ejpmr, 2025, 12(3), 319-337

SJIF Impact Factor 7.065

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

ESTIMATION OF STATURE FROM LENGTH AND BREADTH OF RIGHT AND LEFT THUMBS IN A NIGERIAN POPULATION

[*1]Johnbull T. O., [2]Amambgu J. N. and [2]Oladipo G. S.

[1]Department of Anatomy, Faculty of Basic Medical Sciences, Niger Delta University, Bayelsa State, Nigeria.
[2]Department of Anatomy, Faculty of Basic Medical Sciences, University of Port Harcourt, Nigeria.

***Corresponding Author: Johnbull T. O.**

Department of Anatomy, Faculty of Basic Medical Sciences, Niger Delta University, Bayelsa State, Nigeria.

Article Received on 16/01/2025 **Article Revised on 05/02/2025** **Article Accepted on 26/02/2025**

ABSTRACT

Stature estimation has been found to be useful in forensic investigation. Stature estimation by the means of human vestiges anchors on the rule that there exists a linear correlation between stature and different parts of the human body and bones. Body markers that could reveal the identity of unknown persons are of great importance to forensic experts. **Methods**: random sampling technique was employed in getting 250 participants for this study comprising of 120 (48%) Igbos, while 130 (52%) were from the Yoruba ethnic group. Participants involved students and staff of the University of Port Harcourt and its environs who were either Igbos or Yoruba. Parameters measured include the left and right thumb length, the left and right thumb breadth, and the left and right thumb thickness and height. **Results:** Results obtained were analyzed using SPSS IBM version 23.0 for Pearson correlation and multivariate regression. Regression equations were derived in this study with weak correlation in most parameters though with the exception of the right thumb breadth of Igbos that showed a significant association. **Conclusion**: Considering this outcome, equations derived from the right thumb breadth could serve as an adjunct tool in the forensic anthropology of Igbos. Thus, the study is recommended for forensic experts in Nigeria.

KEYWORDS: *stature, Body makers, anthropology, Nigerians.*

INTRODUCTION

The anatomy of the hand is multifaceted, intricate, and interesting. It is indeed indispensable when it comes to the functionality of our day to day living. The hand is made up of several diverse bones, ligaments and muscles that enable a wide range of movement and agility. The hand consists of 3 major types of bones which are phalanges, metacarpal, and carpal bones (Oliver, 2020, Zancolli, 1992).

The wrist joint is the complex joint found amid the distal ends of the radius and ulna and the carpal bones. The ulna which is the larger of the two forearm bones tapers at the wrist end, to become narrower than the radius at this point. The radius is positioned on the thumb side of the wrist, and the ulna on the little finger side (Oliver, 2020).

Fingers are constructed of ligaments, tendons, and three phalanges. Muscles are not present in the fingers, rather the fingers move by the pull of the muscles of the forearm on the tendons. Four of the fingers have 3 bones each; the proximal, middle and distal phalange except the thumb which is devoid of a middle phalange (Zancolli, 1992).

Scientist especially forensic anthropologists estimate stature by using different bones of the human skeleton and have achieved varying degree of precision (Dupertuis & Hadden, 1951, Nat, 1931). Forensic Anthropologist has since established Population-specific equations for stature estimation. Also several researchers have carried out studies on the phalanges to determine stature estimation among various populations (Kumar *et al*., (2012; Sharma *et al.*, 2016; Akhlaghi *et al*., 2017; Alabi *et al.*, 2017; Oladipo *et al.*, 2015;. Oladipo *et al*. 2009; Numan *et al.*, 2013) they have all contributed in establishing anthropometric values for estimation of stature using hand length. Igbigbi *et al.*, (2018) studied 384 Nigerian students aged between 18 and 30 years to determine stature using measurements of hand & foot dimensions, which revealed noteworthy gender difference in mean right & left-hand breadth and foot. Uche *et al.*, (2020) carried out a research on 483 adolescent school children in a Nigerian population aged 10-17 years to evaluate the predictive relationships between hand anthropometric dimensions & stature where multiple linear regression modeling show a correlation between stature and hand dimensions where male left-hand length was the strongest positive and female right-hand length was the weakest positive

correlation. Katwal *et al.,* (2021) studied 100 males and 100 females 18-25 years of age at a medical college in Nepal to originate the regression formula in order to detail the connection existing between height and finger length in healthy persons and derive a multiple regression equation.

This study is therefore intended to determine stature using anthropometric measurements of thumb dimensions to establishing standard anthropometric values in Igbo and Yoruba populations.

It is well known that stature estimation is a vital parameter in identifying commingled, mutilated, and skeletal remains in forensic examinations. Forensic estimation of stature is part of the identification process required when dismembered body parts are found. Stature provides a clearer understanding into a range of features of a giving group of people which includes health, nutrition and genetics; geographical setting, environment, and climatic condition. The stature of a person is a vital distinguishing feature regarded to be a significant evaluation in identifying unknown human remains. Adult height may be obtained anywhere from the early teens to early twenties, though it is most commonly reached during the mid-teens for females and the late teens for males (Ghai *et al.,* 2009). In Nigeria, this study will play an important role in forensic science.

There is a paucity of information on the estimation of the stature from the length & breadth of the right & left thumbs of Nigerians residing in Rivers state. In view of this, the present study was carried out to determine how the right and left thumbs correlated with stature in a Nigerian population. Where there is data, it is not comprehensive enough and there is no work at all done using the Igbos & Yorubas. Also, there is an insufficient sample size to better represent this work. The studies carried out made use of archaic measuring tools for a more accurate result needed, as well.

METHODS

The research design used is a descriptive cross-sectional study to estimate the stature from length & breadth of right & left thumbs of Nigerian Igbos & Yorubas residing in Rivers State.

A Total of 250 (Yoruba = 130 and Igbo = 120) males and females between the ages of 18 years and 55 years were randomly selected using the convenient sampling technique.

Participants with deformity, injury, fracture, or history of any surgical procedures on fingers of both hands, are not part of this study.

Ethical approval was obtained from the university ethical board (UPHR&D/REC/04) before the start of this study. Also an informed consent was gotten from each participant involved in this study.

MATERIALS

I. Digital Vernier Calliper with a precision of 0.01 mm (Microtech, 2015) (Raider professional. RNDC 708)
II. Stadiometer (The Ayrton 226 Hite-Rite Precision Seca 226 Stadiometer)
III. Gloves
IV. Permanent Markers
V. Project Journal
VI. Wipes
VII. File

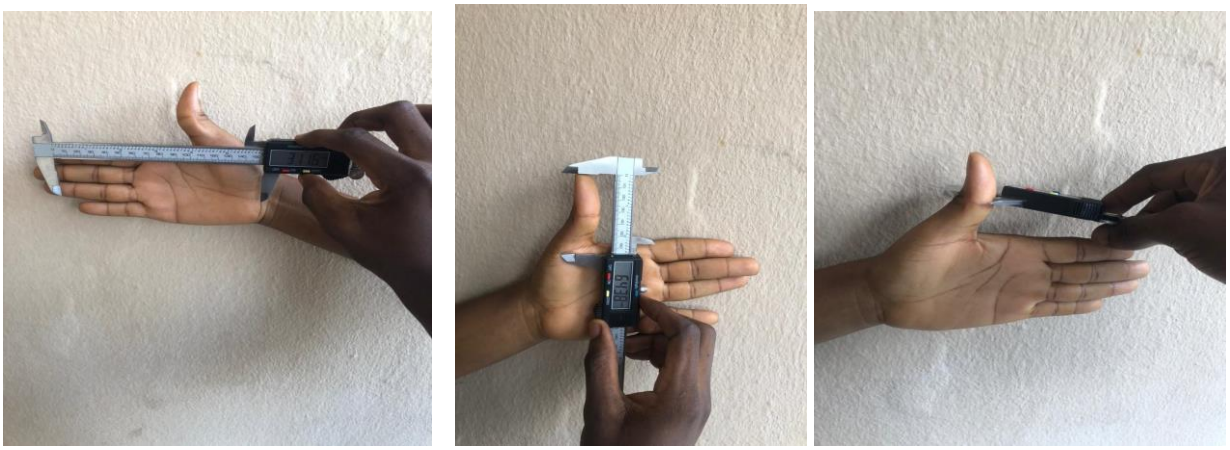

Fig 1: measurement techniques.

Figure 2: showing stadiometer used in the study.

Figure 3 The Camry weighing scale.

Anthropometric Measurement of Parameters/Variables

Each consented participant was made to stand or sit comfortably to take all the measurements after adequate explanation of the procedure was done since none of the procedure was invasive.

All measurements were evaluated in millimeter (mm) except for height taken in meter (m) and weight in kilogram (kg).

The procedures for measurement were as follows.

Height (stature)

Each participant stood erect with minimal clothing, bare heads and feet, arms hanging loosely to the side, feet together and with heels, buttocks and shoulder blades in contact with the vertical surface of the stadiometer. Stature was taken from the vertex to the floor (ground surface) in anatomical position.

Weight

Weight of each participant was checked using the weighing scale. The subjects put on minimal clothing and were asked to remove excess materials like shoes, belt, wrist watch etc. The weighing scale was set on a hard, level and even surface and was checked for accuracy using known weights, and always set at zero before use.

Hand Length & Breadth

The measurements of the hand lengths and breadths were done with the subjects sitting with elbows flexed and drawn backwards, with forearm supinated and resting on the table with the wrist extended and hand stretched.

Hand Length

Hand length (HL) was measured from the projected distance between the midpoint of a line joining the styloid process of radius and ulna bones of forearm to the tip of the middle finger using a sliding calliper. (Fig. 1a)

Hand Breadth

Hand breadth (HB) was measured from the base of the 5th to the 2nd metacarpal bones using a sliding caliper. (Fig. 1b)

Digits Length

The digit length (Index (2PDL); Middle (3PDL); Ring (4PDL) and Little Finger (5PDL) length) was measured as the distance between the proximal flexion creases of the finger to the tip (dactylion) of the respective fingers.

The anatomical landmarks were marked and a straight line drawn from the proximal flexion crease to the tip (dactylion) of the respective fingers, with the use of a meter rule readings were taken to the nearest 0.01cm.

Thumb Length & Breadth

Thumb Length

The length of the subject's thumb is measured by placing the outside jaws of the digital caliper from the top to the metacarpo-phalangeal joint crease.

Thumb Breadth

The breadth of the subject's thumb is measured by placing the outside jaws of the digital calipers on the widest parts of the thumb.

Data analysis was done using SPSS (Statistical package for Social Sciences, IBM® version 23, Armonk, New York, USA) and Minitab V17 Minitab® Inc State College, Pennsylvania) statistical software.

Mean, standard deviation (SD) and standard error (SE) were recorded. Similarly, linear and multiple regression equations and correlation coefficients between the mean height and the measured dimensions of thumb lengths and breadths were determined. Inferential statistics was achieved by unpaired t-test, while bi-laterality was analyzed using paired t-test. Pearson correlation analysis was done to determine the correlation between height

and the measured parameters. Also, regression analysis was done and regression equation for stature estimation was derived. Confidence interval was set at 95%, therefore $P < 0.05$ was considered significant.

