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Research Article

Male Linear Anthropometrics of Selected Nigerian Ethnicities: A Cross - Sectional Analysis

Michael Okon[1]*, HB Fawenhinmi[1], LE Oghenemavwe[1], PD Okoh[1], LK David[1], CA Oparaocha[2], CE Ebieto[3], TA James[4], AN Maryam[4] and TK Adenowo[5]

[1]Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Rivers State, Nigeria
[2]Department of Fine Arts and Design, Faculty of Humanities, University of Port Harcourt, Port Harcourt, Nigeria
[3]Department of Mechanical Engineering, Faculty of Engineering, University of Port Harcourt, Port Harcourt, Nigeria
[4]Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Yusuf Maitama Sule University, Kano State, Nigeria
[5]Department of Anatomy, Faculty of Basic Medical and Health Sciences, College of Medicine, Lead City University Ibadan, Nigeria

More Information

***Address for correspondence:** Michael Okon, Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Rivers State, Nigeria, Email: zadok2k6@gmail.com

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Keywords: Nigeria; Igbo; Yoruba; Hausa; Anthropometry; Linear measurements

Abbreviations: 3D: Three-dimensional; ISAK: International Society for the Advancement of Kinanthropometry; NHP: Natural Head Position; SPSS: Statistical Package for the Social Science; ANOVA: Analysis of Variance; SH: Standing Height; AL: Arm Length; TL: Thigh Length; FHL: Forearm length; FL: Foot Length; AS: Arm Span; W: Body Weight; BMI: Body Mass Index; SB: Shoulder Breadth; EB: Elbow Breadth; WB: Wrist Breadth; BIB: Bi-iliac Breadth; NCD-RisC: NCD Risk Factor Collaboration; CAHAP: Central Asia High Altitude Population

Abstract

Introduction: This study aims at evaluating selected linear anthropometrics of three Nigerian ethnic groups to provide baseline data for the creation of 3D Negroid anatomic models.

Methods: The research design was a cross-sectional design. The sampling technique was multistage proportionate random sampling. The places of study were Imo, Oyo, and Kano States of Nigeria. The study lasted for one (1) year. Random selection of 1500 adult males from three major tribes (500 Igbo, 500 Yoruba, and 500 Hausa between the ages of 18 and 40 years). Tukey's Post Hoc test of multiple comparisons was carried out to determine the specific ethnic groups that differ in specific anthropometric parameters.

Results: The differences in standing height, arm length, and thigh length across the Hausa, Igbo, and Yoruba ethnic groups are statistically significant ($p < 0.05$).

Conclusion: The study concluded that the Igbo and Yoruba groups had higher standing heights compared to the Hausa group. Arm length was longer in the Igbo and Yoruba groups compared to the Hausa group. However, thigh length was greater in the Hausa group compared to both the Igbo and Yoruba groups, while the Hausa group had longer thigh lengths than both the Igbo and Yoruba groups. The Igbo group displayed the largest arm span, whereas the Hausa group had the widest shoulder breadth. However, the Hausa group had a lower bi-iliac breadth in comparison to the other two ethnic groups.

Introduction

Anthropometry involves the study of human body measurements to understand the physical variations among different population groups. In forensic investigations, identifying individuals is crucial. Estimating a person's stature is especially important when dealing with unknown or mixed human remains, such as in mass casualties and natural disasters, as it aids in the identification process.

Linear measurements form the basic measurements when determining stature and this is very critical in the determination of human identification [1]. Anthropometric measurements form the crucial part of anthro-forensic examinations without these measurements correctly and appropriately carried out, forensic results could be misleading [2,3].

The significance of accurate measurements is incontestable in various industries. From ensuring precise fits in mechanical assemblies to guaranteeing consistent product dimensions, reliable linear measurements and techniques are crucial.

The relevance of standardized anthropometric parameters for the design of three-dimensional (3D) gross anatomical models provides a reliable background for accurately representing human anatomy, ensuring that models reflect the variations in body dimensions and proportions that exist across different populations [4,5]. Human populations exhibit significant anatomical differences that are heavily influenced by genetic, environmental, and cultural factors [6]. Therefore, standardized anthropometric data allows for the creation of models that are representative of specific populations for applications in medical education, public health, and ergonomic design.

