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Determination of sex from clavicular and scapular parameters from normal posteroanterior chest radiographs of adults in Bayelsa State, Nigeria

Johnbull T.O. and Onyema N.C.

ABSTRACT

Background and aim: Identification of sex from human remains has been an imperative aspect in forensic anthropology. This can be achieved from bony structures such as the scapular and clavicle which has shown to be sexually dimorphic. This study evaluated the anatomy of the scapular and clavicular parameters of adults in Bayelsa State using normal anterioposterior chest radiographs.

Methods: A total of 500normal chest radiographs of Males (n=250, mean age 40.5±0.9) and females (n=250, mean age 40.7±0.9) were used for this study. The parameters studied were length of right and left clavicle, thickness of right and left clavicle; height of right and left scapular; and width of right and left scapular.

Results: The results showed that males had longer and thicker clavicles than females. Similarly, scapula measurements (Height and Width) were larger in males than females. P-value for TRC and HRS were p<0.05 indicating statistical significance. There were also differences within genders, with left clavicles and scapulas being slightly larger than their right counterparts.

Conclusion: The present study confirmed sex dimorphic characteristics of the measured parameters of the clavicle and scapula in normal chest radiographs of adult population in Bayelsa state in different age levels.

Keywords:

Sex identification; Clavicle; Scapula; Radiograph; Bayelsa; Nigerians

The identification of the sex of skeletonized or

Sex identification is crucial in forensic

anthropology for identifying individuals from

skeletal remains (Singh & Chavali, 2011). It may decrease the potential matches of unidentified

persons by fifty percent, specifically categorizing

them as either male or female, instantaneously

Most anthropological techniques for addressing

ambiguous identity situations have been

formulated for application on dried bones and, at

a minimum, necessitate a forensic examination;

yet, in most cases, these bodies are very intact. In

such cases, it may be a simple process to

commence identification operations utilizing

fingerprints, ocular verification, distinctive

physical traits, dental records, or previous

medical interventions as supporting evidence.

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INTRODUCTION

(DiGangi & Moore, 2012).

dismembered human remains is the initial phase in bioarchaeological and forensic anthropological Submitted: 29th January, 2025 inquiries. Biological anthropologists or forensic Revised: 6th March, 2025 experts typically employ "morphological" or Accepted: 30th March, 2025 "classical" techniques, which produce 95-100% Published: 31st March, 2025 accuracy in sex determination (Derya et al., 2010).

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Occasionally, an individual may be excessively decomposed for these approaches to be effective, or ante-mortem medical and/or dental data may be insufficient, inaccessible, or challenging to find. Consequently, any method that enables a swift, straightforward, and costeffective determination of sex is of paramount significance. This study specifically focuses on the determination of sex in forensic circumstances using chest radiographs (McCormick et al., 1985).

Numerous discriminant functions have been developed utilizing metric analysis of sexual dimorphism across various human skeletal elements, including the skull (Mahakkanukrauh et al., 2016), sternum, scapula (Peckmann et al., 2017), clavicle (Kaewma et al., 2017; Ungchittrakool & Sinloyma, 2018), radius (Jongmuenwai et al., 2021), carpal bones (Barnes рt al.. 2020) and hand phalanges (Mahakkanukrauh et al., 2013), among others. Nonetheless, the integration of many parameters is intriguing and will improve the precision of sex determination, such as that derived from the scapula and clavicle. Some authors (Frutos 2002;

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Koukiasa *et al.,* 2017) indicated that the combined analysis of scapular and clavicular measurements may yield a precise assessment of sex.

Most anthropological techniques for addressing ambiguous identity situations have been formulated for application on dry skeletal remains and, at a minimum, necessitate a partially or completely defleshed corpse. Although all individuals necessitating a forensic investigation are in various stages of decomposition, in most cases, these bodies remain pretty intact. Nevertheless, on certain occasions, an individual may be excessively degraded to effectively employ these tactics. Consequently, any method that enables a swift, straightforward, and cost-effective determination of sex is of paramount significance.

In circumstances of natural or man-made disasters, genocides or accidents where direct or positive identification of the victim is difficult, there is need for an accurate, timely, simple and inexpensive method for sex determination. For the purpose of identifying the victims, one of such method that has proved reliable is the use of high-resolution chest radiographs (McCormick *et al.*, 1985).

Because there are no reference values for identification of sex from clavicular and scapular parameters using normal chest radiographs for the people of Bayelsa State, Nigeria, hence the need for this current study. This study also aims to ascertain if these parameters are sexually dimorphic and can be used as a tool for sex identification in this population

MATERIALS AND METHODS

Ethical Clearance

Ethical approval was obtained from the institutions ethical committee before the commencement of this study (FMCY/REC/ECC/2024/MARCH/728).

