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Sex Determination by Metric Analysis of Coronoid and Mental Breadth of the Mandible – Nigerian Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aim: This research aimed at investigating the applicability of linear measurements of Bicoronoid (BRB) and Bimental Breadth (BMB) of mandible in sex determination in four geo-political zones in Nigerian.
Study Design: A cross-sectional descriptive study was adopted for this research.
Place and Duration of Study: Anthropometric data were obtained from adult mandibles from selected medical schools across four geo-political zones in Nigeria from January to June 2021.
Methodology: 52 males and 30 females mandibles were used for this study. Bicoronoid Breadth (BRB) and Bimental Breadth (BMB) were measured using vernier caliper and data analyzed using SPSS IBM version 23.0.

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Results: Descriptive analysis of BRB and BMB showed higher mean values for males 98.25mm and 45.79mm than females 90.99mm and 44.03mm respectively. Independent t-test analysis of the parameters showed significant sexual difference at 95% confident interval. The discriminant function analysis sufficiently discriminated sex and after cross-validation, BRB accurately predicted 82.7% males and 53.3% females while BMB accurately predicted 84.6% males and 26.7% females.
Conclusion: Bicoronoid and Bimental breadth measurements of mandible are recommended for sex determination in forensic investigation due to its role in sexual dimorphism.

Keywords: Measurement; bicoronoid; bimental breadth; mandible; sex; forensic investigation.

1. INTRODUCTION

Identification of human in any society is critical in forensic, social and personal purposes [1]. The forensic means have several methods for identifying individual [2]. Conclusive methods, such as fingerprinting, iris reading, DNA etc are very important, but in situations where the body remains is in an advanced state of putrefaction or when only bone fragments are available, anthropometric data becomes equally important as many methods are no longer an option. In such case, the evaluation of the skeleton often becomes the only alternative to obtain the identification of the deceased [3,4]. This circumstance underscores the relevance of the classical anthropological examinations in building a biological profile in terms of age, sex, ancestry, and stature which is fundamental in the human identification process.

Sex determination of bone is a very important part of study in Anthropology and Forensic science and can be achieved through morphological and metric methods. It is the first step involved in the development of any biological profile as it provides a better understanding of other elements such as the determination of stature and age at death [5]. In human sex identification, the pelvic and cranial bones are highly reliable; however, in the absence of the pelvic bones, analysis of the mandible may be the best alternative due to its strong sexual dimorphism [6,7].

The mandible is a moveable, U-shaped bone that forms the chief articulating segment of the skull [8]. It is one of the bones of the face considered to be the largest and hardest facial bone, that commonly resist post mortem damage and forms an important source of information on sexual dimorphism [8,9,10]. Measurements of the mandible are important not only to address surgical or clinical issues, but also to answer forensic questions of age, sex and stature estimation or to characterize different populations [11,12]. The advantage of metric analysis is that it eliminates subjectivity in the analysis of morphological characteristics, increasing confidence in the results [13]; and data obtained can easily be compared with other studies [14]. According to Rai and Kaur [15], sex of an unknown individual can be determined based on the data from the morphology and metric features of skull and mandible. Morphologically, male mandibles are large with prominent muscular markings and are slightly more robust than the female mandibles [16,17,18]. They are further distinguished by chin shape, gonial (angle) appearance and gonial flare [17].

Previous studies on sex determination in different populations using the mandible [7,19-25] emphasized the need for population specific standards to be set because standards for sex determination valid for one population may not be useful for another [17,26]. In this study, Bicoronoid and Bimental Breadth measurements of mandible were considered as indicators for sex determination and the study aimed to determine the efficacy of these parameters in sex determination among Nigerians.

