The Journal of Anatomical Sciences
Email: anatomicaljournal@gmail.com

J. Anat Sci 14(1)

Estimation of Stature from Anthropometric Length Parameters and Sitting Height of Agoi, Ayiga, Ekoi and Lokaa Adult of Yakurr, Local Government Area of Cross River State, Nigeria

Arikpo KO*, Danborno B[1], Timbuak JA[1,2], Nwankwo M[3]

[1]*Department of Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, Ahmadu Bello University, Zaria, Nigeria*

[2]*Department of Anatomy, Faculty of Basic Medical Sciences, Yusuf Maitama Sule University, Kano State, Nigeria*

[3]*Department of Human Anatomy, Faculty of Basic Medical Sciences, Federal University of Lafia, Nasarawa State, Nigeria*

Corresponding Author: Department of Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, Ahmadu Bello University, Zaria, Nigeria

E-mail: arikpokoko1@gmail.com; 08062679628

ABSTRACT

Stature estimation has a significant importance in the field of forensic anthropology. Assessment of the height of an individual, from measurements of different parts of the body, has always been of immense interest to anatomists, anthropologists and forensic experts. Stature is fundamental to establishing an individual's identity. The present study was designed to generate regression equations for stature estimation using demi span, biaxillary, hand and foot lengths and sitting height, in some ethnic populations of Yakurr, Cross River State. The subjects (male n = 400 and female n = 400) were adult indigenes of Agoi, Ayiga, Ekoi and Lokaa between the ages of 18 and 32 years from Yakurr LGA. The participants were mostly students in College of Nursing and non-students of the named communities. Weight, demispan length, biaxillary length, hand length, foot length and sitting height of each individual were measured. The data were analysed statistically using SigmaStat 3.5 (Systat Inc., San Rafael, CA). Statistical analysis indicated that the difference in demi span length, hand length, foot length and sitting height between male and female was statistically significant ($P< 0.05$). Correlation coefficients between stature and the dimensions measured were found to be highly significant and positively correlated with stature in both sexes. Linear regression models and multiple regression models were derived for estimation of stature from the different anthropometric measurements. Multiple regression models estimate stature with greater accuracy than the linear regression models. The study shows that estimation of stature can be made possible using various anthropometric dimensions of the body, however, sitting height was more reliable in estimating stature in both male and female subjects.

Keywords: Stature estimation; Demi span, Hand, Foot lengths; Sitting height; Anthropometry Agoi; Ayiga; Ekoi; Lokaa

INTRODUCTION

Determination of stature is a major concern in forensic medicine and forensic anthropology. Estimation of stature is considered to be an important assessment in the identification of unknown human remains[1]. The reconstruction of stature has been a subject of study since the beginning of the 19th century in the specialized areas of forensic anthropology which deals with the application of methods and techniques of analysing skeletal remains. The hand bones have been recognized as good anthropometric parameters and have been shown to exhibit sexual dimorphism. A study was carried out by Numan *et al*. on estimation of stature from anthropometric measurement of hand in three major ethnic groups in Nigeria [2]. Other studies involving Nigerian populations were carried out by Danborno and Elukpo who estimated stature in Northern Nigerian subjects when they used the dimensions of hand[3]. Correlation between hand length and foot length has also been studied and that if the hand length is known, the foot length can be predicted and vice-versa. Hand length has been shown to be a reliable and precise means in predicting the height of an individual[4,5]. Fatmah (2009) reported a strong positive correlation between height and sitting height in Indonesian Javanese elderly people[6]. Ngoh *et al*. (2012) reported in their study of demi-span equations for predicting height among the Malaysian elderly of which Pearson's correlation analyses revealed that there was a strong, positive association between height and demi-span in both genders[7].

