



## **Prediction of Stature from Hand Anthropometry: A Comparative Study in the Three Major Ethnic Groups in Nigeria**

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### **Authors' contributions**

*This study was carried out in collaboration between all authors. Author AIN was involved in conception and design of the study and first manuscript writing, author JVZ did statistical analysis and interpretation of data. Author DSA performed final analysis of manuscript and literature searches. Author MOI did the measurements and author MBD provision of study materials and design of measurements procedures. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Aims:** The study was carried out to establish standard anthropometric values for stature estimation by using hand length in the three major ethnic groups in Nigeria.

**Study Design:** Cross-sectional study.

**Place and Duration of Study:** University of Maiduguri, Borno State, Nigeria between January - April 2010.

**Methodology:** A total of 407 right hand dominant students (210 males and 197 females) aged 18 – 35 years who were purely of Hausa, Igbo and Yoruba origin by both parents and grandparents, are included in this study. Each person has been studied for measurements of stature, hand length and handbreadth.

**Results:** No significant difference was observed in stature and hand dimensions between the Igbos and Hausas. However the Yorubas are significantly shorter and have shorter hands than the Igbos and the Hausas. The males are significantly taller than the females in all the three tribes and have longer hands than the females in the Hausas and Igbos. Both the sexes of Yorubas are significantly shorter than the Hausas and have significantly shorter hands than the Hausas and Igbos when comparison was made

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between same sexes. The Yoruba females have shorter but wider hands than the Hausa females. No significant difference was observed in stature and hand dimensions between the Hausas and Igbos when compared between same sexes. Regression equations for estimation of stature were formulated for each ethnic group and both sexes.

**Conclusion:** The study supports the fact that variations are present not only between races but also among ethnic groups, thus formulae derived for one ethnic group and both sexes may not be applicable to other ethnic group and sex. This study therefore provides standard anthropometric values and regression equations for the three major ethnic groups in Nigeria.

*Keywords: Anthropometry; stature; hand length; hand breadth; sex differences; ethnic differences; Nigeria.*

## 1. INTRODUCTION

Forensic anthropology is a branch of physical anthropology which interacts with other disciplines pertaining to the understanding of crime and its investigations [1]. The biological profile of a person such as age, sex, ethnicity and stature can be determined with the help of anthropometry [2]. Among these 'big fours' of anthropology, estimation of stature is considered as an important anthropometric parameter to Anthropologist, Anatomist, Obstetrician and in medico-legal practice. Many human features have been used to estimate stature from skeletal remains and body parts owing to the established relationship between stature and different parts of the body [3]. Some examples include, metatarsals [4], foot [5,6,7,8], tibia [9,1], femur [10], head length [11], phalanges [12], hand [12,13,6,14], ulna length [9,15,16], upper arm length [17] and clavicle [18]. Many studies have established a positive correlation between stature and hand dimensions in different populations [19,20,12,21,22,13,23,6,24,14] and offered regression equations. However regression formulae derived for one population do not always give accurate results for other population [15] and studies have stressed that formula for stature estimation should be population specific [25]. These variations from population to population and ethnic region to ethnic region may be due to differences in nutrition and level of physical activity [26].

Stature varies with race and is determined by genetics of a person, geographical location and climate condition [27]. Nigeria is a vast country with varied geographical condition and ethnic groups. The three major ethnic groups in Nigeria are the Hausa, Igbo and Yoruba tribes from Northern, Eastern and Western part of the country respectively. Due to the variations observed in different population groups and the paucity of data specific to Nigerians emphasize the need to investigate the relationship between stature and hand dimension among the three major ethnic groups in Nigeria and to devise a regression formulae specific for that population.

## 2. MATERIALS AND METHODS

The present study was undertaken in the University of Maiduguri, Maiduguri Borno state, Nigeria, where students from various parts of the country seek admission. Four hundred and seven healthy students (210 males and 197 females) who had no deformities and were purely of Hausa, Igbo or Yoruba origin by both parents and grandparents were randomly recruited. The subjects comprised of 134 Hausas (70 males and 64 females), 138 Igbo (70

males and 68 females) and 135 Yorubas (70 males and 65 females) aged between 18 - 35 years.

Ethical approval was obtained from the University ethical committee and informed consent of the students were taken for the measurements. Students who did not consent and those with poorly defined wrist creases, deformities of the vertebral column and limbs were excluded. Left handed students were also excluded to maintain uniformity since the effect of hand dominance on hand measurements has been suggested [28]. The stature, hand length and hand breadth of the sample group were measured by same person to avoid inter- observer bias.

