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Discriminant and Multiple Linear Regression Analysis for Sex and Stature Estimation Using Upper Arm and Forearm-Hand Length: A Study among Mgbidi Population of Imo State Nigeria

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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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ABSTRACT

Background: The key aspect of forensic anthropology is the estimation of biological profile characteristics such as sex, age, stature, etc. Its application is wide across various disciplines like forensic science, anthropology, archaeology, and medical sciences. The study aims to estimate sex and stature using upper arm and forearm-hand length among the Mgbidi population of Imo State, Nigeria.

Methods: The study adopted a descriptive cross-sectional study design and a total of three hundred (150 males and 150 females) subjects were recruited for the study using multistage random sampling techniques. Data were obtained via direct measurements using mega-size calipers and a stadiometer. The obtained data was analyzed using IBM SPSS (version 25).

Results: The study shows that males are significantly higher in anthropometric values ($p<0.05$) than females. The multivariate regression among the sexes to estimate Stature using the right side anthropometry shows R=0.62 and SEE= 6.45 and on the left side anthropometry; R=0.61 and SEE=6.49. the stature predictive power of females was (R=0.52, 52.0% SEE= 5.35) and males (R=0.46, 46.0%, SEE=5.51) on the right and left side anthropometry shows females (R=0.49, 49.0%, SEE=5.42) and males was (R=0.45, 45.0%, SEE=5.72). the estimation for sex shows overall significance (X^2=72.78, ƛ= 0.78, R=0.46, $p<0.05$) from the right side and the left side also shows significance in sexual estimation (X^2= 71.84, ƛ=0.79, R=0.46, $p<0.05$).

Conclusion: The study reveals statistical differences in the upper arm and forearm-hand length compared to the sexes. Females are better predictors of stature using the upper arm and forearm-hand length than males and upper arm and forearm-hand length are good predictors of sex.

Keywords: Estimation; upper arm length; forearm-hand length; Mgbidi population; sex and stature.

1. INTRODUCTION

One of the key aspects of forensic anthropology is the estimation of biological profile characteristics, such as sex, age, ancestry, and stature, from skeletal remains. Sex and stature estimation are fundamental components of biological profiling, as they can provide valuable information for narrowing down the pool of potential missing persons, aiding in criminal investigations, and reconstructing the biological profile of unidentified individuals [1,2,3]. This field of study is essential in forensic anthropology, forensic medicine, and criminal investigations [2,4]. Several studies have shown that there exist significant relationships between upper limb anthropometry and the overall stature of an individual by establishing robust regression equations that can accurately predict stature based on these upper limb measurements in various racial populations [4,5,6,7]. Also, it has been postulated that sex-specific regression models are better used for stature estimation from limb measurements due to inherent anatomical variations between both male and female genders.

Poorhassan et al. [8] conducted a study on stature estimation from forearm length in Iranian medical students and found a correlation between forearm length and stature, suggesting that forearm measurements can be used as a reliable indicator for estimating stature in the Iranian population. Another study investigated the determination of stature from upper arm length in medical students revealing a correlation between upper arm length and stature, with regression equations developed for stature estimation in the Iranian population [9]. The findings from a previous study by Ahmed [6] having explored the estimation of sex from upper limb measurements in Sudanese adults indicated that upper limb measurements could be used to predict sex with a standard error of estimation (SEE) ranging from ±3.54 to ±5.85 thereby highlighting the importance of sex-specific models in forensic stature estimation. Kushwah et al [10] conducted a study to show a relationship between the combined length of the forearm and hand with stature using an Indian cadaveric male population. Their study showed that there were significant, positive correlations between the combined length of the forearm and hand and stature with a correlation coefficient of 0.668. Another study revealed that males had higher correlation coefficients for upper arm length and forearm length while females had higher correlation coefficients for hand length in association with stature [11].

