

ORIGINAL ARTICLE

Correlation between Tooth Crown Dimensions and Sex Determination in a Bangladeshi Population

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ABSTRACT

Background: Forensic odontology plays a critical role in post-mortem identification, with sex determination serving as a fundamental step, and teeth being especially valuable due to their exceptional resistance to post-mortem degradation. Odontometric assessment of tooth crown dimensions, particularly mesiodistal and buccolingual measurements, has shown population-specific sexual dimorphism, highlighting the need to evaluate their applicability in the Bangladeshi population. **Objective:** The aim of the study was to evaluate the correlation between tooth crown dimensions and sex determination in a Bangladeshi adult population. **Methods & Materials:** This cross-sectional study was conducted at the Department of Dentistry (OPD), Mugda Medical College and Hospital, Dhaka, Bangladesh, from April 2024 to March 2025, including 120 healthy adults (60 males, 60 females). Mesiodistal and buccolingual crown dimensions of six permanent teeth were measured twice using a digital vernier caliper, and mean values were analyzed. Independent t-tests, Cohen's d, percentage sexual dimorphism, and sex prediction accuracy were calculated using SPSS 26.0, with $p < 0.05$ considered significant. **Results:** In 120 participants (60 males, 60 females; mean age 21.3 ± 2.0 years, $p = 0.414$), males had significantly larger mesiodistal (6.93–11.08 mm vs 6.51–10.61 mm) and buccolingual (6.25–10.65 mm vs 6.01–10.22 mm) crown dimensions across all teeth ($p < 0.001$), with highest sexual dimorphism in canines (3.6–7.4%). Sex prediction accuracy ranged from 66.2% to 79.8%, maximal for mandibular (79.8%) and maxillary canines (78.3%). **Conclusion:** Mesiodistal and buccolingual crown dimensions, particularly of canines, reliably differentiate sexes in the Bangladeshi adult population.

Keywords: Sex Determination, Tooth Crown Dimensions, Forensic Odontology

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INTRODUCTION

Forensic odontology is a specialized branch of forensic medicine that contributes to the reconstruction of the post-mortem biological profile, which typically involves the assessment of age, sex, stature, and ancestry [1-3]. Within this framework, determining sex is a fundamental and initial step. Teeth are regarded as one of the most resilient structures of the human body, as they can withstand mechanical, chemical, physical, and thermal influences, as well as microbial degradation and other post-mortem changes [4]. Compared with other hard tissues, teeth demonstrate greater resistance to destruction and fragmentation after death [5]. This exceptional durability makes dentition particularly valuable for sex determination in forensic investigations and mass disaster scenarios, where skeletal remains are often incomplete or severely damaged [5].

Sex estimation using dentition is mainly based on observable differences in tooth size and morphology between males and females. Odontometric studies commonly rely on mesiodistal (MD) and buccolingual (BL) crown measurements, which are widely accepted parameters in dental sex determination research [4]. Maximum MD and BL crown dimensions are among the most frequently utilized measurements for this purpose [6-9]. Among all tooth groups, mandibular canines are regarded as especially important for personal identification because they are less susceptible to periodontal disease, tend to be retained longer in the dental arch, and exhibit pronounced dimorphic characteristics [10,11]. Previous observations have shown that mandibular canines demonstrate the highest degree of sexual dimorphism when compared to other teeth [12].

In human populations, sexual differences in dental dimensions are well recognized, with males generally exhibiting larger

tooth sizes than females, a feature that has been extensively applied in sex estimation. However, the extent of dental sexual dimorphism is not uniform across populations and varies due to genetic background and environmental influences. Numerous investigations have highlighted population-specific variations in tooth size and dimorphic expression, underscoring the need for regional odontometric data [13-16]. Consequently, population-based studies are essential for improving the reliability of dental sex determination, particularly in forensic and archaeological contexts where accurate identification of skeletal remains is required [17]. Despite the substantial body of evidence supporting the use of odontometric parameters for sex determination, most existing studies have been conducted in non-Bangladeshi populations, with considerable variation reported in the degree and pattern of sexual dimorphism across different ethnic and geographic groups. The applicability of odontometric standards derived from other populations to Bangladeshi individuals therefore remains uncertain. Moreover, limited data are available evaluating the combined predictive value of mesiodistal and buccolingual crown dimensions of multiple tooth types within a single regional adult population. Addressing this gap is particularly important for establishing population-specific reference data that can enhance forensic accuracy and anthropological relevance. The purpose of the study is to evaluate the correlation between tooth crown dimensions and sex determination in a Bangladeshi adult population.