Height of an individual was measured between the vertex and floor, after the individual was instructed to stand erect and barefooted in anatomical position with the head in Frankfort plane, using a standard standing height measuring instrument, the measurement was taken in centimeters by bringing the horizontal sliding bar to the vertex [29].

Hand dimensions were taken on the right side of each individual using a manual sliding caliper.

Hand length: the subjects were asked to place their hands supine on a flat hard horizontal surface with fingers extended and adducted. Then the hand length was measured as a straight linear distance between midpoint of the distal crease of wrist joint and distal end of the most anterior projecting point that is tip of the middle finger [29].

Hand breadth: the subjects were asked to place their hands in prone position on the flat hard horizontal surface with the thumb abducted and other fingers in extended and adducted position. Then the hand breadth was measured on a distance between the radial side of the 2<sup>nd</sup> metacarpo-phalangeal joint and the ulnar side of the 5<sup>th</sup> metacarpo-phalangeal joint [29].

## **2.1 Statistical Analysis**

Data analysis was done using a computer based statistical package (Graph Pad InStat version 4.0) to calculate the mean, standard error of mean, correlation, regression equation and comparison between the ethnic groups was by means of one way analysis of variance (ANOVA). The significance of the results between each two ethnic groups was tested using student's t-test (independent). 'P' value of less than 0.05 was considered significant.

## **3. RESULTS**

Comparison of stature, hand dimensions, and linear regression equations for stature estimation between the Hausa, Igbo and Yoruba tribes irrespective of gender is shown in Table 1. The Hausas have the largest stature and hand length among the three tribes while the Igbos have larger stature and hand length than Yorubas. The difference was significant in the Hausas when compared to Yorubas ( $p < 0.05$ ) and also significant in the Igbos when compared to Yorubas ( $p < 0.05$ ), however an insignificant difference in stature and hand length was observed in the Hausas when compared to Igbos ( $p > 0.05$ ). No difference was observed in hand breadth between the ethnic groups.

**Table 1. Comparison of stature (cm), hand dimensions (cm), and linear regression equations for stature estimation of Hausa, Igbo and Yoruba tribes**

<b>Variables</b>	<b>Hausa</b>	<b>Igbo</b>	<b>Yoruba</b>
Total number	134	138	135
Mean height ± SEM	171.75 ± 0.75 <sup>b</sup>	170.50 ± 0.70 <sup>c</sup>	167.64 ± 0.74
Mean hand length ±SEM	20.32 ± 0.11 <sup>b</sup>	20.10 ± 0.10 <sup>c</sup>	19.42 ± 0.12
Mean handbreadth ±SEM	9.44 ± 0.06	9.40 ± 0.05	9.49 ± 0.05
Correlation coefficient	0.76	0.58	0.48
Regression coefficient	5.27	4.46	3.08
Value of constant	64.73	80.86	107.85
Regression equation ± SEE	64.73 + 5.27(HL) ±5.18	80.86 + 4.46(HL) ±4.46	107.85 + 3.08(HL) ±5.12

HL: hand length; SEM: Standard error of mean; SEE: Standard error of estimate; <sup>b</sup>P<0.05 for Igbo vs. Yoruba; <sup>c</sup>P<0.05 for Hausa vs. Yoruba.

The mean values of stature and hand dimensions and the linear regression equations derived for estimation of stature in both sexes of the Hausas, Igbos and Yorubas are shown in Tables 2, 3 and 4 respectively. The average values in males for all the three tribes are higher than their female counterparts. The stature was significantly larger in males compared to the females (p<0.05) in all the three populations. The hand length was significantly larger in males compared to females (p<0.05) in Hausas and Igbos, however the difference was insignificant between the sexes in the Yorubas (p>0.05). No significant difference was observed in hand breadth between the sexes in all the three populations.

**Table 2. Comparison of stature (cm), hand dimensions (cm) and linear regression equations for stature estimation in Hausa tribe by sex**

<b>Variables</b>	<b>Males</b>	<b>Females</b>
Total number	70	64
Mean height ± SEM	174.79 ± 0.86*	167.03 ± 1.04
Mean hand length ± SEM	20.62 ± 0.13*	19.85± 0.18
Mean hand breadth ± SEM	9.73 ± 0.01	9.00 ± 0.07
Correlation coefficient	0.73	0.89
Regression Coefficient	4.67	4.75
Value of constant	78.42	72.79
Regression equation ±SEE	78.42 + 4.67(HL) ±4.22	72.79 + 4.75 (HL) ±4.54

HL: hand length, SEM: Standard Error of Mean, SEE: Standard Error of Estimate, \*P<0.05 when compared with females.

