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# Assessment of sexual dimorphism in a subpopulation of Ghaziabad young adults using maxillary intercanine, interpremolar, and intermolar widths

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## ABSTRACT

**Background:** Dental structures are among the most durable biological tissues and play a crucial role in forensic identification. Sexual dimorphism in dental arch dimensions has been widely studied; however, population-specific data remain limited.

**Objective:** To evaluate sexual dimorphism in maxillary intercanine, interpremolar, and intermolar widths in a Ghaziabad subpopulation and assess their utility in sex determination.

**Materials and Methods:** This cross-sectional study included 50 systemically healthy adults (25 males and 25 females) aged 20–30 years. Maxillary impressions were obtained using alginate and casts were prepared in dental stone. Arch width measurements were recorded using a digital Vernier caliper with 0.01 mm precision. Statistical analysis was performed using IBM SPSS (statistics version 25.0); mean differences were assessed using an independent t-test, and ROC curve analysis was used to evaluate diagnostic performance and determine cut-off values. A p-value < 0.05 was considered statistically significant.

**Results:** Males exhibited higher mean values for all parameters. Intermolar width was significantly greater in males (49.48 ± 3.72 mm) than females (46.60 ± 4.34 mm) (p = 0.015). Intercanine and interpremolar widths did not show statistically significant differences (p > 0.05). ROC analysis revealed that mesiodistal canine width demonstrated the highest diagnostic accuracy (AUC = 0.762), followed by intermolar width (AUC = 0.694).

**Limitations:** The study is limited by small sample size and restriction to a single geographic population.

**Conclusion:** Intermolar width and mesiodistal canine width demonstrated better discriminatory potential. These parameters, when used alongside other forensic methods, may improve the accuracy of sex determination.

## KEY WORDS

Dental arch; ROC curve; Alginate; Sample size; Cross-sectional study

## ARTICLE HISTORY

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## Introduction

Forensic identification is an essential component of medico-legal investigations, particularly in situations involving mass disasters, criminal investigations, skeletal remains, and advanced decomposition. Establishing the biological identity of an individual often requires the assessment of multiple parameters, including age, sex, stature, and ancestry [1]. Among these, sex determination is considered a primary step because it significantly narrows the search for identity by reducing the possible matches by approximately 50%. While DNA profiling and fingerprint analysis are considered highly reliable methods for identification, they are not always feasible due to degradation of biological tissues, lack of available comparative records, or environmental factors affecting sample preservation [2].

Teeth are among the most durable structures of the human body and can withstand extreme environmental conditions such as fire, trauma, and decomposition. Their resistance to physical and chemical degradation makes them invaluable tools in forensic identification. Dental tissues are often preserved even when other skeletal structures are fragmented or destroyed. The morphological characteristics of teeth, including crown size, root morphology, and dental arch dimensions, exhibit variations between males and females, a phenomenon known as sexual dimorphism [3].

Odontometric analysis, which involves the measurement of tooth dimensions and dental arch widths, has been widely investigated as a supplementary method for sex determination. Among the commonly studied parameters, maxillary intercanine width, interpremolar width, and intermolar width have demonstrated potential in differentiating between sexes. These parameters reflect craniofacial growth patterns influenced by genetic, hormonal, and environmental factors. Males generally exhibit larger craniofacial dimensions compared to females due to differences in growth hormone levels, muscle attachment patterns, and skeletal development [4,5].

Sex determination using dental parameters has gained increasing importance in forensic odontology due to the need for reliable and reproducible methods that can be applied in diverse populations. Numerous studies have reported that odontometric measurements can provide sex determination accuracy ranging from 60% to 80%, depending on the population studied and the parameters evaluated. However, variations in dental arch dimensions are influenced by ethnicity, geographic distribution, genetic factors, and environmental influences. Therefore, odontometric standards derived from one population may not be directly applicable to another [6,7].

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In the Indian context, population diversity is particularly significant due to genetic heterogeneity and regional variations in craniofacial morphology. Studies conducted in different Indian populations have demonstrated variations in the degree of sexual dimorphism observed in dental arch widths. Such variability highlights the need to establish population-specific baseline data that can improve the reliability of forensic identification [8].

