Journal of Advances in Medicine and Medical Research

32(4): 78-89, 2020; Article no.JAMMR.55609
ISSN: 2456-8899
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

A Comparison of Linear Anthropometric Body Features of the Igbo, Ijaw and Yoruba Ethnic Groups of Southern Nigeria

P. D. Okoh[1*] and M. A. Amadi[2]

[1]Department of Surgery, Faculty of Clinical Sciences, University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria.
[2]Department of Anatomy, Faculty of Basic Medical Sciences, PAMO University of Medical Sciences, Port Harcourt, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author PDO designed the study and wrote the protocol. Author MAA wrote the first draft of the manuscript, managed the analyses of the study and also managed the literature searches. Both authors performed the statistical analysis, read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2020/v32i430403
Editor(s):
(1) Dr. Mohamed Essa, Sultan Qaboos University, Oman.
Reviewers:
(1) Mra Aye, Melaka Manipal Medical College, Malaysia.
(2) John Ogedengbe, University of Abuja, Nigeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/55609

Original Research Article

Received 16 January 2020
Accepted 23 March 2020
Published 30 March 2020

ABSTRACT

Aim: The aim of the study was to investigate and compare the linear anthropometric body features of the Igbo, Ijaw and Yoruba, the three major ethnic groups in Southern Nigeria. The research design was a cross-sectional design.
Methodology: The study made use of a total number of one thousand two hundred (1200) subjects divided into four hundred (400) subjects randomly selected from each of the Igbo, Yoruba and Ijaw ethnic groups of southern Nigeria whose ages ranged between 21 to 40 years with BMI of 18.50 to 30.00. Due to bone density, subjects whose BMI fell within the category of overweight according to conventional BMI classification, looked apparently healthy and were included in the study. Determination of minimum sample size was done using the Taro Yamane's formula. BMI and linear body anthropometric measurements were taken using stadiometer, calibrated flexible meter tape, meter rule and weighing scale. Statistical analysis was done using statistical package

**Corresponding author: E-mail: peterdoneokoh56@gmail.com;*

for the social science (SPSS version 25.0) and Microsoft Excel 2019. Continuous variables were presented as mean±SD; minimum and maximum. Age was grouped into two categories (21 – 30 and 31 – 40) years. Body Mass Index (BMI) was also grouped into two; normal weight and slightly overweight. Independent sample t-test was thus carried out to determine significant difference in the measured anthropometric variables across age and BMI groups. Confidence interval was set at 95%, therefore $p< 0.05$ was considered significant.

Results: Results were presented in charts and tables. Variations were observed across the different ethnic groups. Age related changes and variations in BMI were also observed in the anthropometric parameters studied. On comparison with other racial populations, certain parameters were close while most showed marked variation which underscores racial variation. Though certain degree of variation was observed across the three negroid ethnic groups, it is not adequate to subcategorise these Southern Nigerian ethnic groups.

Conclusion: These anthropometric values not only provide a description of the standard linear anthropometric body features of southern Nigeria but could find use in anthropological and medical studies, standardization of anatomical models as well as in the design of products to fit this negroid population.

Keywords: Comparison; linear; anthropometric features; Southern Nigeria.

1. INTRODUCTION

The dominant ethnic groups found in southern Nigeria are the Igbo, Ijaw and Yoruba. The Igbo and Yoruba along with the Hausa of northern Nigeria are the three major ethnic groups in Nigeria. The Igbo are found predominantly in southeastern and midwestern (Delta State) of Nigeria. They are also found in other African countries [1,2] and outside Africa. The Igbo people are one of the largest ethnic groups in Africa [3]. The Ijaw are found in the southernmost part of Nigeria. They dwell in riverine locations near many sea trade routes [4]. The Yoruba are predominantly found in southwestern Nigeria, where they make up to about 21% of the country's population, according to the CIA World Factbook [5] and in some West African countries.

Human anatomy though gives a description of the structure of the body as seen in most people and has traditional value in surgery, there exists a widespread range of ethnic and racial variation in the physical appearance and body proportions of different populations [6]. Anthropometric studies are therefore carried out along the lines of these variations. Studies have been undertaken by various researchers to demonstrate the relationship between long bones and linear anthropometric parameters such as standing height and how they vary across different ethnic and racial groups, [7-13] and also in various regions [14-19].

Anthropometric measurements have been adopted as methods in clinical and public health works, as they are applicable to large samples and can provide national estimates and data for the analysis of secular changes [20]. In addition to finding applicability in racial differentiation, linear anthropometric measurements have been used as important variables in the assessment of nutritional status and growth rate [21].

This study rationale was to document normal pattern of linear anthropometric body parameters of southern Nigerian population. Humans evolved relatively recently, but with complex culture and technology have been able to spread throughout the world and to occupy a wide range of environments. This resulted in species that are highly variable in physical appearance, despite the similar genetic identity. In this regard, this study therefore aimed at investigating and comparing the linear anthropometric body features of adult male Igbos, Ijaws and Yorubas of southern Nigeria and how they vary with those of other populations.