The application of discriminant function analysis utilizes body morphological differences to develop mathematical models or formulas that can predict the sex and stature of an individual based on specific body anthropometric measurements [4,12]. By analyzing these morphological measurements from known male and female individuals of different heights, discriminant functions can be developed to classify unknown individuals into male or female categories and estimate their stature based on their characteristics. These functions essentially act as decision rules that assign a probability of sex and stature classification to an unknown individual based on their skeletal measurements [4,13,14]. There is a huge gap in literature within any Nigerian population concerning the application of discriminant function analysis in classifying sex and stature using upper limb anthropometric measurements – hence the study aims at estimating sex and stature using arm and forearm-hand length among the Mgbidi population of Imo State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Design

This study used a cross-sectional descriptive research design to gather data on the anthropometry of the upper extremity (upper arm and forearm-hand length) of Mgbidi people of Imo State, Nigeria. The study lasted for four months (January 2024 to April 2024), and the study population comprised three hundred subjects (150 males and 150 females) within the age interval of 18-37 years. Mgbidi town was used as the study frame, and a multi-stage random proportionate sampling technique was employed to select the subjects without bias. The minimum sample size was calculated using the Taro Yamane formula for Quantitative research.

2.2 Selection Criteria

The study only recruited respondents whose grandparents and parents are of Mgbidi Origin and had not undergone any surgery or sustained any trauma that could alter the stature or hand morphology. Subjects whose ages were between 18-37 years and who had consented to participate in the study were also recruited in the study. The study excluded subjects who were not of Mgbidi origin or did not meet the age specification of the study as well as subjects who had surgery or sustained deformities that could affect standing height or hand morphology.

2.2.1 Anthropometric landmarks

The study employed some anthropometric variable measures (upper arm length, forearm-hand length, and standing height), and these variables are defined as follows;

- ***Upper arm length***: this is the measurement from the lateral tip acromion down to the distal part of the arm (lateral and medial epicondyle).
- ***Forearm-hand length***; this measurement runs from the proximal head of the radius to the most distal limit of the third finger.
- ***Standing height***; this is a vertical measurement of the human body that runs from the vertex of the head to the sole when the subject is standing upright in an anatomical position.

2.3 Method of Data Collection

A semi-constructive descriptive questionnaire and a personal interview were used to gather the sociodemographic data for the Mgbidi people of Imo state Nigeria. This ensured that the subjects met the inclusion criteria and were fit to participate in the study. The upper arm and forearm-hand lengths were measured using a mega-size caliper, adopting the appropriate anatomical landmarks. The standing height was measured from the vertex of the head to the sole in an upright position using a ZT-160 Goodcare stadiometer. Data readings were recorded and preserved by the authors.

2.4 Method of Data Analysis

Data obtained were subjected to statistical analysis using the International Business Machine of Statistical Package for Social Science (IBM version 25) and results obtained were presented in the table as mean ± standard deviation. T-test was used as an inferential statistic to evaluate sexual and asymmetry differences. Discriminant and multivariate regression were used to estimate sex and stature. A probability less than 0.05 ($p<0.05$) was considered statistically significant and 95% was denoted as confidence level.

3. RESULTS

The present study comprised three hundred subjects of Mgbidi origin who were 18-37 years of age. The comparison between the males and females has shown that males had a standing height of 176.46±6.36 cm, right arm length of 34.58±3.76 cm, right forearm-hand of 50.91±3.27 cm, left arm length of 34.50±3.50 cm and left forearm-hand length of 50.91±3.24 cm while the females had 105.97±6.21 cm, 33.61±3.68 cm, 47.21±3.75 cm, 33.50±3.68 cm and 47.23±3.77

cm for standing height, right arm length, right forearm-hand length, left arm length and left forearm-hand length respectively. The inference has shown that there are sexual differences in standing height, right arm length, right forearm-hand length, left arm length, and left forearm-hand length (Table 2). There were no asymmetry differences in the upper arm and forearm-hand length among the Mgbidi population (Table 3).

Table 4, shows the multivariate regression analysis for stature estimation using upper arm (AL) and forearm-hand length (FHL). It presents that stature prediction in all sexes (males and females) was significant across the parameters (AL and FHL) from the left to the right anthropometry and the collinearity statistics (VIF) have shown that the parameters (L.AL, L.FHL, R.AL and R.FHL) are good predictors for stature (VIF<2). The standard error of estimation has shown the accuracy of the prediction (SEE< 1).