Dental arch width measurements provide a simple, non-invasive, and cost-effective method for assessing sexual dimorphism. Intercanine width represents the transverse distance between the cusp tips of maxillary canines and reflects anterior arch dimensions. Interpremolar width corresponds to the distance between distal pits of first premolars and represents mid-arch morphology, while intermolar width represents posterior arch dimensions measured between the central fossae of first molars. These parameters collectively describe the transverse dimensions of the dental arch and may demonstrate sex-related differences [9].

The stability of dental arch dimensions after adolescence makes early adulthood an ideal age group for studying odontometric characteristics. Individuals aged 20–30 years typically exhibit fully erupted permanent dentition with minimal influence of growth-related changes or age-related attrition. This age group provides relatively stable measurements that can be reliably compared across individuals [10].

Although several studies have explored dental arch dimensions in different populations, there is limited data available for the Ghaziabad subpopulation. Furthermore, variations across ethnic and geographic groups necessitate population-specific standards. The objective of the present study was to evaluate sexual dimorphism in maxillary intercanine, interpremolar, and intermolar widths among young adults in the Ghaziabad subpopulation and to assess their diagnostic performance in sex determination using statistical and ROC curve analysis.

## Materials and Methods

### Study design

A cross-sectional morphometric study was conducted in the Department of Oral and Maxillofacial Pathology and Oral Microbiology after obtaining ethical clearance from the Institutional Ethics Committee.

### Sample selection

These dimensions are established after adolescence and remain relatively stable in early adulthood; therefore, selecting individuals aged 20–30 years minimizes the influence of growth-related changes and attrition.

### Inclusion criteria

- Systemically healthy individuals
- Fully erupted maxillary dentition
- Healthy periodontium

### Exclusion criteria

- Carious or restored teeth (canines, premolars, molars)
- Malocclusion (crowding/spacing)
- Parafunctional habits
- Previous orthodontic treatment
- Craniofacial abnormalities

### Impression procedure

Maxillary impressions were obtained using irreversible hydrocolloid (alginate) impression material due to its accuracy, ease of manipulation, and ability to capture fine anatomical details. Appropriately sized perforated stock trays were selected for each participant to ensure adequate coverage of the dental arch without causing discomfort. The impression material was mixed according to manufacturer instructions to achieve optimal consistency and working time. The mixed alginate was evenly loaded into the tray and inserted into the oral cavity, ensuring proper positioning to capture the entire maxillary dentition.

Participants were instructed to remain still during the setting period to avoid distortion of the impression. After complete setting of the material, impressions were carefully removed to prevent tearing or dimensional inaccuracies. The impressions were rinsed under running water to remove saliva and debris, disinfected according to standard infection control protocols, and immediately poured using Type III dental stone. Immediate pouring of impressions minimizes dimensional changes associated with alginate shrinkage or expansion, thereby ensuring accurate cast reproduction. Dental stone casts were allowed to set completely before separation from impressions. Each cast was visually inspected for defects such as air bubbles, voids, or distortions. Only defect-free casts were included in the study to ensure accuracy of measurements.

### Measurements

All odontometric measurements were performed on dental stone casts using a digital Vernier caliper with an accuracy of 0.01 mm. The caliper was calibrated prior to each measurement session to maintain consistency and reduce instrumental error. Measurements included:

- **Intercanine width:** measured as the linear distance between cusp tips of right and left maxillary canines.
- **Interpremolar width:** measured as the distance between distal pits of right and left first premolars.
- **Intermolar width:** measured as the distance between central fossae of right and left first molars.
- **Mesiodistal canine width:** measured as the maximum mesiodistal dimension of the crown of the maxillary canine.

Each measurement was recorded twice by the same observer to minimize intra-observer variability, and the average value was considered for statistical analysis. Standardized measurement techniques were followed to maintain reproducibility.

### Statistical analysis

All recorded data were tabulated in Microsoft Excel and analyzed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics including mean and standard deviation were calculated separately for males and females.

Independent sample t-test was used to compare mean differences between male and female groups for each



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odontometric parameter. The level of statistical significance was set at $p < 0.05$.

Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance of each parameter in distinguishing between sexes. Area Under Curve (AUC) values were calculated to determine the discriminatory accuracy of each measurement. Sensitivity and specificity values were calculated at optimal cut-off points to assess the predictive reliability of each odontometric parameter.

## Results

### Descriptive analysis

Males exhibited higher mean values across all parameters compared to females.