MATERIALS AND METHODS

Sample: The study was composed of 800 (400 males and 400 females) adult of Yakurr, aged between 18 and 32 years (mean age = 24.75 ± 4.05 years). The participants were taken from the four ethnic groups (Agoi, Ayiga, Ekoi and Lokaa) of Yakurr LGA. In the Agoi, we used subjects from Agoi Ekpo and Agoi Mbani. In Ayiga, we used subjects from Assiga. In Ekoi, we used subjects from Inyima. In the Lokaa, we used subjects from Ugep, Idomi and Ekori. The criteria for selecting the subjects included healthy individuals without any physical deformity of length or spine. Additionally, individuals whose parents and grandparents were indigenes of the ethnic group. Permission to conduct the study was taken from the principal of college of nursing and clan heads of the various communities involved. The participants were informed about the study in their classrooms and communities and were advised that the data would be used for research purposes. Informed consent to participation was taken from the participants. The study and data gathering were carried out over a period of 24 months and all measurements were taken in the afternoon.

Methodology: The data consisted of a set of measurements that included stature and demi span length, hand length, foot length and sitting height. All the measurements were taken following standard procedures and landmarks defined by International Biological Program using standard instruments; anthropometric rod, weighing scale, meter scales, measuring tape, calliper and small adjustable chair[8,9]. Further details of how anthropometric measurements, were taken have been

described elsewhere[10,11]. Male experimenters measured the male subjects; whereas the female experimenters measured the female subjects. All the measurements were recorded to the nearest centimeter. The following measurements and techniques were used:

Stature: Stature was measured to the nearest 0.1 cm taking the maximum distance from the floor to the highest point on the head (vertex), using an anthropometer with subject standing erect on a horizontal resting plane, bare footed, having the palms of the hands turned inwards and the finger pointing downwards, heels held together, toes apart, and the head held in the Frankfurt plane.

Demi span length: Demi span length was taken as the distance from the middle of the sternal notch to the tip of the middle finger in the coronal plane.

Biaxillary Length: Biaxillary length was taken on the ventral surface, side to side at the junction of deltopectoral groove and anterior axillary fold, in a supine or sitting position with an adduction close to the body.

Hand length: Hand length was taken as a straight distance between the distal crease of the wrist joint and the most anterior projecting point (tip of the middle finger) in extension.

Foot length: Foot length was taken as the maximum distance between the most prominent part of the heel (tip of heel) to the most distal part of the longest toe (great or second toe) with a sliding calliper.

Sitting height: Sitting height was taken as the distance from the vertex of the head to the base of the sitting surface on fully erect posture.

DATA ANALYSIS

Data were expressed as mean ± standard deviation (SD). Student's independent t-test was used to investigate significant difference between males and females. One-way ANOVA was used to test the differences in the means between Lokaa, Ayiga, Agoi and Ekoi ethnic groups. The Pearson's moment correlation was used to investigate relationship between anthropometric variables. Simple linear and multiple linear regression analyses were performed to derive population-specific equations for predicting stature in the four ethnic groups. $P < 0.05$ was deemed statistically significant. SigmaStat 3.5 (Systat, Inc, CA) for Windows and Microsoft Excel (Microsoft, Inc, WA) was used for the data analyses.

ETHICAL APPROVAL

In line with Belmont declaration of 1979, the study protocol was reviewed and approved by Health Research Ethics Committee on Human Subjects of the Ahmadu Bello University Zaria Kaduna, Nigeria.

RESULTS

Table 1 shows the mean stature, demi span length, biaxillary length, hand length, foot length and sitting height for both sexes. Stature in male subjects had a mean value of 169.11 ± 5.50 cm while in females had a mean value of 162.29 ± 4.99 cm. Demi span length, biaxillary length, hand length, foot

length and sitting height mean value in males was 90.16 ± 3.92 cm, 36.12 ± 2.47 cm, 19.97 ± 0.86 cm, 25.88 ± 2.74 cm and 83.52 ± 2.61 cm respectively while in females was 84.41 ± 4.20 cm, 35.71 ± 3.94 cm, 18.74 ± 1.11 cm, 24.40 ± 1.31 cm and 79.63 ± 2.37 cm respectively. When independent sample *t*-test was performed, the results showed that the differences between males and females demi span length, biaxillary length, hand length, foot length and sitting height were statistically significant (P <0.05).