RESULT

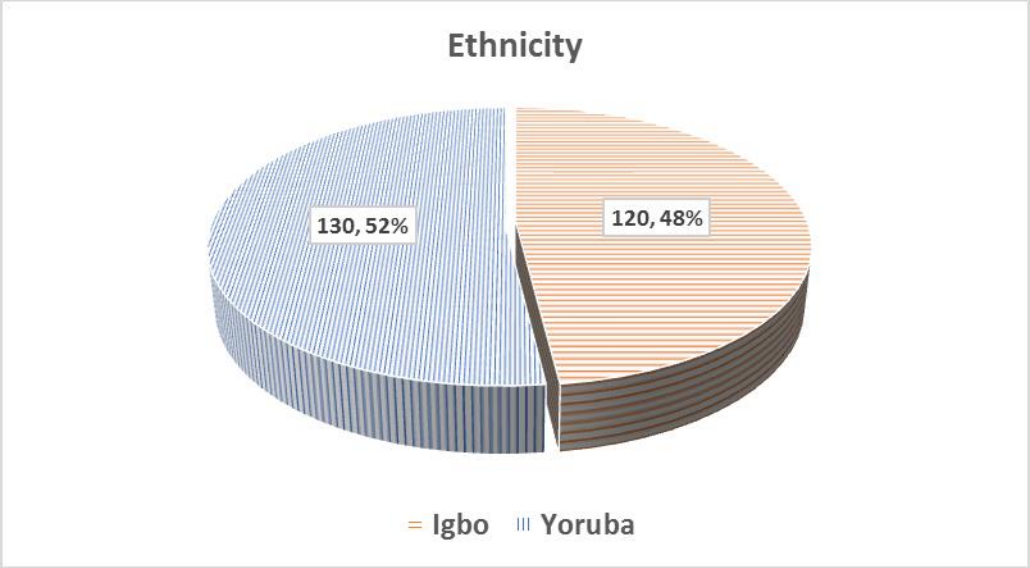

Figure 5: Distribution of the subjects according to ethnicity.

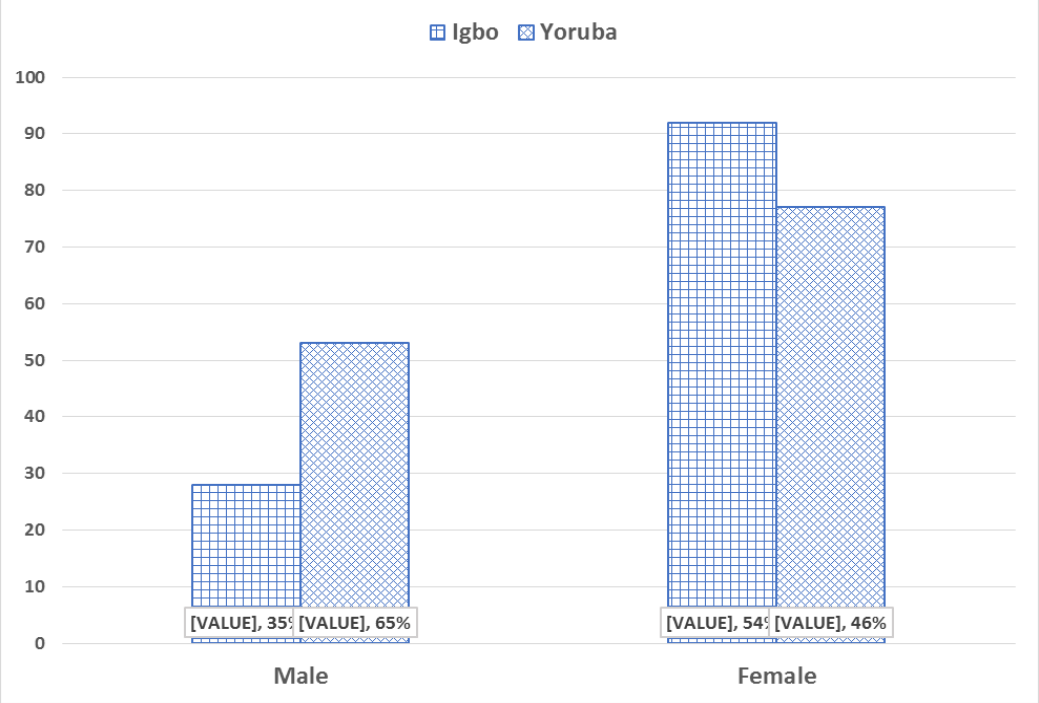

Figure 6: Distribution of the subjects according to sex and ethnicity.

Table 1: Descriptive statistics of the measured parameters and test of mean difference in Igbo subjects.

Measured parameters	Sex	N	Min	Max	Mean±±SD	T-test		
						df	t-value	P-value
Age (years)	Male	28	19.00	32.00	24.71±3.67	118.00	-0.62	0.54
	Female	92	18.00	54.00	25.46±5.99			
	Total	120	18.00	54.00	25.28±5.53			
Right thumb length (mm)	Male	28	50.25	72.20	61.21±5.11	118.00	0.24	0.81
	Female	92	51.36	73.36	60.92±5.74			

	Total	120	50.25	73.36	60.99±5.58			
Right thumb breadth (mm)	Male	28	17.99	22.97	20.66±1.32	118.00	2.05	**0.04***
	Female	92	15.62	23.10	20.00±1.54			
	Total	120	15.62	23.10	20.16±1.51			
Right thumb thickness (mm)	Male	28	14.93	21.33	17.69±1.76	118.00	0.00	1.00
	Female	92	13.27	21.84	17.69±1.92			
	Total	120	13.27	21.84	17.69±1.87			
Right hand length (mm)	Male	28	156.34	205.37	178.80±4.52	118.00	-0.27	0.79
	Female	92	145.22	293.19	179.81±18.17			
	Total	120	145.22	293.19	179.57±17.33			
Right hand breadth (mm)	Male	28	71.76	104.67	93.56±7.93	118.00	1.15	0.25
	Female	92	75.34	112.45	91.40±8.88			
	Total	120	71.76	112.45	91.91±8.68			
Left thumb length (mm)	Male	28	54.22	72.81	61.84±5.36	118.00	0.33	0.74
	Female	92	53.55	72.99	61.50±4.62			
	Total	120	53.55	72.99	61.58±4.78			
Left thumb breadth (mm)	Male	28	16.01	21.06	19.17±1.32	118.00	0.68	0.50
	Female	92	17.00	21.77	18.99±1.22			
	Total	120	16.01	21.77	19.03±1.24			
Left thumb thickness (mm)	Male	28	15.20	21.80	16.90±1.50	118.00	-0.47	0.64
	Female	92	13.13	22.45	17.83±10.42			
	Total	120	13.13	22.45	17.62±9.15			
Weight (kg)	Male	28	49.00	78.00	59.13±7.64	118.00	-1.16	0.25
	Female	92	44.00	89.00	61.22±8.58			
	Total	120	44.00	89.00	60.73±8.39			
Height (cm)	Male	28	156.00	199.00	182.43±0.93	118.00	-0.99	0.32
	Female	92	156.00	202.00	184.65±10.20			
	Total	120	156.00	202.00	184.13±10.37			

** = Significant at P < 0.05, **N** = Number of subjects, **Min** = Minimum, **Max** = Maximum, **SD** = Standard deviation*

Table 2: Descriptive statistics of the measured parameters and test of mean difference in Yoruba subjects.

Measured parameters	Sex	N	Min	Max	Mean±±SD	T-test		
						df	t-value	P-value
Age (years)	Male	53	18.00	52.00	32.11±9.50	128.00	1.11	0.27
	Female	77	18.00	50.00	30.35±8.41			
	Total	130	18.00	52.00	31.07±8.88			
Right thumb length (mm)	Male	53	51.59	73.53	63.11±5.97	128.00	0.79	0.43
	Female	77	53.22	73.00	62.28±5.81			
	Total	130	51.59	73.53	62.62±5.87			
Right thumb breadth (mm)	Male	53	16.69	23.01	20.07±1.58	128.00	0.10	0.92
	Female	77	15.62	23.10	20.04±1.64			
	Total	130	15.62	23.10	20.05±1.61			
Right thumb thickness (mm)	Male	53	13.00	21.84	17.66±2.11	128.00	0.23	0.82
	Female	77	13.27	21.36	17.58±1.88			
	Total	130	13.00	21.84	17.61±1.97			
Right hand length (mm)	Male	53	147.47	210.33	179.47±13.21	128.00	-0.10	0.92
	Female	77	145.22	293.19	179.77±18.76			
	Total	130	145.22	293.19	179.65±16.66			
Right hand breadth (mm)	Male	53	65.66	112.45	91.92±9.48	128.00	0.76	0.45
	Female	77	57.86	111.07	90.61±9.70			
	Total	130	57.86	112.45	91.15±9.60			
Left thumb length (mm)	Male	53	53.55	72.99	61.46±4.70	128.00	-0.15	0.88
	Female	77	53.12	72.81	61.59±4.93			
	Total	130	53.12	72.99	61.54±4.82			
Left thumb breadth (mm)	Male	53	15.00	21.76	18.96±1.46	128.00	0.37	0.71
	Female	77	15.39	22.78	18.87±1.40			

	Total	130	15.00	22.78	18.91±1.42			
Left thumb thickness (mm)	Male	53	13.00	22.45	18.44±13.66	128.00	1.00	0.32
	Female	77	13.13	21.80	16.88±1.71			
	Total	130	13.00	115.45	17.52±8.81			
Weight (kg)	Male	53	46.00	81.00	61.30±8.17	128.00	0.01	0.99
	Female	77	49.00	92.00	61.29±8.56			
	Total	130	46.00	92.00	61.30±8.37			
Height (cm)	Male	53	157.00	202.00	182.98±11.13	128.00	-0.36	0.72
	Female	77	156.00	201.00	183.64±9.58			
	Total	130	156.00	202.00	183.37±10.21			

** = Significant at P < 0.05, **N** = Number of subjects, **Min** = Minimum, **Max** = Maximum, **SD** = Standard deviation*

Table 3: Ethnic differences in the measured parameters among Igbo and Yoruba male subjects.

Measured parameters	Measured differences				t-test for Equality of Means		
	MD	SE	95% C.I of the Difference		df	t-value	P-value
			Lower	Upper			
Age (years)	-7.40	1.48	-10.34	-4.45	74.13	-5.01	**0.00***
Right thumb length (mm)	-1.89	1.33	-4.54	0.75	79.00	-1.42	0.16
Right thumb breadth (mm)	0.60	0.35	-0.09	1.29	79.00	1.72	0.09
Right thumb thickness (mm)	0.03	0.47	-0.90	0.96	79.00	0.07	0.95
Right hand length (mm)	-0.66	3.19	-7.02	5.69	79.00	-0.21	0.84
Right hand breadth (mm)	1.64	2.10	-2.54	5.81	79.00	0.78	0.44
Left thumb length (mm)	0.38	1.15	-1.92	2.67	79.00	0.33	0.75
Left thumb breadth (mm)	0.21	0.33	-0.45	0.87	79.00	0.64	0.52
Left thumb thickness (mm)	-1.54	2.60	-6.72	3.63	79.00	-0.59	0.55
Weight (kg)	-2.18	1.87	-5.89	1.54	79.00	-1.17	0.25
Height (cm)	-0.55	2.59	-5.70	4.59	79.00	-0.21	0.83

** = Significant at P < 0.05, **MD** = Mean difference, **SE** = Standard error, **C.I** = Confidence interval*

Table 4: Ethnic differences in the measured parameters among Igbo and Yoruba female subjects.