Table 5, displays the multivariate regression analysis for males, considering the estimation of stature from the left to the right anthropometry. The analysis has a strong significant value (p<0.05) to stature estimation in males and the accuracy of the prediction across the parameters was observed to be high (SEE<1). The collinearity of the parameters further proof that the parameters are good predictors of stature (VIF<2). Among the females, our results present a similar finding to the males showing that the overall prediction was significant (p<0.05) with a high level of accuracy (SEE<1) of the parameters to stature estimation. However, the collinearity of the parameters to stature estimation has shown that the parameters are good predictors for stature (VIF<2) (Table 6).

The summary of the multivariate regression model between the sexes from the right and left anthropometry has shown that right anthropometry has a correlation coefficient (R=0.62) with a standard error of estimate 6.45 while for the left side, anthropometry shows a correlation coefficient (R=0.61) with standard error of estimate 6.49. Comparing the males and the females using the right anthropometry to stature (standing height) shows that a female's stature is better predicted from the right compared to the males (females, R=0.52, SEE=5.35; males, R=0.46, SEE=5.51). Using the left anthropometry to stature estimation shows that males have a correlation coefficient (0.45) with a 5.72 standard error of estimate to stature and the females display a correlation coefficient (R=0.49) with a 5.42 standard error of estimate. Indicating that females are also better predicted from the left anthropometry compared to males. The stature model shows the Right anthropometry for males, $S = 126.88 + AL(0.39) + FHL(0.70)$ and females $S = 122.19 + AL(0.32) + FHL(0.70)$ while left anthropometry for males shows $S = 126.43 + AL(0.43) + FHL(0.69)$ and females $S = 124.09 + AL(0.21) + FHL(0.73)$ (Table 7).

Table 8 shows the discriminant analysis using the right anthropometry to classify sex using the arm length and forearm-hand length. The overall chi-square test shows a significant value (X^2=72.78, ƛ= 0.78, canonical correlation = 0.46, Df= 2, and p<0.05). The discriminant functions extracted accounted for nearly (21.16%) of the variance of sexual differences and the sexual centroid displayed that male was 0.53 while female was -0.53. The discriminant model shows that $Sex = -14.03 + R.AL(0.01) + R.FHL(0.28)$ while for specificity and validity, the discriminant classification coefficient model for males shows $male = -123.75 + R.AL(1.69) + R.FHL(3.68)$ while $female = -109.01 + R.AL(1.68) + R.FHL(3.38)$ (Table 8).

Discriminant function analysis was used to classify sex and using the left anthropometry of the upper extremity the test showed significance (X^2= 71.84, ƛ=0.79, canonical correlation= 0.46, Df=2, p<0.05). The discriminant functions accounted for nearly 21.16% of the variants of sexual differences and the sexual centroid shows that male was 0.52 and female was -0.52. A model was deduced to be; $sex = -14.29 + l.AL(0.02) + l.FHL(0.27)$ but for more specificity, the discriminant classification coefficient shows that $male = -127.13 + l.AL(1.88) + l.FHL(3.69)$ while $female = -112.23 + l.AL(1.86) + l.FHL(3.41)$ (Table 9).

Table 1. Descriptive Statistics of Stature (S), upper Arm (AL), and Forearm-hand Length (FHL) in Mgbidi Subjects

	N	Min	Max	Mean	Std. Deviation
AGE (years)	300	18	37	24.57	3.52
S (cm)	300	150.5	191.0	171.21	8.18
R.AL (cm)	300	25.0	44.0	34.09	3.75
R.FHL (cm)	300	34.1	70.0	49.06	3.98
L.AL (cm)	300	25.0	44.0	34.00	3.67
L.FHL (cm)	300	34.1	70.0	49.07	3.97

S=Standing height, R.Al= right arm length, R.FHL= right forearm-hand length, L.AL=left arm length, L.FHL= left forearm-hand length

Table 2. Sexual differences of the upper extremity of the Mgbidi subjects

Parameters	Male	Female	T-test	p-value	Inference
S (cm)	176.46±6.36	105.97±6.21	14.43	0.000	S*
R.AL (cm)	34.58±3.76	33.61±3.68	2.27	0.024	S*
R.FHL (cm)	50.91±3.27	47.21±3.75	9.09	0.000	S*
L.AL (cm)	34.50±3.50	33.50±3.68	2.39	0.018	S*
L.FHL (cm)	50.91±3.24	47.23±3.77	9.01	0.000	S*

