Original Research Article

Discriminant Function Analysis of Mandibular Condyle and Notch for sex Determination.

.

ABSTRACT

Aim: This research aimed at deriving discriminant function equation from Bicondylar Braedth (BCB) and mandibular Notch Breadth (MNB) for sex determination.

Study design: A cross-sectional descriptive study was adopted for this research.

Place and Duration of Study: BCB and MNB measurements were obtained from 13 universities across South – South, South – East, North Central and South – west geo – political zones in Nigeria from January to June 2021.

Methodology: BCB and MNB were measured from 52 males and 30 females mandibles using vernire caliper. Data obtained were analyzed using SPSS IBM version 23.0.

Results: Descriptive analysis of BCB showed higher mean values for males 115.46mm compared to females 107.78mm; while MNB showed a higher mean value for females 25.00mm compared to males 24.41mm. Independent t-test analysis of the parameters showed BCB had significant sexual difference while MNB did not show significant sexual difference at 95% confident interval. The discriminant function analysis of BCB well discriminated sex and after cross-validation, BCB accurately predicted 82.7% males and 56.7% females but MNB could not discriminate sex..

Conclusion: BCB is a reliable parameter for sex determination which is fundamental in forensic investigation whereas MNB is not suitable for sex determination.

Keywords: (*measurement, bicondylar, Mandibular notch Breadth, mandible, Sex, determination).*

INTRODUCTION

The large concentrations of people of mixed age, origin, sex and stature suggest that in the event of mass disaster, explosions, collapsed buildings and fatal automobile accidents there will be an increased number of victims, resulting in the need for the remains to be separated and identified. Sex determination is one of the ‘‘big four” (identifying age, sex, stature and ancestry or race) of forensic anthropology. It is the first task for forensic experts in Identification of cases where bodies are damaged beyond recognition, followed by age and stature estimation as both are sex dependent [1,2,3]. Generally, the stature of skeleton elements are good morphological indicators of sexual dimorphism in more than 95% of cases, but in mass disasters only some bones fragments are found making it difficult to obtain correct diagnosis [4,5]. Previous studies done by Rosing FW,[3] Saini V *et al.*,[6] Hu KS *et al.*,[7] Scheuer L,[8] and Raj JD *et al.,*[9] revealed that pelvis and skull bones are the most reliable source for sex determination, providing accuracy more than 92% [6]. But in the absence of pelvis bones or non-intact skull bones, the mandible becomes a source and plays a major role in sex determination and is considered most dimorphic, more durable, largest, and strongest bone of skull [6,7,10,11]

Previous studies on the mandible in different populations [11,12,13,14,15,16,17,18] 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[19,20]. Therefore, this study seeks to derive discriminant equation from Bicondylar Breadth (BCB) and Mandibular Notch Breadth (MNB) and determine their efficacy in sex determination in Nigerian population.

MATERIAL AND METHODS

52 males and 30 females dry adult mandibles were used for this study. These mandibles obtained from 13 universities across South – South, South – East, North Central and South – west geo – political zones in Nigeria. The mandibles were first identified and categorized into male and female using four morphological parameters namely: Chin shape, Angle appearance, Gonial flare and Size. Each mandible was categorized when at least three traits clearly suggested a particular sex.

Measurements were obtained from mandibles that satisfied the inclusive criteria such as firm and properly ossified non – broken mandibles with evidence of complete dentition.

Two parameters were measured from each mandible using digital venire caliper as described by Singh *et al.*[21] Maria *et al.*[22].

1. Bicondylar breadth: the straight horizontal distance between the most lateral points on the two condyles; measured using digital vernier caliper (fig 1).
2. Mandibular notch breadth: straight distance from the condylion superoanterior point to the coronion superoposterior point; measured using digital vernier caliper (fig 2).

Figure 1: Bicondylar breadth measured using digital vernier caliper (mm)

Figure 2: Mandibular Notch 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±SD (cm) in descriptive statistics Independent t-test was done to test for sex difference. Discriminant function analysis was carried out for sex discrimination. Confidence interval was set at 95%, and therefore $P < .05$ was considered significant.

RESULTS

Table 1 shows result for Descriptive statistics of mandibular parameters. The mean value for BCB was higher in Males than females, but higher in females than males for MNB.

Table 2 shows the results for the assessment of sexual difference. BCB had P-value of .00 which is less than .05 showing significant sexual difference while MNB had P-value of .39 which is higher than .05 indicating no significant sexual difference.

