The use of canine dimensions as markers for sex estimation in biological profiling

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KEYWORDS

Dental Records, Dental Impressions, Mandibular Canine Index, Maxillary Canine Index, Mesiodistal Width, Intercanine Distance

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ABSTRACT

Forensic dentistry focuses on identifying individuals through distinctive characteristics of their dental structures. There is a lack of documentation of dental records in developing countries, particularly in Ghana. Therefore, the study aimed to generate detailed baseline data on the sexually dimorphic features of the canine tooth. A convenience sampling technique was employed to recruit a total of 280 participants (140 males and 140 females) aged 18-42 years. Ethical approval was obtained from the Committee on Human Research, Publications and Ethics, Kwame Nkrumah University of Science and Technology. Informed consent was sought from the participants. Dental impressions were made using alginate powder, and study models were prepared using dental stone. Measurements of right and left mesiodistal width of the mandibular and maxillary canines, and Intercanine distances were taken using Digital Vernier Calipers. The means of the Right and Left Mandibular, Maxillary Mesiodistal Widths, Intercanine Distances, and the Right Mandibular Canine index were sexually dimorphic. Binary logistic regression analyses showed that models employing the Right and Left Mandibular Mesiodistal Width, Mandibular Intercanine Distance, Maxillary Intercanine Distance, Right and Left Maxillary Mesiodistal Width, and Right Mandibular Canine Index were good and statistically significant in predicting sex. The best-performing model was the Left Maxillary Mesiodistal Width, which correctly predicted 65% of males and 67.9% of females, with an overall prediction accuracy of 66.40%. Microdont was the predominant tooth type for left and right maxillary canines, followed by mesodont and microdont among both sexes. The results of this study indicate sexual dimorphism, providing a baseline for further research. Canine dimensions, combined with other dental and skeletal indicators, can enhance the accuracy of sex estimation.

INTRODUCTION

The teeth and their dimensions appear to be the most accurate approach in sex estimation, since they are the most resilient and long-lasting component of the skeleton. The fact that the majority of teeth reach their full development before skeletal maturation makes them a valuable indicator of sex, particularly in young persons.[1] The alveolar processes of the maxilla and mandible contain the sockets that house the teeth.

Odontometric features are useful indicators in the estimation of sex.[2,3] Estimating sex is an important step in the identification of fragmented human remains in forensic anthropology. [4] The most stable teeth, the canines, exhibit the greatest degree of sexual dimorphism. The canine index and tooth measurements have thus been used exclusively in odontometric sex assessment. [5] The Mandibular and Maxillary Canine Indices are the ratio between the mesiodistal measurement of the mandibular and maxillary canine teeth and the lower intercanine distance, expressed as a percentage.[6,7] The size of the tooth is influenced by ethnic, cultural, environmental, and genetic factors. The largest dimension disparities are found in the mandibular canines, where males have larger teeth than females. This could be attributed to longer amelogenesis for both the temporal and permanent dentition, which results in bigger tooth crowns in males than in females.[8,9] Maxillary odontometric indices can be used to model crime scenes or other situations when the only available skull has a maxilla, establishing dimorphism[10]. According to a study by Gupta *et al* [11]in North India, males had significantly wider maxillary canines at the midline than females. The maxillary canine exhibited a higher degree of sexual dimorphism compared to the mandibular canine in a Japanese population and a Swedish population.[8] Dental records include clinical images, radiographs, dental casts, and the medical history of patients. Dental casts allow for highly accurate analysis of tooth size.[1] Dental practitioners in developed countries are required by law to keep and create sufficient patient records.[13] However, there are poor dental records practices and a dearth of data on the canine index as an identification tool in Ghana. There are differences in odontometric features in different populations. There is therefore a need for population-specific data. This study sought to generate detailed baseline data on the use of the canine index for identification among young adults in the Ghanaian population.

MATERIALS AND METHODS

Study Design and Area

The study design was quantitative and cross-sectional. This study was conducted from July 2023 to December 2024. A convenience sampling technique was employed to sample a total of 280 participants (140 males,140 females) aged 18-42 years. This age range was selected because canine eruption is completed by early adolescence. However, because minors cannot provide informed consent, the minimum age for participation in the study was set at 18 years. The study adhered to the Helsinki Declaration, and ethical approval was obtained from the Committee on Human Research, Publications Ethics, Kwame Nkrumah University of Science and Technology (KNUST), with reference number CHRPE/AP/131/23. Informed consent was sought from the students of KNUST, School of Medical Sciences.