**Table 3. Comparison of stature (cm), hand dimensions (cm) and linear regression equations for stature estimation in Igbo tribe by sex**

<b>Variables</b>	<b>Males</b>	<b>Females</b>
Total number	70	68
Mean height ± SEM	171.58± 1.23*	169.40 ± 0.73
Mean hand length ± SEM	20.22 ± 0.15*	19.97 ± 0.10
Mean hand breadth ± SEM	9.57 ± 0.06	9.22 ± 0.07
Correlation coefficient	0.76	0.23
Regression Coefficient	5.36	1.77
Value of constant	63.11	134.28
Regression equation± SEE	63.11+ 5.36 (HL) ±5.06	134.28 + 1.77 (HL) ±4.96

*HL: hand length; SEM: Standard Error of Mean; SEE: Standard Error of Estimate; \*P<0.05 when compared with females.*

**Table 4. Comparison of stature (cm), hand dimensions (cm) and linear regression equations for stature estimation in Yoruba tribe by sex**

<b>Variables</b>	<b>Males</b>	<b>Females</b>
Total number	70	65
Mean height ± SEM	170.53± 1.00*	164.05 ± 0.80
Mean hand length ± SEM	19.55± 0.08	19.27 ± 0.13
Mean hand breadth ± SEM	9.57 ± 0.04	9.38 ± 0.07
Correlation coefficient	0.70	0.37
Regression Coefficient	2.74	2.88
Value of constant	116.92	108.52
Regression equation ± SEE	116.92+ 2.34 (HL) ±4.62	108.52 + 2.88 (HL) ±4.03

*HL: hand length SEM: Standard Error of Mean, SEE: Standard Error of Estimate, \*P<0.05 when compared with females.*

Table 5. Shows the comparison of stature, hand dimensions and linear regression equations derived for estimating the stature of males in the three ethnic groups. The Hausa males have the largest stature and hand dimensions among the three tribes and the Igbo males have larger stature and hand length when compared to Yoruba males. The difference in stature was significant in Hausa males when compared to Yoruba males ( $p < 0.05$ ) and insignificant when compared to Igbo males ( $p > 0.05$ ). An insignificant difference in stature was observed between Igbo males and Yoruba males ( $p > 0.05$ ). The difference was insignificant in hand breadth when comparison was made between males of the three tribes ( $p > 0.05$ ).

**Table 5. Comparison of stature (cm), hand dimensions (cm) and linear regression equations for stature estimation of males in Hausa, Igbo and Yoruba tribes**

Variables	Hausa	Igbo	Yoruba
Mean height ± SEM	174.79 ± 0.86 <sup>b</sup>	171.58 ± 1.23	170.53 ± 1.00
Mean hand length ± SEM	20.62 ± 0.13 <sup>b</sup>	20.22 ± 0.15 <sup>c</sup>	19.55 ± 0.08
Mean hand breadth ± SEM	9.73 ± 0.07	9.57 ± 0.06	9.57 ± 0.04
Correlation coefficient	0.73	0.76	0.70
Regression Equation ± SEE	78.42 + 4.67(HL) ±4.22	63.11 + 5.36(HL) ±5.06	116.92 + 23.4(HL) ±4.62
Total number	70	70	70

HL: hand length; SEM: Standard Error of Mean; SEE: Standard Error of Estimate; <sup>b</sup>P<0.05 for Hausa vs. Yoruba; <sup>c</sup>P<0.05 for Igbo vs. Yoruba.

Table 6. Presents the comparison in stature, hand dimensions and linear regression equations derived for estimating stature of females in the three ethnic groups. The Igbo females have the largest stature and hand length among the tribes while the Hausa females have larger stature and hand length compared to Yoruba females. The difference in stature was insignificant in Igbo females when compared to both the Hausa and Yoruba females (p>0.05), however a significance difference in stature was observed in the Hausa females when compared to Yoruba females (<0.05). A significant difference was observed in the hand lengths of both Hausa and Igbo females when compared to Yoruba females (p>0.05), however the difference was insignificant when Igbo females were compared to Hausa females (p>0.05). The Yoruba females have the largest hand breadth among the three tribes and the Igbo females have larger hand breadth than the Hausa females. The difference was significant in Yoruba females when compared to Hausa females (p<0.05) and insignificant when compared to Igbo females (p>0.05). The difference in hand breadth was insignificant when Igbo females were compared to the Hausa females.

