

**GENDER DETERMINATION USING ROBUSTNESS INDEX OF THE CLAVICLE IN SOUTH-SOUTH AND SOUTH EAST ADULT NIGERIANS*****¹Benwoke Ihunwo I. W.**

Department of Human Anatomy, PAMO University of Medical Sciences, Port Harcourt, Rivers State, Nigeria.

***Corresponding Author: Benwoke Ihunwo I. W.**

Department of Human Anatomy, Pamo University of Medical Sciences, Port Harcourt, Rivers State, Nigeria.

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ABSTRACT

The clavicle of human body is a long bone placed horizontally. It has two ends, sternal and acromial end and a shaft which is curved with a forward convexity in its medial two third and a forward concavity in its lateral one third. It is one of the bones which is used for gender determination especially in cases where only skeletal remains are available for forensic identification. The gender determination of the individual is a primary criterion of identification but this is a very difficult problem and becomes even more challenging when only a single bone like the clavicle is available. Osteometric indices are determined by applying formulae based on measurements. This study was carried out to assess the accuracy of the robustness index of the clavicle in gender determination in Nigerian population. In the present study the robustness index of the clavicle was calculated from already measured parameters (length and mid-shaft circumference) to determine gender in Nigeria population (40 Nigerian south-south and south East clavicles 25 males and 15 females). Data were analyzed using statistical package for social science (IBM version 23) and p-values ≤ 0.05 was considered significant. From the result, mean robustness index of right male clavicle was 25.54 ± 1.99 and left was 24.49 ± 2.45 . The mean robustness index of right female clavicle was 22.65 ± 1.22 and left was 22.00 ± 1.28 . From the result, the mean of the robustness index was significantly higher in males ($p < 0.001$). Again the RI was higher on the right side for both clavicle for both males and females. Gender can be predicted or determined with a high degree of accuracy, even when only the clavicle is available. This can be very useful in sex determination in cases of explosions, plane crashes, decomposed and mutilated bodies.

KEYWORDS: Clavicle, Gender determination, accuracy, males, females.**INTRODUCTION**

Determinations of gender from human skeletal remains have always involved forensic workers, anthropologists, anatomists and students. Several works have been done on the skeleton as a whole as well as an individual bone. Though the pelvic bones show sexual dimorphism to a greater degree than any other bone, the human clavicle also shows dimorphism to an extent. Determination of gender of deceased is stress-free when a complete skeleton is available for examination.^[1] The pelvis, skull and the round head of ball joint provides fair means for gender determination.^[2,3] Thus, gender can also be determined from the remains of long bone with 95% accuracy. The female clavicle is shorter, thinner, less curved and smoother, and its acromial end is carried lower than the sternal end in comparison with the male. In males the acromial end is on a level with, or slightly higher than the sternal end. Robustness index of the clavicles have been studied by many authors in different population in an attempt to determine gender.^[4,5,6] Osteometric Indices are determined by applying formula based on measurements and provides an insight into morphology. From these studies their results showed statistical significance for gender determination ($P < 0.05$)

using Robustness index of the clavicle, the males had higher mean values compared to the females.^[4,5,6] Hence the present study was carried out to assess the reliability of the robustness index of the clavicle as an indicator in gender determination from Nigerian population.

MATERIALS AND METHODS

A total of 40 clavicles extracted from adult human bodies of known sex (25 males and 15 females) of right and left clavicles were sourced from Anatomy Departments of the following Universities: University of Port Harcourt Rivers State, Igbinedion University, Okada, Ambros Ali University Ekpoma Edo State and Nnamdi Azikiwe University, Akwa, Anambra State. Selections were specifically bodies ascertained to be adult with age ranging from 25-70 years; clavicles with complete ossification, normal morphology were included in the present study. Bone showing deformity, degradation and fracture were excluded.

Parameters measured before calculating the robustness index of the clavicle: Maximum length of each clavicle was measured in millimeters using a vernier caliper.

Measurement was taken from sternal to acromial ends (Fig. 1).



Figure 1: Measurement of the length of the clavicle.

Mid-shaft Circumference of Clavicle: To measure the mid-shaft Circumference of the clavicle, a mark was done with a pencil at the middle distance between two

ends of clavicle. At this mid-point, circumference was measured in millimeters with a calibrated narrow strip of graph paper (Fig. 2).



Figure 2: Measurement of the mid-shaft circumference of the clavicle.