Study population

This retrospective study of 500 (250 males & 250 females) normal adult posterioanterior chest radiographs certified normal by the Radiologist were used from the Federal Medical center and Tobis Clinic and Consultants in Yenagoa, Bayelsa State, Nigeria.

Inclusion Exclusion criteria

Radiographs were from adult males and females aged 18 to 80 years with no deformity, fracture or degeneration were used while radiographs showing any pathology like degenerative disease, fracture; and bones showing incomplete ossification were excluded from this study.

Methodology

Length of Clavicle: The maximum length of each clavicle was measured in millimeters (mm) from sternal end to acromial end by ignoring the curves of the bone. Mid-shaft Thickness of Clavicle: By bisecting the entire length using compass and measure the thickness (superior to inferior border) of the clavicle at that level in millimeter (mm) using ruler.

Maximum Scapular Height: Maximum distance between the highest point of the superior angle (Medial angle and the lowest point of the inferior angle was measured in millimeter (mm) using rule.

Maximum Scapular Width: The maximum distance between the longitudinal axis of the glenoid cavity and the medial border of the scapular was measured using ruler in millimeter (mm), as described by Ozer *et al.* (2006).

Statistical Analysis

The data were expressed as mean \pm standard deviation. All the variables measured in males and females were tested for significant differences. Data analysis was carried out using statistical package for social sciences version 22.0 software (IBM Corporation, Armonk New York, USA) P-value less than 0.05 (p < 0.05) was considered significant.

RESULTS

The above results presented in table1 indicate that in almost all the parameters studied, the value of males is significantly greater than that of females except that of the thickness of the left clavicle (TLC) where there was no significant difference between males and females.

Results from table 2 above shows the measured values of the length of the right and left clavicle of males and females in all age groups studied. In both the LRC and LLC, male values are significantly higher than those of the females across all age groups.

Table 3 indicates the values of the thickness of the right and left clavicle in males and females in this study population amongst all age groups. It shows that in all age groups the male parameters are higher than that of females. Although it is noteworthy of mention that the TLC of male and female among all age groups doesn't show statistically significant difference in values.

Table 4 shows the comparison of the height of the right and left scapula in males and female across all age groups in this study population. The result indicates that there is considerable difference in male and female parameters across all age groups although not statistically significant.

Table 5 is about the measured values of the scapula width (right and left) across all ages in both males and females in our study population. The result shows no statistical significant difference in males and females across all age groups studied. The parameters for the left scapular width are generally greater than those of the right in both males and females.

Table 1: Comparison of all parameters between males and remain
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Tuble 1. companion of	an parameters between males and	lemaies		
Parameter	Male	Female	P-Value	
LRC	161.28 ± 5.56	145.32 ± 4.58	0.01	
TRC	17.67 ± 1.51	14.61 ± 1.18	0.02	
LLC	162.31 ± 5.40	146.12 ± 4.49	0.01	
TLC	17.31 ± 1.23	16.39 ± 1.49	0.31	
HRS	181.24 ± 6.01	162.28 ± 5.36	0.01	
WRS	82.36 ± 3.19	98.58 ± 5.16	0.01	
HLS	183.24 ± 4.59	164.96 ± 5.20	0.02	
WLS	93.05 ± 2.65	82.45 ± 2.31	0.01	

KEY:-LRC= Length of Right Clavicle; TRC= Thickness of the Right Clavicle; LLC= Length of Left Clavicle; TLC= Thickness of the Left Clavicle; HRS= Height of Right Scapula; WRS= Width of Right Scapula; HLS= Height of Left Scapula; WLS= Width of Left Scapula.

Table 2: Comparison of the Length of Right & Left Clavicle (LRC & LLC)) between males and females based on age groups

Age Groups	Males(LRC)	Females(LRC)	P-Value	Males(LLC)	Females(LLC)	P-Value
(Years)	(Mean±SD)	(Mean±SD)		(Mean±SD)	(Mean±SD)	
	(Mm)	(Mm)		(Mm)	(Mm)	
18 – 25	159.91 ± 6.25	145.04 ± 7.01	0.06	161.71 ± 5.42	145.40 ± 5.46	0.07
	(n=34)	(n=29)		(n=34)	(n=29)	
26 – 35	161.03 ± 5.05	145.31 ± 4.73	0.15	161.68 ± 4.96	145.87 ± 4.63	0.10
	(n=75)	(n=79)		(n=75)	(n=79)	
36 – 45	162.00 ± 4.84	145.40 ± 4.05	0.04	162.42 ± 5.06	146.27 ± 4.53	0.06
	(n=48)	(n=55)		(n=48)	(n=55)	
46 – 55	160.78 ± 4.72	145.25 ± 3.27	0.06	161.98 ± 4.67	146.08 ± 3.43	0.06
	(n=56)	(n=50)		(n=56)	(n=50)	
56 – 65	161.54 ± 6.77	146.05 ± 3.60	0.07	162.28 ± 7.41	146.89 ± 3.77	0.06
	(n=22)	(n=23)		(n=22)	(n=23)	
66 - 80	164.76 ± 8.20	144.63 ± 5.45	0.06	167.82 ± 5.49	147.24 ± 5.94	0.05
	(n=15)	(n=14)		(n=15)	(n=14)	

n = number of individuals in each specific age group.