Anthropometric variables such as stature, arm length, thigh length, wrist circumferences, and forearm length among others are among the most critical biological parameters used in forensic identification and ethnic variability [7,8]. Research has shown that there are significant ethnic variations in stature and limb proportions in Nigeria, additionally, certain cultural practices may influence physical activities that promote upper body strength, potentially affecting arm and forearm development [1,9]. These cultural practices differ from one ethnic group to another. This suggests that ethnicity is a major attributive factor in determining head, face, and possibly body dimensions [10]. There is an abundance of anthropometry data for Nigerians but due to changes in diet and lifestyle which could alter their body morphology, there is a need for continuous evaluation to remain current and relevant.

Bhat, et al. carried out a study where they concluded that ethnicity has a major influence on the anthropometry of individuals from that culture [11]. Ethnic differences in anthropometric data have been observed for years, and this significant correlation of the anthropometric measurements influenced by ethnicity and gender can have a measurable bearing on the evaluation of grip and pinch strength values, as reported in their study.

Studies have shown that the anthropometric characteristics of Nigerians differ from those of other populations, this makes it difficult to use anthropometric data from other populations to develop accurate 3D models of Nigerians [12]. Therefore, it is important to have standardized anthropometric parameters for Nigerians to ensure accurate 3D modeling and forensic identification. Therefore, developing reliable Negroid models for estimation based on specific anthropometric measurements is essential for forensic applications [13]. The current study was aimed at evaluating selected linear anthropometrics of three Nigerian ethnic groups to provide baseline data for the creation of 3D Negroid anatomical models.

Materials and methods

Participant selection

The research design was a cross-sectional design that cataloged values of the anthropometric features of adult Nigerian males using anthropometric standards for the reconstruction of a three–dimensional Negroid gross anatomical modeling. The sampling technique was multistage proportionate random sampling. Subjects were randomly selected from adult males from three major tribes (Igbo, Yoruba, and Hausa) residing in Imo, Oyo, and Kano states of Nigeria.

The study comprised of one thousand five hundred Nigerian males (500 Igbo, 500 Yoruba, and 500 Hausa) between the age of 18 years and 40 years with a BMI of 18.50 to ≤ 30.00. It was ascertained that recruited subjects have both parents and four grandparents from the same ethnic group. This was determined through direct personal interviews with the participants.

The 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.

Data collection

The data were collected through a structured, pretested interviewer-administered questionnaire and anthropometric parameters were taken by direct measurements. The anthropometric measurements were taken using the protocol of the International Society for the Advancement of Kinanthropometry (ISAK). The length was measured by using a nonelastic tape meter, vernier calipers, and spreading calipers. Participants were fully informed to obtain consent, and the study received approval from the institutional review ethics committee of the University of Port Harcourt with reference code: UPH/CEREMAD/REC/MM96/023. The study employed whole-body anthropometric measurements. The measurements were taken in centimeters and all the anthropometric measurements were measured when the subjects were standing in the Frankfort horizontal plane.

1. **Standing height:** This was measured using a stadiometer, with participants standing barefoot against a vertical wall. The apex of the stadiometer was placed on the vertex of the head in the Natural Head Position (NHP) of the subject while standing in the anatomical position.
2. **Arm Length:** Arm length was taken from the tip of the humerus (acromion) bone to the tip of the middle finger (dactylion) of the right arm while the arm hanging downwards lateral to the body.
3. **Arm Span:** This was measured from the tip of the middle finger of one arm to the tip of the middle finger of the other arm (dactylion to dactylion) with the arms

outstretched at right angles of 180° to the body and with extended elbow and wrist, and the palms facing directly forward.

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

5. **Wrist breadth:** It was measured as the distance between the styloid process of radius and ulna, using a caliper in centimeters.

6. **Foot Length:** It was measured as a direct distance from the most prominent point of the back of the heel (pterion) to the tip of the hallux or to the tip of the second toe (when the second toe is longer than the hallux) by non-stretchable tape in centimetre [14]. The left foot was selected for measurement as per the recommendation of the international agreement for paired measurements at Geneva (1912) [15].

7. **Shoulder breadth:** The subjects stand erect with arms hanging freely at their sides while on an even surface. The examiner locates the lateral border of the acromial process on each shoulder. The arms of the sliding caliper are placed directly on the skin next to the lateral border of each acromial process and pressure is applied to compress the soft tissue over the acromial processes without hurting the subject.