2. MATERIALS AND METHODS

2.1 Research Design

The research design was cross-sectional design which investigated the linear anthropometric body features of adult male Igbo, Ijaw and Yoruba of southern Nigerian using anthropometric standards.

2.2 Population for the Study

The population for the study included participants drawn from locations in Yenegoa, Amassoma, Ogbia, Kaima and Igbogene in Bayelsa State, Owerri, Mbaitoli, Ngor-Okpala, Orlu, Mbaise and Okigwe in Imo State; Akure, Idanre, Akoko and

Okitipupa in Ondo State constituted the study areas representing the Igbo, Ijaw and Yoruba areas respectively.

2.3 Sample Size and Sampling Technique

The sampling technique was multistage random sampling. Subjects were randomly selected from amongst adult males from the 3 major tribes (Yoruba, Ijaw and Igbo) residing in Imo, Ondo and Bayelsa states all in southern Nigeria. The study made use of a total number of one thousand two hundred (1200) subjects divided into four hundred (400) subjects each from the Igbo, Yoruba and Ijaw ethnic groups whose ages ranged between 21 to 40 years with BMI of 18.50 to 30.00. Minimum sample size for the study was determined using the Taro-Yamane formula, $n=N/1+N(e)^2$〗 where n = minimum sample size, N = total population and e = margin of error = 0.05.

Only Adult males between the ages of 21 and 40 years with BMI of 18.50 to <30.00 were included in this study. It was ascertained that recruited subjects have both parents and four grand parents from the same ethnic group and had no previous history of orthodontic or surgical treatment. This was determined through questionnaires. By convention, BMI range of >24.9 to ≤30.0 is considered overweight by normal BMI classification. However, among Africans, individuals who fall into this category look apparently healthier than those within the range classified as normal. This is due to bone density. Therefore, subjects who fell into this category were considered normal in our study but were however designated slightly overweight to distinguish them from those categorized as normal by conventional BMI classification.

Methods: The study involved measurement of some selected linear body anthropometric variables. Fifteen (15) trained research personnel embarked on field trips to different study areas in southern Nigeria and undertook the measurements. Using appropriate landmarks, the following linear measurements were taken: standing height, sitting height, arm span, bi-acromial breadth, upper limb length elbow breadth, wrist breadth, bi-iliac breadth, thigh length, knee height and foot length.

Standing height: Maximum distance from the floor to the Vertex.

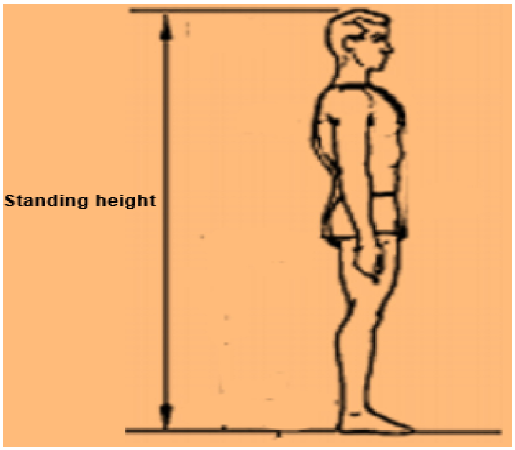

Fig. 1. Standing height

Sitting height: Measured distance from the Vertex to the seated buttocks.

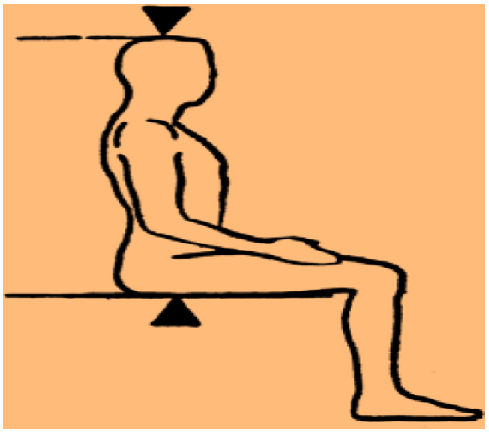

Fig. 2. Measurement of sitting height
(Source: NHANESIII [22])

Arm span: The distance from one end of an individual's arms (measured at the fingertips) to the other when raised parallel to the ground at shoulder height at a 90° angle.

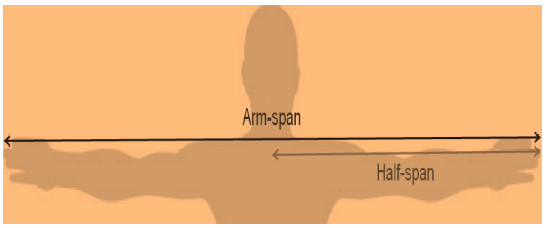

Fig. 3. Arm span measurement

Biacromial breadth: Distance between the external borders of the two acromial processes in

a subject standing upright with arms hanging loosely at the sides.