Table 3 shows the unstandardized discriminant function coefficients, constants, Wilk's lambda, centroids and accuracy rates for each of the two parameters involved in the discriminant function analyses. Discriminant function equation for each of the parameters of the mandible was developed as:

Y = 0.14 (BCB) + (- 15.58) - - - - - - - (eqn 1)

Y = 0.34 (MNB) + (- 8.33) - - - - - - - (eqn 2)

Where y = discriminant function score.
A discriminant function score greater than 0.000 indicates male mandible and less than 0.000 indicates female mandible. This analysis provides a sectioning points from which it is possible to determine sex from a single numeric value. Wilks' lambda is a measure of how well each function separates cases into groups. The smaller the value of Wilks' lambda the greater the discriminatory ability of the function. The analysis shows a significantly smaller Wilks' lambda value of 0.79 for BCB. This implies that BCB has a greater discriminatory ability compare to MNB whose value 0.99 cannot discriminate sex. This sequence of discriminatory ability by Wilks' lambda values agrees with the percentage predictability (Cross validation accuracy) which shows that BCB had accuracy prediction of 82.7% males and 56.7% females whereas MNB showed a poor sex prediction of 98.1% males and 0.0% females; hence not suitable for sex determination in Nigerian population.

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
BCB	100.84	129.80	115.46±7.12	92.71	120.82	107.78±7.42	92.71	129.80	112.65±8.09
MNB	16.45	31.15	24.41±3.21	18.84	29.97	25.00±2.45	16.45	31.15	24.62±2.95

N = Number of Specimen, Min = Minimum, Max = Maximum, SD = Standard Deviation, BCB = Bicondylar Breadth, MNB = Mandibular Notch 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			
BCB	7.68	1.66	4.38	10.98	80.00	4.63	**0.00***
MNB	-0.59	0.68	-1.94	0.76	80.00	-0.87	0.39

MD = Mean Difference, SEM = Standard error of mean difference, C.I = Confidence Interval, BCB = Bicondylar Breadth, MNB = Mandibular Notch 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
BCB	0.14		**0.79***	0.39	-0.67	82.7	56.7	82.7	56.7
Cons	-15.58								

tant									
MNB	0.34	1.00	0.99	-0.07	0.13	100.0	0.0	98.1	0.0
Constant	-8.33								

BCB = Bicondylar Breadth, MNB = Mandibular Notch Breadth. * = significant at P < 0.05

DISCUSSION

This study evaluated two metric parameters of the mandible in order to derive and document a discriminant function equation for sex determination in Nigerian population.

The mean value for bicondylar breadth (BCB) was higher in males (115.46 mm) than in females (107.78 mm) in this study. This is consistent with researches conducted in Northern Thailand population (Ongkana and Sudwan (2009), Southern Indian population (Vinay *et al.*, (2013), Central Indian Population (Kanchankumar *et al.*, (2015), Western Indian population (Kallalli *et al.*, (2016) and Brazil (Thais *et al.,* (2017) ; where mean values were reported to be higher in males than in females. 12.38 cm for males 11.61cm for females in Northern Thailand population; 11.34 cm for males, 10.82 cm for females in Southern Indian population; 11.43 cm for males, 10.76 cm for females in Central Indian Population; 9.94 cm for males, 8.75 cm for females in Western Indian population and 116.7 mm for males, 111.1 mm for females in Brazil.
This study shows that the mean BCB value for male mandibles in Nigerian population is larger than that of Indian population but less than that of Northern Thailand and Brazilian population. Similarly, the mean BCB value for female mandibles in Nigerian population is larger than that of Central Indian population and Western Indian population but less than that of Southern Indian population, Brazilian population and Northern Thailand population. The difference in mean between Nigerian population and other population may exist because of hormonal and environmental factors which can affect bone growth Balci *et al.,* (2005). This underscores the necessity for population specific standards. There is statistically significant difference in BCB values of male and female mandible; therefore, BCB is statistically sexually dimorphic. This findings agrees with studies Ongana and Sudwan (2009), Kharoshah *et al.,* (2010), Vinay *et al.,* (2013), Sikka and Jain (2016), Kumar and Yuvaraj (2016), Kallali *et al.,* (2016) and Thais *et al.,* (2017); but disagree with the work of Kharoshah *et al.,* (2010) conducted among modern Egyptian population which showed no significant sexual dimorphism. BCB accurately predict 82.7% males and 56.7% females in this population; whereas Bertsatos *et al.,* (2019) reported 65.8% accurate prediction of sex in Athens Greece; while Wankhede *et al.,* (2015) reported 75.6% accuracy in Central India.

The mean value of MNB in this study is lower in males (24.41 mm) than in females (25.00 mm); but Thais *et al.,* (2017) reported a higher mean value for males (32.62 mm) than in females (30.85 mm). This study and the one conducted in Brazil by Thais *et at.*, (2017) revealed no significant sexual difference in MNB of males and females mandibles. This implies that MNB is not suitable for sex determination.

CONCLUSION

This research derived discriminant function equations for sex determination. The discriminant equation derived from Bicondylar Breadth (BCB) of the mandible effectively discriminated sex but that of Mandibular Notch Breadth (MNB) could not discriminate sex. BCB showed significant sexual difference while MNB did not show significant sexual

difference. Therefore, BCB is a reliable parameter for sex determination in Nigerian population; whereas MNB is not suitable for sex determination.

ETHICAL APPROVAL

Ethical approval was sought for and obtained from the research Ethics Committee of University of Port Harcourt prior to the commencement of this research.

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