Legend: S=Standing height, R.Al= right arm length, R.FHL= right forearm-hand length, L.AL=left arm length, L.FHL= left forearm-hand length and S= significant (p<0.05)*

Table 3. Difference between the Right and Left upper extremities

Parameters	Right	Left	T-test	p-value	Inference
AL (cm)	34.09±3.74	34.00±3.66	3.32	0.19	NS
FHL (cm)	49.06±3.97	49.07±3.97	-0.411	0.68	NS

Legend: AL= arm length, FHL= forearm-hand length and NS= non-significant (p>0.05)

Table 4. Multivariate regression of Stature estimation using upper arm (AL) and forearm-hand length (FHL) for all sexes (males and females)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	103.32	5.254		19.666	0.000		
L.AL	0.35	0.106	0.16	3.293	0.001	0.941	1.063
L.FHL	1.14	0.098	0.55	11.713	0.000	0.941	1.063
(Constant)	102.808	5.138		20.008	0.000		
R.AL	.369	0.103	0.169	3.582	0.000	0.931	1.074
R.FHL	1.138	0.097	0.553	11.713	0.000	0.931	1.074

Legend: S=Standing height, R.Al= right arm length, R.FHL= right forearm-hand length, L.AL=left arm length, L.FHL= left forearm-hand length and AL= arm length, FHL= forearm-hand length

Table 5. Multivariate regression of Stature estimation using upper arm (AL) and forearm-hand length (FHL) for the males

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	126.875	8.006		15.848	0.000		
R.AL	0.399	0.125	0.236	3.182	0.002	0.982	1.019
R.FHL	0.703	0.144	0.362	4.886	0.000	0.982	1.019
(Constant)	126.430	8.181		15.453	0.000		
L.AL	0.430	0.131	0.243	3.273	0.001	.985	1.015
L.FHL	0.691	0.145	0.354	4.772	0.000	.985	1.015

Legend: S=Standing height, R.Al= right arm length, R.FHL= right forearm-hand length, L.AL=left arm length, L.FHL= left forearm-hand length and AL= arm length, FHL= forearm-hand length

Table 6. Multivariate regression of Stature estimation using upper arm (AL) and forearm-hand length (FHL) for the females

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	122.197	6.016		20.312	.000		
R.AL	.319	.125	.189	2.544	.012	.900	1.111
R.FHL	.700	.123	.424	5.692	.000	.900	1.111
(Constant)	124.096	6.156		20.160	.000		
L.AL	.211	.125	.125	1.681	.095	.925	1.081
L.FHL	.737	.122	.448	6.028	.000	.925	1.081

Legend: S=Standing height, R.Al= right arm length, R.FHL= right forearm-hand length, L.AL=left arm length, L.FHL= left forearm-hand length and AL= arm length, FHL= forearm-hand length

Table 7. Summary of Multivariate regression of Stature estimation using Arm and forearm-hand length

Subjects	Multivariate model	R	R square	Standard error of Estimate	Sig F Change
ALL	S= 102.81+ R.AL (0.37) +R.FHL (1.14)	0.62	0.34	6.45	0.00
	S= 103.32 + L.AL (0.35) + L.FHL (1.14)	0.61	0.37	6.49	0.00
	RIGHT				
Male	S= 126.88 + AL (0.39) + FHL (0.70)	0.46	0.21	5.51	0.00
Female	S= 122.19 + AL (0.32) + FHL (0.70)	0.52	0.27	5.35	0.00
	LEFT				
Male	S=126.43 + AL (0.43) + FHL (0.69)	0.45	0.21	5.72	0.00
Female	S= 124.09 + AL (0.21) + FHL (0.73)	0.49	0.24	5.42	0.00

Legend: S=Standing height, R.Al= right arm length, R.FHL= right forearm-hand length, L.AL=left arm length, L.FHL= left forearm-hand length and AL= arm length, FHL= forearm-hand length

Table 8. Sex discriminant function of right upper extremity of Mgbidi subjects

Eigenvalue	Canonical correlation	Wilks' Lambda	Chi-square	Df	Inference
0.28	0.46	0.78	72.78	2	**Significant**
Sex centroid					
Male	0.53	Sex= -14.03 + R.AL (0.01) + R.FHL (0.28)			
Female	-0.53				
Classification coefficient				**Predicted group membership**	
Male = -123.75 + R.AL (1.69) +R.FHL (3.68)				male	female
			Male	109	41
Female = -109.01 + R.AL (1.68) + R.FHL (3.38)			Female	27	123
			Male	72.7%	27.3%
			Female	18.0%	82.0%