Table 3: Comparison of the Thickness of the Right & Left Clavicle (TRC & TLC) between males and females based on age groups.

Age Groups	Males (TRC)	Females(TRC)	P-Value	Males(TLC)	Females(TLC)	P-Value
(years)	(Mean±Sd)	(Mean±Sd)		(Mean±Sd)	(Mean±Sd)	
	(mm)	(mm)		(mm)	(mm)	
18 – 25	17.24 ±1.55	14.4 ±1.28	0.63	16.37± 1.46	17.38± 1.78	0.62
	(n=34)	(n=29)		(n=34)	(n=29)	
26 – 35	17.48 ±1.53	14.4 ±1.16	0.08	16.30 ±1.31	17.18± 1.53	0.79
	(n=75)	(n=79)		(n=75)	(n=79)	
36 – 45	18.02 ±1.46	14.73 ± 1.26	0.06	16.42 ±1.11	17.55± 1.28	0.81
	(n=48)	(n=55)		(n=48)	(n=55)	
46 – 55	17.60 ±1.23	14.73 ± 1.04	0.13	16.40 ±1.20	17.54 ±1.35	0.59
	(n=56)	(n=50)		(n=56)	(n=50)	
56 – 65	17.63 ±1.50	14.64 ± 0.91	0.79	15.67 ±1.01	17.35 ±1.71	0.61
	(n=22)	(n=23)		(n=22)	(n=23)	
66 - 80	18.70±1.95	14.50 ±1.61	0.58	16.52±0.91	17.47 ±1.52	0.54
	(n=15)	(n=14)		(n=15)	(n=14)	

n = number of individuals in each specific age group.

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Age Groups	Males(HRS)	Females(HRS)	P-Value	Males(HLS)	Females(HLS)	P-Value
(years)	(Mean±SD)	(Mean±SD)		(Mean±SD)	(Mean±SD)	
	(mm)	(mm)		(Mm)	(Mm)	
18 – 25	180.37 ± 7.75	160.47 ± 7.44	0.49	183.20 ± 4.52	166.25 ± 6.36	0.51
	(n=34)	(n=29)		(n=34)	(n=29)	
26 – 35	181.38 ± 5.38	162.23 ± 4.82	0.56	182.95 ± 4.18	164.26 ± 4.60	0.63
	(n=75)	(n=79)		(n=75)	(n=79)	
36 – 45	181.62 ± 4.91	162.45 ± 4.77	0.64	183.52 ± 4.10	165.11 ± 5.40	0.49
	(n=48)	(n=55)		(n=48)	(n=55)	
46 – 55	181.65 ± 5.99	163.51 ± 5.44	0.62	183.31 ± 5.21	165.05 ± 5.27	0.53
	(n=56)	(n=50)		(n=56)	(n=50)	
56 – 65	180.19 ± 6.17	162.75 ± 1.64	0.59	181.72 ± 5.94	164.16 ± 1.88	0.50
	(n=22)	(n=23)		(n=22)	(n=23)	
66 – 80	181.40 ± 8.06	160.59 ± 8.00	0.60	185.78 ± 2.67	166.64 ± 7.80	0.58
	(n=15)	(n=14)		(n=15)	(n=14)	

n = number of individuals in each specific age group.

Table 5: Comparison of the Width of Right & Left Scapula (WRS & WLS) between males and females based on age groups.

Age Groups	Males(WRS)	Females(WRS)	P-Value	Males(WLS)	Females(WLS)	P-Value
(years)	(Mean±SD)	(Mean±SD)		(Mean±SD)	(Mean±SD)	
	(Mm)	(Mm)		(Mm)	(Mm)	
18 – 25	82.92 ± 3.06	82.62 ± 3.05	0.47	92.14 ± 2.74	95.26 ± 7.43	0.51
	(n=34)	(n=29)		(n=34)	(n=29)	
26 – 35	82.00 ± 2.41	82.83 ± 3.07	0.53	99.23 ± 2.67	93.25 ± 5.19	0.63
	(n=75)	(n=79)		(n=75)	(n=79)	
36 – 45	82.49 ± 3.17	82.16 ± 1.29	0.56	99.25 ± 2.38	93.25 ± 4.26	0.49
	(n=48)	(n=55)		(n=48)	(n=55)	
46 – 55	81.97 ± 3.93	82.48 ± 1.57	0.64	99.01 ± 3.02	94.03 ± 3.86	0.53
	(n=56)	(n=50)		(n=56)	(n=50)	
56 – 65	83.11 ± 4.03	81.90 ± 1.15	0.61	98.57 ± 3.56	93.55 ± 3.42	0.50
	(n=22)	(n=23)		(n=22)	(n=23)	
66 – 80	83.17 ± 2.38	81.85 ± 2.23	0.64	97.86 ± 1.87	92.46 ± 6.80	0.58
	(n=15)	(n=14)		(n=15)	(n=14)	

n = number of individuals in each specific age group.