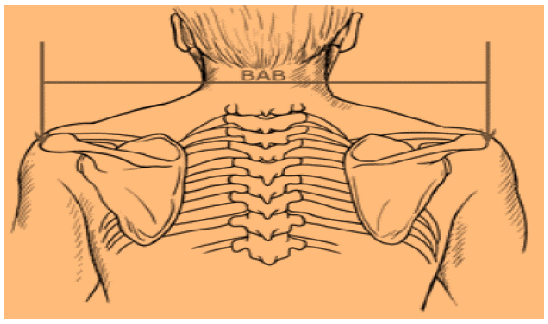

Fig. 4. Measurement of bi-acromial breadth (BAB)
(Source: Karadayi et al. [23])

Upper limb length: Distance from the acromion to the fingertip (dactylion) with the elbow and wrist stretched.

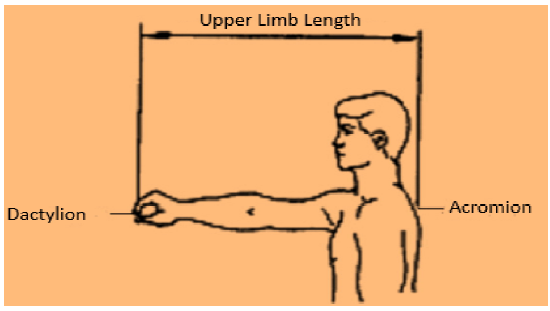

Fig. 5. Upper limb length
(Source: Kamal and Yadav [24])

Elbow breadth: The horizontal distance between either side of the elbow.

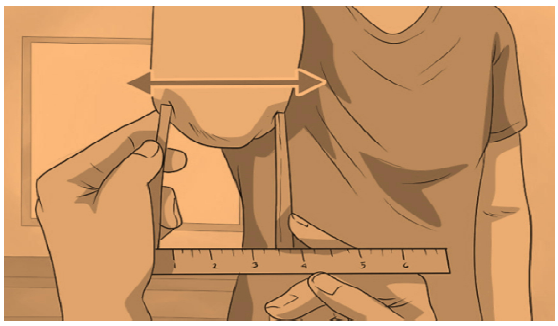

Fig. 6. Elbow breadth

Wrist breadth: The horizontal distance between the epicondyles of the humerus.

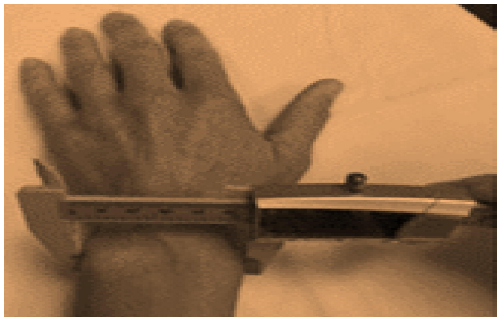

Fig. 7. Wrist breadth

Bi-iliac breadth: The measure of the pelvis between the outer edges of the upper iliac bones.

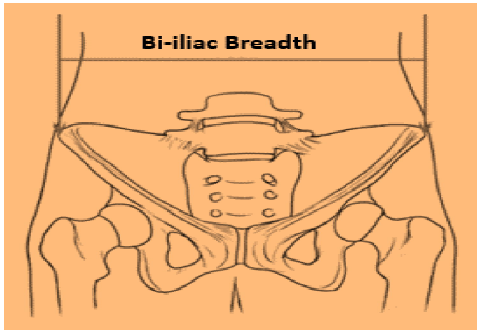

Fig. 8. Bi-iliac breadth

Thigh length: The measured distance from the mid-point of the inguinal ligament to the proximal edge of the patella.

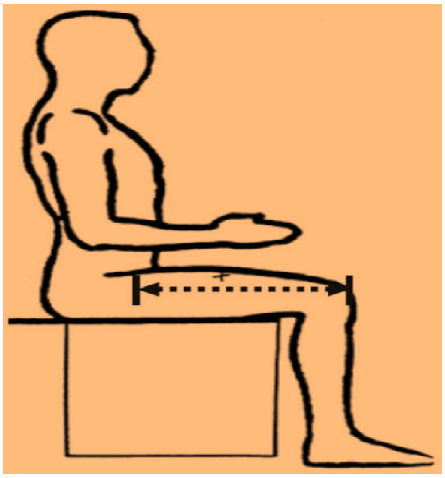

Fig. 9. Thigh length
(Source: NHANESIII [22])

Knee height: Measured distance between the anterior surface of the thigh (above the condyles of the femur and about 4 cm above the patella) and the floor.

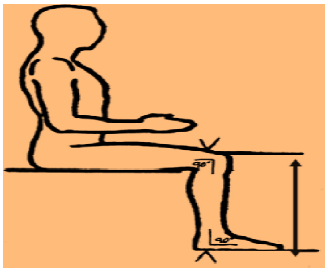

Fig. 10. Knee height
(Source: NHANESIII [22])

Foot length: Distance from the tip of the hallux (acropodion) to the heel of the foot (pternion) either in sitting or standing position.