Sample Size

A calculated sample size of 280 was used. The sample size was calculated via Yamane's formula (1967).

$$n = \frac{N}{1 + N(e)2}$$

Where n = sample size

N = study population

α = margin of error = 0.05; confidence level of 95% (Adam, [14])

Inclusion and Exclusion Criteria

Participants without anterior teeth spacing, a complete set of fully erupted teeth, noncarious teeth, nonattrited, intact teeth, satisfactorily aligned mandibular and maxillary teeth were included in the study. Participants with dental caries, teeth attrition, impacted canines, retained deciduous canines, morphologically altered teeth, developmental abnormalities of the jaws, crowded or excessive spacing in the anterior teeth, orthodontic treatment, and trauma to the canine teeth were all excluded from the study.

Data collection

- *Materials for data collection*
- Chromatic Hygedent (ISO 21563 EN 21563, ANSI ADA Standard Number 128, 454g, China)
- Dental mixing bowl (U -life, UYKWN0101, China)
- Perforated Aluminium dentulous dental impression (ITRLDPU4) trays, (GDC fine crafted Dental Pvt. Ltd, India)

- Dental stone, super hard Dental Plaster Gypsum powder (HTBR, HT-2308, HT-2309),25Kg, China)
- Shahe 5110-150 precision stainless steel 150mm IP54 Digital Vernier Caliper, China (Resolution of 0.01mm, accuracy ±0.02mm).
- Hospital Disposable Vinyl latex gloves, Dongguan Godetia Medical Supplies Technology Co., Ltd. (Dongguan City, Guangdong Province , China

Data collection procedures

The participants were seated on a dental chair and a clinical examination was performed using a mouth mirror and a probe. Alginate impressions of the mandibular and maxillary teeth were obtained using perforated metal trays, an alginate bowl, a kidney tray, and gloves. The alginate impression material (Chromatic Hygedent) was mixed with water according to the manufacturer's instructions. The mixed material was loaded onto perforated aluminium dentulous dental impression trays of appropriate sizes with large and extra-large mostly used. Each tray was then placed in the participant's mouth over the mandibular and maxillary dental arch, one at a time, to obtain the impressions. Once set, the mandibular and maxillary impressions were removed from the participants' mouths and disinfected with a hypodisinfectant. Dental stone powder was then mixed with water according to the manufacturer's recommended water-to-powder ratio and carefully poured into the mandibular and maxillary alginate impressions. The mixture was also poured onto a model base to create a flat surface for the final study models, facilitating accurate measurement of the canine teeth. The impressions, now embedded in the dental stone, were allowed to set and dry for at least four hours. Finally, the mandibular and maxillary dental casts were separated from the model base for subsequent study. Measurements of the canines were done using a Shahe Digital Vernier Caliper with a resolution of 0.01mm. The following measurements were taken from the study model of each participant: right and left mesiodistal width of the mandibular canine, right and left mesiodistal width of the maxillary canine, and Intercanine distance.

Measurements obtained from dental stone models may be subject to minor dimensional changes, such as shrinkage, expansion, or air entrapment. However, alginate impressions and stone casts are well-established and widely used in odontometric and forensic studies, and standardized protocols such as impressions were quickly poured using dental stone and vibration technique to minimize air bubbles and potential errors. Advanced digital imaging techniques such as intraoral scanners or Cone Beam Computed Tomography (CBCT) can further reduce measurement variability. However, such technologies have cost and accessibility implications in the study setting. To assess the reproducibility and precision of the measurements, fifty randomly chosen dental casts were measured. All measurements were performed by a single trained observer; therefore, interobserver reliability was not assessed. Intraobserver reliability was assessed using the intraclass correlation coefficient (ICC) based on a two-way mixed-effects model with absolute agreement. Excellent reliability was observed across all parameters, with ICC values ranging from 0.929 to 0.981:Right Mandibular Mesiodistal width (RMMW) 0.964 (95% CI: 0.937–0.979),Mandibular Intercanine Distance (MICD) 0.958 (95% CI: 0.928–0.976),Left Mandibular Mesiodistal Width (LMMW) 0.957 (95% CI: 0.926–0.976),Left Maxillary Mesiodistal Width (LMAMW) 0.959 (95% CI: 0.929–0.977), Maxillary Intercanine Distance (MAICD) 0.981 (95% CI: 0.967–0.989), and Right Maxillary Mesiodistal Width (RMAMW) 0.929 (95% CI: 0.878–0.959).

