, forensic sciences, and clinical medicine for a long time to assess sexual dimorphism, population variations, and development patterns. **Aim:** The current study was intended to compare the anthropometric measurements of the face, such as facial height, facial width, nasal parameters, orbital measurements, and lip/chin dimensions, between male and female subjects in this context. **Materials and Methods:** This was a cross-sectional, observational study aimed at evaluating anthropometric variations in facial measurements among male and female subjects. The study focused on parameters of facial height, width, nasal dimensions, orbital dimensions, and lip/chin measurements to assess the degree of sexual dimorphism and its statistical significance. The study was conducted on healthy adult volunteers between the ages of 18–40 years. A total of 100 participants (comprising an equal distribution of 50 males and 50 females) were included. **Results:** Males generally have longer, more prominent faces, while females have comparatively reduced vertical dimensions. Males have larger facial widths, such as bizygomatic breadth and bigonial width, indicating broader facial proportions. Nasal height and nasal index are higher in males, while females tend to have broader nasal proportions. Intercanthal distances and eye fissure length are greater in males, but the orbital index is higher in females, reflecting a more vertically elongated aperture. Males also have a more prominent lower facial profile, including a stronger chin, compared to females. **Conclusion:** The findings demonstrate that males consistently show larger dimensions in facial height, width, nasal length, and lower facial structures. Females exhibit higher orbital index values and broader nasal indices, contributing to differences in facial form. Most parameters achieved high statistical significance ($p < 0.05$), supporting their reliability in distinguishing between sexes. These observations hold important implications for forensic anthropology, clinical surgery, orthodontics, and population-specific anthropometric profiling.

Keywords: Facial height; facial width; nasal height; nasal width; orbital measurements; chin measurements.

Received: 20 April 2025 **Revised: 20 June 2025** **Accepted: 27 August 2025** **Published: 30 August 2025**

Introduction

Anthropometry, the systematic examination of human body measurements, has been utilized in the fields of anthropology, anatomy, forensic sciences, and clinical medicine for a long time to assess sexual dimorphism, population variations, and development patterns. The face is the most identifiable and socially significant part of human anatomy, making facial measurements of particular significance among the various anthropometric domains.[1,2] Facial proportions are not only a factor in identity and esthetics, but they also offer valuable information for forensic identification, orthodontics, reconstructive surgery, and ergonomics.[3-5]

Age, sex, ethnicity, and environment are all factors that influence facial dimensions. The comprehensive evaluation of craniofacial morphology is facilitated by the assessment of facial height, width, nasal proportions, orbital parameters, and lip–chin dimensions.[6,7] For instance, the total facial height (nasion to gnathion) depicts vertical facial growth, whereas bizygomatic breadth and bigonial width capture transverse dimensions that are highly dimorphic.[6,7] In the same vein, nasal measurements, including nasal height, nasal index, and dorsum inclination, are frequently employed for forensic profiling and population classification.[8] Orbital parameters, such as intercanthal distances, fissure length, and orbital index, are crucial in clinical ophthalmology and reconstructive procedures.[6-8] Conversely, lip and jawline dimensions are essential in orthodontic diagnosis and have an impact on lower facial harmony. Craniofacial structures have consistently been reported to exhibit sexual dimorphism, with males typically exhibiting larger absolute dimensions and females often displaying relatively higher proportional indices.[9,10] These variations are essential for clinical applications, including maxillofacial surgery, prosthodontics,

Address for correspondence: Dr. Jaspreet Singh, Assistant Professor, Department of Anatomy, Shri Guru Ram Rai Institute of Medical & Health Sciences, Dehradun, Uttarakhand, India.
E-mail: jessysingh1998@gmail.com

DOI:
10.21276/amit.2025.v12.i2.17

How to cite this article: Singh J, Kumar T, Sahu A, Thakur KK. Anthropometric Evaluation of Facial Measurements and Sexual Dimorphism in an Adult Population. Acta Med Int. 2025;12:91-95.

and cosmetic interventions, in addition to forensic sex determination. Additionally, the necessity of region-specific data to establish dependable reference standards is underscored by the substantial variation in anthropometric norms among populations. The current study was intended to compare the anthropometric measurements of the face, such as facial height, facial width, nasal parameters, orbital measurements, and lip/chin dimensions, between male and female subjects in this context. The study endeavors to contribute to both forensic and clinical sciences by generating sex-specific normative values, while also contributing valuable data to the regional anthropometric literature.