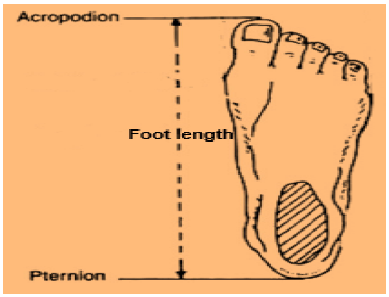

Fig. 11. Foot length
(Source: Kamal and Yadav [24])

2.4 Statistical Analysis

Statistical analysis was done using statistical package for the social science (SPSS version 25.0) and Microsoft Excel 2019. Continuous variables were presented as mean±SD; minimum and maximum. Age was grouped into two categories (21 – 30 and 31 – 40) years. Similarly, body mass index (BMI) was grouped into two; normal weight (18.5 – 24.9) and slightly overweight (25.0 – 30.0). Independent sample t-test was thus carried out to determine significant difference in the measured anthropometric parameters according to age. Confidence interval was set at 95%, therefore $p< 0.05$ was considered significant.

3. RESULTS

Table 1 shows descriptive statistics of the measured linear body parameters among three southern Nigerian ethnic groups. ANOVA test for linear body parameters compared according to ethnic group revealed that Standing Height, Sitting Height, Arm Span, Bi-Acromial Breadth, Upper Limb Length, Elbow Breadth, Wrist Breadth, Bi-Iliac Breadth, Knee Height and Foot Length showed statistically significant difference ($\rho<0.00$) whereas thigh length was not statistically significant ($\rho>0.05$) (Table 2). Table 3 shows the descriptive statistics of the measured linear body parameters according to age. On comparison between the age groups, independent sample t-test shows that Sitting Height, Bi-acromial Breadth, Wrist Breadth, Bi-Iliac Breadth and Knee Height were statistically significant ($\rho<0.05$) while the others showed no statistically significant difference ($\rho>0.05$). Table 4 shows the descriptive statistics of the measured linear body parameters according to BMI. Standing Height, Arm Span, Upper Limb Length and Knee Height showed statistically significant difference ($\rho<0.05$). The others were not statistically significant ($\rho>0.05$).