**Table 6. Comparison of stature (cm), hand dimensions (cm), c and linear regression equations for stature estimation of females in Hausa, Igbo and Yoruba tribes**

Variables	Hausa	Igbo	Yoruba
Mean height ± SEM	167.03 ± 1.04 <sup>b</sup>	169.40 ± 0.73	164.05 ± 0.80
Mean hand length ± SEM	19.85 ± 0.18 <sup>b</sup>	19.97 ± 0.10 <sup>c</sup>	19.27 ± 0.13
Male hand breadth ±SEM	9.00 ± 0.07 <sup>b</sup>	9.22 ± 0.07	9.38 ± 0.07 <sup>b</sup>
Correlation coefficient	0.89	0.23	0.37
Regression Equation ± SEE	72.79 + 4.75(HL) ±4.54	134.28 + 1.77(HL) ±4.96	108.52 + 2.88(HL) ±4.03
Total number	64	68	65

HL; hand length; SEM: Standard Error of Mean; SEE: Standard Error of Estimate; <sup>b</sup>P<0.05 for Hausa vs. Yoruba; <sup>c</sup>P<0.05 for Igbo vs. Yoruba.

Table 7. Presents the comparison between the true stature and stature estimated from hand length of the three ethnic groups. There was no significant difference between the measured stature and the stature estimated (P>0.05)

**Table 7. Comparison of true stature and stature estimated of the three ethnic groups**

Ethnic groups	Gender	True stature(cm) ±SEM	Estimated stature(cm) ±SEM	t	p-value
Hausa	Both	171.75±0.75	171.75±0.75	0.31	0.76 (NS)
	Male	174.79±0.86	174.71±0.58	0.08	0.94 (NS)
	Female	167.03±1.04	167.08±0.72	0.04	0.97 (NS)
Igbo	Both	170.50±0.70	170.31±0.68	0.19	0.85 (NS)
	Male	171.58±1.23	171.48±0.99	0.06	0.95 (NS)
	Female	169.40±0.73	169.63±1.04	0.18	0.86 (NS)
Yoruba	Both	167.64±0.74	167.66±0.73	0.02	0.98 (NS)
	Male	170.53±1.00	170.49±0.88	0.03	0.97 (NS)
	Female	164.05±0.80	164.67±0.63	0.03	0.98(NS)

*SEM: Standard error of mean; NS: Not significant.*

#### 4. DISCUSSION

Anthropometrics techniques are commonly used by anthropologists and adopted by medical scientists to estimate the stature of an individual. Studies have shown that hand dimensions vary in different races therefore formulae derived for one ethnic group may not be applicable to another ethnic group and this may be attributed to biological and environmental factors [30,31,32]. As the three ethnic groups are from Nigeria, even though from different geographical locations and climatic conditions, some similarity and dissimilarity may be expected among the ethnic groups. Studies have shown that no two individuals are exactly alike genetically; even identical twins differ in some aspects, and the variability is strongly influenced by genetic and environmental factors [33,34].

The present study shows that the Hausas are taller and have longer hands than the Igbos and Yorubas, while the Igbos are taller than the Yorubas. The difference in the stature and hand length was statistically significant between the Hausas and Yorubas and also significant between the Igbos and Yorubas but insignificant between the Hausas and Igbos. This may be due to the fact that body physique is influenced by climatic, hereditary, nutritional and racial factors [24], it was also reported that the ratios of various body parts to stature differ from one population to another [15] and that ethnic differences and environmental factors can influence body proportion [35,36]. No difference was observed in the hand breadth between the tribes (Table 1).

In all the three ethnic groups, the males showed a higher mean values in stature as well as hand dimensions which is consistent with other studies [19,24,23,22]. The males are significantly taller than the females in all the three ethnic groups (Tables 2, 3, 4). This finding is in agreement with the works of many researchers which observed that stature was larger in males compared to females [17,2,6,37,16,14]. It was reported by [24] that genetically males are taller than females. The females mature earlier than males because skeletal maturity in males and females during the course of development varies [38]. Females tend to show a higher growth rate during the first half of second decade while in males it is during the second half of the second decade [35,39]. Thus males have additional time for growth since the age of puberty is 2 years late in males as compared to females [40,31]. When comparison was made between sexes of the same tribe, it showed that the males have longer and wider hands than the females and the difference in hand length was statistically significant in Hausas and Igbos males however insignificant in the Yorubas males (Tables 2, 3, 4). This result is not keeping with the works of [20,41] which showed no significant

difference in hand length between the sexes of some Nigerian populations. However, many studies have shown that the hand lengths in males are larger than that of their female counterparts [42,43,22]. The difference in hand breadth was insignificant between the sexes in all the three tribes (Tables 2, 3, 4).