Mesiodistal width of the canine

The mesial and distal surfaces of the teeth were identified, and the distance between the crest of curvature on the mesial surface and the distal surface was measured with a Digital Vernier calliper (Shanghai, China), accurate to 0.01 mm. The mean mesiodistal widths of the left, right mandibular and maxillary canines in males and females were measured on the dental stone models (Figure 1).

Intercanine Distance

It was measured from the cusp tip of one upper canine to the cusp tip of the opposite canine for both mandibular and maxillary canines. The Vernier calipers were attached to the tips of the mandibular and maxillary canines (Figure 2).

Figure 1. A photograph showing the measurement of the maxillary mesiodistal width of a canine on a study model (x 0.5)

Figure 2. A photograph showing the measurement of mandibular intercanine distance of canines on a study model (x 0.5)

Observed Mandibular/Maxillary Canine Index (MCI)
The mandibular and maxillary canine indices were calculated by dividing the mesiodistal width of the canine by the Intercanine distance expressed as a percentage.

Mandibular/Maxillary Canine index

$$= \frac{\text{Mesiodistalwidthofcanine}}{\text{Intercaninedistance}} \times 100$$

Canine Index Classification
A novel method for classifying the tooth size was devised according to the indices obtained from the ratio of the canine dimensions.
Microdont (small-sized teeth): Canine index 1≤ 25.0
Mesodont (medium size tooth) Canine index 25.1-37.5
Megadont (large size tooth) Canine index ≥37.6

RESULTS

The age of the participants ranged from 18 to 42 years, with a mean age of 22.04 ± 3.41 years for males and 22.58 ± 3.72 years for females. The mandibular and maxillary canine dimensions are shown in Table 1. The mean values of the mandibular and maxillary mesiodistal widths were significantly higher in males than in females. All the canine dimensions exhibited sexual dimorphism ($p < 0.05$). The maxillary dimensions were numerically higher than the mandibular dimensions in both sexes. The mean values for the right mandibular mesiodistal width of the canine were 7.06 ± 0.53 mm for males, whereas females had 6.67 ± 0.53 mm. The left mandibular mesiodistal width of the canine tooth was 7.05 ± 0.56 mm for males and 6.67 ± 0.47mm for females. The mean values for the right maxillary mesiodistal widths were 7.76 ± 0.58 mm and 7.32 ± 0.54 mm for males and females, respectively. The maxillary intercanine distance was numerically higher than the mandibular intercanine distance. The mean maxillary mesiodistal width was numerically higher than that of the pooled mandibular mesiodistal width (Table 1).

Table 1. Independent samples T-test comparing mandibular and maxillary canine dimensions between males and females

Parameter	Sex	N	Mean ± SD (mm)	t	p-Value
Right Mandibular Mesiodistal Width	M	140	7.06 ± 0.53	6.37	<0.001
	F	140	6.67 ± 0.50		
Left Mandibular Mesiodistal Width	M	140	7.05 ± 0.56	6.22	<0.001
Mean Mandibular Mesiodistal Width	F	140	6.67 ± 0.47	7.07	<0.001
	M	140	7.06 ± 0.56		
	F	140	6.67 ± 0.42		

Right Maxillary Mesiodistal Width	M	140	7.76 ± 0.58	6.34	<0.001
	F	140	7.32 ± 0.54		
Left Maxillary Mesiodistal Width	M	140	7.75 ± 0.62	6.24	<0.001
Mean Maxillary Mesiodistal Width	F	140	7.33 ± 0.5	6.85	<0.001
	M	140	7.76 ± 0.56		
	F	140	7.32 ± 0.50		
Mandibular Intercanine Distance	M	140	27.84 ± 2.23	3.02	<0.001
	F	140	26.80 ± 2.06		
Maxillary Intercanine Distance	M	140	37.01 ± 2.50	4.45	<0.001
	F	140	35.35 ± 2.22		

mm= millimetres, SD= Standard Deviation, t= t-statistic; p= probability, statistically significant difference (p < 0.05), M = Male, F = Female

Paired Sample t-test was conducted to assess the significant difference between the means of the left and right mandibular, maxillary, and canine indices in both sexes. There was no significant difference between all the paired canine dimensions in both sexes. Paired dimensions were bilaterally symmetrical (Table 2).