**Table 1.** Comparison of maxillary arch width parameters between males and females.

| Parameter | Male Mean (mm) | Female Mean (mm) | p-value |
|---|---|---|---|
| Intercanine width | 35.92 ± 4.24 | 34.08 ± 3.81 | 0.114 |
| Interpremolar width | 34.72 ± 3.96 | 34.20 ± 4.00 | 0.646 |
| Intermolar width | 49.48 ± 3.72 | 46.60 ± 4.34 | 0.015* |

Statistically significant ($p < 0.05$)

These findings suggest that intermolar width demonstrates significant sexual dimorphism, whereas intercanine and interpremolar widths show limited discriminatory value when used independently (Table 1).

The mean intercanine width was 35.92 ± 4.24 mm in males and 34.08 ± 3.81 mm in females, which was not statistically significant ($p = 0.114$). Similarly, interpremolar width showed no significant difference between males (34.72 ± 3.96 mm) and females (34.20 ± 4.00 mm) ($p = 0.646$).

### Combined measurements

Combined odontometric parameters showed higher mean values in males; however, the differences were not statistically significant.

### ROC analysis

Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance of arch width measurements in sex determination.

**Table 2.** ROC curve analysis.

| Parameter | Cut-off Value (mm) | AUC | Sensitivity (%) | Specificity (%) | p-value |
|---|---|---|---|---|---|
| Intercanine width | 35 | 0.654 | 60 | Specificity (%) | 0.063 |
| Interpremolar width | 34.5 | 0.542 | 55 | Specificity (%) | 0.614 |
| Intermolar width | 47.5 | 0.694 | 65 | Specificity (%) | 0.018* |
| Mesiodistal canine width | 7.2 | 0.762 | 72 | Specificity (%) | 0.001** |

The ROC analysis with corresponding cut-off values, sensitivity, and specificity is presented in Table 2.

Mesiodistal canine width demonstrated the highest diagnostic performance with a sensitivity of 72% and specificity of 68%, followed by intermolar width (65% and 60%, respectively), indicating moderate discriminatory ability.

Mesiodistal width of the canine demonstrated the highest discriminatory ability (AUC = 0.762, $p = 0.001$), indicating good diagnostic accuracy. Intermolar width also showed moderate accuracy (AUC = 0.694, $p = 0.018$), whereas intercanine width exhibited borderline significance (AUC = 0.654, $p = 0.063$). Interpremolar width showed poor diagnostic performance (AUC = 0.542).

These findings suggest that mesiodistal canine width and intermolar width are more reliable indicators for sex determination compared to other arch width parameters.

### Graph interpretation

Figure 1 and 2 represents the comparison of mean maxillary arch widths between males and females. Males consistently exhibited higher values across all parameters, with the most pronounced difference observed in intermolar width, indicating its stronger discriminatory potential.

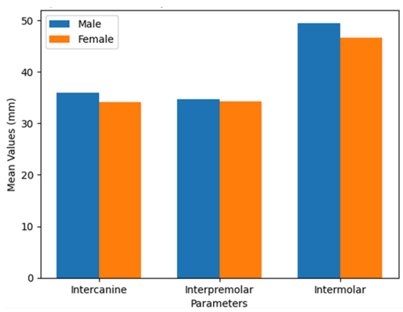


**Figure 1.** Comparison of maxillary widths between male and female.

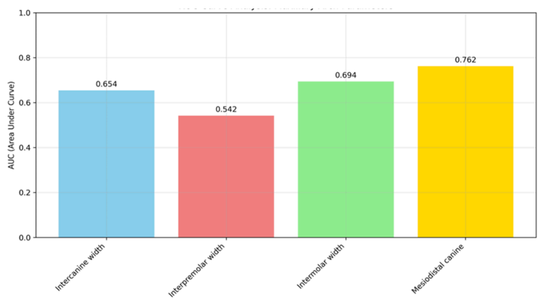


**Figure 2.** ROC curve analysis: Maxillary arch parameters.



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## Discussion

The present study evaluated sexual dimorphism in maxillary dental arch dimensions in a Ghaziabad subpopulation using intercanine, interpremolar, and intermolar width measurements. The findings demonstrated that males exhibited greater mean values for all measured parameters compared to females, which is consistent with established craniofacial growth patterns and previously reported odontometric studies [11].

Sexual dimorphism in craniofacial structures is primarily influenced by genetic and hormonal factors. Testosterone plays a significant role in stimulating bone growth and muscle development, resulting in greater skeletal dimensions in males. This biological variation contributes to differences in dental arch morphology, including arch width and tooth size. Consequently, odontometric parameters have been widely investigated as potential indicators for sex determination in forensic science [12].