Tables 2 and 3 shows the relationship between the different anthropometric dimensions and stature. One-way analysis of variance (ANOVA) showed statistically significant differences between males and females, P <0.005 with females having a lower mean value than males.

Table 4 shows the relationship between the different anthropometric dimensions and stature. This relationship was studied using Pearson's correlation. In the male subjects, all the parameters exhibited positive correlation with the stature which was statistically significant (P < 0.01). More so, in males, the highest correlation was exhibited by sitting height (r = 0.71) and the lowest by hand length (r = 0.33). In females, all the parameters also exhibited positive correlation with stature which was statistically significant (P < 0.01). The maximum correlation coefficient was observed in sitting height (r = 0.75) and the lowest by foot length (r = 0.25).

Tables 5, 6 and 7 shows the linear regression equations that were formulated to estimate stature from different anthropometric dimension of the body. Regression analysis of the measurement was performed separately for male and female since statistically significant differences were observed between these two groups, and also for each parameter studied. The equations that were formulated revealed standard error of estimate (SEE) which predicts the deviations of estimated stature from the actual stature. A small value shows greater consistency in the predicted stature.

Table 1a: Descriptive statistics for all the subjects

Variables	Male + Female (n = 800) Mean + SD	Min – Max	Males (n = 400) Mean + SD	Min - Max	Females (n = 400) Mean + SD	Min - Max
Age (years)	24.75 ± 4.05	18.00 – 32.00	24.94 ± 3.94	18.00 – 32.00	24.55 ± 4.15	18.00 – 32.00
Height (cm)	165.70 ± 6.26	150.00-187.00	169.11 ± 5.50	155.00 – 187.00	162.29 ± 4.99	150.00 - 179.00
Weight (kg)	63.06 ± 7.58	40.00 – 91.00	64.26 ± 6.16	48.00 – 83.00	61.87 ± 8.62	40.00 – 91.00
Demi span length (cm)	87.28 ± 4.98	69.00 – 101.00	90.16 ± 3.92	80.00 – 101.00	84.41 ± 4.20	69.00 – 97.00
Biaxillary length (cm)	35.92 ± 3.29	22.00 – 84.00	36.12 ± 2.47	31.00 – 43.00	35.71 ± 3.94	22.00 – 84.00
Hand length (cm)	19.36 ± 1.17	13.00 – 25.00	19.97 ± 0.86	17.20 – 25.00	18.74 ± 1.11	13.00 – 22.00
Foot length (cm)	25.14 ± 2.27	17.00 – 72.00	25.88 ± 2.74	19.00 – 72.00	24.40 ± 1.31	17.00 – 34.00
Sitting height (cm)	81.58 ± 3.16	70.00 – 93.00	83.52 ± 2.61	75.00 – 93.00	79.63 ± 2.37	70.00 – 89.00