OBJECTIVE

To evaluate the correlation between tooth crown dimensions and sex determination in a Bangladeshi adult population.

METHODS & MATERIALS

This cross-sectional observational study was conducted at the Department of Dentistry (OPD), Mugda Medical College and Hospital, Dhaka, Bangladesh, from April 2024 to March 2025. A total of 120 healthy adult participants, including 60 males and 60 females aged 18–25 years, were enrolled based on specific inclusion and exclusion criteria. Data were collected from the outpatient department to evaluate the correlation between tooth crown dimensions and sex determination in the Bangladeshi population.

Inclusion Criteria:

- Healthy adults aged 18–25 years.
- Fully erupted permanent dentition with intact maxillary and mandibular anterior and first molar teeth.

- Participants willing to provide informed consent.
- Individuals without a history of orthodontic treatment, prosthetic restorations, or significant dental trauma affecting crown morphology.

Exclusion Criteria:

- Teeth affected by dental caries, fractures, or significant wear altering crown dimensions.
- Teeth with restorations, crowns, or developmental anomalies.
- Participants with systemic conditions affecting tooth morphology.
- Non-compliant individuals or those unwilling to participate.

Informed written consent was obtained from all participants prior to enrollment. Demographic data, including age and sex, were recorded for each individual. Tooth crown dimensions were measured on six selected permanent teeth: maxillary central incisor, maxillary lateral incisor, maxillary canine, maxillary first premolar, mandibular canine, and mandibular first molar. Measurements were performed using a digital vernier caliper with 0.01 mm precision under natural light. The mesiodistal (MD) dimension was recorded as the maximum distance between the mesial and distal contact points, while the buccolingual (BL) dimension was measured as the maximum distance between the buccal and lingual surfaces perpendicular to the MD axis. Each measurement was recorded twice by the same examiner, and the mean value was used to minimize intra-observer variability. Data were analyzed using SPSS version 26.0. Descriptive statistics, including mean and standard deviation, were calculated for MD and BL dimensions of all teeth. Independent samples t-tests were used to compare measurements between males and females, and Cohen’s d was calculated to assess the magnitude of sexual dimorphism. Percentage sexual dimorphism was computed using standard formulas. The accuracy of sex prediction was determined by calculating the proportion of correctly classified individuals for each tooth. A p-value < 0.05 was considered statistically significant.

RESULTS

Table I presents the age distribution of the study participants, including 60 males and 60 females, with a mean age of 21.3 ± 2.0 years. No statistically significant difference in mean age was observed between males (21.4 ± 2.1 years) and females (21.1 ± 1.9 years) (p = 0.414).

Table - I: Demographic Characteristics of the Study Population (n = 120)

Variable	Male (n=60)	Female (n=60)	Total (N=120)	p-value
Mean age ± SD (years)	21.4 ± 2.1	21.1 ± 1.9	21.3 ± 2.0	0.414
Age range (years)	18–25	18–24	18–25	

Table II compares mesiodistal crown measurements of six selected teeth between sexes. Mean mesiodistal dimensions were consistently higher in males than females, ranging from

6.93–11.08 mm in males and 6.51–10.61 mm in females, with statistically significant differences (p < 0.001) and Cohen’s d values ranging from 0.71 to 1.03.

Table - II: Comparison of Mesiodistal Crown Dimensions (mm) Between Males and Females

Tooth	Male (Mean ± SD)	Female (Mean ± SD)	p-value	Cohen’s d
Maxillary central incisor	8.65 ± 0.41	8.29 ± 0.38	<0.001	0.91
Maxillary lateral incisor	6.82 ± 0.37	6.51 ± 0.35	<0.001	0.86
Maxillary canine	7.82 ± 0.42	7.41 ± 0.38	<0.001	1.03
Maxillary first premolar	7.15 ± 0.39	6.88 ± 0.36	<0.001	0.71
Mandibular canine	6.93 ± 0.39	6.58 ± 0.36	<0.001	0.92
Mandibular first molar	11.08 ± 0.59	10.61 ± 0.55	<0.001	0.82

Table III summarizes buccolingual crown dimensions, demonstrating significantly greater measurements in males (6.25–10.65 mm) compared to females (6.01–10.22 mm). All

comparisons were statistically significant ($p < 0.001$), with effect sizes (Cohen's d) ranging from 0.70 to 1.18.