Measured parameters	Measured differences				t-test for Equality of Means		
	MD	SE	95% C.I of the Difference		df	t-value	P-value
			Lower	Upper			
Age (years)	-4.89	1.14	-7.16	-2.63	134.02	-4.28	**0.00***
Right thumb length	-1.36	0.89	-3.12	0.40	167.00	-1.53	0.13
Right thumb breadth	-0.03	0.25	-0.51	0.45	167.00	-0.12	0.90
Right thumb thickness	0.11	0.29	-0.47	0.69	167.00	0.37	0.71
Right hand length	0.04	2.85	-5.58	5.66	167.00	0.01	0.99
Right hand breadth	0.79	1.43	-2.03	3.62	167.00	0.55	0.58
Left thumb length	-0.09	0.74	-1.55	1.36	167.00	-0.13	0.90
Left thumb breadth	0.12	0.20	-0.27	0.52	167.00	0.62	0.54
Left thumb thickness	0.96	1.20	-1.42	3.33	167.00	0.80	0.43
Weight (kg)	-0.07	1.32	-2.68	2.54	167.00	-0.05	0.96
Height (cm)	1.02	1.53	-2.01	4.04	167.00	0.66	0.51

** = Significant at P < 0.05, **MD** = Mean difference, **SE** = Standard error, **C.I** = Confidence interval*

Table 5: Correlation of hand and thumb dimensions with stature in Igbo and Yoruba subjects.

Measured parameters		Height (m)	
		IGBO	YORUBA
Male subjects [N = 28]			
Age (years)	Pearson Correlation	-0.055	-0.080
	Sig. (2-tailed)	0.781	0.571
Right thumb length	Pearson Correlation	0.240	-0.239
	Sig. (2-tailed)	0.219	0.085
Right thumb breadth	Pearson Correlation	-0.012	0.155
	Sig. (2-tailed)	0.951	0.267
Right thumb thickness	Pearson Correlation	0.139	0.285*
	Sig. (2-tailed)	0.481	0.038

Right hand length	Pearson Correlation	0.139	-0.028
	Sig. (2-tailed)	0.482	0.840
Right hand breadth	Pearson Correlation	0.092	-0.050
	Sig. (2-tailed)	0.642	0.721
Left thumb length	Pearson Correlation	-0.030	0.083
	Sig. (2-tailed)	0.879	0.554
Left thumb breadth	Pearson Correlation	0.154	0.239
	Sig. (2-tailed)	0.433	0.084
Left thumb thickness	Pearson Correlation	-0.091	0.093
	Sig. (2-tailed)	0.643	0.508
Female subjects [N = 92]			
Age (years)	Pearson Correlation	0.218*	0.158
	Sig. (2-tailed)	0.037	0.170
Right thumb length	Pearson Correlation	0.161	-0.129
	Sig. (2-tailed)	0.124	0.262
Right thumb breadth	Pearson Correlation	0.085	0.079
	Sig. (2-tailed)	0.422	0.497
Right thumb thickness	Pearson Correlation	0.163	0.052
	Sig. (2-tailed)	0.120	0.656
Right hand length	Pearson Correlation	-0.181	-0.221
	Sig. (2-tailed)	0.084	0.054
Right hand breadth	Pearson Correlation	0.005	0.197
	Sig. (2-tailed)	0.966	0.086
Left thumb length	Pearson Correlation	0.083	0.089
	Sig. (2-tailed)	0.431	0.442
Left thumb breadth	Pearson Correlation	0.181	0.185
	Sig. (2-tailed)	0.085	0.108
Left thumb thickness	Pearson Correlation	0.041	-0.140
	Sig. (2-tailed)	0.699	0.223

* = Correlation is significant at the 0.05 level (2-tailed), **N** = Number of subjects

Table 6: Model summary for the regression analysis for stature estimation using the measured parameters among Igbo subjects.

Model	R	R^2	Adjusted R^2	S.E of the Estimate	ANOVA		
					df	F-value	P-value
Male							
Height	0.43	0.19	-0.16	11.75	8.00	0.54	0.81
Female							
Height	0.36	0.13	0.05	9.95	8.00	1.57	0.15

***** = *Significant at P < 0.05,* ***R*** *= Pearson correlation,* $\boldsymbol{R^2}$ *= Coefficient of determination,* ***ANOVA*** *= Analysis of variance*

Predictors: (Constant), Left thumb thickness, Right hand length, left thumb breadth, Right thumb thickness, Left thumb length, Right thumb breadth, Right hand breadth, Right thumb length

Table 7: Model summary for the regression analysis for stature estimation using the measured parameters among Yoruba subjects.

Model	R	R^2	Adjusted R^2	S.E of the Estimate	ANOVA		
					df	F-value	P-value
Male							
Height	0.46	0.22	0.07	10.72	8	1.51	0.18
Female							
Height	0.37	0.14	0.04	9.39	**8**	1.38	0.22

***** = *Significant at P < 0.05,* ***R*** *= Pearson correlation,* $\boldsymbol{R^2}$ *= Coefficient of determination,* ***ANOVA*** *= Analysis of variance*

Predictors: (Constant), Left thumb thickness, Right hand length, left thumb breadth, Right thumb thickness, Left thumb length, Right thumb breadth, Right hand breadth, Right thumb length.

Table 8: Multivariate regression analysis of stature, using the measured parameters in Igbo subjects.

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	P-value
	B	S.E.	Beta		
Male					
(Constant)	133.32	56.05		2.38	**0.03***
Right thumb length	1.39	0.95	0.65	1.46	0.16
Right thumb breadth	-4.25	3.98	-0.51	-1.07	0.30
Right thumb thickness	0.41	1.76	0.07	0.23	0.82
Right hand length	0.15	0.18	0.20	0.84	0.41
Right hand breadth	-0.36	0.50	-0.26	-0.73	0.48
Left thumb length	0.21	0.62	0.10	0.34	0.74
Left thumb breadth	1.31	2.76	0.16	0.48	0.64
Left thumb thickness	0.80	2.09	0.11	0.38	0.71
Female					
(Constant)	159.70	23.81		6.71	**0.00***
Right thumb length	0.45	0.34	0.25	1.34	0.18
Right thumb breadth	-0.43	0.89	-0.06	-0.48	0.63
Right thumb thickness	0.76	0.57	0.14	1.34	0.18
Right hand length	-0.10	0.06	-0.18	-1.74	0.09
Right hand breadth	-0.32	0.19	-0.28	-1.66	0.10
Left thumb length	0.21	0.25	0.10	0.86	0.39
Left thumb breadth	1.35	1.28	0.16	1.05	0.30
Left thumb thickness	0.08	0.10	0.08	0.74	0.46

***** = *Significant at P < 0.05*, ***SE*** *= Standard error*, ***MFL*** *= Middle finger length*

Table 9: Multivariate regression analysis of stature using the measured parameters in Yoruba subjects.

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	P-value
	B	S.E.	Beta		
(Constant)	163.75	34.67		4.72	**0.00**
Male					
Right thumb length	-0.45	0.28	-0.24	-1.62	0.11
Right thumb breadth	0.01	1.54	0.00	0.01	1.00
Right thumb thickness	0.77	0.88	0.15	0.87	0.39
Right hand length	0.07	0.12	0.08	0.55	0.59
Right hand breadth	-0.47	0.22	-0.40	-2.10	**0.04**
Left thumb length	0.23	0.37	0.10	0.64	0.53
Left thumb breadth	2.63	1.61	0.34	1.63	0.11
Left thumb thickness	0.07	0.11	0.08	0.57	0.57
Female					
(Constant)	192.19	25.51		7.53	**0.00**
Right thumb length	-0.19	0.19	-0.11	-0.96	0.34
Right thumb breadth	-0.78	0.87	-0.13	-0.89	0.38
Right thumb thickness	0.26	0.60	0.05	0.43	0.67
Right hand length	-0.11	0.06	-0.22	-1.92	0.06
Right hand breadth	0.16	0.16	0.16	1.00	0.32
Left thumb length	0.22	0.25	0.11	0.86	0.39
Left thumb breadth	0.96	1.04	0.14	0.93	0.36
Left thumb thickness	-0.67	0.66	-0.12	-1.00	0.32

***** = *Significant at P < 0.05*, ***SE*** *= Standard error*, ***MFL*** *= Middle finger length*

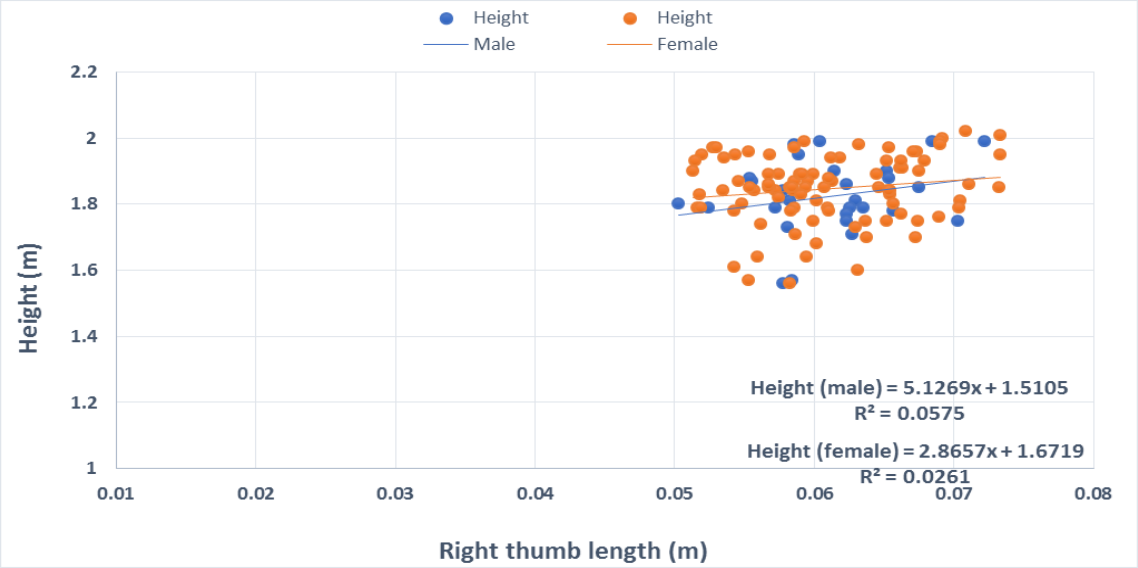

Figure 7: Scatterplot of height against right thumb length in Igbo subjects.