The right and left mandibular canine indices were numerically higher than the right and left maxillary canine indices. The right mandibular canine index for males was 25.48 ± 2.33 mm and 24.83 ± 1.92 mm for females whereas the right maxillary canine indices recorded 20.97 ± 1.42 mm and 20.65 ± 1.62mm for males and females respectively (Table 2). The right mandibular canine index and the mean mandibular canine index were the only parameters that exhibited sexual dimorphism ($p < 0.05$). All the other canine indices were bilaterally symmetrical and sexually non-dimorphic (Table 3).

Table 2. Paired Sample T-Test of Right and Left Mandibular and Maxillary Canine Dimensions

Sex	Parameter	Mean CD ± SD (mm)	t	P-value	95% C.I Lower	Upper
Male	RMMW	7.05 ± 0.53	0.04	0.96	-0.07	0.07
	LMMW	7.05 ± 0.56				
	RMAMW	7.74 ± 0.56	-0.41	0.69	-0.09	0.05
	LMAMW	7.76 ± 0.58				
	RMCI	25.46 ± 2.34	0.08	0.93	-0.26	0.29
	LMCI	25.46 ± 2.42				
	RMACI	20.95 ± 1.41	-0.56	0.57	-0.26	0.14
	LMACI	21.01 ± 1.51				
	RMMW	6.67± 0.48	0.44	0.65	-0.05	0.07
	LMMW	6.66 ± 0.48				

Female	RMAMW	7.33 ± 0.55	-0.58	0.56	-0.09	-0.04
	LMAMW	7.34 ± 0.58				
	RMCI	24.80 ± 1.99	0.38	0.71	-0.19	0.28
	LMCI	20.72 ± 1.59				
	RMACI	20.67 ± 1.62	-0.50	0.61	-0.24	0.14
	LMACI	20.72 ± 1.59				

mm: millimetres, CD: Canine Dimensions; CI: Confidence Interval SD: Standard Deviation, t: t-statistic; p: probability, statistically significant difference (p < 0.05),RMMW: Right Mandibular Mesiodistal Width; MICD: Mandibular Intercanine Distance; LMMW: Left Mandibular Mesiodistal Width; RMAMW: Right Maxillary Mesiodistal Width; LMACI: Left Maxillary Canine Index; LMAMW: Left Maxillary Mesiodistal Width; RMCI: Right Mandibular Canine Index; LMCI: Left Mandibular Canine Index,; RMACI: Right Maxillary Canine Index ; LMACI; Left Maxillary Canine Index

Table 3. Independent Samples T-Test Comparing Canine Indices Between Males and Females

Parameter	Sex	N	Mean ± SD (mm)	t	p-Value
Right Mandibular Canine Index	M	140	25.48 ± 2.33	2.17	**0.03**
	F	140	24.83 ± 1.92		
Left Mandibular Canine Index	M	140	25.47 ± 2.42	1.80	0.07
Mean Mandibular Canine Index	F	140	24.83 ± 2.04	2.10	**0.03**
	M	140	25.47 ± 2.23		
	F	140	24.96 ± 1.81		
Right Maxillary Canine Index	M	140	20.97 ± 1.42	0.97	0.33
	F	140	20.65 ± 1.62		
Left Maxillary Canine Index	M	140	21.03 ± 1.52	1.82	0.07
Mean Maxillary Canine Index	F	140	20.70 ± 1.57	1.50	0.13
	M	140	21.00 ± 1.35		
	F	140	20.74 ± 1.45		

N= Number; mm= millimetres; SD= Standard Deviation, t= t-statistic; p= probability, statistically significant difference (p < 0.05), M = Male, F = Female