Table 1b: Descriptive statistics for the different ethnic groups studied

Variables	Agoi (n = 200) Mean + SD	Min - Max	Ayiga (n = 200) Mean + SD	Min - Max	Ekoi (n = 200) Mean + SD	Min - Max	Lokaa (n = 200) Mean + SD	Min - Max
Age (years)	24.26 ± 4.35	18.00 – 32.00	25.72 ± 3.58	18.00 – 32.00	24.78 ± 4.21	18.00 – 32.00	24.23 ± 3.85	18.00 – 32.00
Height (cm)	162.61 ± 4.87	151.00 – 174.00	166.00 ± 7.29	150.00 – 184.00	167.15 ± 6.03	155.00 – 180.00	167.04 ±5.53	152.00 – 187.00
Weight (kg)	63.90 ± 5.34	50.00 – 82.00	61.84 ± 9.25	40.00 – 91.00	63.75 ± 6.83	51.00 – 77.00	62.77 ± 8.22	46.00 – 86.00
Demi spam length (cm)	87.99 ± 3.26	81.00 – 95.00	83.62 ± 5.36	69.00 – 101.00	88.18 ± 3.79	81.00 – 99.00	89.35 ± 5.16	76.00 – 101.00
Biaxillary length (cm)	35.50 ± 4.27	31.00 – 84.00	36.32 ± 3.10	30.00 – 72.00	36.57 ± 2.45	25.00 – 43.00	35.27 ± 2.92	22.00 – 46.00
Hand length (cm)	18.10 ± 0.95	17.00 – 20.30	19.12 ±1.14	13.50 – 22.30	19.69 ± 1.01	17.50 – 23.00	19.63 ± 1.38	13.00 – 25.00
Foot length (cm)	24.26 ± 0.87	21.00 – 26.00	25.09 ± 1.31	21.00 – 29.00	25.29 ± 1.64	22.00 – 36.00	25.92 ± 3.75	17.00 – 72.00
Sitting height (cm)	80.07 ± 2.14	76.00 – 85.00	82.10 ± 3.74	74.00 – 90.00	81.77 ± 2.43	75.00 – 90.00	82.37 ± 3.53	70.00 – 93.00

Table 1c: Sexual dimorphism in anthropometric parameters of Agoi and Ayiga subjects

	Agoi				Ayiga			
	Males (n = 100)	Females (n =100)			Males (n = 100)	Females (n =100)		
Variables	**Mean + SD**	**Mean + SD**	**t**	***P***	**Mean + SD**	**Mean + SD**	**t**	***P***
Age (years)	24.49 ± 4.49	24.02 ± 4.21	- 0.76	0.446	25.46 ± 3.57	25.97 ± 3.60	1.01	0.316
HT (cm)	164.34 ± 4.94	160.88 ± 4.15	- 5.36	<0.001	171.16 ± 4.43	160.84 ± 5.77	- 14.19	<0.001
WT (kg)	62.93 ± 5.98	64.86 ± 4.42	2.59	0.010	64.94 ± 5.67	58.74 ± 10.97	- 5.02	<0.001
DSL (cm)	90.34 ± 2.55	85.64 ± 1.92	- 14.72	<0.001	87.14 ± 3.88	80.09 ± 4.19	- 12.35	<0.001
BL (cm)	34.79 ± 2.84	36.21 ± 5.25	2.38	0.019	36.09 ± 1.56	36.55 ± 4.09	1.05	0.295
HL (cm)	19.77 ± 0.43	18.22 ± 0.64	- 20.13	<0.001	19.77 ± 0.83	18.47 ± 1.03	- 9.82	<0.001
FL (cm)	24.62 ± 0.89	23.91 ± 0.70	- 6.23	<0.001	25.81 ± 1.34	24.38 ± 0.81	- 9.17	<0.001
SHT (cm)	81.39 ± 1.32	78.75 ± 1.99	- 11.06	<0.001	85.20 ± 1.77	79.00 ± 2.37	- 20.99	<0.001

Table 1d: Sexual dimorphism in anthropometric parameters of Ekoi and Lokaa subjects