2. MATERIALS AND METHODS

This research involved 82 (52 males and 30 females) dry adult mandibles obtained from medical institutions across four geo – political zones (South – South, South – East, North Central and South – west) in Nigeria. The mandibles used were first categorized into male and female using non-metric (morphological) parameters; viz:

.i. Gonial flare - everted in males but inverted in females.
ii. Chin shape - square in males but rounded or pointed in females.
iii. Angle appearance: In males the lateral aspect of the mandibular angle shows rough appearance while in females it is comparatively smooth.

iv. Size: Male mandibles are robust, larger, and broader while female mandibles are slender and smaller [27,28].

This categorization was done on the basis where at least three traits clearly suggested a particular sex.

Data were collected from mandibles that satisfied the inclusive criteria.

Each bone was carefully inspected to ascertain that they were in good shape from the knowledge of their anatomy before they were selected for the study. Pathological, deformed, damaged, or broken bones were excluded to avoid errors in measurement and only firmly and properly ossified bones with evidence of complete dentition were included.

Two parameters were measured from each mandible using digital venire caliper as described by Vinay et al.; Maria et al. [18,29].

1. **Bicoronoid Breadth:** The straight horizontal distance between the lateral points on the two coronoid processes (*coronion)*; measured using digital vernier caliper (Fig. 2).
2. **Bimental Breadth:** The straight distance between the most inferior points on the margin of the mandibular mental foramen; measured using digital vernier caliper (Fig. 3).

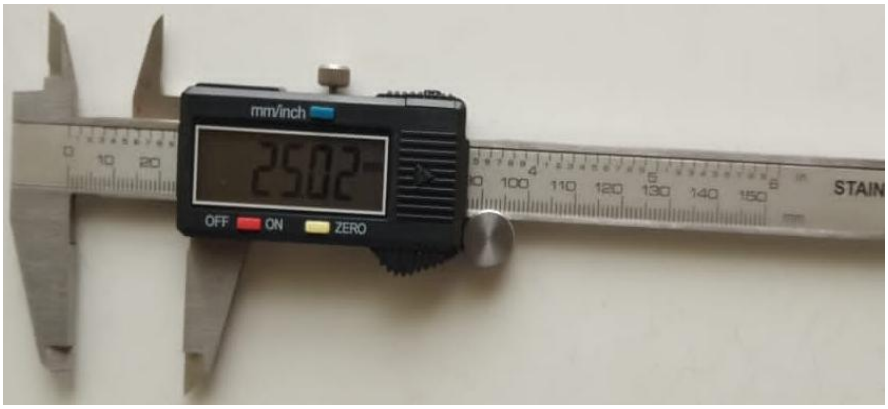

Fig. 1. Digital vernier caliper

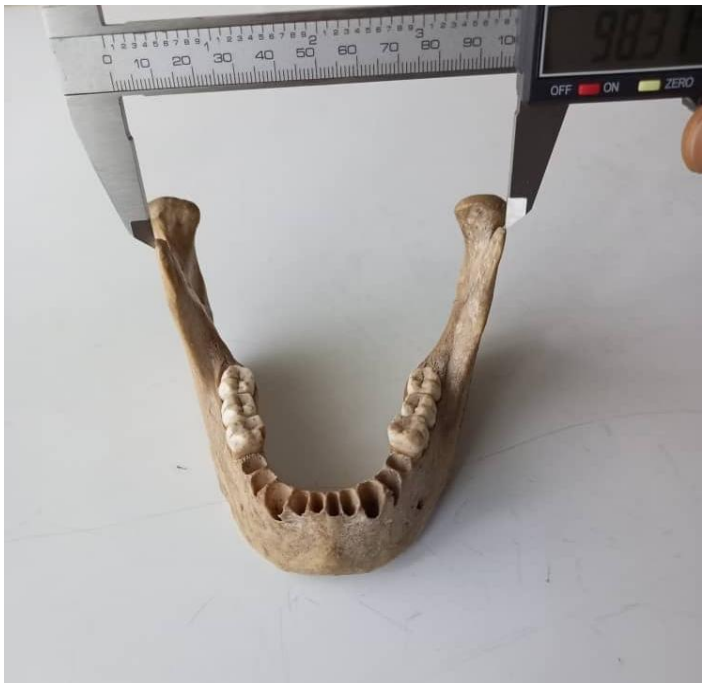

Fig. 2. Bicoronoid breadth measured using digital vernier caliper (mm)