Binary logistic regression analyses were performed to assess the association between mandibular and maxillary dimensions, indices, and sex (Table 4). All predictor variables were statistically significant ($p < 0.05$) except for the right mandibular canine index, right, and left maxillary canine indices. Regression coefficients (B) ranged from 0.07 to 1.68, with standard errors between 0.05 and 0.28. Corresponding odds ratios (Exp(B)) ranged from 1.08 to 5.42. The strongest association was observed for Left Maxillary Mesiodistal Width (LMaMW) (B = 1.49, Exp(B) = 4.46). The binary logistic regression model was statistically significant, Omnibus Test of Model Coefficients ($p < 0.001$). The model demonstrated good fit to the data, evidenced by a non-significant Hosmer–Lemeshow test ($p = 0.435$), and explained approximately 19.6% of the variance in sex. LMaMW emerged as a strong and significant predictor, increasing the likelihood of male classification by more than fourfold. Although the overall classification accuracy was moderate (66.4%), the findings support the utility of LMaMW as a reliable odontometric parameter for sex estimation. Incorporation of additional dental variables may further enhance predictive performance (Table 5).

Table 4. Binary Logistic Regression Equations for sex prediction using Mandibular and Maxillary Dimensions

Logistic regression equations	B	S.E	Wald	P-value	Exp(B)
$\log_e (p/1-p)= -11.58 +1.68$ (RMMW)	1.68	0.287	34.63	< 0.01	5.42
$\log_e (p/1-p)= -5.87 + 0.22$(MICD)	0.22	0.058	13.76	< 0.01	1.24
$\log_e (p/1-p)= 10.10+ 1.47$ (LMMW)	1.47	0.272	29.36	< 0.01	4.36
$\log_e (p/1-p)= -10.83 + 0.29$ (MaICD)	0.29	0.057	27.66	< 0.01	1.35
$\log_e (p/1-p)= = -9.17 +1.21$(RMaMW)	1.21	0.23	27.68	< 0.01	3.35
$\log_e (p/1-p)= -11.26 +1.49$ (LMaMW)	1.49	0.251	35.38	< 0.01	4.46
$\log_e (p/1-p)= -3.16+ 0.13$ (RMCI)	0.13	0.059	4.53	0.03	1.13
$\log_e (p/1-p) = -3.79+ 0.10$ (LMCI)	0.10	0.056	3.15	0.07	1.10
$\log_e (p/1-p= -1.60 + 0.07$(RMaCI)	0.07	0.07	0.93	0.33	1.08
$\log_e (p/1-p)= -3.03 + 0.14$ (LMaCI)	0.14	0.08	3.25	0.07	1.15

RMMW: Right Mandibular Mesiodistal Width ; MICD: Mandibular Intercanine Distance; LMMW: Left Mandibular Mesiodistal Width; RMaMW: Right Maxillary Mesiodistal Width; LMaCI: Left Maxillary Canine Index; LMaMW: Left Maxillary Mesiodistal Width; RMCI: Right Mandibular Canine Index; LMCI: Left Mandibular Canine Index; RMaCI: Right Maxillary Canine Index ; LMaCI; Left Maxillary Canine Index ; S.E: Standard Error; p = probability, statistically significant difference ($p < 0.05$);B: regression coefficient; Exp(B) : Exponent of Beta (Odds ratio)

Table 5. Classification Accuracy of Binary Logistic Regression Models for Mandibular and Maxillary Dimensions

Predictor	Correctly classified Males (%)	Correctly classified females (%)	Overall Correctly classified (%)
RMMW	62.1	70.0	66.1
MICD	55.7	61.4	58.6
LMMW	61.4	63.6	62.5
RMaMW	62.9	62.9	62.9
MaICD	65.7	65.7	65.7
LMaMW	65.0	67.9	66.4
RMCI	56.4	56.4	56.4
LMCI	51.4	57.1	54.3
RMaCI	53.6	96.7	58.6
LMaCI	56.4	53.6	55.0