Thus the Robustness index was calculated using the formula;

$$\frac{\text{Mid - shaft circumference}}{\text{Maximum length of clavicle}} \times 100$$

Data Analysis

The statistical analysis was performed using SPSS (IBM) ® Version 23.0; SPSS, Inc., Chicago, IL) and XLSTAT

(Version 2015) Statistical packages. Continuous Variables were presented in mean (S.D). Paired sample t-test was used for side comparison while student t-test was used to determine sex-differences. Confidence interval was set at 95% with significance of the difference accepted at $P \leq 0.05$.

RESULTS

The results presented were measurement of the robustness index (RI) of the clavicle, tables were used to represent and compare mean values for the males and the females clavicles. The descriptive characteristics comparison of gender, side differences in the mean values were represented in Tables 1-3. Table 4 shows comparison of mean value in the present study with other studies.

The mean \pm (S.D) values obtained for right and left clavicle were 25.54 ± 1.99 and 24.49 ± 2.45 for males (M) and 22.65 ± 1.22 and 22.00 ± 1.28 for females (F) respectively.

The result in Table 1 was based on 40 cadaveric measurement of the clavicle comprising of 25 males and 15 females. The evaluation of the interpredictability of both sides of the clavicle was presented in Table 1 with categorization into total as well as sex specific relationships. The RI of the right and left clavicle were significant with positive correlation for the male and females. For the male clavicle, the RI was significant with correlating value (R vs L RI; $r=0.970$, $P<0.001$), while the female value was (R vs L volume; R Vs L RI; $r=0.870$, $p<0.001$). The side-specific sex differences illustrated in Table 2 showed significant morphometric asymmetry in RI. The mean difference in RI of males and females were (M): (M.D= 1.05 . [L<R], $P<0.001$.), (F): (M.D = 0.65 . [L<R], $P=0.001$). However, the t-test showed that values were significantly higher in males than females ($P<0.001$), for right and left clavicle: (R) (M.D \pm S.E.D= 2.89 ± 0.57 , $t=5.076$, $P<0.001$), The left clavicle (L) (M.D \pm S.E.D= 2.49 ± 0.69 , $t=3.639$, $P<0.001$), (Table 3a and b).

Table 1: Descriptive characteristics and inter-predictability of the clavicle (side).

Parameters	Total (N=40)			Male (N=25)			Female (N=15)		
	Mean±S.D	r	P-value (Inf.)	Mean±S.D	r	P-value (Inf.)	Mean±S.D	r	P-value (Inf.)
R. Length (mm)	143.88±10.6	0.442	0.001 (S)	146.96±12.05	0.995	<0.001 (S)	136.13±7.20	0.994	<0.001 (S)
L. Length (mm)	148.86±9.39			149.08±11.79			137.60±6.99		
R. Mid-shaft circumference (mm)	36.47±4.17	0.354	0.012 (S)	37.43±4.14	0.882	<0.001 (S)	30.93±1.65	0.963	<0.001 (S)
L. Mid-shaft circumference (mm)	33.10±4.35			35.90±4.68			30.22±1.58		
R. Robustness index	24.85±2.17	0.737	<0.001 (S)	25.54±1.99	0.970	<0.001 (S)	22.65±1.22	0.870	<0.001 (S)
L. Robustness index	23.35±2.38			24.49±2.45			22.00±1.28		

Note: R = Right, L = Left, N = Distribution, S.D = Standard deviation, r = Pearson's correlation, P-value = Probability value, Inf = Inference (S = Significant, NS = Not Significant).

Table 2: Side difference evaluation using paired sample t-test.

Parameters	Total (N=40)				Male (N=25)				Female (N=15)			
	Mean	S.D	t-value	P-value	Mean	S.D	t-value	P-value	Mean	S.D	t-value	P-value
R. Vs L Length (mm)	-4.98	10.29	-3.423	0.001 (S)	-2.12	1.27	-8.354	<0.001 (S)	-1.47	0.83	-6.813	<0.001 (S)
R. Vs L Mid-shaft circumference (mm)	3.37	4.85	4.920	<0.001 (S)	1.52	2.21	3.444	0.002 (S)	0.71	0.45	6.174	<0.001 (S)
R. Vs L. Robustness index	1.50	1.66	6.637	<0.001 (S)	1.05	0.72	7.281	<0.001 (S)	0.65	0.64	3.953	0.001 (S)

Note: F-value = Fisher's calculated value, EVA = Equal variance assumed, Inf. = Inference, EVNA = Equal variance not assumed, df = degree of freedom, t-value = t-test calculated value, P-value = Probability value, M.D = Mean difference, S.E.D = Standard error of the difference, C.I = Confidence interval, S = Significant, NS = Not Significant.