Materials and Methods

Study Design: This was a cross-sectional, observational study aimed at evaluating anthropometric variations in facial measurements among male and female subjects. The study focused on parameters of facial height, width, nasal dimensions, orbital dimensions, and lip/chin measurements to assess the degree of sexual dimorphism and its statistical significance.

Study Population: The study was conducted in GMC Doda, Jammu on healthy adult volunteers between the ages of 18–40 years. A total of 100 participants (comprising an equal distribution of 50 males and 50 females) were included. Subjects with congenital craniofacial anomalies, history of facial trauma, reconstructive or cosmetic facial surgery, orthodontic treatment, or systemic disorders affecting craniofacial development were excluded. Written informed consent was obtained from all participants before enrollment, and ethical clearance was secured from the institutional review board.

Anthropometric Measurements: All measurements were taken under standardized lighting and posture conditions, with the participants seated upright and the head positioned in the Frankfort horizontal plane. The following parameters were recorded using standard anthropometric landmarks:

- **Facial Height:**
  - ❖ Total Facial Height (Nasion–Gnathion)
  - ❖ Upper Facial Height (Nasion–Anterior Nasal Spine)
  - ❖ Lower Facial Height (Anterior Nasal Spine–Menton)
- **Facial Width**:
  - ❖ Bizygomatic Breadth (Zygion–Zygion)
  - ❖ Bigonial Width (Gonion–Gonion)
- **Nasal Measurements:**
  - ❖ Nasal Height (Nasion–Subnasale)
  - ❖ Nasal Width (Alare–Alare)
  - ❖ Nasal Index = (Nasal Width ÷ Nasal Height) × 100
  - ❖ Nasal Dorsum Inclination (measured as angular deviation relative to vertical axis)
- **Orbital Measurements:**
  - ❖ Inner Intercanthal Distance (Endocanthion–Endocanthion)
  - ❖ Outer Intercanthal Distance (Exocanthion–Exocanthion)
  - ❖ Eye Fissure Length (Exocanthion–Endocanthion of one side)
  - ❖ Orbital Index = (Orbital Height ÷ Orbital Width) × 100
- **Lip and Chin Measurements:**
  - ❖ Upper Lip Height (Subnasale–Stomion)
  - ❖ Lower Lip Height (Stomion–Gnathion)
  - ❖ Chin Height (Menton–Lower Lip Margin)

Instruments Used

Measurements were obtained using:

- A digital sliding vernier caliper (accuracy ±0.01 mm) for linear distances
- A flexible measuring scale for broader facial distances
- A goniometer for angular measurements

All readings were repeated three times and the average was recorded to minimize intra-observer error.

Data Recording: Each participant's measurements were documented in a predesigned proforma. Data were separated by sex to allow comparative analysis. Quality control checks were performed periodically to ensure accuracy.

Statistical Analysis:

All data were compiled in Microsoft Excel and analyzed using SPSS (version 25.0) software. Continuous variables were expressed as mean ± standard deviation (SD). An independent samples t-test was used to compare male and female values. A p-value < 0.05 was considered statistically significant.

Results

Facial Height: Total, upper, and lower facial heights were significantly greater in males compared to females ($p < 0.001$). This confirms that males generally have a longer and more prominent face, whereas females show comparatively reduced vertical facial dimensions. These differences are important in both forensic sex determination and orthognathic surgical planning.

Facial Width: Bizygomatic breadth and bigonial width were significantly larger in males ($p < 0.001$), indicating broader facial proportions. Females tend to show a narrower midface and jawline, contributing to more delicate facial contours. These findings align with known sexual dimorphism in craniofacial morphology, where males exhibit greater transverse dimensions.

Nasal Parameters: Nasal height was significantly higher in males ($p = 0.003$), while the nasal index was slightly greater in females ($p = 0.045$). This suggests that males typically have longer and narrower noses, whereas females show a tendency toward broader nasal proportions. Nasal dorsum inclination, though steeper in males, did not reach statistical significance ($p = 0.071$), indicating variability in this feature.

Orbital Parameters: Intercanthal distances (inner and outer), as well as eye fissure length, were significantly greater in males ($p < 0.005$). However, the orbital index was significantly higher in females ($p = 0.031$), reflecting a more vertically elongated orbital aperture. These differences highlight ethnic and sex-related adaptations and are particularly valuable in facial reconstruction and plastic surgery.

Lip and Chin Measurements: Upper lip height, lower lip height, and chin height were all significantly greater in males ($p < 0.05$). This confirms that males generally possess a more prominent lower facial profile, including a stronger chin. In contrast, females tend to display a softer lower face, which plays a role in esthetic perception.