%: Percentage**;** *RMMW: Right Mandibular Mesiodistal Width; MICD: Mandibular Intercanine Distance; LMMW: Left Mandibular Mesiodistal Width; RMaMW: Right Maxillary Mesiodistal Width; LMaCI: Left Maxillary Canine Index; LMaMW: Left Maxillary Mesiodistal Width; RMCI: Right Mandibular Canine Index; LMCI: Left Mandibular Canine Index; RMaCI: Right Maxillary Canine Index ; LMaCI; Left Maxillary Canine Index*

Microdont was the most dominant tooth type for right maxillary indices for both sexes**.** Males and females recorded 49.46% and 49.82% respectively. A few participants, 0.36% recorded mesodont for both sexes. None of the participants recorded the megadont tooth type (Figure 3). Left Maxillary canine index was predominantly microdont; females recorded 50% whereas males recorded 49.29%. Only a few of the males (0.71%) had the mesodont tooth type (Figure 4). For the right mandibular canine index, mesodont was the most predominant tooth type, males and females recorded 30.4% and 23.08% respectively. Microdont was the commonest tooth type in females (26.74%) whereas males had 19.78%. Megadont tooth type was not recorded. (Figure 5). For the Left Mandibular Canine index, mesodont was the commonest tooth type in males (27.27%) whereas microdont was the most predominant tooth type in females (26.91%). Only a few (0.36%) of males were megadont (Figure 6).

Figure 3. A bar graph showing the right maxillary indices of both sexes

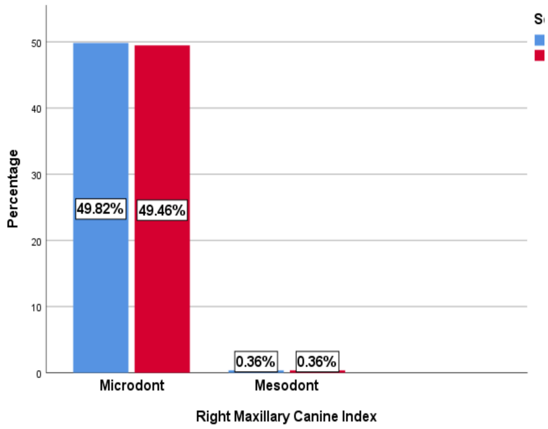


Figure 4. A bar graph showing the left maxillary canine indices of both sexes

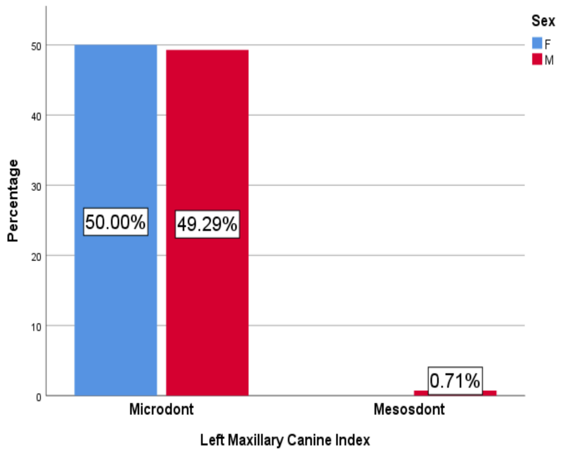


Figure 5. A bar graph showing the right mandibular canine indices of both sexes

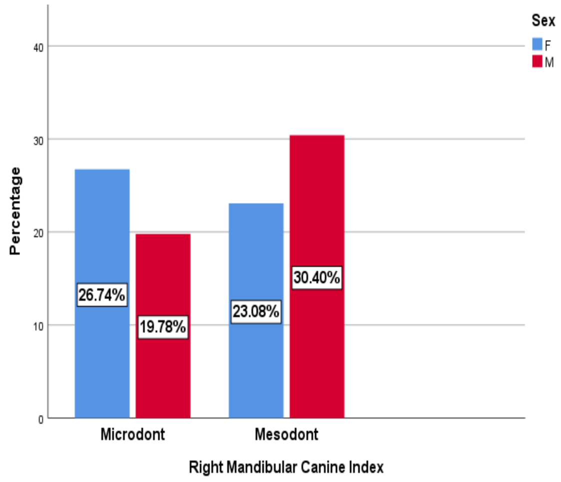
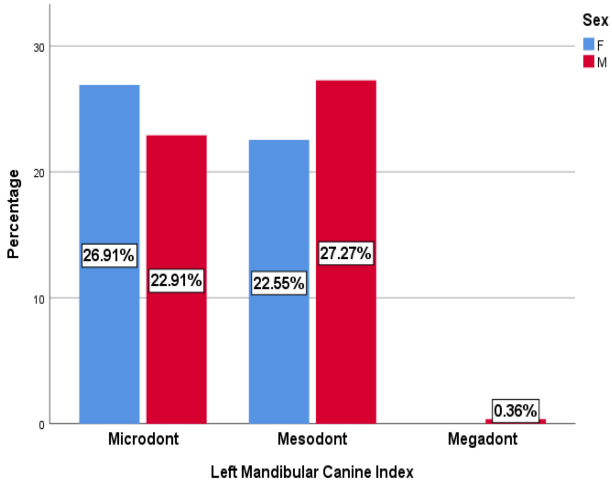