Table 3a: Evaluation of the sex difference in right clavicular parameters using student t-test.

Parameter	Levene's Test for Equality of Variances			t-test for Equality of Means					
	F-value	P-value	Inf	Df	M.D	S.E.D	t-value	P-value	Inf.
R. Length (mm)	2.53	0.120	ENA	38	10.83	3.44	3.150	0.003	S
R. Mid-shaft circumference (mm)	8.623	0.006	EVNA	34.273	6.50	0.93	6.987	<0.001	S
R. Robustness index	1.211	0.278	ENA	38	2.89	0.57	5.076	<0.001	S

Table 3b: Evaluation of the sex difference in left clavicular parameters using student t-test (cadaveric measurement).

Parameter	Levene's Test for Equality of Variances			t-test for Equality of Means					
	F-value	P-value	Inf.	df	M.D	S.E.D	t-value	P-value	Inf.
L. Length (mm)	2.241	0.143	ENA	38	11.47	3.36	3.416	0.002	S
L. Mid-shaft circumference (mm)	15.129	0.000	EVNA	32.016	5.69	1.02	5.565	<0.001	S
L. Robustness index	3.402	0.073	ENA	38	2.49	0.69	3.639	0.001	S

Note: F-value = Fisher's calculated value, EVA = Equal variance assumed, Inf. = Inference, EVNA = Equal variance not assumed, df = degree of freedom, t-value = t-test calculated value, P-value = Probability value, M.D = Mean difference, S.E.D = Standard error of the difference, Inf = Inference (S = Significant, NS = Not Significant).

Table 4: Comparison of mean robustness index of male and female clavicle in the present study with other studies.

Authors	Population	Male		Female	
		Right	Left	Right	Left
Olivier (1951)	France	25.00	25.00	23.9	22.9
Jit and Singh (1966)	Amritsar zone	24.78	25.33	22.82	22.78
Shoba (2010)	India-North Karantaka	26.25	25.82	23.28	22.88
Present Study	Nigeria	25.54	24.49	22.65	22.00

DISCUSSION

Measurement of most human bones indicates that males most times have greater values than females. This is also the same for the clavicle as evident in the present study and previous studies. Many authors around the world has shown substantial evidence that in most anthropometric measurement parameters like length, mid-shaft circumference and robustness index are greater in males than females.^[4,5,6,7,8,9,10,11,12,13,14,15] Comparison of the findings in this study with that of other populations, confirms the existence of gender differences between various groups studied. This study was done to scientifically generate mean value of clavicle dimensions using Robustness index of adult Nigeria especially in south-south and south-East population by osteometric (cadaveric) method.

The mean value of the Robustness index for the male right clavicle was 25.54. This value was slightly higher than the values obtained by Jit and Singh (1966) 24.78^[16] and Olivier (1951) 25.00^[6] but lower than that of Shobha (2010) 26.25.^[7] The female value of 22.65 in the present study for the female right clavicle was lower than the values obtained by Shobha (2010) 23.28,^[7] Jit and Singh (1966) 22.82^[16] and Olivier (1951) 23.90.^[6] The value of the male left clavicle in the present study was 24.49 which was slightly lower than the values obtained by Shobha (2010) 25.82,^[7] Jit and Singh (1966) 25.33,^[16] and Olivier (1951) 25.00.^[6] The value obtained for the female left clavicle in the present study was 22.00 this was slightly lower than that of Shobha (2010) 22.88, Jit and Singh (1966) 22.76, and Olivier (1951) 22.90. In the present study, the mean values of the Robustness index for males were found to be higher than that of females. The mean difference for the male right clavicle compared to the female right was 2.89, while that of male left compared to the female left was 2.49. These findings conform to the results from other scholars that the Robustness index of the male clavicles was higher than that of the females. This difference in the present study was found to be statistically significant for sex determination ($P < 0.001$).

CONCLUSION

Gender can be predicted or determined with a high degree of accuracy, even when only the clavicle is available. This can be very useful in gender determination in cases of explosions, plane crashes, decomposed and mutilated bodies. From this study, it is therefore recommended that further work be carried out on various population with emphasis on ethnic and ancestral difference as it will contribute immensely to the field of anthropology.

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