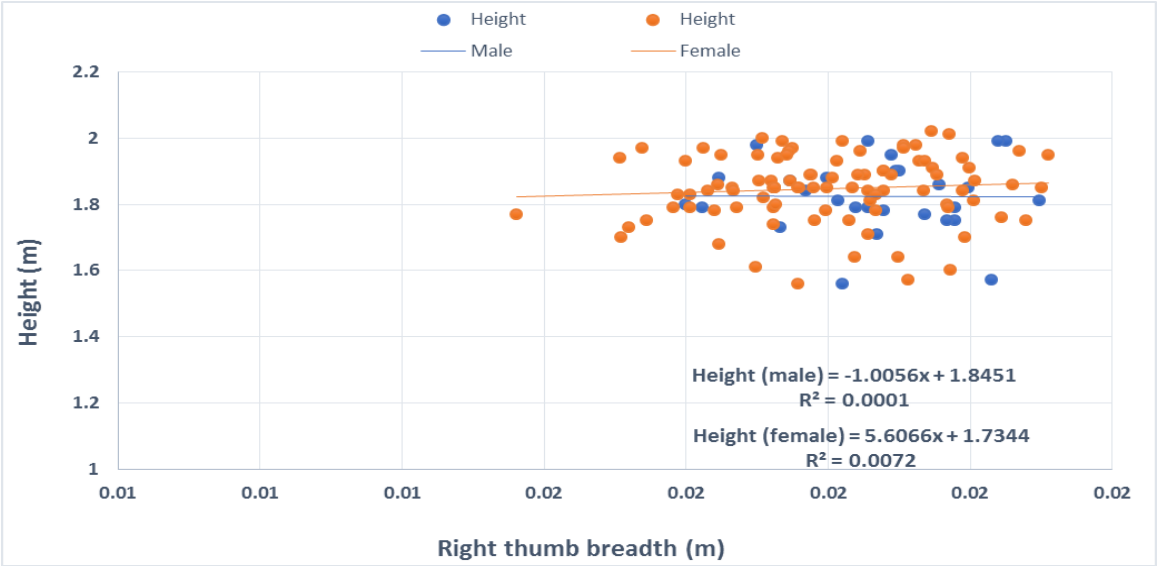

Figure 8: Scatterplot of height against right thumb length in Igbo subjects.

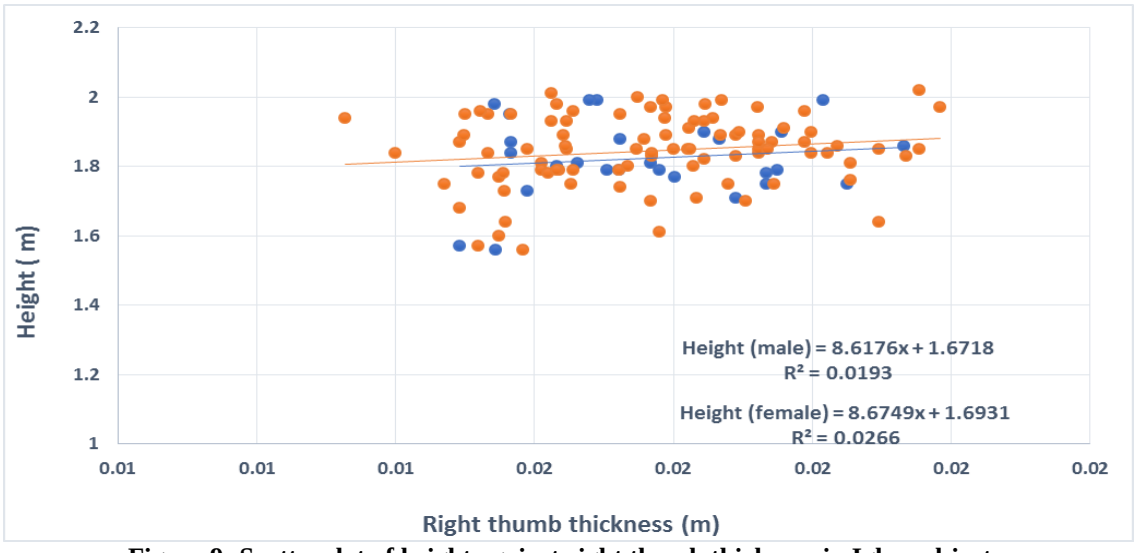

Figure 9: Scatterplot of height against right thumb thickness in Igbo subjects.

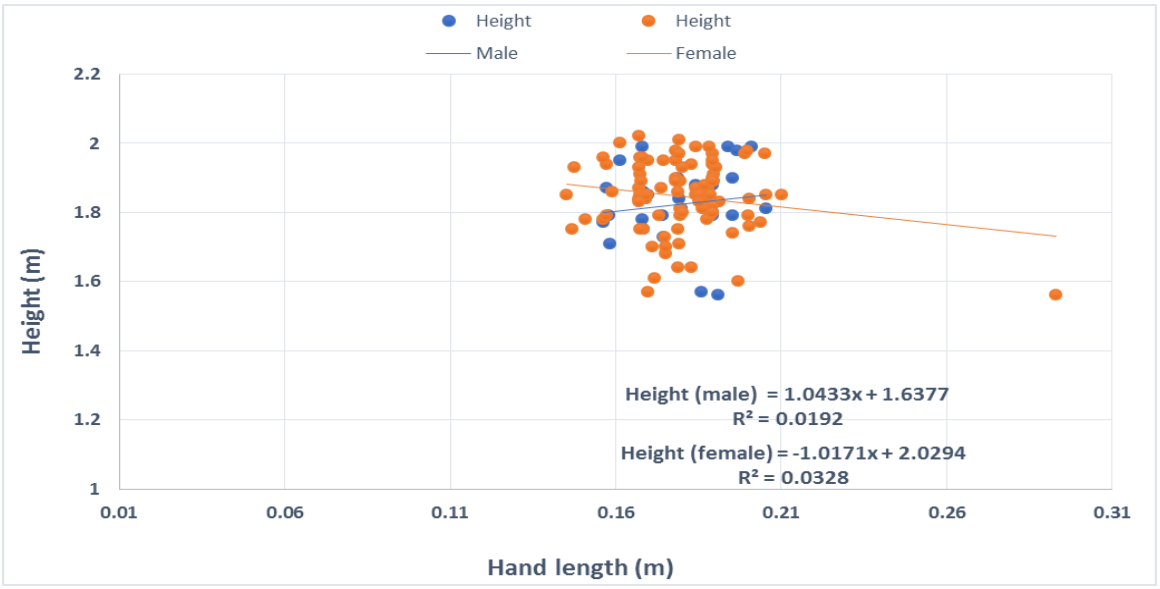

Figure 10: Scatterplot of height against hand length in Igbo subjects.

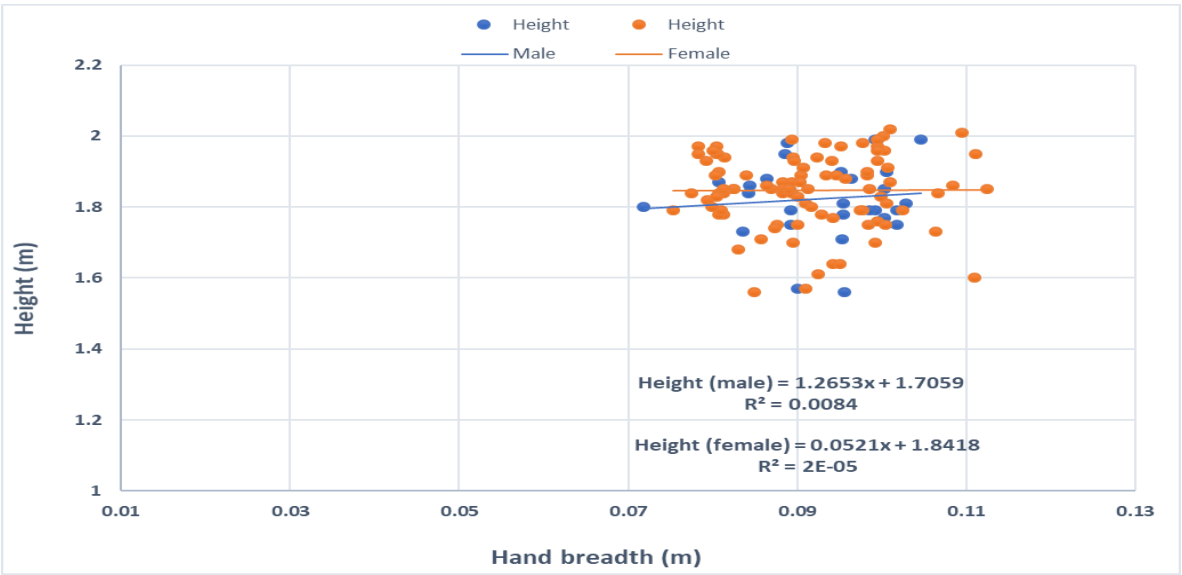

Figure 11: Scatterplot of height against right thumb thickness in Igbo subjects.

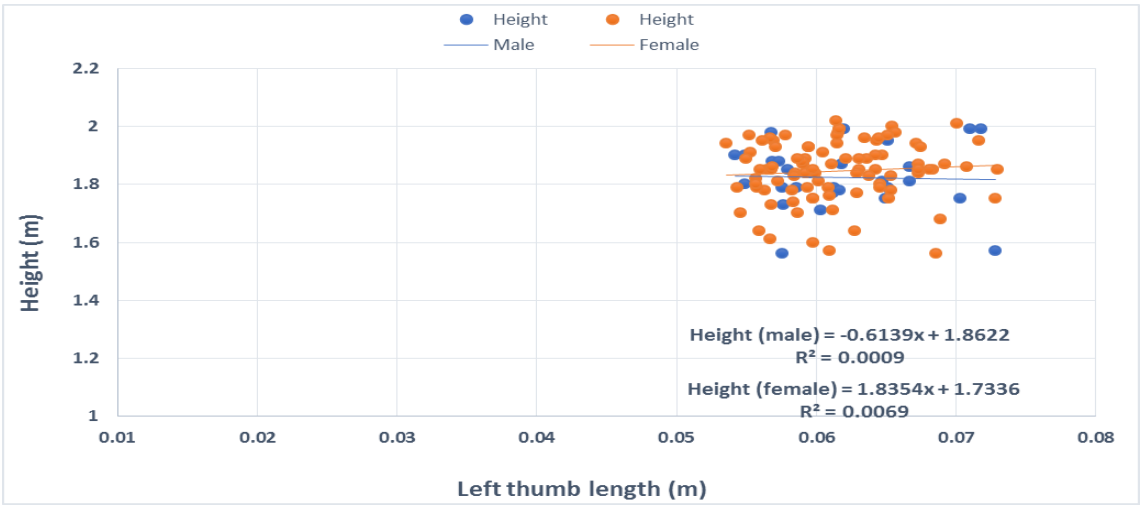

Figure 12: Scatterplot of height against left thumb length in Igbo subjects.