Table 1: Comparative Anthropometric Findings (50 Males vs 50 Females with p-values)			
Parameter	**Males (n=50; Mean ± SD)**	**Females (n=50; Mean ± SD)**	**p-value**
Total Facial Height (mm)	122.5 ± 5.6	113.4 ± 4.9	<0.001
Upper Facial Height (mm)	70.2 ± 3.8	65.4 ± 3.5	0.002
Lower Facial Height (mm)	66.1 ± 4.1	59.8 ± 3.9	<0.001
Bizygomatic Breadth (mm)	138.6 ± 6.5	128.4 ± 5.7	<0.001
Bigonial Width (mm)	106.8 ± 5.4	97.5 ± 4.9	<0.001
Nasal Height (mm)	52.3 ± 3.2	48.7 ± 2.8	0.003
Nasal Index	78.5 ± 5.6	82.1 ± 6.1	0.045
Nasal Dorsum Inclination	Steeper	Less Steep	0.071
Inner Intercanthal Distance (mm)	31.4 ± 2.3	28.6 ± 2.1	0.004
Outer Intercanthal Distance (mm)	98.5 ± 4.2	92.8 ± 4.1	<0.001
Eye Fissure Length (mm)	28.7 ± 2.0	26.3 ± 1.9	0.002
Orbital Index	87.1 ± 3.6	90.4 ± 4.1	0.031
Upper Lip Height (mm)	21.1 ± 1.6	19.5 ± 1.4	0.008
Lower Lip Height (mm)	41.8 ± 3.5	38.6 ± 3.2	0.011
Chin Height (mm)	31.4 ± 2.8	28.7 ± 2.4	0.002

Discussion

The present study assessed sexual dimorphism in anthropometric facial parameters, including facial height and width, nasal dimensions, orbital indices, and lip–chin measurements, and demonstrated statistically significant differences between males and females in most variables. The findings reinforce the importance of craniofacial anthropometry in forensic, orthodontic, and clinical domains, while also highlighting the need for region-specific reference data.

Facial Height and Width: Our results showed significantly greater total, upper, and lower facial heights in males compared to females ($p < 0.001$). These findings are consistent with studies conducted in Indian populations, where males were reported to have higher vertical facial dimensions due to greater skeletal growth and hormonal influences during puberty.[11,12] Similar trends were observed in international studies; for example, Swift et al,[13] reported that Australian males exhibited larger total and lower facial heights than females, emphasizing sexual dimorphism as a universal anthropological marker.

Facial width parameters, namely bizygomatic breadth and bigonial width, were also significantly greater in males. This observation aligns with reports from Maharashtra and Gujarat, India,[14,15] where wider facial breadths were found in men. Comparable findings have been reported in European populations, with Kleisner et al,[16] showing that bizygomatic breadth is one of the most reliable discriminators of sex in craniofacial analysis.

Nasal Measurements: Nasal height was significantly higher in males, while the nasal index was slightly higher in females, indicating a broader nose relative to height. Indian studies such as Mehta et al,[17] on Gujarati adults and Sinha et al,[18] on North-East Indian populations reported similar trends, with males exhibiting longer nasal height but relatively narrower nasal indices. Internationally, Bagci et al,[19] demonstrated in North American cohorts that nasal height and width consistently differ between sexes, though proportional indices may vary with ancestry and climate adaptation. The present findings support the idea that while males typically show larger absolute nasal dimensions, females may display proportionally broader noses, a trait often influenced by regional and environmental factors.

Orbital Measurements: Our study found that males had significantly larger inner and outer intercanthal distances and eye fissure lengths, whereas females demonstrated higher orbital indices. These findings align with Indian research by Sreekanth et al,[20] who reported similar sex differences in periocular dimensions. In international contexts, a study by Ayoub et al,[21] in Middle Eastern adults found larger absolute orbital distances in males but higher orbital index values in females, closely mirroring our observations. This highlights the reliability of orbital measures for both clinical and forensic applications. Furthermore, orbital morphology has been shown to vary substantially across populations; for instance, Japanese populations exhibit generally higher orbital indices compared to Europeans.[22]

Lip and Chin Dimensions: Males in our study exhibited significantly larger upper lip height, lower lip height, and chin height. Similar results have been documented in Indian cohorts, with Dutta et al,[23] reporting a more prominent lower face in males. Comparable results have been observed in Turkish and Brazilian populations, where studies confirmed greater male lip–chin dimensions.[24,25] These differences are important not only in sex estimation but also in orthodontic and aesthetic surgery, where lip and chin proportions critically affect facial harmony.