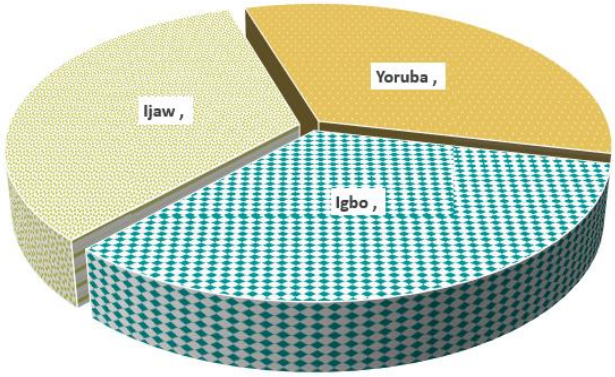

Fig. 12. Distribution of subjects according to ethnic group

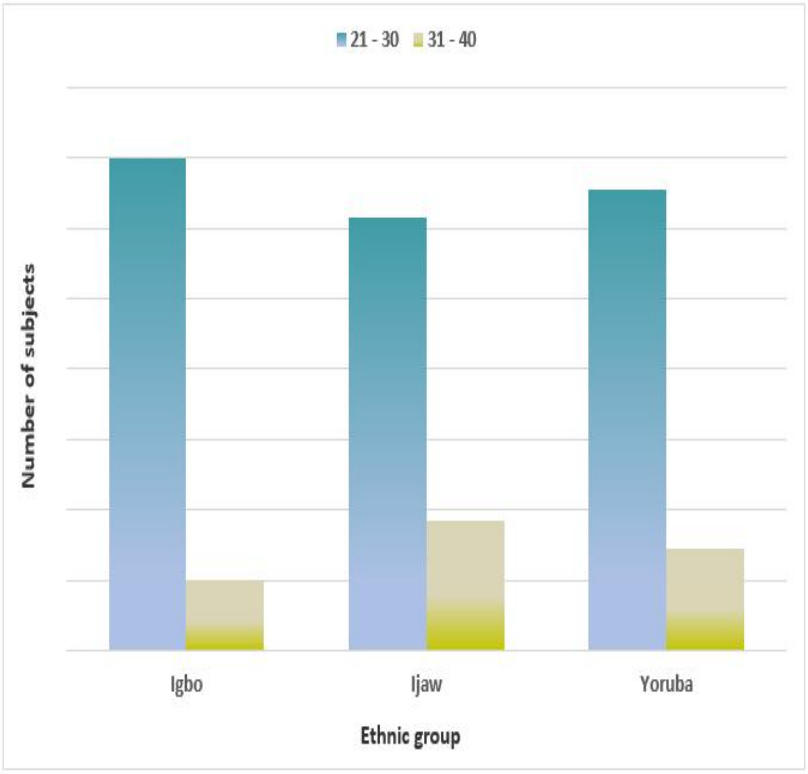

Fig. 13. Distribution of subjects according to age group

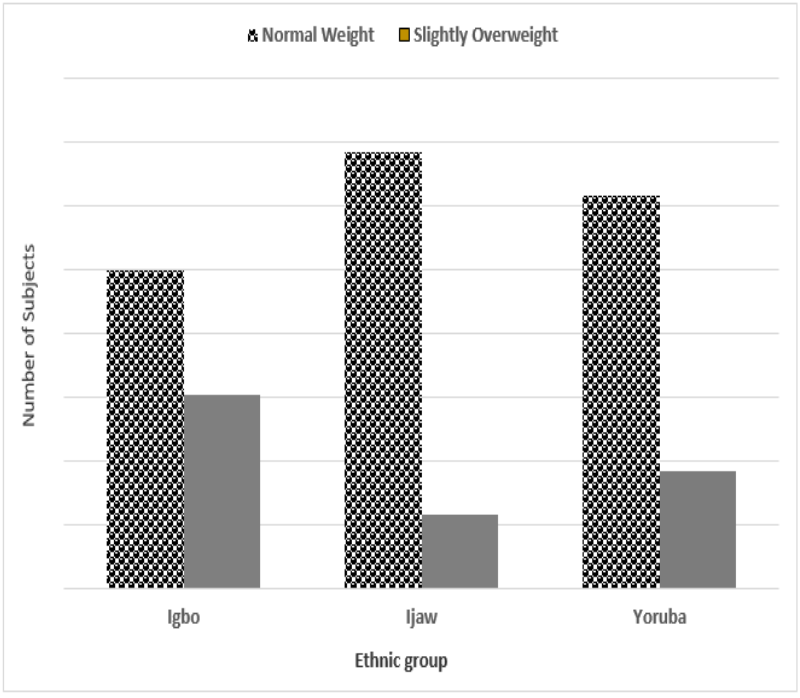

Fig. 14. Distribution of subjects according to Body Mass Index (BMI)

Table 1. Descriptive statistics of the measured linear body parameters of the Igbo, Ijaw and Yoruba ethnic groups (cm)

Linear body parameters	IGBO [N = 400]			IJAW [N = 400]			YORUBA [N = 400]			ALL [N = 1200]		
	Mean± SD	Min	Max	Mean± SD	Min	Max	Mean± SD	Min	Max	Mean± SD	Min	Max
Standing Height	178.88±10.12	161.24	191.46	173.09±5.56	152.80	191.20	175.23±7.18	162.70	190.24	175.73±7.62	152.80	191.46
Sitting Height	84.94±5.55	73.22	98.87	80.59±3.90	73.80	92.50	84.12±4.75	73.80	91.00	83.21±4.73	73.22	98.87
Arm Span	182.55±9.76	151.90	196.90	179.79±9.47	154.70	197.20	180.33±10.85	153.23	192.44	180.89±10.03	151.90	197.20
Bi-acromial Breadth	40.29±3.11	35.20	47.45	38.44±3.96	32.60	44.91	38.48±4.10	32.10	45.90	39.07±3.85	32.10	47.45
Upper Limb Length	80.73±7.40	62.40	89.92	76.64±7.39	62.40	90.30	78.15±6.48	62.40	89.92	78.51±7.13	62.40	90.30
Elbow Breadth	7.68±1.50	5.30	10.80	8.02±1.35	5.30	11.20	7.43±1.61	5.10	10.80	7.71±1.50	5.10	11.20
Wrist Breadth	6.45±1.09	4.11	7.96	5.98±0.87	4.20	7.91	5.80±0.99	4.11	7.91	6.08±1.02	4.11	7.96
Bi-iliac Breadth	30.53±2.27	24.10	31.96	28.10±2.12	24.50	30.92	29.59±2.59	24.10	31.96	29.41±2.37	24.10	31.96
Thigh Length	52.41±6.07	43.50	60.40	49.01±6.18	43.60	61.20	50.08±6.28	43.80	60.40	49.16±6.17	43.50	61.20
Knee Height	51.69±3.55	43.90	59.20	49.44±3.57	44.80	54.80	50.17±3.91	44.30	55.64	50.43±3.71	43.90	59.20
Foot Length	28.04±1.69	23.00	31.70	26.24±1.39	23.00	32.20	27.95±1.64	23.00	31.70	27.41±1.58	23.00	32.20

SD = Standard deviation, Min = Minimum, Max = Maximum

Table 2. Linear body parameters compared according to ethnic group using ANOVA

Linear body parameters	Sum of squares	Mean square	df	F-value	p-value	Inference
Standing Height	10528.47	5264.24	2	85.43	0.00	S
Sitting Height	4269.51	2134.76	2	93.40	0.00	S
Arm Span	16749.01	8374.51	2	83.00	0.00	S
Bi-acromial Breadth	895.53	447.77	2	31.83	0.00	S
Upper Limb Length	575.44	287.72	2	5.70	0.00	S
Elbow Breadth	69.66	34.83	2	15.76	0.00	S
Wrist Breadth	90.28	45.14	2	46.29	0.00	S
Bi-iliac Breadth	176.52	88.26	2	16.18	0.00	S
Thigh Length	36.90	18.45	2	0.48	0.62	NS
Knee Height	326.86	163.43	2	12.07	0.00	S
Foot Length	17.77	8.88	2	3.57	0.03	S