	Ekoi				Lokaa			
	Males (n = 100)	Females (n =100)			Males (n = 100)	Females (n =100)		
Variables	**Mean + SD**	**Mean + SD**	**t**	***P***	**Mean + SD**	**Mean + SD**	**t**	***P***
Age (years)	25.38 ± 4.01	24.18 ± 4.34	- 2.03	0.043	24.44 ± 3.57	24.02 ± 4.12	- 0.77	0.442
HT (cm)	171.56 ± 4.14	162.73 ± 4.05	- 15.23	<0.001	169.39 ± 5.22	164.70 ± 4.81	- 6.61	<0.001
WT (kg)	65.77 ± 5.97	61.72 ± 7.05	- 4.38	<0.001	63.40 ± 6.62	62.14 ± 9.54	- 1.09	0.279
DSL (cm)	90.25 ± 3.42	86.10 ± 2.90	- 9.24	<0.001	92.90 ± 3.45	85.80 ± 4.02	- 13.41	<0.001
BL (cm)	37.67 ± 2.12	35.47 ± 2.26	- 7.09	<0.001	35.94 ± 2.32	34.60 ± 3.29	- 3.33	0.001
HL (cm)	19.96 ± 0.82	19.41 ± 1.10	- 3.93	<0.001	20.40 ± 1.08	18.86 ± 1.21	- 9.48	<0.001
FL (cm)	26.07 ± 1.37	24.51 ± 1.51	- 7.66	<0.001	27.02 ± 4.77	24.82 ± 1.74	- 4.35	<0.001
SHT (cm)	83.43 ± 1.79	80.10 ± 1.74	- 13.33	<0.001	84.07 ± 3.41	80.67 ± 2.74	- 7.77	<0.001

HT = Height; WT = Weight; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; FL = Foot Length; SHt = Sitting Height.

Table 2: Comparison of the male anthropometric dimension means from various ethnic groups

Variables	Agoi (n = 100) Mean ± SD	Ayiga (n = 100) Mean ± SD	Ekoi (n = 100) Mean ± SD	Lokaa (n = 100) Mean ± SD	F	*P*
Height (cm)	164.34 ± 4.94^{a}	171.16 ± 4.43^{bc}	171.56 ± 4.15^{c}	169.39 ± 5.22^{d}	49.81	<0.001
Weight (kg)	62.93 ± 5.98^{abd}	64.94 ± 5.67^{bc}	65.77 ± 5.97^{c}	63.40 ± 6.62^{bd}	4.75	0.003
Demi span length (cm)	90.34 ± 2.55^{a}	87.14 ± 3.88^{b}	90.25 ± 3.42^{ac}	92.90 ±3.45^{d}	49.21	<0.001
Biaxillary length (cm)	34.79 ± 2.84^{a}	36.09 ± 1.56^{b}	37.67 ± 2.12^{c}	35.94 ±2.32^{bd}	27.47	<0.001
Hand length (cm)	19.77 ± 0.43^{ac}	19.77 ± 0.83^{abc}	19.96 ± 0.82^{c}	20.40 ± 1.08^{d}	13.17	<0.001
Foot length (cm)	24.62 ± 0.89^{a}	25.81 ± 1.34^{bc}	26.07 ± 1.37^{c}	27.02 ± 4.77^{d}	14.42	<0.001
Sitting height (cm)	81.39 ± 1.32^{a}	85.20 ± 1.77^{b}	83.43 ± 1.79^{c}	84.07 ± 3.41^{d}	51.84	<0.001

Means with different superscript are significantly different with $P < 0.05$

Table 3: Comparison of the female anthropometric dimension means from various ethnic groups

Variables	Agoi (n = 100) Mean ± SD	Ayiga (n = 100) Mean ± SD	Ekoi (n = 100) Mean ± SD	Lokaa (n = 100) Mean ± SD	F	*P*
Height (cm)	160.88 ± 4.15^{ab}	160.97 ± 5.94^{bc}	162.75 ± 4.04^{c}	164.55 ± 4.72^{d}	13.24	<0.001
Weight (kg)	64.74 ± 4.39^{a}	58.89 ± 11.09^{b}	61.87 ± 7.11^{cd}	61.96 ± 9.46^{d}	8.09	<0.001
Demi span length (cm)	85.60 ± 1.91^{acd}	80.16 ± 4.31^{b}	86.16 ± 2.88^{c}	85.71 ± 4.01^{cd}	69.31	<0.001
Biaxillary length (cm)	36.18 ± 5.26^{ab}	36.60 ± 4.09^{b}	35.50 ± 2.26^{abc}	34.55 ± 3.26^{cd}	5.33	0.001
Hand length (cm)	18.24 ± 0.66^{ab}	18.47 ± 1.03^{b}	19.42 ± 1.10^{c}	18.84 ± 1.21^{d}	25.52	<0.001
Foot length (cm)	23.93 ± 0.73^{ab}	24.37 ± 0.79^{bcd}	24.52 ± 1.50^{cd}	24.79 ± 1.75^{d}	8.03	<0.001
Sitting height (cm)	78.71 ± 2.01^{ab}	79.07 ± 2.38^{b}	80.12 ± 1.73^{cd}	80.62 ± 2.74^{d}	15.72	<0.001