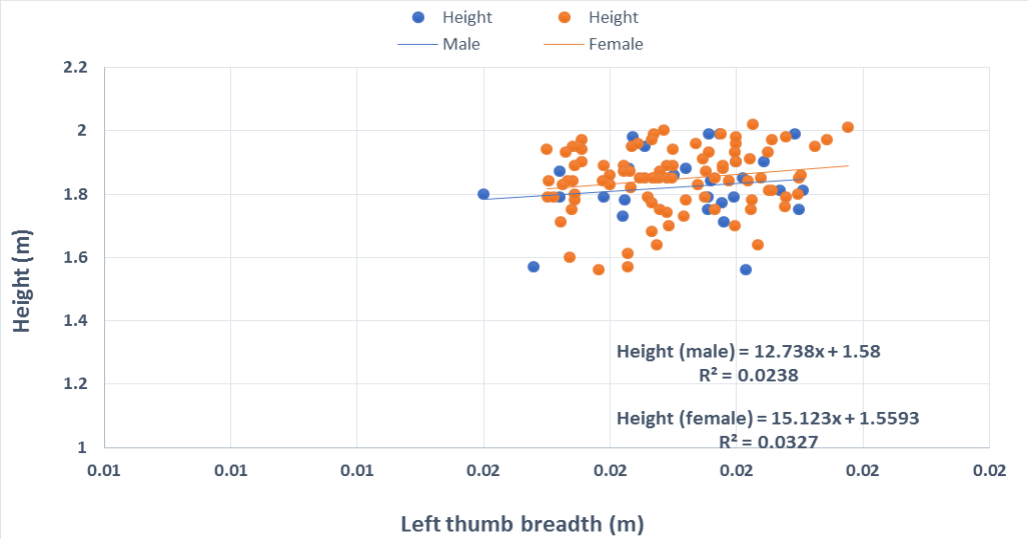

Figure 13: Scatterplot of height against left thumb breadth in Igbo subjects.

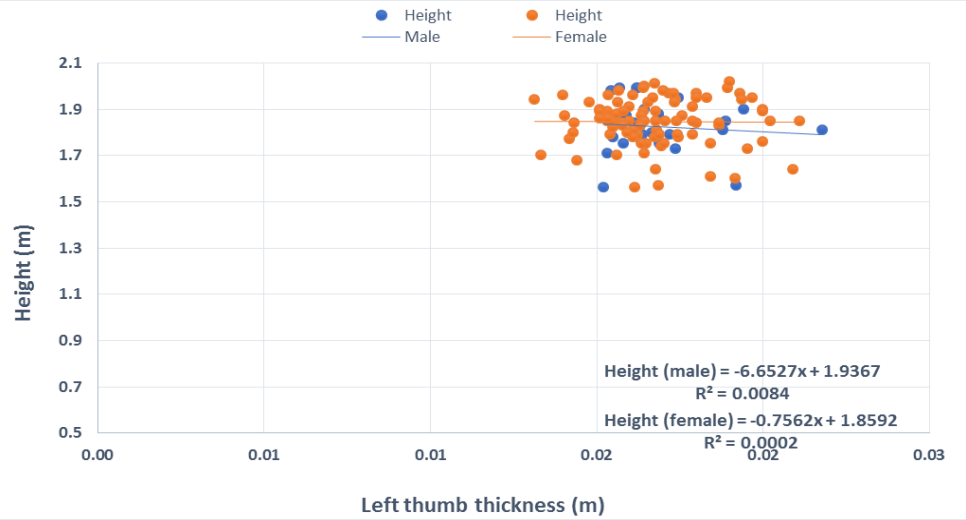

Figure 14: Scatterplot of height against left thumb thickness in Igbo subjects.

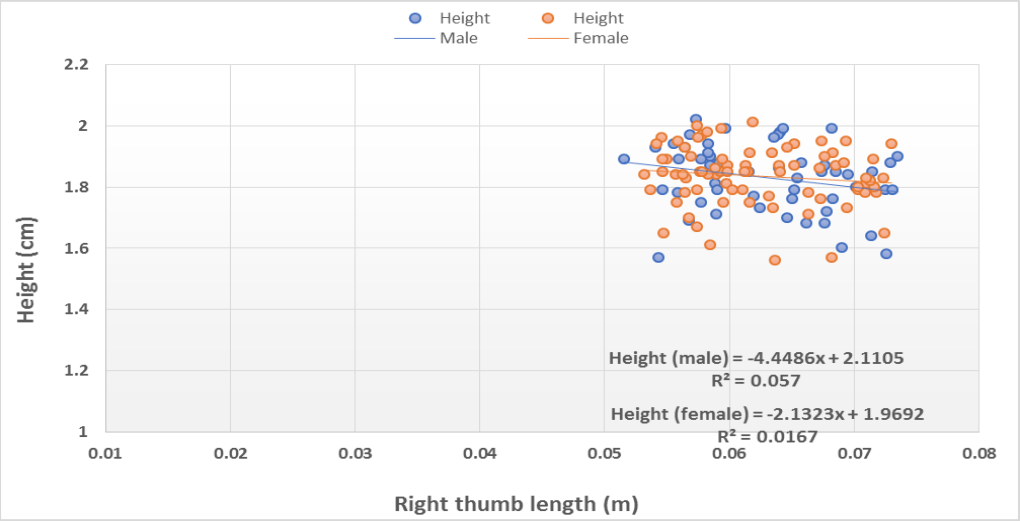

Figure 15: Scatterplot of height against right thumb length in Yoruba subjects.

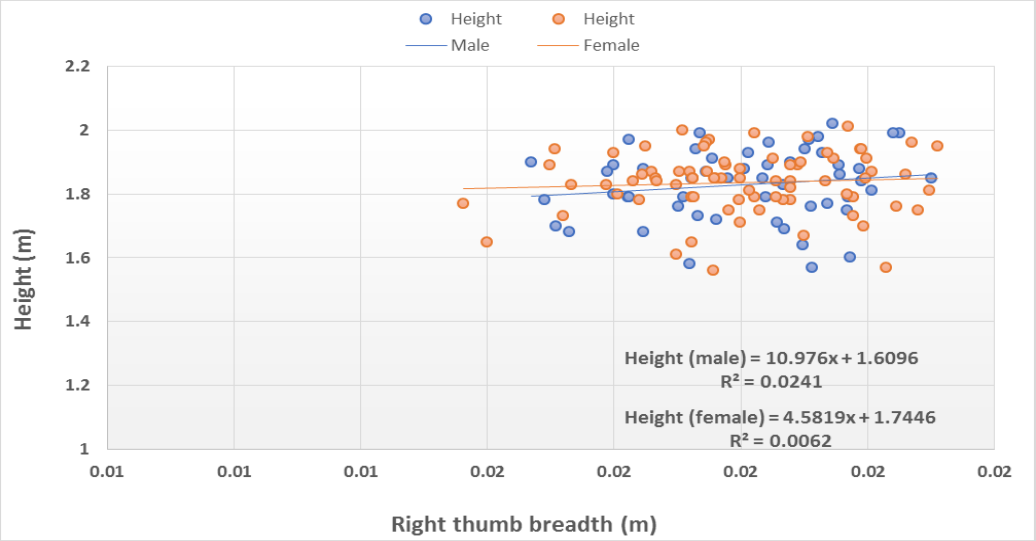

Figure 16: Scatterplot of height against right thumb breadth in Yoruba subjects.

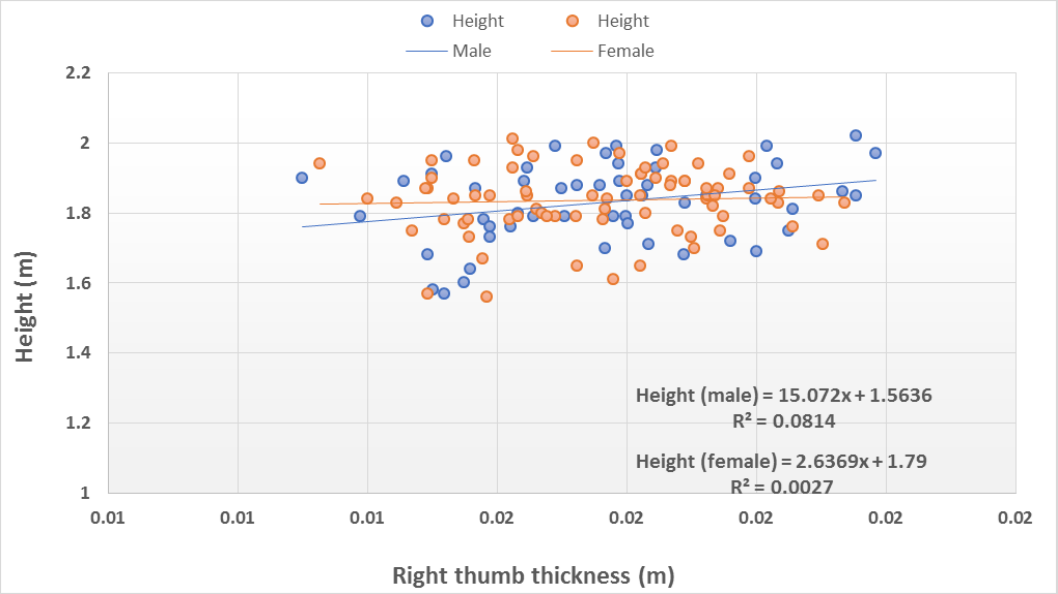

Figure 17: Scatterplot of height against right thumb thickness in Yoruba subjects.

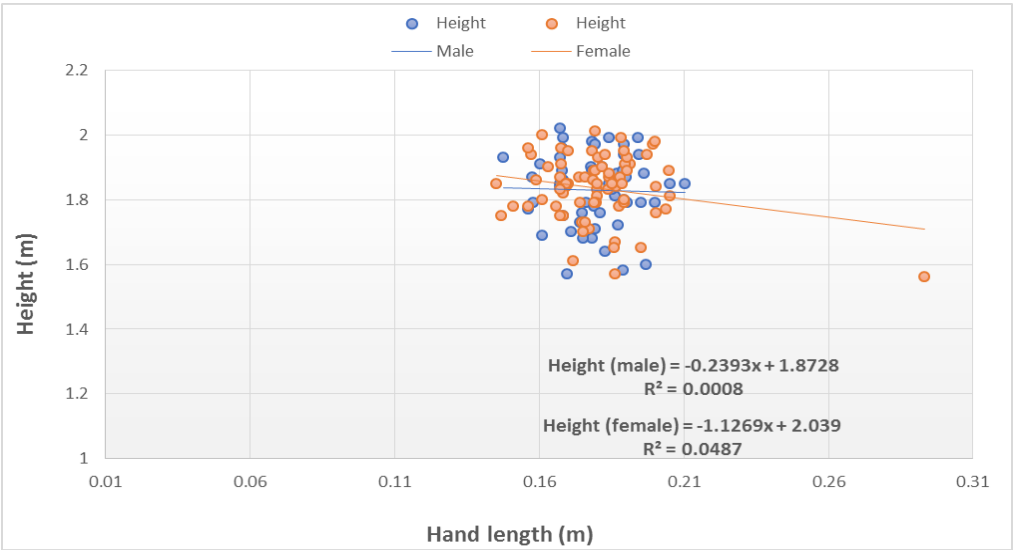

Figure 18: Scatterplot of height against hand length in Yoruba subjects.