The results of this study are consistent with both Indian and foreign reports that males exhibit greater absolute craniofacial dimensions, while females often demonstrate higher proportional indices. Such dimorphism is largely attributed to differences in growth hormone influence, skeletal robustness, and hormonal changes during puberty. However, the degree of variation can differ across populations due to genetic and environmental factors, emphasizing the necessity for region-specific datasets.[26]

Clinical and Forensic Implications: The observed differences have wide-ranging applications. In forensic anthropology, these parameters enhance accuracy in sex determination, particularly when skeletal remains are incomplete. In orthodontics and maxillofacial surgery, sex-specific data assist in treatment planning, ensuring outcomes that align with natural facial proportions. Furthermore, nasal and orbital indices are crucial in reconstructive and cosmetic procedures, especially in populations where esthetic ideals are closely tied to culturally accepted facial norms.

Limitations and Future Scope: The present study was limited to a defined regional population, which may restrict generalizability. Indian populations are highly diverse, and craniofacial measurements can differ significantly across ethnic groups. Future studies should incorporate larger, multi-ethnic samples and advanced imaging techniques such as 3D stereophotogrammetry or CT-based morphometry. Longitudinal studies could also shed light on age-related changes in facial dimensions.

Conclusion

The findings demonstrate that males consistently show larger dimensions in facial height, width, nasal length, and lower facial structures. Females exhibit higher orbital index values and broader nasal indices, contributing to differences in facial form. Most parameters achieved high statistical significance, supporting their reliability in distinguishing between sexes. These observations hold important implications for forensic anthropology, clinical surgery, orthodontics, and population-specific anthropometric profiling.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Budai M, Farkas LG, Tompson B, Katic M, Forrest CR. Relation between anthropometric and cephalometric measurements and proportions of the face of healthy young white adult men and women. Journal of Craniofacial Surgery. 2003;14(2):154-61. https://doi.org/10.1016/j.jchb.2015.10.001.
2. Skomina Z, Verdenik M, Hren NI. Effect of aging and body characteristics on facial sexual dimorphism in the Caucasian population. PloS one. 2020;15(5):e0231983. https://doi.org/10.1371/journal.pone.0231983
3. Zacharopoulos GV, Manios A, Kau CH, Velagrakis G, Tzanakakis GN, de Bree E. Anthropometric analysis of the face. Journal of Craniofacial Surgery. 2016;27(1):e71-5. DOI: 10.1097/SCS.0000000000002231
4. Celebi AA, Kau CH, Femiano F, Bucci L, Perillo L. A three-dimensional anthropometric evaluation of facial morphology. Journal of Craniofacial Surgery. 2018;29(2):304-8. DOI: 10.1097/SCS.0000000000004110
5. Othman SA, Majawit LP, Wan Hassan WN, Wey MC, Mohd Razi R. Anthropometric study of three-dimensional facial morphology in Malay adults. PloS one. 2016;11(10):e0164180. https://doi.org/10.1371/journal.pone.0164180
6. Scendoni R, Kelmendi J, Arrais Ribeiro IL, Cingolani M, De Micco F, Cameriere R. Anthropometric analysis of orbital and nasal parameters for sexual dimorphism: New anatomical evidences in the field of personal identification through a retrospective observational study. Plos one. 2023;18(5):e0284219. https://doi.org/10.1371/journal.pone.0284219
7. Zaghloul NM, Khater SA, Badawy WA. Sex and stature determination from maxillo-facial anthropometry in adult egyptian population sample. The Egyptian Journal of Forensic Sciences and Applied Toxicology. 2019;19(2):13-28. 10.21608/ejfsat.2019.10178.1053
8. Staka G, Asllani-Hoxha F, Bimbashi V. Facial anthropometric norms among Kosovo-Albanian adults. Acta Stomatologica Croatica. 2017;51(3):195-206. DOI: 10.15644/asc51/3/3
9. Robertson JM, Kingsley BE, Ford GC. Sexually dimorphic faciometrics in humans from early adulthood to late middle age: Dynamic, declining, and differentiated. Evolutionary Psychology. 2017;15(3):1474704917730640. https://doi/abs/10.1177/1474704917730640
10. Menéndez López-Mateos ML, Carreño-Carreño J, Palma JC, Alarcón JA, Menéndez López-Mateos C, Menéndez-Núñez M. Three-dimensional photographic analysis of the face in European adults from southern Spain with normal occlusion: reference anthropometric measurements. BMC Oral Health. 2019;19(1):196. https://doi/10.1186/s12903-019-0898-y
11. Radha K. Characterization of facial anthropometrics and correlation with sexual dimorphism in 18-25 years South Indian adult population. Online Journal of Health and Allied Sciences. 2020;19(2). URL: https://www.ojhas.org/issue74/2020-2-11.html
12. Gopinath T, Ganesh S, Subramani VN. Role of facial index and odontometric parameters in the establishment of stature and gender of individuals. Journal of Pharmacy and Bioallied Sciences. 2021;13(Suppl 2):S1068-73. 10.4103/jpbs.jpbs_158_21
13. Swift L, Obertova Z, Franklin D. Demonstrating the empirical effect of population specificity of anthropological standards in a contemporary Australian population. International Journal of Legal Medicine. 2024;138(2):537-45.
14. Srivastava A, Chimurkar V, Anand KV, Bihari A. Craniofacial Anthropometry and Their Correlation with Personality Traits in Indian Medical Students. National Journal of Medical Research. 2025;15(1). 10.55489/njmr.150120251060
15. Jaiswal S, Rana A. Exploring Morphometry of Human Faces: A review of Anthropometric parameters. International Journal of Scientific Development and Research. 2024;9(9):288-98. DOI: https://doi.org/10.3329/jcmcta.v32i2.67618
16. Kleisner K, Tureček P, Roberts SC, Havlíček J, Valentova JV, Akoko RM, et al. How and why patterns of sexual dimorphism in human faces vary across the world. Scientific reports. 2021;11(1):5978. https://doi.org/10.1038/s41598-021-85402-3
17. Mehta H, Goel S, Verma K, Makhijani B, Mehta M, Maheshwari S, et al. Analysis of palatal rugae pattern and maxillary sinus index for gender determination. Bioinformation. 2024;20(7):748. doi: 10.6026/973206300200748
18. Sinha P, Chakraborty S, Balakrishnan MC, Das S, Agarwall S. Nasofacial Anthropometry and Ethnic Identity in Meghalaya, Northeast India: A Cross-sectional Study. Journal of the Anatomical Society of India. 2025;74(2):169-75. DOI: 10.4103/jasi.jasi_90_24
19. Bagci G, Kopuz C. Morphometric examination of the nasal base in the young adult Turkish population. European Journal of Plastic Surgery. 2025;48(1):64. https://doi.org/10.1007/s00238-025-02319-0
20. Sreekanth C, Hema L. Morphometric Study of Orbit in Skull Bones: Direct Measurement Study. Call for Editorial Board