8. **Forearm Hand length:** this measurement is taken was measured between the midpoint of the radius and ulnar styloid and the tip of the middle finger. The subject stands facing the examiner and the forearm is kept perpendicularly.

9. **Elbow breadth:** The subject stands erect with feet together facing the examiner. The right arm is extended forward until it is perpendicular to the body. The right arm is then flexed so that the elbow forms a 90^0 angle with the fingers pointing up and the posterior part of the wrist toward the examiner. With the small sliding caliper held at a 45-degree angle to the plane of the long axis of the upper arm, the greatest breadth across the epicondyles of the elbow is measured to the nearest 0.1 cm. This measurement is taken with the calipers at a slight angle because the medial condyle is more distal than the lateral condyle.

10. **Bi-iliac Breadth:** The measurement was taken by locating the right side of the iliac crest at its highest point and the sliding caliper is spread to the lateral border of each iliac crest. The soft tissue is compressed to obtain the bony measurement without hurting the subject. The maximum breadth was read to the nearest 0.1 cm.

All measurements were typically taken by trained personnel to minimize inter-observer variability. Multiple measurements were taken for each parameter, and the average was calculated to enhance accuracy.

Data analysis

Statistical analysis was done using a statistical package for social science (SPSS version 25.0) and Microsoft Excel 2019. Continuous variables were presented as mean ± SD; minimum and maximum. Analysis of variance (ANOVA) was done to establish significant differences in the measured anthropometric parameters according to ethnic group while Tukey's Post Hoc test of multiple comparisons was carried out to determine the specific ethnic groups that differ in specific anthropometric parameters. The confidence limit was set at 95%, therefore $p < 0.05$ was considered significant. The reliability of the data was assessed by computing Cronbach's Alpha, and the computed value of Cronbach's alpha was found to be 0.747, 0.783, and 0.673 for Hausa, Igbo, and Yoruba respectively which shows that there was an acceptable level of internal consistency between all items in the questionnaire and instrumentation.

Results

For Table 1, Standing Height (SH) had a mean value of 172.17 cm, with relatively low variability (S.D of 6.69 cm) within the sample. Arm Length (AL) had a mean value of 32.65 cm, with even lower variability (S.D of 2.53 cm), indicating that most individuals' arm lengths were close to this average. Thigh Length (TL) had a mean value of 52.13 cm, with a slightly higher variability (S.D of 4.61 cm) compared to arm length, suggesting more variation in thigh length among the individuals. Forearm length (FHL) had a mean value of 49.26 cm, with a low variability (S.D of 2.62) which indicates that most of the subjects' FHL were close to this average. The foot length (FL) had a mean value of 25.88 cm and a low variability. (S.D of 1.86). The Arm Span (AS) was 181.25 cm as the mean value with a very high variability (8.19) indicating that most individuals with the sample had variable arm spans. Shoulder Breath on the other hand had a mean of 41.06 cm and a low variability (S.D of 2.48). Elbow breadth, Wrist breadth, and Bi-iliac breadth had their mean values of 6.67 cm, 5.33 cm, and 22.02 cm respectively. EB had the lowest variability (S.D

Table 1: Descriptive Statistics for Hausa Linear Anthropometric Dimensions.

Parameters	N	min	max	Mean	SEM	SD
SH	500	150.00	191.20	172.17	0.29	6.69
AL	500	23.00	43.00	32.65	0.11	2.53
FHL	500	40.00	58.00	49.26	0.11	2.62
TL	500	31.40	68.00	52.13	0.20	4.61
FL	500	20.00	55.00	25.88	0.08	1.86
AS	500	150.00	205.00	181.25	0.36	8.19
SB	500	30.00	51.00	41.06	0.11	2.48
EB	500	4.10	9.00	6.67	0.02	0.52
WB	500	3.80	7.00	5.33	0.02	0.53
BIB	500	18.00	32.00	22.02	0.09	2.12

Abbreviations: SH: Standing Height; W: Body Weight; BMI: Body Mass Index; AL: Upper Arm Length; FHL: Forearm-Hand Length; TL: Thigh Length; FL: Foot Length; AS: Arm Span; SB: Shoulder Breadth; EB: Elbow Breadth; WB: Wrist Breadth; BIB: Bi-Iliac Breadth of 0.52) while BiB had the highest variability of the three respectively (S.D of 2.12).