Means with different superscript are significantly different with $P < 0.05$

Table 4: Correlation between stature and anthropometric dimensions in male and female subjects

	Male		Female	
Variables	**Correlation (r)**	**R^2**	**Correlation (r)**	**R^2**
Weight (kg)	0.52	0.27	0.50	0.25
Demi span length (cm)	0.34[c]	0.12	0.50[c]	0.25
Biaxillary length (cm)	0.52	0.27	0.11	0.01
Hand length (cm)	0.33[c]	0.11	0.36[c]	0.13
Foot length (cm)	0.35[c]	0.12	0.25[c]	0.06
Sitting height (cm)	0.71[c]	0.51	0.75[c]	0.56

[c] Correlation is statistically significant ($P < 0.001$) two-tailed

Table 5: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups (n = 800)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 152.72 + (0.523*Age)	0.34	0.12	5.89	10.19	<0.001
Weight (kg)	HT = 139.85 + (0.410*WT)	0.50	0.25	5.44	16.16	<0.001
Demispan length (cm)	HT = 99.70 + (0.756*DSL)	0.60	0.36	5.01	21.25	<0.001
Biaxillary length (cm)	HT = 148.21 + (0.487*BL)	0.26	0.07	6.05	7.48	<0.001
Hand length (cm)	HT = 110.82 + (2.835*HL)	0.53	0.28	5.32	17.61	<0.001
Foot length (cm)	HT = 136.51 + (1.161*FL)	0.42	0.18	5.68	13.08	<0.001
Sitting height (cm)	HT = 33.73 + (1.618*SHt)	0.82	0.67	3.61	40.05	<0.001

HT = Height; WT = Weight; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; FL = Foot Length; SHt = Sitting Height.

Table 6: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups for males (n = 400)

Parameters	Predictive Equations	R	R^2	SEE	t	p
Age (years)	HT = 154.17 + (0.599*Age)	0.43	0.19	4.97	9.49	<0.001
Weight (kg)	HT = 139.25 + (0.465*WT)	0.52	0.27	4.70	12.16	<0.001
Demispan length (cm)	HT = 126.35 + (0.474*DSL)	0.34	0.12	5.18	7.17	<0.001
Biaxillary length (cm)	HT = 127.37 + (1.156*BL)	0.52	0.27	4.70	12.13	<0.001
Hand length (cm)	HT = 126.89 + (2.114*HL)	0.33	0.11	5.19	7.00	<0.001
Foot length (cm)	HT = 150.82 + (0.707*FL)	0.35	0.12	5.15	7.50	<0.001
Sitting height (cm)	HT = 43.71 + (1.501*SHt)	0.71	0.51	3.86	20.29	<0.001

HT = Height; WT = Weight; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; FL = Foot Length; SHt = Sitting Height

Table 7: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups for females (n = 400)

Parameters	Predictive Equations	R	R^2	SEE	t	p
Age (years)	HT = 152.93 + (0.381*Age)	0.32	0.10	4.74	6.66	<0.001
Weight (kg)	HT = 144.50 + (0.288*WT)	0.50	0.25	4.33	11.42	<0.001
Demispan length (cm)	HT = 111.88 + (0.597*DSL)	0.50	0.25	4.32	11.60	<0.001
Biaxillary length (cm)	HT = 157.47 + (0.135*BL)	0.11	0.01	4.97	2.14	0.033
Hand length (cm)	HT = 132.36 + (1.597*HL)	0.36	0.13	4.67	7.58	<0.001
Foot length (cm)	HT = 139.43 + (0.937*FL)	0.25	0.06	4.84	5.04	<0.001
Sitting height (cm)	HT = 36.84 + (1.575*SHt)	0.75	0.56	3.32	22.47	<0.001

HT = Height; WT = Weight; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; FL = Foot Length; SHt = Sitting Height.