Table – III: Comparison of Buccolingual Crown Dimensions (mm) Between Males and Females

Tooth	Male (Mean ± SD)	Female (Mean ± SD)	p-value	Cohen's d
Maxillary central incisor	7.12 ± 0.35	6.85 ± 0.33	<0.001	0.79
Maxillary lateral incisor	6.25 ± 0.32	6.01 ± 0.30	<0.001	0.77
Maxillary canine	8.15 ± 0.51	7.62 ± 0.45	<0.001	1.1
Maxillary first premolar	9.45 ± 0.48	9.12 ± 0.46	<0.001	0.7
Mandibular canine	7.68 ± 0.48	7.15 ± 0.42	<0.001	1.18
Mandibular first molar	10.65 ± 0.54	10.22 ± 0.51	<0.001	0.81

In Table IV, Percentage sexual dimorphism values ranged from 3.6% to 7.4% across the examined teeth. The highest dimorphism was observed in the mandibular canine

buccolingual dimension (7.4%), followed by the maxillary canine buccolingual (7.0%) and maxillary canine mesiodistal dimensions (5.5%).

Table – IV: Percentage Sexual Dimorphism of Selected Teeth Based on Crown Dimensions

Tooth	Mesiodistal (%)	Buccolingual (%)
Maxillary central incisor	4.3	3.9
Maxillary lateral incisor	4.8	4.0
Maxillary canine	5.5	7.0
Maxillary first premolar	3.9	3.6
Mandibular canine	5.3	7.4
Mandibular first molar	4.4	4.2

Table V shows sex prediction accuracy based on mesiodistal and buccolingual crown measurements, with classification accuracy ranging from 66.2% to 79.8%. Buccolingual

dimensions of the mandibular canine (79.8%) and maxillary canine (78.3%) demonstrated the highest predictive accuracy among all teeth examined.

Table – V: Accuracy (%) of Sex Prediction Using Tooth Crown Dimensions

Tooth	Mesiodistal Accuracy (%)	Buccolingual Accuracy (%)
Maxillary central incisor	70.2	68.5
Maxillary lateral incisor	69.8	68.9
Maxillary canine	74.8	78.3
Maxillary first premolar	66.7	66.2
Mandibular canine	73.5	79.8
Mandibular first molar	72.1	71.4

DISCUSSION

Sex determination plays a pivotal role in forensic identification and anthropological investigations, particularly when human remains are incomplete or fragmented. Tooth crown dimensions, owing to the structural durability of teeth and their resistance to post-mortem alterations, serve as reliable indicators for assessing sexual dimorphism. The findings of the present study demonstrate a clear and consistent association between tooth crown dimensions and sex, with males exhibiting significantly larger mesiodistal and buccolingual measurements across all examined teeth. These results highlight the practical value of odontometric analysis—especially canine crown dimensions—as an effective and population-relevant approach for sex determination in Bangladeshi adults, reinforcing the importance of dental parameters in forensic and biological profiling.

The demographic characteristics of the present study demonstrate a well-balanced distribution between male and female participants, with no statistically significant difference in mean age between sexes ($p = 0.414$). This age homogeneity minimizes potential confounding effects on odontometric measurements, thereby strengthening the validity of observed sex-related differences in tooth crown dimensions. Similar age-controlled designs have been employed in previous

odontometric investigations, including those by Da et al. and Mazumder et al., which ensured stability of adult dentition prior to measurement [17,18]. Da et al. reported consistent sexual dimorphism across all tooth crown measurements, particularly in canines and molars among adults from different ethnic groups [17], aligning with the controlled age distribution in the present Bangladeshi sample. Likewise, Mazumder et al. observed significantly larger mesiodistal canine dimensions in males across multiple ethnic cohorts ($p < 0.05$) [18], reinforcing the importance of minimizing age-related variability to accurately assess sex-based odontometric differences. These observations indicate that the comparable demographic structure of this study allows the observed differences in crown dimensions to be attributed primarily to sexual dimorphism in the Bangladeshi population.

The present study demonstrated that mesiodistal crown dimensions of all examined teeth were significantly larger in males than in females, with mean values ranging from 6.93 to 11.08 mm in males and 6.51 to 10.61 mm in females, and Cohen's d values indicating moderate to large effect sizes, particularly in the canines. These findings are consistent with Khangura et al., who observed that all permanent maxillary incisors and canines had larger mean mesiodistal dimensions in males, with the greatest statistical significance noted in