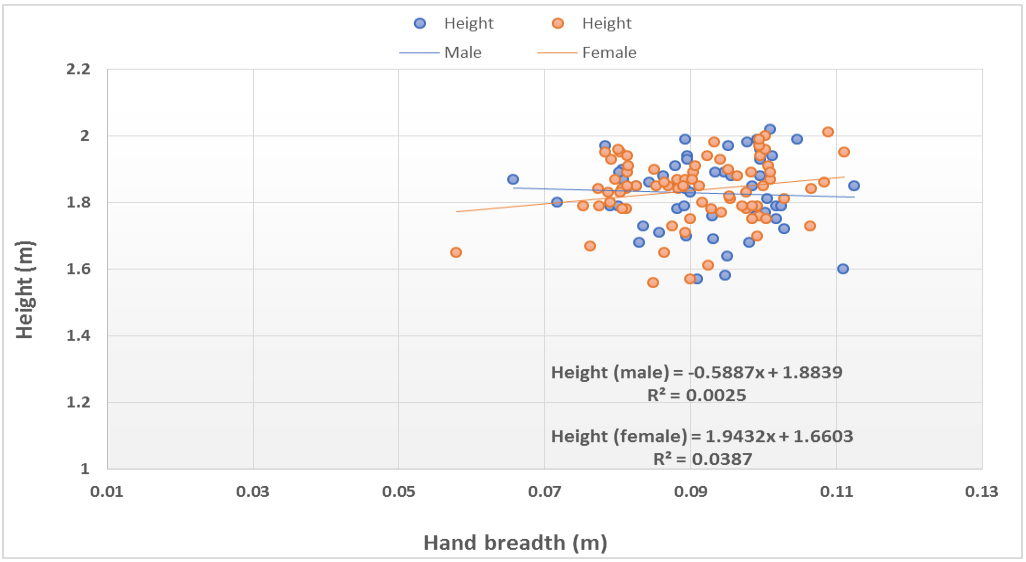

Figure 19: Scatterplot of height against hand breadth in Yoruba subjects.

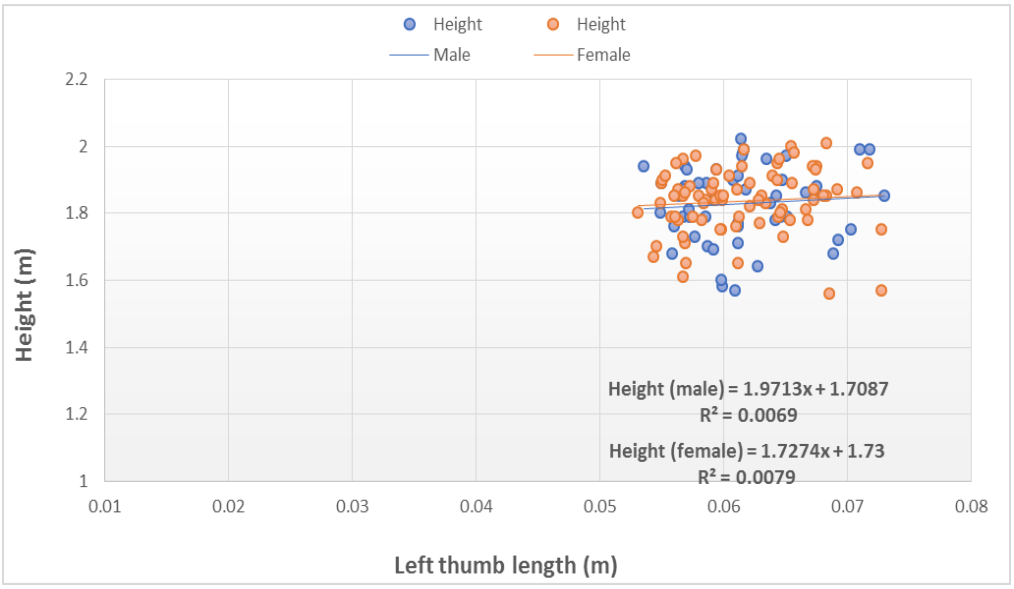

Figure 20: Scatterplot of height against left thumb length in Yoruba subjects.

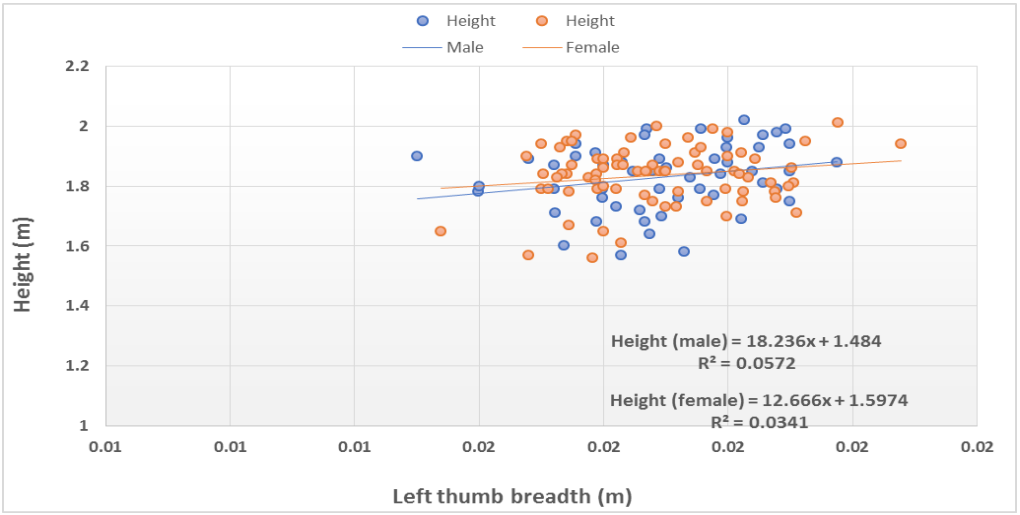

Figure 21: Scatterplot of height against left thumb breadth in Yoruba subjects.

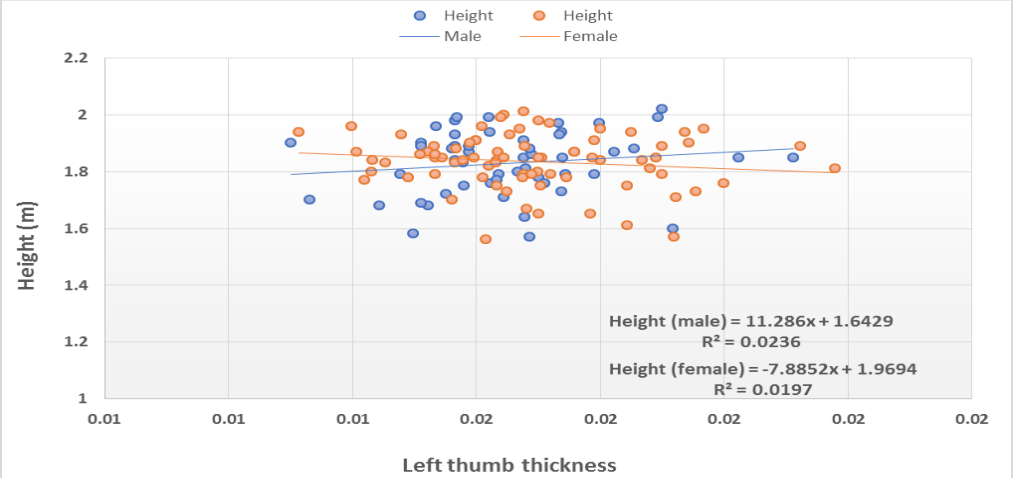

Figure 22: Scatterplot of height against left thumb thickness in Yoruba subjects.

Table 10: Summary of correlation and univariate regression analysis for estimating stature using the measured parameters in Igbos.

Predictors	Prediction model			
	r	***R*^{2} (%)**	***P*-value**	***R*^{E}**
Male subjects				
Right thumb length	0.24	5.75	0.22	5.1269x + 1.5105
Right thumb breadth	-0.01	0.01	0.95	-1.0056x + 1.8451
Right thumb thickness	0.14	1.93	0.48	8.6176x + 1.6718
Hand length	0.14	1.92	0.48	1.0433x + 1.6377
Hand breadth	0.09	0.84	0.64	1.2653x + 1.7059
Left thumb length	-0.03	0.09	0.88	-0.6139x + 1.8622
Left thumb breadth	0.15	2.38	0.43	12.738x + 1.58
Left thumb thickness	-0.09	0.84	0.64	-6.6527x + 1.9367
Female subjects				
Right thumb length	0.16	2.61	0.12	2.8657x + 1.6719
Right thumb breadth	0.09	0.72	0.42	5.6066x + 1.7344
Right thumb thickness	0.16	2.66	0.12	8.6749x + 1.6931
Hand length	-0.18	3.28	0.08	-1.0171x + 2.0294
Hand breadth	0.01	0.00	0.97	0.0521x + 1.8418
Left thumb length	0.08	0.69	0.43	1.8354x + 1.7336
Left thumb breadth	0.18	3.27	0.09	15.123x + 1.5593
Left thumb thickness	0.04	0.02	0.70	-0.7562x + 1.8592

r *= Pearson Correlation,* ***R*^{2}** *= Coefficient of determination,* ***R*^{E}** *= Regression equation*

Table 11: Summary of correlation and univariate regression analysis for estimating stature using the measured parameters in Yorubas.

Predictors	Prediction model			
	r	***R*^{2} (%)**	***P*-value**	***R*^{E}**
Male subjects				
Right thumb length	-0.24	5.70	0.09	-4.4486x + 2.1105
Right thumb breadth	0.16	2.41	0.27	10.976x + 1.6096
Right thumb thickness	0.29*	8.14	0.04	15.072x + 1.5636
Hand length	-0.03	0.08	0.84	-0.2393x + 1.8728
Hand breadth	-0.05	0.25	0.72	-0.5887x + 1.8839
Left thumb length	0.08	0.69	0.55	1.9713x + 1.7087
Left thumb breadth	0.24	5.72	0.08	18.236x + 1.484
Left thumb thickness	0.09	2.36	0.51	11.286x + 1.6429
Female subjects				
Right thumb length	-0.13	1.67	0.26	-2.1323x + 1.9692
Right thumb breadth	0.08	0.62	0.50	4.5819x + 1.7446
Right thumb thickness	0.05	0.27	0.66	2.6369x + 1.79

Hand length	-0.22	4.87	0.05	-1.1269x + 2.039
Hand breadth	0.20	3.87	0.09	1.9432x + 1.6603
Left thumb length	0.09	0.79	0.44	1.7274x + 1.73
Left thumb breadth	0.19	3.41	0.11	12.666x + 1.5974
Left thumb thickness	-0.14	1.97	0.22	-7.8852x + 1.9694

r *= Pearson Correlation,* $\boldsymbol{R^2}$ *= Coefficient of determination,* $\boldsymbol{R^E}$ *= Regression equation, * = Correlation is significant at the 0.05 level (2-tailed)*

INTERPRETATION OF RESULTS

As shown in figure 4.1, a total of 250 subjects were involved in the study of which 120 of them (48%) are Igbos, while 130 (52%) are Yorubas.

In figure 4.2, it was seen that 28 (35%) and 53 (41%) of the male subjects were Igbo and Yoruba respectively, while 92 (54%) and 77 (59%) of the female subjects were Igbo, and Yoruba respectively. This distribution is according to sex and ethnicity.