DISCUSSION

Stature estimation is considered as one of the basic parameters of the investigation process in unknown and commingled human remains in medico-legal case work[1,12,13]. It is of the utmost importance as it completes the biological profile of a person along with the other three parameters of identification[1,14,15]. Though stature is an important parameter in clinical practice there are limitations in some clinical situations[8]. Anthropometric measurements for stature prediction were suggested to solve this problem and many formulae and equations have been reported[8,16]. These measurements included demispan length, sitting height, foot length and hand dimensions[6,17,18]. However, ethnic differences, gender and age are a major concern in this regard for application and external validation for other populations. The results of the descriptive statistics showed that males presented with statistically significant higher mean value of total stature than females. Males also showed higher mean values compared to females for all the anthropometric measurements P <0.05. It can therefore be inferred that males are generally taller than females, which is in line with previous reports on stature estimation among Nigerians[2,3,5,9,10]. These sex differences in physical characteristics are often related to hormonal, genetic, and environmental factors[11,19,20].

This study showed that the male demi span length, hand length, foot length and sitting height were higher than the female in the four ethnic group studied. The difference in anthropometric dimension between male and female could be explained as part of genetic expression of male being larger than female. However, this finding is in line with earlier findings which shows that there are ethnic differences in the anthropometric dimensions and its relation to sex[12,13,21,22]. It has also been emphasized that differences in body dimension among population and ethnic origins are as a result of differences in nutrition and levels of physical activity.

The accuracy of each regression equation derived in this study was assessed using the obtained standard error of estimate (SEE). Regression equations for height estimation in females presented with slightly higher SEE compared to those obtained in males, this is contrary with the report of Danborno and Elukpo[3,23,24], in their study of Nigeria population which reported that, when hand and foot were correlated the relationship between hand and foot length was higher in the females than the males, but when hand and foot lengths were compared to height the relationship was stronger in the males than in the females.

CONCLUSION

This study has established standard values of anthropometric dimensions for Yakurr population which will serve as a useful tool in forensic investigation and clinical practice. The study has also shown that sitting height presents the strongest relationship with stature, and thus the most reliable for estimation of stature in both adult male and female of Yakurr population of Cross River State.