Among the evaluated parameters, intermolar width demonstrated statistically significant differences between males and females ($p = 0.015$), suggesting its potential reliability as a predictor of sex. This finding is consistent with studies conducted which reported greater intermolar widths in males compared to females. Posterior dental arch dimensions are considered relatively stable and less affected by environmental factors, which may explain their stronger discriminatory ability [13].

Intercanine and interpremolar widths showed higher mean values in males; however, these differences were not statistically significant. Similar findings have been reported in certain population-based studies, suggesting that anterior arch dimensions may exhibit greater variability due to environmental influences such as dietary habits, occlusal forces, and minor orthodontic variations. Additionally, the relatively small sample size in the present study may have influenced the statistical significance of these parameters [14,15].

ROC curve analysis further supported the role of mesiodistal canine width and intermolar width as useful indicators of sexual dimorphism. Mesiodistal canine width demonstrated the highest AUC value (0.762), indicating good diagnostic accuracy, followed by intermolar width (AUC = 0.694), indicating moderate accuracy. These findings suggest that combining multiple odontometric parameters may improve the overall reliability of sex determination [16].

The variation in odontometric findings across populations highlights the importance of developing population-specific standards. Differences in genetic background, ethnicity, dietary patterns, and environmental factors contribute to variability in dental arch morphology. Therefore, odontometric values derived from one population may not be universally applicable [17].

The present study contributes to the growing body of forensic odontometric literature by providing baseline data for the Ghaziabad population. Such data may assist forensic experts, anthropologists, and medico-legal investigators in narrowing down identification in cases involving fragmented remains or limited biological evidence [18].

The differences observed in odontometric measurements may also be attributed to evolutionary and functional adaptations in craniofacial morphology. Studies suggest that dietary patterns, masticatory forces, and environmental influences may affect dental arch development. Populations consuming harder diets often demonstrate wider dental arches due to increased functional loading on the maxilla. Additionally, genetic variability contributes to differences in craniofacial growth patterns across ethnic groups. These variations emphasize the importance of developing regional odontometric standards rather than relying solely on universal reference values. The integration of odontometric parameters with other skeletal indicators such as mandibular ramus height, gonial angle, and cranial indices may further improve accuracy of sex estimation in forensic investigations [19,20].

However, certain limitations must be considered. The relatively small sample size may limit generalizability of findings. Additionally, measurements were restricted to maxillary arch dimensions, and mandibular parameters were not included. Future studies incorporating larger sample sizes and additional odontometric parameters may provide more robust predictive models. Overall, the findings indicate that maxillary arch width measurements can serve as useful adjunctive tools in forensic identification when interpreted alongside other skeletal and dental indicators [21].

## Conclusion

The present study demonstrated that maxillary dental arch dimensions exhibit measurable sexual dimorphism in a Ghaziabad subpopulation, with males showing greater mean values compared to females. Among the evaluated parameters, mesiodistal canine width demonstrated the highest diagnostic accuracy, while intermolar width showed statistically significant differences between sexes. These findings support the use of odontometric measurements as supplementary tools in forensic identification, particularly in situations where conventional identification methods are limited or unavailable. Although intercanine and interpremolar widths did not demonstrate statistically significant differences in the present study, their contribution as part of a combined odontometric assessment should not be overlooked. The combination of multiple dental parameters may enhance predictive reliability and improve accuracy in sex determination. Future research should focus on increasing sample size and including participants from diverse geographic populations to develop standardized odontometric databases. Such databases can improve reliability of forensic identification and facilitate comparison across populations. Incorporating mandibular arch parameters may further enhance discriminatory capability of odontometric analysis. Technological advancements such as 3D digital scanning and artificial intelligence-based predictive models offer promising avenues for improving accuracy, reproducibility, and efficiency of forensic dental identification methods. Integration of digital technologies may reduce measurement errors and allow automated analysis of dental dimensions. Further longitudinal studies are also recommended to evaluate stability of odontometric parameters across age groups. Establishing standardized measurement protocols and combining odontometric analysis with other forensic indicators such as craniofacial measurements and DNA profiling may significantly improve the reliability of human identification. Overall, odontometric analysis remains a valuable adjunct in forensic science, and continued research in this field may contribute to the development of more accurate, population-specific identification methods.



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