It is evident from the comparison of the stature and hand dimensions among same sexes of the three ethnic groups (Tables 5 and 6) that Hausa males are the tallest and have longest and widest hands when compared to the Igbo and Yoruba males, while Igbo males are taller than the Yoruba males. The difference in stature was statistically significant in Hausa males compared to Yoruba males but insignificant when compared to the Igbo males. The difference in stature was insignificant between Igbo and Yoruba males. The difference in hand breadth was not significant among the males of the three tribes. Comparison of stature and hand dimensions among the females of the three groups shows that the Igbo females are the tallest while the Hausa females are taller than the Yoruba females. Though the difference in stature was not significant between Hausa and Igbo females and also between Igbos and Yorubas females, it was significant between the Hausa and Yoruba females. Both the Igbo and Hausa females have significantly longer hands than the Yoruba females, however, the Yoruba females have significantly wider hands than the Hausa females. This study supports the work of [43] which observed that the eastern females in Nigeria have wider hands than their western and northern counterparts when comparison was made based on regional differences, though the author was not specific on the ethnicity of the subjects in the study. Earlier studies have shown that various hand measurements tend to differ in various races, ethnic groups and sexes [20,45,43,12,21,13,31,46,24,14] and found to be sexually dimorphic [19,42,43,2,47]. These population variations may be attributed to genetic and environmental factors [40,32,30]. Consequently the formulae designed for one ethnic group and sex cannot be applied to another ethnic group and sex for stature estimation but to the population from which the data have been collected.

Correlation coefficient was 0.76 in the Hausas, 0.48 in Yorubas and 0.58 in Igbos. Linear regression equations were derived (Tables 1-6), to estimate stature using hand length for each tribe, and checked for accuracy by comparing the measured stature and the stature estimated. The difference was found to be statistically insignificant (Table 7) therefore the regression formulae derived can effectively be applied to estimate the stature of the three major tribes in Nigeria.

## **5. CONCLUSION**

In the present study, a total of 407 subjects (210 males and 197 females) aged 18- 35 years who were purely of either Hausa, Igbo or Yoruba origin by both parents and grandparents were included for the estimation of stature using hand length in the three major ethnic groups in Nigeria. It was shown that:

- The Yorubas are significantly shorter and have shorter hands than the Hausas and Igbos.
- No significant difference was observed in stature and hand dimensions between the Hausas and Igbos
- No significant difference was observed in hand breadth between the 3 ethnic groups
- The males are significantly taller than females in all the 3 tribes
- The males have longer hands than the females in Hausa and Igbo tribes. The difference was not significant in Yorubas



- No significant difference was found in hand breadth between sexes in the 3 ethnic groups.
- Both sexes of Yorubas were significantly shorter than the Hausas when compared between same sexes
- Both sexes of Yorubas have significantly shorter hands than the Hausas and Igbos when comparison was made between same sexes
- The Yoruba females have a shorter but wider hands than the Hausa females
- No significant difference was observed in stature and hand breadth between Hausa and Igbo and also between Igbo and Yoruba when compared between same sexes
- Linear regression equations for stature estimation were derived, from hand length, for the tribes and both sexes and the difference between true stature and estimated stature was insignificant. Ethnic differences in anatomical dimensions and its relation to stature have been highlighted.
- The study provides standard anthropometric data and formulae for estimation of stature in the major ethnic groups in Nigeria which may be used for comparison of similar studies that may be conducted both within and outside Nigeria. It is, thus, possible to predict stature of any one of the three tribes when a hand remain is found in a scene of a crime, accidents, or disasters by applying the regression equations.

## **CONSENT**

All authors declare that 'written informed consent was obtained from the University of Maiduguri Teaching Hospital (UMTH) for publication of this study.

## **ETHICAL APPROVAL**

Authors hereby declare that all measurement protocol have been examined and approved by the ethical committee of the University of Maiduguri Teaching Hospital (UMTH) and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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## **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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