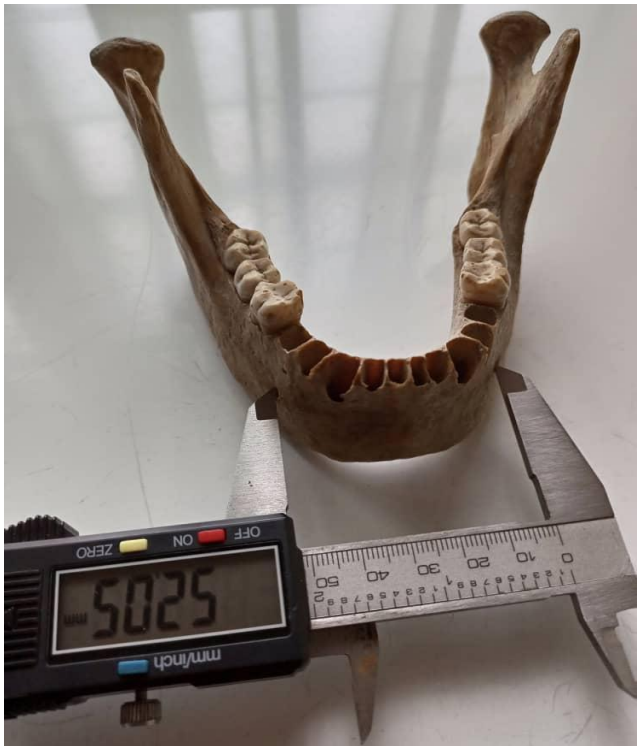

Fig. 3. Bimental breadth measured using digital vernier caliper (mm)

Data collected were analyzed using Statistical Package for the Social Sciences (SPSS IBM version 23.0) Mandibular parameters were expressed as mean $\pm$ SD (cm) in descriptive statistics Independent sample t-test was done to test for sexual dimorphism. Discriminant function analysis was used to discriminate sex. Confidence interval was set at 95%, and therefore $p < .05$ was considered significant.

3. RESULTS

Table 1 shows result for Descriptive statistics of mandibular parameters Males were seen to have higher mean values than females in both measured parameters. Bicoronoid breadth (BRB) has a mean value higher in males (98.25 mm) than in females (90.99 mm) in this study. Males 9.53 cm: female 9.13 cm in central Indian Population [30] and 95.63 mm: 80.45 mm in Brazilian population [31]. Bimental breadth (BMB) has a mean value higher in males (45.79 mm) than in females (44.03 mm) in this study. Thais et al., [31] also recorded higher value in males (45.34 mm) than in females (43.63 mm) for Brazilian population.

Table 2 shows the results for the assessment of sexual dimorphism.

All p-values are less than .05 indicating the presence of significant sexual difference in both measured parameters of the mandible.

Table 3 shows the accuracies resulting from the univariate analysis. This analysis sufficiently discriminate sex. Wilks' lambda is a measure of how well each function discriminate (separates) cases into groups. The smaller the value of Wilks' lambda the greater the discriminatory ability of the function. The table reveals that BRB has a smaller Wilks' lambda value of 0.77 meaning that BRB has a greater discriminatory ability than BMB. The table also show that BRB accurately predict 82.7% males, 53.3% females; while BMB accurately predict 84.6 males and 26.7 females. Discriminant function equation for each of the parameters of the mandible was developed as:

$$Y = 0.16\ (BRB) + (-\ 14.98) \qquad \text{(eqn 1)}$$

$$Y = 0.36\ (BMB) + (-\ 16.23) \qquad \text{(eqn 2)}$$

Where y = discriminant function score.