Figure 6. A bar graph showing the left mandibular canine indices of both sexes



DISCUSSION

The young age range in this study was chosen to reduce age-related tooth wear and changes in tooth shape. Sex estimation through dental morphometrics, especially mesiodistal (MD) tooth widths, is a well-known method in forensic anthropology and human anatomy due to the durability of dental tissues and their genetically controlled growth patterns. Odontometric sexual dimorphism refers to the noticeable difference in tooth size between males and females, with males usually having larger teeth. This trend is linked to sex-related growth hormones and hormonal effects during tooth development (Banerjee *et al.* [15]). In this study, the average mandibular and maxillary mesiodistal widths were significantly greater in males than in females ($p < 0.05$). Several past studies have shown similar patterns of sexual dimorphism across different populations in South Asia, the Middle East, and Africa. This aligns with findings in studies from Egypt, Nepal, India, and Nigeria (Awwad [16]; Bajracharya *et al.*[17]; Gandhi *et al.*[18]; Jain and Kuriakose [19]; Nuhu *et al.*[20]; Otuaga *et al.*[21]; Rani [22]). It is also supported by reports from Karaman [23] in Turkey, Kapila *et al.* [2] in South India, Rani [22] among the Nalgondian population in India, as well as Zirahei [7] among Kogi Polytechnic students in Nigeria, and Edibamode *et al.* [24] among the Ijaw ethnic group in Nigeria, where a significant difference between males and females was observed in the canine teeth. This may be due to males having more developed chewing systems than females, as confirmed by Ates *et al.* [25], who noted that males tend to consume more meat than females.

Similar studies by Rajarathnam *et al.* [12] and Vishwakarma and Guha [26] asserted that the sexual dimorphism of the mandibular and maxillary mesiodistal widths could be due to genetic variables and amelogenesis which make the X chromosome of males hold 90% of the genetic code for ameloglobin, and the Y chromosome holds the remaining 10% and that leading to longer enamel creation, which leads to larger canine size in males than that of females. Moreover, during the early bell stage, enamel knots form on the cusp of tooth development, controlled by activators and inhibitors prior to calcification. The gene that regulates the expression of activators and inhibitors affects the rate and amount of enamel deposition. Some teeth can be dimorphic across both sexes due to genetic influences (Mazumder *et al.*[27]). On the contrary, the mean mesiodistal width of mandibular and maxillary canines was not sexually dimorphic for the Saudi Arabian population [28]. The variation in mesiodistal widths of both sexes could be a result of the narrow age range of 15-18 years, Moire's topography, and Fourier's analysis in the previous study, as opposed to 18 - 42 years and the use of vernier calipers in the present study.

The statistical thresholds used in different studies all affect the results. Some conflicting results can be explained by the fact that smaller or heterogeneous samples do not detect considerable dimorphism, but larger, well-standardized samples typically do.

In contrast, other similar studies by Boaz and Gupta *et al.* [29] in South India, Alanazi *et* al.[30] in Saudi Arabia, Acharya and Mainali [31] among the Nepalese population, reported the reverse dimorphism of mandibular and maxillary mesiodistal widths. These findings could be related to evolution leading to a reduction in sexual dimorphism, generating an overlap of tooth dimensions in males and females.