Legend: R.Al= right arm length, R.FHL= right forearm-hand length, 77.3% of original grouped cases correctly classified

Table 9. Sex discriminant function of left upper extremity of Mgbidi subjects

Eigenvalue	Canonical correlation	Wilks' Lambda	Chi-square	Df	Inference
0.27	0.46	0.79	71.84	2	Significant
Sex centroid					
Male	0.52	Sex= -14.29 + L.AL (0.02) + L.FHL (0.27)			
Female	-0.52				
Classification coefficient			**Predicted group membership**		
				male	**female**
Male = -127.13 + L.AL (1.88) +L.FHL (3.69)			Male	108	42
			Female	27	123
Female = -112.23 + L.AL (1.86) + L.FHL (3.41)			Male	72.0%	28%
			Female	18%	82%

Legend: L.AL=left arm length, L.FHL= left forearm-hand length, 77.0% of original grouped cases correctly classified

4. DISCUSSION

The fundamental difficulty in anthropological study remains the classification of humans and animals. The present study evaluates sexual dimorphism using the upper arm and forearm-hand length among the Mgbidi population of Imo State, Nigeria. The findings present that Males had a standing height of 176.46±6.36 cm, right arm length of 34.58±3.76 cm, right forearm-hand length of 50.91±3.27 cm, left arm length of 34.50±3.50 cm, and left forearm-hand length of 50.91±3.24 cm, while females had 105.97±6.21 cm, 33.61±3.68 cm, 47.21±3.75 cm, 33.50±3.68 cm, and 47.23±3.77 cm for standing height, right arm length, and right forearm-hand length. Our findings have shown that males have higher mean values compared to females which directly showed gender-based variation in standing height, right upper arm and forearm-hand lengths, and left upper arm and forearm-hand lengths. The study's findings are consistent with the fact that males have higher anthropometry values than females [15] due to factors like hormonal surge during puberty. During puberty, males typically experience a significant increase in testosterone production, which promotes growth spurts and contributes to the development of longer bones and larger body size compared to females. The growth plates located at the ends of our long bones are the key players in making us taller as we grow up. Interestingly, these growth plates close later in males than in females, hinting that males might keep growing taller for a bit longer compared to females. This prolonged growth period in males could lead to bigger differences in anthropometric measurements between adult males and females. To mention but a few, social and cultural factors among the Mgbidi population could also be attributed to the variations observed because males from Mgbidi to be precise, are handymen and well known for their creativity and industrialization so the males tend to have more muscle mass compared to females. However, diet intake can also be attributed to the significant differences observed, because due to the nature of the daily activities, males consumed more carbohydrates “Okpa, Ede, ji, Akpu, Abacha, Achicha, Garri” protein and fat to acquire enough energy for works, directly and indirectly promoting growth compared to the females whom by culture are treated like a princess “Ada”. The sexual-based variation observed in this present study is consistent with previous works among different populations, that revealed that males differ significantly ($p<0.05$) compared to females [16-23].

The study also explores the bilateral symmetry of the Upper extremity anthropometry (upper arm and forearm-hand length) to evaluate if there are possible differences in length. The findings present no statistical differences observed among the Mgbidi population. However, variations in the bilateral structure could arise from different factors such as genetic mutation or developmental anomalies, environmental influences, or compensatory mechanisms arising from injuries. However, subjects with such factors were excluded from the study; the study only employed non-pathological samples. The findings of this study agree with Howley et al., [22] that bilateral symmetry of the arm and forearm length shows no statistical differences.