For Table 2, Standing Height (SH) has a mean of 176.57 cm, with a standard deviation of 7.06 cm, suggesting moderate variability in the height of individuals within the sample. Arm Length (AL) shows a mean of 34.38 cm, with a standard deviation of 3.77 cm, indicating that the arm lengths in the sample have a smaller range of variation. Thigh Length (TL) has a mean of 47.18 cm, with a standard deviation of 4.16 cm, reflecting moderate variation in thigh length among the individuals. The FHL had a mean value of 50.61 and a variability of 3.18, which indicates that most of the subjects' FHL were of the average length. The foot length (FL) had a mean value of 26.63 cm and a low variability (S.D of 1.32) indicating that most subjects had Foot Length within the range of the mean value. The Arm Span (AS) had a mean value of 181.25 cm and a very high variability (9.07) indicating that most individuals in the sample had variable arm spans. Shoulder Breath had 40.87 cm as the mean value and and a low variability (S.D of 3.64). Elbow breadth, Wrist breadth, and Bi-iliac breadth had their mean values of 6.85 cm, 5.64 cm, and 23.73 cm respectively. EB had the lowest variability (S.D of 0.55) while BiB had the highest variability of the three respectively (S.D of 2.48). Whilst WB had a low variability (S.D of 0.43).

For Table 3, Standing Height (SH) has a mean value of 175.79 cm, with a standard deviation of 6.85 cm, indicating that most individuals in the sample have a height close to this average, with some variability. Arm Length (AL) shows a mean of 34.98 cm, with a standard deviation of 2.92 cm, suggesting that arm lengths in the sample are consistent, with less variation compared to standing height. Thigh Length (TL) has a mean of 45.08 cm, with a standard deviation of 5.42 cm, indicating a broader range of thigh lengths in the sample, as reflected by the larger standard deviation and the wider range between the minimum and maximum values. The mean value of forearm length (FHL) was 48.95 cm, with a low standard deviation (S.D of 3.00), indicating that most subjects had FHL close to this average. Foot length (FL) had a mean value of 26.20 cm and a low variability (S.D of 1.51). The mean value of Arm Span (AS) was 182.96 cm, with a very high variability (9.19), indicating that individuals in the sample had very highly variable arm spans. Shoulder breadth had a mean of 40.96 cm and a low variability (S.D of 3.65). The mean values for elbow breadth, wrist breadth, and bi-iliac breadth were 6.74 cm, 5.62 cm, and 23.62 cm respectively. Bi-iliac breadth had the highest variability of the three respectively (S.D of 2.12), while elbow breadth had the lowest variability (S.D of 0.52) and wrist breadth had a low variability (S.D of 1.77).

Table 2: Descriptive Statistics for Igbo Linear Anthropometric Dimensions.

Parameters	N	min	max	Mean.	SEM	SD
SH	500	158.00	200.00	176.57	0.31	7.06
AL	500	23.00	48.00	34.38	0.16	3.77
FHL	500	36.50	62.50	50.61	0.14	3.18
TL	500	40.00	58.50	47.18	0.18	4.16
FL	500	20.40	29.80	26.63	0.05	1.32
AS	500	163.00	212.00	186.20	0.40	9.07
SB	500	30.00	53.40	40.87	0.16	3.64
EB	500	4.90	9.00	6.85	0.02	0.55
WB	500	4.20	7.00	5.64	0.02	0.43
BIB	500	19.00	35.00	23.73	0.11	2.48

Abbreviations: SH: Standing Height; W: Body Weight; BMI: Body Mass Index; AL: Upper Arm Length; FHL: Forearm-Hand Length; TL: Thigh Length; FL: Foot Length; AS: Arm Span; SB: Shoulder Breadth; EB: Elbow Breadth; WB: Wrist Breadth; BIB: Bi-Iliac Breadth

Table 3: Descriptive Statistics for Yoruba Linear Anthropometric Dimensions.