S – Significant, NS – Not significant

4. DISCUSSION

In southern Nigeria just like in most other parts of West Africa, members of the various ethnic groups have similar physical features which makes it difficult to distinguish one from another by mere observation. If placed side-by-side with the individuals not bearing any tribal marks on their face, or speaking, which could easily suggest one's ethnicity by their accent, the Igbo, Ijaw and Yoruba as well as the minor ethnic groups in southern Nigeria share similar physical features. Although there is a common assumption among southern Nigerians that the Yoruba and Ijaw have a more pigmented skin than the Igbo, there is however, no scientific basis for this assumption. Besides, a few light complexioned individuals do still exist among the Yoruba and Ijaw. From the results, variations were observed in some of the parameters when compared among the three major ethnic groups. Some of the respective mean values were not wide apart and thetotal mean value did not vary greatly from them(as seen in Table 1). Of the three ethnic groups, the Ijaw exhibited the broadest chest circumference. This could be attributed to the fact that Ijaws being riverine dwellers are swimmers, and perhaps consequently developed broad chests. Just like the assumption among most Nigerians that Igbos are light skinned, Yorubas are thought to have a bulky body-build. However, there is also no scientific basis for this assumption as individuals of similar physique are found among the Igbo, Ijaw and other ethnic groups in Nigeria. Coincidentally, in our findings, the Yoruba exhibited the widest hip and waist circumference.

Height is typically a major and instantly recognisable skeletal feature which is principally an inherited trait within hominoid species. It is however subject to environmental factors like diet, environmental driven derivative mutations and disease exposure [25]. Standing height was highest in the Igbo. The Igbo could therefore be said to be the tallest. However, the variation was not marked compared to the others and the mean standing height of the three ethnic groups.

On comparison with the Caucasians, there was a marked difference in the parameters. Mean standing height (175.73±7.62) in the present study was lower than those reported in Kosovo (178.79±6.07) [26], Bosnia and Herzegovina (183.9) [11] and Macedonia (178.10 ± 6.79) [27] but higher than that reported in India (165.96±6.33) [28]. Mean sitting height (83.21±4.73) was lower than that of the Kosovans (96.07±3.51) [26]. The length of limbs just like height varies between the different hominoid sub-species [25]. Mean arm span (180.89±10.03) was higher than those of Indians (166.40±7.20) [28] and Macedonians (178.78 ± 7.71) [27]. This could be because subspecies which are localized in open savannah country commonly have longer limbs than those that evolved over long periods of time in a forest environment. The African's long limb causes a high surface area - to - volume ratio which helps to dissipate heat, while the arctic hunter's bulky body for instance, conserves heat. These reflect genetic adaptation to climate [25]. The length of limbs in hominoid species are subject to the temperature of the environment in which they are located (Allen and Bergmann's Rule) [29]. The rule dictates that hominoid in warmer climes evolve longer and leaner body parts for greater heat loss while those in cooler climes evolve shorter stockier parts for increased heat conservation [29]. In Africa, hominoids located in the warmer savannah generally evolved longer-leaner limbs than hominoids localised to the cooler and shadier forest environment [25]. Bi-acromial breadth (39.07±3.85) in the present

study was higher than that reported for the Turks (386.06±23.09 mm [38.606 cm]) [23] and slightly lower than the values obtained in a Turko-Mongolic population in Central Asia High Altitude Population (CAHAP); (39.9) mean bi-acromial breadth for all CAHAP, (39.5) High Altitude Kirghizs, (40.1) Mid Altitude Kazakhs, (40.7) Low Altitude Kirghizsand (39.0) Low Altitude

Table 3. Descriptive statistics of the measured linear body parameters according to age

Linear body parameters	Age group	N	Mean	SD	*t*-test			
					df	*t*-value	*p*-value	Inference
Standing Height	21 - 30	985	179.57	8.56	347.76	-1.60	0.11	NS
	31 - 40	215	180.50	7.48				
Sitting Height	21 - 30	985	83.36	5.11	1198.00	2.04	0.04	S
	31 - 40	215	82.57	5.23				
Arm Span	21 - 30	985	180.38	10.71	1198.00	-1.19	0.23	NS
	31 - 40	215	181.34	10.69				
Bi-acromial Breadth	21 - 30	985	39.19	3.78	1198.00	2.23	0.03	S
	31 - 40	215	38.54	4.08				
Upper Limb Length	21 - 30	985	77.05	7.10	1198.00	-1.31	0.19	NS
	31 - 40	215	77.75	7.29				
Elbow Breadth	21 - 30	985	7.74	1.47	292.57	1.30	0.19	NS
	31 - 40	215	7.58	1.65				
Wrist Breadth	21 - 30	985	6.11	1.04	342.36	2.38	0.02	S
	31 - 40	215	5.94	0.93				
Bi-iliac Breadth	21 - 30	985	28.18	2.31	295.80	3.26	0.00	S
	31 - 40	215	27.57	2.55				
Thigh Length	21 - 30	985	49.09	6.15	1198.00	-0.86	0.39	NS
	31 - 40	215	49.49	6.28				
Knee Height	21 - 30	985	49.89	3.71	1198.00	2.51	0.01	S
	31 - 40	215	49.19	3.71				
Foot Length	21 - 30	985	28.04	1.61	338.07	-1.81	0.07	NS
	31 - 40	215	28.24	1.45				