Stature construction from the upper limb extremity (upper arm and forearm-hand length) has been explored greatly in this study and the findings present that the sex of the right anthropometry has a correlation coefficient (R=0.62, SEE= 6.45) while the left anthropometry correlates (R=0.61, SEE=6.49). The findings showed that the left and right anthropometry have a similar predictive power for stature with no statistical differences. However, when compared with sexes using the right anthropometry, the findings show that females' stature is better predicted using upper arm and forearm length (R=0.52, SEE= 5.35) compared to the males (R=0.46, SEE= 5.51) and this could be attributed to some factors influencing estimation such as bone length, muscle mass and fat distribution but since females typically have more adipose tissue which is less dense than muscle tissue, their upper arm and forearm-hand lengths may be slightly longer relative to their overall stature compared to males. This can result in a more accurate prediction of stature in females as the SEE is smaller in females than in males. On the other hand, considering the left anthropometry in comparison with sex, the findings have shown similarity with the right anthropometry that female is better predicted using the studied parameters compared to male (SEE of female <SEE of males). The findings of this study agree with the findings of Navid et al. [16] among medical students at Tehran University of Medical Sciences, Tehran, Iran that using arm length, females had more predictive power compared to the males. In 2008, Kanchan et al. [24] also reported that females have a higher power of prediction of stature compared to

males using upper arm length and our findings are also consistent with Akhlaghi et al., [17]. On the contrary, our findings disagreed with Shakya et al. [25], who reported that males upper arm and forearm are better predictors of stature compared to females but Ilayperuma et al. [12] findings were consistent with ours. Our study showed the stature model for the Right anthropometry for males, $S = 126.88 + AL(0.39) + FHL(0.70)$ and females $S = 122.19 + AL(0.32) + FHL(0.70)$ while left anthropometry for males shows $S = 126.43 + AL(0.43) + FHL(0.69)$ and females $S = 124.09 + AL(0.21) + FHL(0.73)$.

Sexual discrimination was also explored to classify sex (male and female) using the upper arm and forearm-hand length from the bilateral asymmetry. The findings from the right anthropometry present that the estimation using arm and forearm-hand length is significant ((X^2=72.78, ƛ= 0.78, p<0.05). 21.16% accounted for the variances in sexual differences, where the sex centroid shows that applying the discriminant model $Sex = -14.03 + R.AL(0.01) + R.FHL(0.28)$, with the study parameters, a positive resultant value from 0-0.53 predicts males and from 0 - -0.53 predicts females. The findings have shown that group membership of the males was 72.7% and females was 82.0% were correctly predicted which account for 77.3% of the total sexes were correctly classified. Our findings agree with the work of Shah et al., [21] that arm length accounts for 90% of sex classification among communities in the Ahmedabad district of Gujarat, India. Ahmed et al., [6] further classified sexes using upper arm and forearm-hand length and accounted for 78.5% of sexes were correctly predicted. This finding is consistent with our findings.

Table 9, further shows the specificity of the model in classifying males and females by applying the measures to the $male = -123.75 + R.AL(1.69) + R.FHL(3.68)$ while $female = -109.01 + R.AL(1.68) + R.FHL(3.38)$. considering the left anthropometry the discriminant function analysis displayed overall significance (X^2= 71.84, ƛ=0.79, p<0.05) which is consistent with [21,25,26,]. The sex centroid explains that the resultant application of the model will give a positive value predicting males and a negative value predicting females, but the specificity classification coefficient was employed to either predict males or females accurately. However, the finding shows that 72% of males and 82% of females were correctly predicted which accounts for 77.0% total sexes correctly predicted. The findings agree with Shah et al. [21] and Charisi et al. [27,28] that upper arm and forearm-hand length are strong predictors of sex.

The study has shown some similarities and differences in sex and stature estimation using upper arm and forearm-hand length among various populations and these differences could be attributed to various factors, like environmental, race, and body composition.

5. CONCLUSION

The study evaluated the sexual dimorphism and bilateral asymmetry difference of the upper arm and forearm-hand length. Thereafter, estimated sex and stature using anthropometric standards. The findings show that males differ in the anthropometric value of their upper arm and forearm-hand length. There was no statistical difference observed in the bilateral asymmetry of both male and female populations of Mgbidi. Using upper arm and forearm-hand length to estimate stature among sexes, our findings show that females are better predictors than males and upper arm and forearm-hand were good predictors of sexes.

CONSENT

According to international standards or university Standards, a written consent form was issued to every research participant underlining the data's aim, purpose, method, and confidentiality. The filled consent forms were retrieved and preserved by the authors.

ETHICAL APPROVAL

The study was approved by the research and ethics committee of the University of Port Harcourt, Port Harcourt, Nigeria.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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