Parameters	N	min	max	Mean.	SEM	SD
SH	500	154.00	198.00	175.79	0.30	6.85
AL	500	27.00	43.70	34.98	0.13	2.92
FHL	500	34.50	59.00	48.95	0.13	3.00
TL	500	30.00	72.40	45.08	0.24	5.42
FL	500	21.00	36.50	26.20	0.06	1.51
AS	500	135.00	207.00	182.96	0.41	9.19
SB	500	30.00	55.00	40.96	0.16	3.65
EB	500	4.20	8.30	6.74	0.02	0.50
WB	500	4.10	44.00	5.62	0.07	1.77
BIB	500	18.00	35.00	23.62	0.11	2.59

Abbreviations: SH: Standing Height; W: Body Weight; BMI: Body Mass Index; AL: Upper Arm Length; FHL: Forearm-Hand Length; TL: Thigh Length; FL: Foot Length; AS: Arm Span; SB: Shoulder Breadth; EB: Elbow Breadth; WB: Wrist Breadth; BIB: Bi-Iliac Breadth

As shown in Table 4, the differences in standing height, arm length, and thigh length across the Hausa, Igbo, and Yoruba ethnic groups are statistically significant ($p < 0.05$). The Igbo and Yoruba groups have significantly greater standing heights compared to the Hausa group. Arm length is significantly longer in the Igbo and Yoruba groups compared to the Hausa group. Thigh length is significantly longer in the Hausa group compared to both the Igbo and Yoruba groups. FHL and EB are significantly different in the Igbos against the Hausas and Yorubas. FL and AS were significantly different among the three ethnic groups while SB was not significantly different at all. WB and BIB were significantly different in the Hausas against Igbos and Yorubas.

Discussion

The current study findings regarding the differences in standing height (SH), arm length (AL), and thigh length (TL) among the Hausa, Igbo, and Yoruba ethnic groups highlight significant anthropometric variations that are consistent with existing literature on racial populations. These differences can be attributed to a combination of genetic, environmental, and cultural factors that influence physical development across different ethnic groups. The observation that the Igbo and Yoruba groups have significantly greater standing heights compared to the Hausa group aligns with studies indicating that height can vary significantly among different ethnicities due to genetic predispositions and nutritional factors. Research has shown that populations in certain regions may have evolved to have taller statures because of environmental adaptations and dietary practices. This aligns with broader findings in anthropometric research, which indicate ethnic and regional variations in height due to genetic, nutritional,

Table 4: Differences between Anthropometric Dimensions in all Ethnic Groups.

Parameters	Hausa	Igbo	Yoruba	F	P value	inference
SH	172.17 ± 6.69**	176.57 ± 7.06*h	175.79 ± 6.85*h	58.46	0.00	S
AL	32.65 ± 2.53**	34.38 ± 3.77**	34.98 ± 2.92**	74.97	0.00	S
FHL	49.26 ± 2.63*i	50.61 ± 3.18**	48.95 ± 3.00*i	44.60	0.00	S
TL	52.13 ± 4.62**	47.18 ± 4.16**	45.08 ± 5.42**	288.78	0.00	S
FL	25.88 ± 1.86**	26.63 ± 1.32**	26.20 ± 1.52**	28.37	0.00	S
AS	181.25 ± 8.19**	186.20 ± 9.07**	182.96 ± 9.19**	40.52	0.00	S
SB	41.06 ± 2.48	40.87 ± 3.64	40.96 ± 3.65	0.43	0.65	NS
EB	6.67 ± 0.53*i	6.85 ± 0.55**	6.74 ± 0.51*i	14.25	0.00	S
WB	5.33 ± 0.53**	5.64 ± 0.43*h	5.62 ± 1.77*h	12.98	0.00	S
BIB	22.02 ± 2.12**	23.73 ± 2.48*h	23.62 ± 2.59*h	78.96	0.00	S

Abbreviations: SH: Standing Height; W: Body Weight; BMI: Body Mass Index; AL: Upper Arm Length; FHL: Forearm-Hand Length; TL: Thigh Length; FL: Foot Length; AS: Arm Span; SB: Shoulder Breadth; EB: Elbow Breadth; WB: Wrist Breadth; BIB: Bi-Iliac Breadth; S: Significant ($p < 0.05$); NS: Non-Significant ($p > 0.05$) ** = Significant in all tribe, *h = Significant with the Hausa, *i = Significant with the Igbo.

and environmental factors. For example, NCD-RisC discusses how height variations are influenced by genetic factors and socio-economic conditions [16]. Gibson also underlines that variations in height among different ethnic groups can also reflect differentiation in nutrition and healthcare access during developmental years [17].