canines, supporting the strong dimorphic pattern identified in our study [19]. Similarly, Abbas et al. reported significantly greater mesiodistal measurements in both maxillary and mandibular canines among males ($p < 0.001$) [20], reinforcing our observation that canines exhibit the highest sexual dimorphism among permanent teeth. Collectively, these results underscore the utility of mesiodistal crown dimensions, particularly of canines, as reliable indicators for sex determination and highlight that patterns of odontometric sexual dimorphism are consistent across different ethnic populations, including the Bangladeshi sample examined here. The analysis of buccolingual crown dimensions revealed that males consistently exhibited larger measurements than females across all examined teeth, with mean values ranging from 6.25 to 10.65 mm in males and 6.01 to 10.22 mm in females, and Cohen's d values indicating moderate to large sexual dimorphism, particularly in the maxillary and mandibular canines. These results are in line with Uslu-Akcam et al., who reported significantly greater mesiodistal and buccolingual crown diameters in males, highlighting greater variability in buccolingual dimensions, similar to the pronounced BL differences observed in this study [21]. Likewise, Akad et al. found that in a young Iranian population, buccolingual measurements of permanent anterior teeth were generally larger in males, with the strongest dimorphism observed in maxillary canines [22], paralleling our findings of the highest BL effect sizes in canines. Overall, these observations support the reliability of buccolingual crown dimensions in detecting sexual dimorphism and emphasize the utility of canines as robust markers for sex determination in odontometric studies.

The percentage sexual dimorphism observed in the present Bangladeshi sample ranged from 3.6% to 7.4% across the examined teeth, with the highest dimorphism noted in the buccolingual dimensions of the mandibular canine (7.4%) and maxillary canine (7.0%), consistent with the established pattern of pronounced canine dimorphism. These findings align with Da et al., whose meta-analysis of over 6,000 individuals across multiple populations reported measurable sexual dimorphism in mesiodistal crown dimensions for all teeth, with canines and second molars exhibiting the largest differences (e.g., lower canines ~5.73%, upper canines ~4.72%) [17], reflecting magnitudes similar to those seen in the current study. Similarly, Shireen et al. found that buccolingual dimensions of permanent maxillary first molars exhibited higher sexual dimorphism (~3.57%) compared to mesiodistal dimensions (~1.92%), with male BL values consistently exceeding female values [23], paralleling our observation that buccolingual measurements tend to show slightly greater dimorphism than mesiodistal values. Collectively, these studies corroborate the pattern observed in the Bangladeshi population, confirming that canines and molars are particularly reliable indicators of sexual dimorphism and highlighting the importance of both mesiodistal and buccolingual measurements in odontometric sex determination.

The accuracy of sex prediction based on tooth crown dimensions in the present Bangladeshi sample ranged from 66.2% to 79.8%, with the highest predictive accuracy observed for the buccolingual dimensions of the mandibular canine (79.8%) and maxillary canine (78.3%), highlighting the utility of canines in odontometric sex determination. These results are consistent with previous studies demonstrating that linear tooth measurements can reliably classify sex with moderate to high accuracy. Ajmal et al., in a systematic review using CBCT, reported sex estimation accuracies ranging from

approximately 47.8% to 92.3% across populations and tooth types [24], confirming the general reliability of odontometric parameters for sex determination. Similarly, Paknahad et al. found that mandibular first molars provided 84% and maxillary first molars 77% accuracy in sex estimation using radio-odontometric measurements [25], which aligns with the 72.1% (MD) and 71.4% (BL) accuracies observed for first molars in this study. Furthermore, Tabasum et al. reported an overall sex prediction accuracy of ~70% using linear and diagonal molar measurements in a North Indian population [26], supporting the range of classification accuracies recorded in our sample. Collectively, these findings confirm that both mesiodistal and buccolingual crown dimensions serve as reliable predictors of sex, with canines and molars demonstrating particularly strong discriminatory power, underscoring their importance in forensic and anthropological applications within the Bangladeshi population.

LIMITATIONS OF THE STUDY

This study had some limitations:

- It was a single-center study. A larger, multi-center study is needed to reach more definitive conclusions.
- The study's limited geographic scope may introduce sample bias, potentially affecting the broader applicability of the findings.

CONCLUSION

In conclusion, sexual dimorphism in tooth crown dimensions is a well-recognized phenomenon that can be utilized for forensic and anthropological sex determination. In the Bangladeshi adult population, males consistently exhibited larger mesiodistal and buccolingual crown measurements across all examined teeth, particularly in the canines, which also showed the highest percentage dimorphism. Sex prediction using these odontometric parameters demonstrated moderate to high accuracy, with the buccolingual dimensions of mandibular and maxillary canines providing the most reliable discrimination between sexes. These findings confirm that both mesiodistal and buccolingual crown measurements, especially of canines, serve as robust indicators for sex determination, supporting their application in forensic and anthropological contexts in Bangladesh.

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Conflicts of interest

There are no conflicts of interest.

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