For each of the equation, a positive y-value will indicate a male mandible and a negative y-value will indicate a female mandible.

Table 1. Descriptive statistics of mandibular parameters (mm)

Mandibular parameters	Male [N = 52]			Female [N = 30]			Total [N = 82]		
	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD
BRB	83.90	110.43	98.25±6.68	80.71	106.45	90.99±5.82	80.71	110.43	95.59±7.25
BMB	38.49	51.12	45.79±3.11	40.26	48.55	44.03±2.08	38.49	51.12	45.15±2.89

N *= Number of Specimen,* ***Min*** *= Minimum,* ***Max*** *= Maximum,* ***SD*** *= Standard Deviation,* ***BRB*** *= Bicoronoid Breadth,* ***BMB*** *= Bimental Breadth*

Table 2. Independent t-test for male and female mandibular parameters

Mandibular Parameters	MD	SEM	95% C.I of the Difference		df	t-value	p-value
			Lower	Upper			
BRB	7.25	1.46	4.34	10.16	80.00	4.96	**0.00***
BMB	1.76	0.57	0.62	2.91	78.12	3.06	**0.00***

MD *= Mean Difference,* ***SEM*** *= Standard error of mean difference,* ***C.I*** *= Confidence Interval,* ***BRB*** *= Bicoronoid Breadth,* ***BMB*** *= Bimental Breadth, * = significant at p < 0.05*

Table 3. Univariate discriminant function analysis

Variables	Unstandardized coefficient	Structure matrix	Wilk's lambda	Centroids		Original accuracy (%)		Cross validation accuracy (%)	
				Male	Female	Male	Female	Male	Female
BRB	0.16	1.00	**0.77***	0.42	-0.72	82.7	53.3	82.7	53.3
Constant	-14.98								
BMB	0.36	1.00	**0.91***	0.23	-0.40	86.5	26.7	84.6	26.7
Constant	-16.23								

4. DISCUSSION

The demand to statistically present data to prove a point in tribunals has made the use of metric method in sex determination gain popularity and increasing importance. This study evaluated two metric parameters of the mandible in order to document its role in sexual dimorphism in Nigerian population.

In the current research, for each parameter, the male mean values were greater than the female mean values. This is consistent with research conducted in Central Indian population and Brazilian population [30,31]. The values in this study show that the mean BRB values for male and female mandibles in Nigerian population were larger than that of Brazilian population whereas the mean value for Nigerian males was higher than that of Central Indian males but the females value was lower than that of Central Indian females.

The two parameters measured on the mandibles of Nigerian population showed significant sex differences between males and females, indicating that the mandible is sexually dimorphic in this population. Therefore, the discriminant function equations derived from these parameters may be used for sex determination (Table 3). Similar conclusions were cited in other works [31,32]. However, Kanchankuma reported no statistically significant sexual difference in BRB [32].

The discriminant function equation developed from BRB in this study accurately predicts 82.7% of males and 53.3% of females in this population whereas Bertsatos et al., [33] reported accurate sex prediction of 65.6% in Athens Greece. Similarly, equation developed from BMB accurately predicts 84.6% of males and 26.7% of females whereas Bertsatos et al., [33] reported 64.7% accuracy of sex prediction in Athens Greece.

5. CONCLUSION

The Bicoronoid and Bimental breadth of the mandible are reliable parameters for sex determination in Nigerian population. Both parameters showed significant sexual difference. The discriminant equation derived from BRB and BMB effectively discriminated sex though BRB was shown to be a better discriminator with higher predictability accuracy.

ETHICAL APPROVAL

Ethical approval was sought for and obtained prior to the commencement of the study from the research Ethics Committee of University of Port Harcourt with approval voucher number UPH/CEREMAD/REC/MM67/010 dated November 22nd, 2019.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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