Table 4. Descriptive statistics of the measured linear body parameters according to BMI in all subjects

Linear body parameters	BMI Cat	N	Mean	SD	*t*-test			
					df	*t*-value	*p*-value	Inference
Standing Height	Normal weight	899	180.20	8.21	3.24	488.46	0.00	S
	Slightly overweight	301	178.34	8.76				
Sitting Height	Normal weight	899	83.14	5.12	-0.91	1198.00	0.36	NS
	Slightly overweight	301	83.45	5.19				
Arm Span	Normal weight	899	181.05	10.79	2.76	1198.00	0.01	S
	Slightly overweight	301	179.09	10.34				
Bi-acromial Breadth	Normal weight	899	39.14	3.77	1.09	1198.00	0.27	NS
	Slightly overweight	301	38.86	4.06				
Upper Limb Length	Normal weight	899	76.88	6.93	-2.49	1198.00	0.01	S
	Slightly overweight	301	78.06	7.66				
Elbow Breadth	Normal weight	899	7.70	1.46	-0.32	472.46	0.75	NS
	Slightly overweight	301	7.74	1.63				

Linear body parameters	BMI Cat	N	Mean	SD	*t*-test			
					df	*t*-value	*p*-value	Inference
Wrist Breadth	Normal weight	899	6.07	1.02	-0.66	1198.00	0.51	NS
	Slightly overweight	301	6.11	1.05				
Bi-iliac Breadth	Normal weight	899	28.13	2.33	1.48	492.98	0.14	NS
	Slightly overweight	301	27.89	2.46				
Thigh Length	Normal weight	899	49.23	6.25	0.67	538.05	0.51	NS
	Slightly overweight	301	48.96	5.95				
Knee Height	Normal weight	899	49.94	3.74	2.88	533.07	0.00	S
	Slightly overweight	301	49.24	3.60				
Foot Length	Normal weight	899	28.06	1.58	-0.53	1198.00	0.59	NS
	Slightly overweight	301	28.12	1.59				

Uighurs [30]. Upper limb length (78.51±2.99) was higher than that reported in India (72.50±4.12) [24]. Elbow breadth in the present study (7.71±1.50) was higher than those obtained in the Turko-Mongolic population; 71 mm (7.1 cm) elbow breadth for all CAHAP, 70 mm (7.0 cm) High Altitude Kirghizs, 71mm (7.1 cm) Mid Altitude Kazakhs, 71 mm (7.1 cm) Low Altitude Kirghizs and 71 mm (7.1 cm) Low Altitude Uighurs [30]. Wrist breadth (6.08±1.02) was higher than that of Turks (4.98±2.84) [31]. Bi-iliac breadth (29.41±2.37) was higher than that of the Turks (28.92±25.94) [23]. On comparison with those of other populations, knee height (50.43±3.71) was higher than that of the Kori (42.42±4.25) [24] and lower than that reported for Caucasian Australians (51.1± 3.6) [32]. Foot length (27.41±1.58) was higher than that reported for a northern Indian population (20.22±1.90) [28] and the Kori population (25.26±1.2) [24].

5. CONCLUSION

Although certain degree of variation was observed across the three negroid ethnic groups studied, it is not adequate for subcategorization of these southern Nigerian ethnic groups. These anthropometric values not only provide a description of the standard linear anthropometric body features of southern Nigeria but could find use in anthropological and medical studies, standardization of anatomical models as well as in the design of products to fit this negroid population.

CONSENT

As per international standard or university standard written patient consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Forrest T. The Advance of African capital: The growth of Nigerian Private Enterprise (Illustrated ed.). Edinburgh University Press. 1994;272.
2. Mwakikagile G. African countries: An introduction with maps. Pan-African Books: Continental Press. 2006;86.
3. Williams L. Nigeria: The Bradt Travel Guide. Bradt Travel Guides. 2008;32.
4. Bob C. The marketing of rebellion: Insurgents, media and International Activism. Cambridge University Press. 2005;55.
5. Yoruba 21% out of a population of 197.8 million. Nigeria at CIA World Factbook; 2016.