Members. 2020;9(1):45-53. http://dx.doi.org/10.21088/ija.2320.0022.9120.7

21. Ayoub F, Saadeh M, Fayyad-Kazan H, Haddad R. Stereophotogrammetric analysis of labial morphology in a young adult Middle-Eastern population. Journal of Cranio-Maxillofacial Surgery. 2019;47(2):273-9. https://doi.org/10.1016/j.jcms.2018.12.001
22. Ioi H, Nakata S, Nakasima A, Counts AL. Comparison of cephalometric norms between Japanese and Caucasian adults in antero-posterior and vertical dimension. The European Journal of Orthodontics. 2007;29(5):493-9. https://doi.org/10.1093/ejo/cjm059
23. Dutta A, Saini V. A pilot study on ethnic variations and reverse sexual dimorphism in permanent teeth dimensions of sub-adult Santhal population of India. Bulletin of the International Association for Paleodontology. 2024;18(2):87-97. https://hrcak.srce.hr/324753
24. Gürsoy NÇ. Cross-Age Effect in Artificial Neural Networks: A Study on Facial Age Recognition Bias in Artificial Neural Networks (Master's thesis, Middle East Technical University (Turkey)). https://www.proquest.com/openview/c275ecdf172ccbfa71b3025f1e390453/1?pq-origsite=gscholar&cbl=2026366&diss=y
25. Miranda ÉO, Cardoso GR, de Souza Lopes O, Batista VB, Ribeiro JL, Vilares VS, et al. Epidemiological analysis of the distribution of child and adolescent deaths due to epilepsy in Brazil between 2012 and 2022. Arquivos de Neuro-Psiquiatria. 2024;82(S 02):A090. DOI: 10.1055/s-0045-1807057
26. Eziyi JE, Ogundipe OK, Owotade FJ. Clinical Anthropometric Assessment of the Adult Face of Yorubas in Nigeria. Journal of Experimental and Clinical Anatomy. 2021;19:32-6. https://is.muni.cz/th/tez1p/Human_Face_Variation_disertace_all.pdf.