DISCUSSION

The determination and identification of sex from human remains has been a very important aspect in forensic anthropology (Singh & Chavali, 2011). This can be achieved from bony structures such as the scapular and clavicle which has shown to be sexually dimorphic. And it may reduce the probable matches of anonymous persons by fifty percent, distinctively categorizing them as either female or male (DiGangi & Moore, 2012).

In the present study, it was discovered that the mean length of left clavicle (LLC) and length of right clavicles (LRC) in males were significantly higher than those in females, which is same in different age groups, this is because males have broader shoulders than females and the clavicles contribute to the breadth of the shoulders (Olivier, 1951).

This result is in agreement with that of Syeda *et al.* (2023) for the people of North Karnataka, but the mean length of males left and right clavicles were 18.51 mm and 19.18 mm less than those of males of the present study and the mean length of the females

left and right clavicles were 19.24 mm and 13.62 mm less than those of females of the present study.

These findings were also in agreement with that of Udoaka and Nwokediuko (2013) for the people of southern Nigeria but their measurement for mean length of male clavicles were 8.99 mm less than the present study and their measurement for the mean length of the female clavicle were 0.73 mm less than the present study. These variations in these studies marks the racial difference which may be observed even in closed related racial groups (Olivier, 1951; Kaur *et al.*, 2002).

It was discovered in this present study that the left clavicle is significantly longer than right in both males and females, which is because of greater curves in the right clavicle than left clavicle which may be due to frequent usage of right hand than left hand (Bilodi *et al.*, 2002; Patel *et al.*, 2012).

In the present study, it was found that the mean thickness of the right clavicle (TRC) in different age groups of males was significantly greater than the mean thickness of right clavicle (TRC) in females, also the mean thickness of the left clavicle (TLC)

of males was significantly greater than the mean thickness of left clavicle (TLC) in females and in different age groups.

This discovery is in agreement with the results of Syeda *et al.* (2023), where the mean thickness of overall males left and right clavicle (TLC and TRC) were significantly greater than the mean thickness of the overall females left and right clavicle.

These findings were also in agreement with that of Udoaka and Nwokediuko (2013), where the mean thickness of overall males left and right clavicle (TLC and TRC) were significantly greater than the mean thickness of the overall females left and right clavicle.

This study found that, males have greater scapulae (HLS and HRS) compared to females, for both total and age-specific groups. This difference might be due to two factors. First, males tend to participate in more physical activities than females (Syeda *et al.*, 2023). Second, broader shoulders are a common physical characteristic of males, and the scapula plays a role in shoulder width (DiVella *et al.*, 1994).

This result is in agreement with the result of Ozer *et al.* (2006) for the East Antolian population, but their measurement for males mean height of the scapula was 31.07 mm less than those of the present study and the females mean height of the scapula was 26.5 mm less than those of the females of the present study.

This result is also in line with the work of Shailesh *et al.*, (2013) for the people of Gujarat India, but their result was for males mean scapula height was 46.21 mm less than the mean scapula height of the present study and the females mean scapula height was 43.99 mm less than the mean scapula height of females of the present study.

This study show that the left scapula is significantly greater in height than right scapula in both males and females, which may be due to frequent use of the right hand, which leads to shorter and thicker right bone as compared to the left (Iscan *et al.*, 1998; Kaur *et al.* 2002).

In the present study, it was found that the mean width of overall males left and right Scapula (WLS and WRS) were greater than the mean width of overall females left and right Scapula (WLS and WRS).

This discovery is in agreement with the results of Ozer *et al.* (2006), where the mean width of overall males left and right Scapula (WLS and WRS) were significantly greater than the mean width of the overall females left and right Scapula (WLS and WRS).

These findings were also in consonant with that of Shailesh *et al.* (2013), where the mean width of overall males left and right Scapula (WLS and WRS) were significantly greater than the mean width of the overall females left and right Scapula (WLS and WRS).

This study also found that the width of left scapulae was significantly greater than the width of the right scapula in both males and females, which may be due to frequent use of the right hand, which leads to shorter and thicker right bone as compared to the left (Kaur *et al.*, 2002).

Conclusion: This study has determined the sexual dimorphic characteristics in the studied parameters of the Clavicle and Scapula in normal chest radiographs of adult population in Bayelsa State in different age levels.

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