Table 4.1 shows the mean values (in mm) for the measured parameters include; age [male (24.71 ± 3.67); female (25.46 ± 5.99)], Right thumb length [male (61.21 ± 5.11); female (60.92 ± 5.74)], Right thumb breadth [male (20.66 ± 1.32); female (20.00 ± 1.54)], Right thumb thickness [male (17.69 ± 1.76); female (17.69 ± 1.92)], Right hand length [male (178.80 ± 14.52); female (179.81 ± 18.17)], Right hand breadth [male (93.56 ± 7.93); female (91.40 ± 8.88)], left thumb length [male (61.84 ± 5.36); female (61.50 ± 4.62)], left thumb breadth [male (19.17 ± 1.32); female (18.99 ± 1.22)], left thumb thickness [male (16.90 ± 1.50); female (17.83 ± 10.42)], weight [male (59.13 ± 7.64); female (61.22 ± 8.58)] and height [male (182.43 ± 10.93); female (184.65 ± 10.20)]. Except for right thumb breadth ($t = 2.05$; $P = 0.04$), all other measured parameters were not statistically significant at $P < 0.05$. Hence right thumb breadth shows sexual dimorphism in Igbos.

Table 4.2 shows the descriptive statistics and test of mean difference in the measured parameters among Yoruba subjects. The mean values (in mm) for the measured parameters include; age [male (32.11 ± 9.50); female (30.35 ± 8.41)], Right thumb length [male (63.11 ± 5.97); female (62.28 ± 5.81)], Right thumb breadth [male (20.07 ± 1.58); female (20.04 ± 1.64)], Right thumb thickness [male (17.66 ± 2.11); female (17.58 ± 1.88)], Right hand length [male (179.47 ± 13.21); female (179.77 ± 18.76)], Right hand breadth [male (91.92 ± 9.48); female (90.61 ± 9.70)], left thumb length [male (61.46 ± 4.70); female (61.59 ± 4.93)], left thumb breadth [male (18.96 ± 1.46); female (18.87 ± 1.40)], left thumb thickness [male (18.44 ± 13.66); female (16.88 ± 1.71)], weight [male (61.30 ± 8.17); female (61.29 ± 8.56)] and height [male (182.98 ± 11.13); female (183.64 ± 9.58)]. All measured parameters in Yoruba subjects did not show sexual dimorphism.

In table 4.3, ethnic differences in the measured parameters were presented. Except for age (t-value = -5.01; P = 0.00), a significant difference was not observed in all measured parameters at $P < 0.05$. Hence the measured parameters did not show the ethnic difference in Igbo and Yoruba male subjects.

In table 4.4, ethnic differences in the measured parameters was also presented. Except for age (t-value = -4.28; P = 0.00), significant difference was not observed in all measured parameters at $P < 0.05$. Hence the measured parameters did not show ethnic difference in Igbo and Yoruba female subjects.

In table 4.5, a correlation between height and other measured parameters was presented. For Igbo male subjects, no significant correlation was observed between height and other measured parameters, while in Yoruba males, a very weak noteworthy correlation was seen in the right thumb thickness. Except for age in Igbo females, insignificant connection was observed between height and other measured parameters in females.

Table 4.6 highlights that male subjects showed weak correlation when all measured parameters were involved in estimating height ($r = 0.43$). Also using all measured hand and thumb dimensions, stature can be estimated with 19% accuracy. For females, very weak correlation ($r = 0.36$) was also observed when all measured parameters were used to estimate height. This reveals a 13% accuracy in height estimation.

Table 4.7 shows a multivariate regression analysis of height and other measured parameters in Yoruba subjects. For male subjects, weak correlation was observed when all measured parameters were involved in stature estimation ($r = 0.46$). It shows that using all measured hand and thumb dimensions, stature can be

estimated with 22% accuracy. For females, very weak correlation (r = 0.37) was also observed when all measured parameters were used to estimate height. It shows that when used together, height can be estimated with 14% accuracy.

Regression equation for stature: Using all measured parameters.

Height in Igbo (male) = 133.32 + 1.39 (Right thumb length) - 4.25 (Right thumb breadth) + 0.41 (Right thumb thickness) + 0.15 (Right hand length) - 0.36 (Right hand breadth) + 0.21 (Left thumb length) + 1.31 (Left thumb breadth) + 0.80 (Left thumb thickness).

Height in Igbo (female) = 159.70 + 0.45 (Right thumb length) - 0.43 (Right thumb breadth) + 0.76 (Right thumb thickness) - 0.10 (Right hand length) - 0.32 (Right hand breadth) + 0.21 (Left thumb length) + 1.35 (Left thumb breadth) + 0.08 (Left thumb thickness).

Regression equation for stature: Using all measured parameters.

Height in Yoruba(male) = 163.75 - 0.45 (Right thumb length) + 0.01 (Right thumb breadth) + 0.77 (Right thumb thickness) + 0.07 (Right hand length) - 0.47 (Right hand breadth) + 0.23 (Left thumb length) + 2.63 (Left thumb breadth) + 0.07 (Left thumb thickness).

Height in Yoruba(female) = 192.19 - 0.19 (Right thumb length) - 0.78 (Right thumb breadth) + 0.26 (Right thumb thickness) - 0.11 (Right hand length) + 0.16 (Right hand breadth) + 0.22 (Left thumb length) + 0.96 (Left thumb breadth) - 0.67 (Left thumb thickness).

Table 4.10 shows the summary of univariate regression analysis of height and other measured parameters. Height can be estimated in Igbo males using the following regression equation.

(1) Height (using the right thumb length) = 5.1269x + 1.5105, with 5.75% accuracy.
(2) Height (using the right thumb breadth) = -1.0056x + 1.8451, with 0.01% accuracy.
(3) Height (using the right thumb thickness) = 8.6176x + 1.6718, with 1.93% accuracy.
(4) Height (using the hand length) = 1.0433x + 1.6377, with 1.92% accuracy.
(5) Height (using hand breadth) = 1.2653x + 1.7059, with 0.84% accuracy.
(6) Height (using left thumb length) = -0.6139x + 1.8622, with 0.09% accuracy.
(7) Height (using left thumb breadth) = 12.738x + 1.58, with 2.38% accuracy.
(8) Height (using left thumb thickness) = -6.6527x + 1.9367, with 0.84% accuracy.

For female Igbo subjects, height can be estimated from the measured parameters using the following regression equation.

(1) Height (using the right thumb length) = 2.8657x + 1.6719, with 2.61% accuracy.
(2) Height (using the right thumb breadth) = 5.6066x + 1.7344, with 0.72% accuracy.
(3) Height (using the right thumb thickness) = 8.6749x + 1.6931, with 2.66% accuracy.
(4) Height (using the hand length) = -1.0171x + 2.0294, with 3.28% accuracy.
(5) Height (using hand breadth) = 0.0521x + 1.8418, with 0.00% accuracy.
(6) Height (using left thumb length) = 1.8354x + 1.7336, with 0.69% accuracy.
(7) Height (using left thumb breadth) = 15.123x + 1.5593, with 3.27% accuracy.
(8) Height (using left thumb thickness) = -0.7562x + 1.8592, with 0.02% accuracy.

Table 4.11 summarizes the univariate regression analysis of height and other measured parameters. Height can be estimated in Yoruba males using the following regression equation.

1. Height (using the right thumb length) = -4.4486x + 2.1105, with 5.70% accuracy.
2. Height (using the right thumb breadth) = 10.976x + 1.6096, with 2.41% accuracy.
3. Height (using the right thumb thickness) = 15.072x + 1.5636, with 8.14% accuracy.
4. Height (using the hand length) = -0.2393x + 1.8728, with 0.08% accuracy.
5. Height (using hand breadth) = -0.5887x + 1.8839, with 0.25% accuracy.
6. Height (using left thumb length) = 1.9713x + 1.7087, with 0.69% accuracy.
7. Height (using left thumb breadth) = 18.236x + 1.484, with 5.72% accuracy.
8. Height (using left thumb thickness) = 11.286x + 1.6429, with 2.36% accuracy.

For female Yoruba subjects, height can be estimated from the measured parameters using the following regression equation.

1. Height (using the right thumb length) = -2.1323x + 1.9692, with 1.67% accuracy.
2. Height (using the right thumb breadth) = 4.5819x + 1.7446, with 0.62% accuracy.
3. Height (using the right thumb thickness) = 2.6369x + 1.79, with 0.27% accuracy.
4. Height (using the hand length) = -1.1269x + 2.039, with 4.87% accuracy.
5. Height (using hand breadth) = 1.9432x + 1.6603, with 3.87% accuracy.
6. Height (using left thumb length) = 1.7274x + 1.73, with 0.79% accuracy.
7. Height (using left thumb breadth) = 12.666x + 1.5974, with 3.41% accuracy.
8. Height (using left thumb thickness) = -7.8852x + 1.9694, with 1.97% accuracy.

DISCUSSION

The present study's focus was on determining stature using anthropometric parameters of the thumb to establishing standard values in Igbo and Yoruba populations residing in Rivers State. Suffice it to say that adequate literature has been reported on stature estimation with respect to hand dimensions, in various Nigerian populations (Numan *et al.*,2013; Igbigbi *et al.*,2018; Uche *et al.*, 2020; Oladipo *et al.*, 2009; Katwal *et al.*, 2021). Nevertheless, it is imperative to note that arguably none of these works evaluated the assessment of stature using thumb dimensions of the Igbo and Yoruba populations.

In this present study, the male Igbo participants had a mean height of 182.43$\pm$10.93mm, while that of females had 184.65$\pm$10.20mm. There was no noteworthy gender difference in height in Igbo subjects. The Yoruba male subjects had a mean height of 182.98$\pm$11.13mm, while the female subjects had a mean height of 183.64$\pm$9.58mm. There was no significant gender difference in height in Yoruba subjects. This shows that the Igbos are taller than the Yorubas, and the female subjects are taller than the male subjects.

In comparison with a study done by Numan *et al* (2013), the values of the present study's mean height were higher compared to their study. This could be due to differences in the selected age groups of both studies as Numan *et al* (2015) examined students in the age group of 18-35, whereas this study considered the age group of 15-54.

In other studies, the mean height values of males are statistically high compared to that of females [Oladipo *et al* (2017); Agnihotri *et al* (2008); Anas *et al* (2010); Ilayperuma *et al* (2009)].

This is not in concordance with the present study which shares that although the females were slightly taller, the gender differences are not significant. This could be a result of the higher number of the female population as stated in this present study.

Assessment of the hand length and hand breadth of Igbo and Yoruba subjects

Morphometry of the hand provides valuable proof in a crime scene inquiry which helps in the estimation of the stature of a criminal. Studies reveal that hand dimensions differ from one race to another therefore formulae derived for one ethnic group may not be suitable to another ethnic group and this may be ascribed to biological and environmental factors (Krishan., 2006). The measurements in this present study were taken from the right hand of Igbo and Yoruba subjects as anthropometric measurements on the dominant hand of a person give more objective results (Nuriye *et al.*, 2018).