REFERENCES

1. Danborno B, Adebisi SS, Adelaiye AB, Ojo S. (2009). Estimation of height and weight from the lengths of second and fourth digits in Nigerians. *The Internet Journal of Forensic Science*, 3-2.
2. Numan AI, Idris MO, Zirahei JV, Amaza DS, Dalori MB. (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, 1062-1073.
3. Danborno B, Elukpo 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).
4. Gauld RF, Rakhir SM. (1996). The prediction of stature from hand length. *Journal of Crime and Criminalistics,* 8, 79-81.
5. Ebite MN, Guachi ST, Frisher KR. (2000). Predicting stature through hand length. J*ournal of Crime and Criminalistics,* 52, 23-27.
6. Fatmah MS. (2009). Predictive equations for estimation of stature from knee height, arm span, and sitting height in Indonesian Javanese elderly people. *International Journal of Medicine and Medical Sciences,* 1 (10), 456-461.
7. Ngoh HJ, Harith S, Harsa AM. (2012). Development of demi-span equations for predicting height among the Malaysian elderly. *Malaysian Journal of Nutrition,* 18 (2):149-159.
8. WHO (1995). Physical status: the use and interpretation of anthropometrics. *Report of a WHO Expert Committee Technical Report, Series No 854, Geneva*.
9. Mauthausen K, Gusen YR. (1959). Estimation of actual individual height during the exhumation of the remains of the former concentration camps. *Journal of Forensic Science,* 3: 533-537.
10. Nwankwo M, Okamkpa JC, Danborno B. (2022). Comparison of diagnostic criteria and prevalence of metabolic syndrome using WHO, NCEP-ATP III, IDF and harmonized criteria: A case study from urban southeast Nigeria. Diabetes and Metabolic Syndrome: Clinical Research and Reviews. 16: 102665-102671.
11. Nwankwo M. Okamkpa JC, Danborno B. (2019). Association between high blood pressure with risk of type 2 diabetes, metabolic syndrome and its predictors: A cross-sectional study. Diabetes and Metabolic Syndrome: Clinical Research and Reviews; 13: 1549-1554.
12. Chittanatarat K, Sakda P, Vibul T, Winai U, Jayanton P. (2012). Height prediction from anthropometric length parameters in Thai people. *Asia Pacific Journal of Clinical Nutrition,* 21 (3):347-354.
13. Ibegbu AO, Danjuma ZC, Hamman WO, Umana UE, Ikyembe D, Musa SA. (2014). Association of the index (2^{nd}) and ring (4^{th}) digit ratios with some physical attributesin Ebira ethnic group of Nigeria. *Applied Technologies and Innovations.* 7:46-54.
14. Oria RS, Igiri AO, Egwu OA, Nandi ME. (2016). Prediction of stature from hand length and breadth: anthropometric study on an adult Cross River State population. *Annals of Biological Anthropology.* 4:12-16.
15. Hasegawa I, Uenishi K, Fukunaga T, Kimura R, Osawa M. (2009). Stature estimation formulae from

radiographically determined limb bone length in a modern Japanese population. *Legal Medicine*, Tokyo. 11, 260-266.

16. Davis KT. (1984). The foot length and hand length to stature ratio. A study of racial variance. MA thesis. Department of anthropology, *Texas Tech University, Lubbock, TX*.
17. Kanchan T, Rastogi P. (2009). Sex determination from hand dimensions of North and South Indians. *Journal of Forensic Science*, 54, 546-550.
18. Vanishri P, Sheikh NA. (2019). Anthropometric Measurements of Hand Length and Breadth for Estimation of Stature in South Indians. *Indian Journal of Forensic and Medical Pathology*. 12(2):124-130.
19. Ugochukwu EG, Augustine EO, Samuel E, Ifechukwude B. (2021). Estimation of stature from stride length and lower limb length of efiks in calabar South, Cross River State, South-South Nigeria. Journal of Anatomical Society of India. 70:216-20.
20. Wube B, Seyoum G, Taye G. (2019). Estimation of stature by anatomical anthropometric parameters in first-year regular undergraduate students at Debre Markos University, North West Ethiopia. *Ethiopian Journal of Health Development.* 33 (3).
21. Binigha M, Karthik GM. (2022). Estimation of Stature from Total Upper Limb Length in Undergraduate Student Population. *European Journal of Molecular and Clinical Medicine*. 09 (08).
22. Tanko M, Ahmadu W, Agbon AN, Bauchi ZM, Sadeeq AA, Musa M. (2020). Determination of Stature using Anthropometric Parameters in Adolescents from Selected Secondary Schools, Samaru-Zaria, Kaduna State, Nigeria. *Dutse Journal of Pure and Applied Science*. 6 (4).
23. Yeasmin N, Asadujjaman M, Islam MR, Hasan MR. (2022). Stature and sex estimation from shoulder breadth, shoulder height, popliteal height, and knee height measurements in a Bangladeshi population. *Forensic Science International: Reports* 5:1- 8.
24. Asadujjaman M, Ali Molla MB, Noman ASN, (2019). Stature estimation from hand anthropometric measurements in Bangladeshi population. *Journal of Forensic and Legal Medicine*. 65:86–91.