The maxillary dimensions were numerically higher in both sexes than the mandibular dimensions in this study. Maxillary growth is influenced by complex interactions, including nasal cavity development, paranasal sinus expansion, and midfacial skeletal growth, which results in a broader and longer maxillary dental arch than the mandible (Jacobson [32]). Transverse maxillary dimensions are further influenced by functional variables, such as masticatory muscle activity (He *et al.* [33]). From an evolutionary perspective, the maxillary arch has adapted to accommodate a broader occlusal table, improving masticatory efficiency in humans (Lieberman [34]). This confirms the work of Zirahei [7], who indicated that maxillary canines were the most sexually dimorphic due to their high rate of survival.

The mean values of the mandibular and maxillary intercanine distance of the present study were sexually dimorphic. This is similar to what was reported by Parekh *et al.* [35] in the Gujarat population and Gupta *et al.*[11], where there was a statistical significance between males and females. Multiple factors, including genetic determinants, hormonal impacts, skeletal growth patterns, masticatory function, and evolutionary adaptation, contribute to sexual dimorphism in mandibular and maxillary intercanine distance. Due to increased transverse jaw growth and skeletal robusticity caused by testosterone and hereditary variables linked to the Y chromosome, males usually exhibit noticeably larger intercanine lengths (Ajmal *et al.* [36] ; Herrera-Escudero *et al.*[37]).

The right mandibular canine index and the mean mandibular canine index were the only canine indices in this study that exhibited significant differences between both sexes. This aligns with earlier findings of Parekh *et al.* [35] among the Gujarat population, where sexual dimorphism was observed in the mandibular canine index. In contrast, Gupta *et al.*[11] in the North Indian population observed no sexual dimorphism for right and left maxillary canine indices.

Binary logistic regression analyses showed that the best model for sex prediction was the left mandibular mesiodistal width. The left mandibular mesiodistal width could correctly predict 65.0% males and 67.9% females, with an overall prediction of 66.4%. This moderate accuracy indicates that canine dimensions alone may not be sufficiently reliable as a sex estimation tool and should ideally be used in conjunction with other skeletal or dental indicators. Meanwhile, the findings of Kumawat *et al.* [38] in Central India, where the mandibular canine index showed sex prediction accuracy of 81.33 % males and 78 % females, with an overall prediction accuracy of 79.66%. The observed differences in prediction accuracies could be attributed to race, differences in sample size, and age group.

The Right Mandibular Canine Index of the present study could predict 56.4% of males, 56.4% of females, with an overall prediction accuracy of 56.4%. A related study by Mohsenpour *et al.*[1] predicted sex using right mandibular canine index recorded accuracies; 44% for males and 62% for females, with an overall accuracy of 53%. However, the Left mandibular canine index sex prediction accuracy in this study was 54% for males and 64% for females, with an overall accuracy of 59%. Mohsenpour *et al.*[1] also reported prediction accuracies of 54% for males, 64% for females, with an overall prediction accuracy of 59% for the left mandibular canine index.

Microdont was the commonest tooth type for right and left maxillary canine indices for both sexes**.** For the right mandibular canine indices, mesodont was the most predominant, whereas microdont and mesodont were the most frequent tooth types for Left Mandibular Canine Indices. Tooth size can be influenced by nutritional status during development. Undernutrition and environmental stresses during tooth growth can decrease overall tooth dimensions.

CONCLUSION

Mandibular and Maxillary mesiodistal widths of the canine tooth exhibited sexual dimorphism. The mandibular canine indices were numerically higher than the maxillary canine indices. However, only the right mandibular canine index exhibited sexual dimorphism. The Left mandibular mesiodistal width was the best predictor of sex. Microdont was the predominant tooth type for both sexes. Canine dimensions alone may not be sufficiently reliable as a sex estimation tool and should ideally be used in conjunction with other skeletal or dental indicators.

LIMITATIONS

- A University-based population may limit full generalizability to the wider Ghanaian population.
- Participants' age range of 18–42 years, with a mean age in the early twenties, may limit generalizability of the study.
- Although measurements obtained from dental stone models may be affected by minor dimensional changes such as shrinkage, expansion, or air entrapment, standardised procedures during impression making, model preparation, and measurement were employed to minimise these potential errors.

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