This study reveals that the male Igbo subjects had a mean hand length of 178.80 $\pm$14.52mm, while that of females had 179.81$\pm$18.17mm. The mean hand breadth was 93.56$\pm$7.93mm, while that of females had 91.40$\pm$8.88mm. The Yoruba male subjects had a mean hand length of 179.47$\pm$13.21mm, while the female subjects had a mean hand length of 179.77$\pm$18.76mm. The mean hand breadth was 91.92$\pm$9.48mm, while that of females had 90.61$\pm$9.70mm.

The dissimilarity in the hand length between the Igbo subjects and Yoruba subjects was statistically insignificant. This may be ascribed to the actuality that body physique is influenced by climatic, hereditary, nutritional, and racial factors (Rastogi *et al.*, 2008), and that cultural difference and environmental factors can influence body proportion (Malina., 1991). There was no visible distinction in the hand breadth between the tribes which is in line with the study by Numan *et al.*, 2013.

When a comparison was made between sexes of the same tribe, it was observed that males have wider hands than females and the difference in hand length was statistically insignificant which is in line with another study by Ismalia in 2009, which showed no significant difference in hand length between the sexes of Nigerian populations. Though, several studies show that the hand lengths in males are larger than that of their female counterparts (Ilayperuma *et al.*, 2009; Dan *et al.*, 2008; El-Morsi *et al.*, 2012). The difference in hand breadth was inconsequential between the sexes in the Igbo and Yoruba subjects.

Assessment of the thumb measurements

Some other researchers have giving estimate of human stature using humeral length, arm length, arm span, hand length, hand breadth, and metacarpal (Patrick, *et al.*, 2018; Banik *et al.*, 2016).

In this study, the mean parameters in the male Igbo subjects were slightly statistically higher than the female Igbo subjects compared to the mean parameters in the male Yoruba subjects being higher than the mean parameters in the female Yoruba subjects significantly. This also revealed that Yoruba male subjects had longer and wider thumbs, than the Igbo subjects. On the other hand, the mean right thumb breadth was significantly greater than the mean left thumb breadth in both tribes. This could be a result of the usage of the dominant hand and therefore, the dominant thumb. There was no disparity statistically in the thumb thickness between both tribes.

Gender differences in the height, length, and breadth of the thumbs

Results in this study showed that the mean values for all the measured parameters in the Igbo population were slightly higher statistically for the males in comparison to the females. This also revealed that except for the right thumb breadth (t = 2.05; P = 0.04), all other measured parameters were insignificant at P < 0.05. Hence, right thumb breadth showed sexual dimorphism in Igbos.

The mean difference in the measured parameters among Yoruba subjects was considerably higher in the male, than in the female population. All measured parameters in Yoruba subjects did not show sexual dimorphism.

Prediction of height using the measured parameters among Igbos & Yorubas

This study deduces that the right thumb length pre-estimates stature better compared to other parameters. Some other studies indicate the influence of factors like environment and genetics and so require the need for population-specific data for stature estimation (Danborno & Elukpo., 2008; Kim., 2019).

CONCLUSION

The present study was aimed at estimating the stature from the length & breadth of the right & left thumbs of the Igbo and Yoruba ethnic groups of Nigeria. The right thumb breadth shows sexual dimorphism in Igbos. All measured parameters in Yoruba subjects did not show sexual dimorphism. The measured parameters did not show ethnic differences in Igbo and Yoruba male subjects. The measured parameters did not show ethnic difference in Igbo and Yoruba female subjects. For Igbo male subjects, there was an insignificant association seen in height and other measured parameters, while in Yoruba males, a very weak significant link was shown in the right thumb thickness. Except for age in Igbo females, no meaningful relationship was seen between height and other measured parameters in females.

In the male Igbo population under study, a weak correlation was observed when all measured parameters were part of the height estimation (r = 0.43). Also using all measured hand and thumb dimensions, stature can be estimated with 19% accuracy. For females, a very weak correlation (r = 0.36) was also observed when all measured parameters are involved in estimating height. It shows that when used together, height can be estimated with 13% accuracy. In the Yoruba male population, a weak correlation was observed when all measured parameters were involved in stature estimation (r = 0.46). The result reveals that with all measured hand and thumb dimensions, stature can be estimated with 22% accuracy. For females, a very weak correlation (r = 0.37) was also observed when all measured parameters were involved in estimating height. When all measured parameters were used, 14% accuracy was achieved in height estimation.

It can be concluded that the thumb is not the most reliable digit to estimate stature in Igbo and Yoruba populations. However, the right thumb length estimates stature better than the other parameters.

REFERENCES

1. Alabi, A., Didia, C., Oladipo, G., & Frederick, E. (2017). Estimation of stature from toe lengths: an evaluation of the Hausa population in Nigeria using linear modeling. *Acadademia anatomica international*, 3(1): 36-42.
2. Akhlaghi, M., Sheikhazadi, A., Khazaie, F., & Sadeghian, M. (2019). The Role of Index and Ring Fingers in Gender Identification and Height Estimation. *International Journal of Medical Toxicology and Forensic Medicine*, *9*(2): 75-82.
3. Agnihotri, A., Agnihotri, S., Jeebun, N., & Googoolye, K. (2008). Prediction of stature using hand dimensions. *Journal of Forensic and Legal Medicine*, 15(8): 479-82.
4. Anas, I., Esomonu, U., & Zagga, A. (2010). Prediction of stature of Hausa ethnic group using hand length and hand breadth. *Journal of Medicine in the Tropics*, 12(1): 30-32.
5. Banik, D., Das, S., Bose, K., & Gritlhare, M. (2016) Estimation of Stature from hand and foot dimensions among university girl-students in Bilaspur, Chhatisgarh, India.*Anthropologie, 54*(3): 291–297.
6. Cunha, E., & Ubelaker, H. (2019). Evaluation of ancestry from human skeletal remains: a concise review. *Forensic Science Research*, 5(2): 89-97.
7. Dan Borno, B., Elupko, A. (2008). Sexual Dimorphism in Hand and Foot Length, Indices, Stature-ratio and Relationship to Height in Nigerians. *The Internet Journal of Forensic Science*, 3(1): 2-5.
8. Dupertuis, W., & Hadden, A. (1951). On the Reconstruction of Stature from Long Bones. *American Journal of Physical Anthropology*, 9: 15-54.
9. El-Morsi, A., & Al Hawary, A. (2012). Sex determination by the length of metacarpals and phalanges: X-ray study on Egyptian population. *Journal of Forensic and Legal Medicine*, 20(1): 6-13
10. García, M., & Galeano, D. (2016). Police, anthropometry, and fingerprinting: a transnational history of identification systems from Rio de la Plata to Brazil. *Historia Cienca Saude Manguinhos*, 1(1): 171-194.
11. Ghai, P., Jain, V., Sankhayan, N., & Agarwal, R. (2009). Normal growth and its disorder. In: Ghai OP, Paul VK, Bagga A, editors. Essential Pediatrics. 7th ed. New Delhi: CBS Publishers and Distributors Pvt Ltd, pp. 1 - 21.
12. Igbigbi, P. S., Ominde, B. S., & Adibeli, C. F. (2018). Anthropometric dimensions of hand and foot as predictors of stature: A study of two ethnic groups in Nigeria. *Alexandria journal of medicine*, *54*(4): 611-617.

13. Ilayperuma, I., Nanayakkara, G., & Palahepitiya, N. Prediction of personal stature based on the hand length. *Galle Medical Journal*, 14(1): 15-18.
14. Ismaila, OS. (2009). Anthropometric data of hand, foot, and ear of University students in Nigeria. *Leonardo Journal of Sciences*, 15: 15-20.
15. Katwal, B., Shrestha, N., & Limbu, B. (2021). Estimation of Stature from Length and Breadth of Left Thumb in Medical Students of a Medical College in Kathmandu, Nepal. *Nepal Medical College Journal*, *23*(2): 114-119.
16. Kim W. (2019). A comparative study on the statistical modeling for the estimation of stature in Korean adults using hand measurements. *Anthropologischer Anzeiger*, 76(1): 57–67.
17. Krishan K. (2006). Anthropometry in Forensic Medicine and Forensic Science-'Forensic Anthropometry'. *The Internet Journal of Forensic Science*, 2(1): 95-97.
18. Kumar, L., Jain, S. K., & Mishra, P. (2012). Study of correlation between length of thumb and stature in Uttarakhand population. *Journal of Indian Academy of Forensic Medicine*, *34*(3): 203-205.
19. Malina, R. (1991) Ratios and derived indicators in the assessment of nutritional status in Himes J.H., editor Anthropometric assessment of nutritional status New York: Wiley-Liss, 151-171.
20. Nat, S. (1931) Estimation of stature from long bones in Indians of the United Province: A medicolegal inquiry in anthropometry. *Indian Journal of Medical Research*, 18: 1245-1253.
21. Numan, A. I., Idris, M. O., Zirahei, J. V., Amaza, D. S., & Dalori, M. B. (2013). Prediction of stature from hand anthropometry: A comparative study in the three major ethnic groups in Nigeria. *British Journal of Medicine and Medical Research*, *3*(4): 10-62.
22. Nuriye, B, & Esin, Ö. (2018). Anthropometric measurement of the hand. Eastern Journal Medicine, 23(4): 298-301.
23. Oladipo, G., Omurula, T., Aigbogun, E., Okoro, D., Erezih, O., & Osuchukwu, W. (2017). Estimation of Stature from Hand and Foot Dimensions of Annang Indigene of Akwa Ibom State, Nigeria. *Academia Anatomica International*, 3(1): 26–30. https://doi.org/10.21276/aanat.2017.3.1.7
24. Oladipo, G. S., Ezi, G., Okoh, P. D., & Abidoye, A. O. (2015). Index and ring finger lengths and their correlation with stature in a Nigerian population. *Annals of Bioanthropology*, *3*(1): 18.
25. Oladipo, G., Bob-Manuel, I., & Ezenatein, G. (2009). Quantitative comparison of foot anthropometry under different weight-bearing conditions amongst Nigerians. *The Internet Journal of Biological Anthropology*, *3*(1): 1-7
26. Oliver, J. (2020). Teach me anatomy. Bones of the hand, 3: 4- 82
27. Patrick, S., Beryl, S., & Chidinma, F. (2018). Anthropometric dimensions of hand and foot as predictors of stature: A study of two ethnic groups in Nigeria. *Alexandria Journal of Medicine*, 54(4): 611-617.
28. Rastogi, P., Nagesh, R., & Yoga, K., (2008). Estimation of stature from hand dimensions of North and South Indians. *Legal Medicine*, 10: 185-189.
29. Sharma, R., Sethi, D., Garg, A., Dhattarwal, K., & Chawla, R. (2016). Estimation of stature from length of thumb. *Journal of Punjab Academy of Forensic Medicine & Toxicology*, *16*(1): 40-44.
30. Uche, U., Babatunde, B., Ebukhaile, O., Adunfe, O., & Ibeabuchi, N. M. (2020). Predictive Modelling of Stature from percutaneous Anthropometric Hand Dimensions of Adolescent Nigerian School Children. *Journal of Forensic Science & Criminal Investigation*, *14*: 78-94.
31. Zancolli, E., & Cozzi, E. (1992). Atlas of surgical anatomy of the hand. *Churchill Livingstone Press*, pp. 134.