Arm length also varies significantly among the three ethnic groups, with the Yoruba having the longest mean arm length, followed by the Igbo, and the Hausa with the shortest. These differences could be due to genetic variations in limb proportions or adaptations to environmental factors. The longer arm lengths in the Igbo and Yoruba groups compared to the Hausa group may reflect evolutionary adaptations related to lifestyle and physical activity. Petrie, et al. provide insights into how limb proportions, including arm length, can vary across different populations due to genetic and environmental influences [18]. The observed differences in arm length among the ethnic groups could reflect these factors. Sutton, et al. also discussed how variability in limb measurements is influenced by both genetic and lifestyle factors, which could be relevant to the differences observed [19].

For instance, populations that engage in more manual labor or activities requiring greater reach may develop longer limbs. This finding is supported by anthropometric studies that document variations in limb proportions among different racial groups. The significant thigh length advantage in the Hausa group over the Igbo and Yoruba groups may be linked to specific cultural practices, such as traditional forms of labor or mobility patterns. Literature suggests that thigh length can be influenced by factors such as walking habits and the types of physical activities prevalent in a community. Sutton et al. highlight that thigh length can exhibit considerable variability due to genetic predispositions and environmental influences [19]. The differences observed among the Hausa, Igbo, and Yoruba groups could be related to these factors. Furthermore, Elia & Cederholm noted that body measurements, including thigh length, can vary widely across populations due to a combination of genetic and environmental factors [20].

Numan, et al. noted that in stature and hand dimensions between the Igbos and Hausas, there was no major difference but those of the Yorubas were significantly shorter than the Igbos and Hausas, when compared with our study, wrist breadth was significantly smaller for Hausas, that of the Igbos and Yorubas were not so different from each other [21]. Numan, et al. concluded that no significant difference was observed in stature and hand dimensions between the Hausas and Igbos when compared between the same sexes, this does not agree with our study as there was a significant difference in wrist breadth between Hausas and Igbos and Yorubas.

The Shoulder breadth (SB) was not significantly different across the three ethnic groups. The wrist breadth and bi-iliac breadth for the Hausas were significantly different from that of Yorubas and the Igbos, with both significantly smaller than that of the Yorubas and the Igbos, however, we must pay attention to the fact that this study had a mean age of 23 years.

In a study by Stulp & Barret, they found that the relationship between height and latitude showed conformity to Allen's rule, which states that body shape and proportions vary by minimizing exposed surface area to decreasing mean temperature (to reduce surface area: volume ratio, and so conserve heat) and maximizing exposed surface area with increasing mean temperature (increasing surface: volume and so improving heat dissipation) [22,23]. This goes to explain why people living in warmer regions like the east and west tended to have longer limbs than those living in colder areas, though generally speaking, this sort of revealed that tropical populations have a more linear body build.

In comparison with the Caucasians, there was a marked difference in the parameters. The mean standing height for Hausa, Igbo, and Yoruba was 172 ± 6.69, 176 ± 7.06, and 175 ± 6.85 respectively in the present study, this was lower than those reported in Kosovo (178.79 ± 6.07), Bosnia and Herzegovina (183.9) and Macedonia (178.10 ± 6.79), but higher than that reported in India (165.96 ± 6.33) [24,25]. The length of limbs just like height varies between the different hominoid sub-species [26].

The mean arm span of Hausa, Igbo, and Yoruba was 181.25 ± 8.19, 186.20 ± 9.07, and 182.96±9.19 respectively, these were higher than those of Indians (166.40 ± 7.20) and Macedonians

(178.78 ± 7.71) [24,25]. This could be because subspecies that are localized in open savannah countries commonly have longer limbs than those that evolved over long periods in a forest environment. The long limbs of Africans create a high surface area-to-volume ratio, aiding in heat dissipation, while the stocky build of Arctic hunters helps them retain heat. These features demonstrate genetic adaptations to their respective climates [26]. In hominoid species, limb length is influenced by the environmental temperature they inhabit (Allen and Bergmann's Rule) [23].