6. Moore KL, Agur AMR. Essential clinical anatomy 2nd edition. Lippincott Williams and Wilkins. 2002;3–4.
7. Bjelica D, Popovic S, Kezunovic M, Petkovic J, Jurak G, Grasgruber P. Body height and its estimation utilizing arm span measurements in Montenegrin adults. Anthropological Notebooks. 2012;18(2): 69–83.
8. Brown JK, Feng JY, Knapp TR. Is self-reported height or arm span a more accurate alternative measure of height? Clinical Nursing Research. 2002;11(4): 417-432.
9. Popovic S, Bjelica D, Georgiev G, Krivokapic D, Milasinovic R. Body height and its estimation utilizing arm span measurements in macedonian adults. Anthropologist. 2016;24(3):737-745.
10. Popovic S, Bjelica D, Molnar S, Jaksic D, Akpinar S. Body height and its estimation utilizing arm span measurements in Serbian adults. International Journal of Morphology. 2013;31(1):271-279.
11. Popovic S, Bjelica D, Tanase GD, Milasinovic R. Body height and its estimation utilizing arm span measurements in Bosnian and Herzegovinian adolescents. Montenegrin Journal of Sports Science and Medicine. 2015;4(1):29-36.
12. Reeves SL, Varakamin C, Henry CJ. The relationship between arm-span measurements and height with special reference to gender and ethnicity. European Journal of Clinical Nutrition. 1996;50(6):398-400.
13. Steele MF, Chenier TC. Arm-span, height and age in black and white women. Annals of Human Biology. 1990;17(6):533-541.
14. Arifi F. Stature and its estimation utilizing arm span measurements of both gender adolescents from Southern region in Kosovo. Sport Science. 2017;10(1):92-95.
15. Arifi F, Sermaxhaj S, Zejnullahu-Raçi P, Alaj I, Metaj Z. Stature and its estimation utilizing arm span measurements of both gender adolescents from Northern Region in Kosovo. ActaKinesiologica. 2017;11(1): 49-52.
16. Milasinovic R, Popovic S, Matic R, Gardasevic J, Bjelica D. Body height and its estimation utilizing arm span measurements in male adolescents from Southern Region in Montenegro. Sport Mont. 2016;14(2):21–23.
17. Milasinovic R, Popovic S, Jaksic D, Vasilejvic I, Bjelica D. Stature and its estimation utilizing arm span measurements in feale adolescents from Southern Region in Montenegro. Sport Mont, 2016;14(3):15–18.
18. Masanovic B, Gardasevic J, Arifi F. Relationship between foot length measurements and body height: A prospective regional study among adolescents in eastern region of Kosovo. Sport Mont, 2018;16(1):9-13.
DOI: 10.26773/smj.180202
19. Masanovic B, Gardasevic J, Arifi F. Standing height and its estimation Utilizing foot length measurements in adolescents from Southern Region in Kosovo. Sport Mont. 2018;16(2).
20. Brown N, Scurr J. The need for a standardized anthropometric protocol for objective assessment of pre – and postoperative breast surgery. Gland Surgery. 2012;1:3.
Available:www.glandsurgery.org/index
21. Quanjer PH, Capderou A, Mazicioglu MM, Aggarwal AN, Banik SD, Popovic S, Tayie FAK, Golshan M, Ip MSM, Zelter M. All-age relationship between arm span and height in different ethnic groups. Eur Respir J. 2014.
DOI: 10.1183/09031936.00054014
22. National Health and Nutrition Examination Survey III (NHANES III). Body Measurements (Anthropometry). Westat, Inc. 1988;8-11.
23. Karadayi B, Ozaslan A, Kolusayin MO, Kaya A. Stature estimation from bi-acromial and bi-iliocristal measurements. Romanian Journal of Legal Medicine. 2011;19(3):171-176.
24. Kamal R, Yadav PK. Estimation of stature from different anthropometric measure-ments in Kori population of North India. Egyptian Journal of Forensic Sciences. 2016;6(4):468-477.
25. Fawehinmi HB. Different tailors for the same people: The same surgeon for different people. 111th Inaugural Lecture of the University of Port Harcourt. University of Port Harcourt Press; 2014.
26. Gardasevic J. Relationship between sitting height measurements and standing height: A prospective regional study among adolescents in Eastern Region of Kosovo. Sport Mont. 2018;16(2):15–19.
27. Popovic S, Bjelica D, Georgiev G, Krivokapic D, Milasinovic R. Body height

and its estimation utilizing arm span measurements in Macedonian adults. Anthropologist. 2016;24(3):737-745.
28. Singh A, Kumar A, Chavali KH, Harish D. Use of arm-span and foot length for estimation of height of the person. Journal of Punjab Academy of Forensic Medicine and Toxicology. 2012;12(2):87-91.
29. Allen JA. The influence of physical conditions in the genesis of species. Radical Review. 1877;1:108–140.
30. Facchini F, Fiori G, Toselli S, Pettener D, Battistini N, Bedogni G. Is elbow breadth a measure of frame size in non-Caucasian populations? A study in low and high-altitude Central-Asia populations. International Journal of Food Sciences and Nutrition. 2003;54:21–26.
31. Cakit E, Durgun B, Cetik O, Yoldas O.A Survey of hand anthropometry and biomechanical measurements of dentistry students in Turkey. Human Factors and Ergonomics in Manufacturing. 2014;24(6): 739-753.
32. Teichtahl AJ, Wluka AE, Strauss BJ, Wang Y, Berry P, Davies-Tuck M, Cicuttini FM. The associations between body and knee height measurements and knee joint structure in an asymptomatic cohort. BMC Musculoskeletal Disorders. 2012;13: 19.
DOI: org/10.1186/1471-2474-13-19

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/55609