Shoulder breadth for Hausa, Igbo, and Yoruba of 41.06 ± 2.48, 40.87 ± 3.64, and 40.96 ± 3.65 respectively in the present study was higher than that reported for the Turks (38.60 cm) including those 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 Kirghizs and (39.0) Low Altitude Uighurs [27,28]. This is different from what was obtained in Okoh and Amadi [29].

In this study, arm length and forearm hand length for Hausas were 32.65 ± 2.53 and 49.26 ± 2.63, that of Yorubas was 34.98 ± 2.92 and 48.95 ± 3.00, that of Igbos was 34.38 ± 3.77 and 50.61 ± 3.18, together, they form the upper limb length which was higher than that reported in India (72.50 ± 4.12) [30]. Elbow breadth in the present study for Hausa (6.67 ± 0.53), Igbo (6.85 ± 0.55), and Yoruba (6.74 ± 0.51) were all lower than those obtained in the Turko-Mongolic population; (7.1 cm) elbow breadth for all CAHAP (7.0 cm) High Altitude Kirghizs, (7.1 cm) Mid Altitude Kazakhs, (7.1 cm) Low Altitude Kirghizs and (7.1 cm) Low Altitude Uighurs [28]. Wrist breadth of 5.33 ± 0.53 for Hausas, 5.64 ± 2.48 for Igbos, and 5.62 ± 1.77 for Yorubas was higher than that of Turks (4.98 ± 2.84) [31]. These corresponded with findings from the study of Okoh and Amadi, 2020 in Southern Nigerians.

Bi-iliac breadth for Hausas, Yourbas, and Igbos was 22.02 ± 2.12, 23.62 ± 2.59 and 23.73 ± 2.48 respectively, these values were lower than that of the Turks (28.92 ± 25.94) [27], Okoh and Amadi found in their study the mean bi-iliac breadth to be 28.13 ± 2.33 for southern Nigerians [29].

Foot length for the three ethnic groups was Hausa (25.88 ± 1.86), Igbo (26.63 ± 1.32), and Yoruba (26.20 ± 1.52), these were higher than that reported for a northern Indian population (20.22 ± 1.90) (Singh, et al. 2012) and the Kori population (25.26 ± 1.2) [30].

The economy and stability of a nation are important factors in comparisons as they can have a severe impact on the lives of individuals physically, however a study [22] asserted that it was not a major factor in accounting for height differences within populations as a population that had everyone on a seemingly equal economic status still had noteworthy differences in height. This sort of suggests more strongly that genetic and perhaps environmental factors play a heavier role in this [32]. Obaje et al. in their work on the anthropometric measurements as nutritional indicators concluded that there is a connection between socioeconomic status and nutritional indicators for the extremely marginalized tribe in Northern Nigeria, this invariably has an impact on the formation of individuals [33].

In summary, the data provided indicates a generally consistent sample. This pattern is consistent with findings in contemporary anthropometric research, which notes that while certain body dimensions show low variability within homogeneous groups, others, especially those influenced by genetic, cultural, and environmental factors, may exhibit greater variation. The fact that it was just three ethnicities that were used for this study and just males is limiting, Nigeria as a country is made of over 300 ethnicities. It is highly recommended that more ethnicities should be included in further studies and females also be included in the study.

Conclusion

The study revealed that the Igbo and Yoruba groups had taller standing heights than the Hausa group. Additionally, arm length was greater in the Igbo and Yoruba groups compared to the Hausa group, while the Hausa group had longer thigh lengths than both the Igbo and Yoruba groups. The Igbo group displayed the largest arm span, whereas the Hausa group had the widest shoulder breadth. However, the Hausa group had a lower bi-iliac breadth in comparison to the other two ethnic groups. Overall, the values obtained with this average age can effectively inform the design of 3D anatomic models for these ethnic groups.

The anthropometric values provide a detailed description of the typical linear body features of individuals in these three ethnic groups of Nigeria. They hold significant potential for applications in anthropological and medical research, as well as in the standardization of anatomical models. Additionally, this information can inform product design to better accommodate the needs of this population, enhancing ergonomic solutions, improving health assessments, and facilitating more effective medical interventions. Understanding these measurements is essential for developing products and services that are tailored to each local community.

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