Prediction of stature from hand length and breadth – anthropometric study on an adult Cross River State population

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ABSTRACT

Introduction: Stature estimation occupies a relatively dominant position in anthropometric research. It is believed that standards for identifying skeleton differ from population to population and the method for one population may not be applicable for another population. **Materials and Method:** This study was carried out to determine the reliability of hand dimensions in estimating stature in an adult Cross River State population. The subjects comprised 1050 adult indigenes (540 male and 510 female) of Cross River State between the ages of 18 and 45 years drawn from the three senatorial districts South, Central, and North. **Results:** Stature in male had a mean value of 168.49 ± 5.53 cm whereas in females it was 162.99 ± 5.91 cm. Also, hand length in male subjects was 19.47 ± 2.00 cm while in females, hand length measured 18.35 ± 1.03 cm. In addition, the mean handbreadth in males was 8.47 ± 0.54 cm while in females, handbreadth was 7.91 ± 0.64 cm. Statistical analysis indicated that the difference in hand length and handbreadth between male and female was statistically significant ($P < 0.05$). Also, a positive correlation coefficient was observed between hand dimensions measured and stature in both sexes. **Conclusion:** However, hand length was more reliable in estimating stature in both male and female subjects. These results will be of immense benefit to forensic studies and bioanthropology.

Key words: Anthropometry, Cross River State, handbreadth, hand length, stature estimation

INTRODUCTION

A significant occurrence in the human population is the difference in their physical morphology. The physical dimensions of the human body are affected by geography, gender, age, etc.[1] Anthropometry is the main tool of physical anthropology. It consists of a series of structured measuring techniques that express quantitatively the dimension of the human body and skeleton. It reflects both health and nutritional status and predicts performance, health, and survival.[2] Stature is the height of a person in the upright posture.[3] It reaches maximum between the age group of 20 and 25 years.[4] Estimation of stature is considered to be an important assessment in the identification of unknown human remains.[5] The hand bones have been recognized as good anthropometric parameters and have been shown to exhibit sexual dimorphism.[6] A study was carried out by Numan *et al*.[7] on estimation of stature from anthropometric measurement of hand in three major ethnic groups in Nigeria. Other studies involving Nigerian populations were carried out by Danborno and Elukpo[8] who estimated stature in Northern Nigerian subjects when they used the dimensions of hand. Similarly, Anas *et al*.[9] estimated stature of 612 Hausa students in Bayero University Kano using hand length and breadth. Furthermore, the Turkish perspective of stature estimation was studied by Ozaslan

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et al.[10] where hand dimension was also used.[11] Abdel-Malek *et al*. estimated the stature of Egyptian subjects using two anthropometric measurements of the hand namely hand length and handbreadth.

The dimensions of the body part of different ethnic groups may differ as a result of selective adaptation to different climatic zone features of each group.[12] Cross River State is found in the southern part of Nigeria, and the climate in this region is the tropical rainforest climate. This climate type is influenced by the monsoons that originate from the South Atlantic Ocean, which find their way into the country by the maritime tropical air mass, a warm moist sea to land seasonal wind.[13] The state has different ethnic groups with the major ones Efik, Ejagham, and Bekwarra, all three mainly located in the three senatorial districts namely Southern, Central, and Northern, respectively. When available literature was searched, we discovered that there was no published literature on estimation of stature in Cross River State indigenes using hand dimensions. Thus, the main aim of this work was to establish the standards for stature reconstruction in indigenes of Cross River State by obtaining population-specific regression equations which can be used for estimating stature from anthropometric measurement of the hand.

MATERIALS AND METHODS

A cross-sectional sample of 1050 indigenes of Cross River State (540 males and 510 females) between the age group of 18 and 45 years drawn from the three senatorial districts (South, Central, and North) were recruited this study. In the Southern senatorial districts, we used subjects from Calabar Municipality, Calabar South, and Akpabuyo. For the central, we used subjects from Obubra, Ikom, and Boki. In the North, we used subjects from Yala, Ogoja, and Obudu.

The criteria for selecting the subjects were that their parents and grandparents were indigenes of Cross River State. Also, subjects whose age fell between 18 and 45 years were likewise selected for the study. This age range was used because, that is, the active population and maximum stature is attained within this age range. Subjects with cases where the skeletal growth was abnormally stunted (dwarfism) or cases where the skeletal growth was abnormally enhanced (Gigantism) were not included in the study sample. More so, subjects who were <18 years and above 45 years were debarred from this study.

The objectives and the methods of the study were explained to each subject. Informed consent was gotten from the subjects before measurements were taken. Three anthropometric measurements, i.e., stature, hand length, and breadth were measured separately for each. All the measurements were recorded thrice and then their mean was calculated and recorded for accuracy.

ANTHROPOMETRIC MEASUREMENTS

Stature

This was taken as the distance between the vertex and the floor. It was measured in with a meter rule in the erect vertical position with the subject standing barefooted and head in Frankfurt plane [Figure 1] as described by Ilayperuma *et al*.[14]

Hand length

As shown in Figure 2 the hand length was measured as a straight distance between the distal crease of the wrist joint and the most anterior projecting point (the middle finger) as described by Ibeachu *et al*.[15]

Handbreadth

As shown in Figure 3 it was measured as the distance between the most prominent point on the lateral aspect of head of second metacarpal and the most prominent point on the medial aspect of the head of fifth metacarpal.[15]

Statistical analysis

The statistical software used was SPSS Statistics for Windows, Version 17.0. Chicago: SPSS Inc., was used for the statistical analysis. Our results were expressed as mean ± standard error of the mean. Comparisons were made of stature and hand dimensions studied between males and females using the Student's *t*-test. The differences were considered statistically significant at 95% confidence level (i.e., when $P < 0.05$).

Figure 1: Measurement of stature

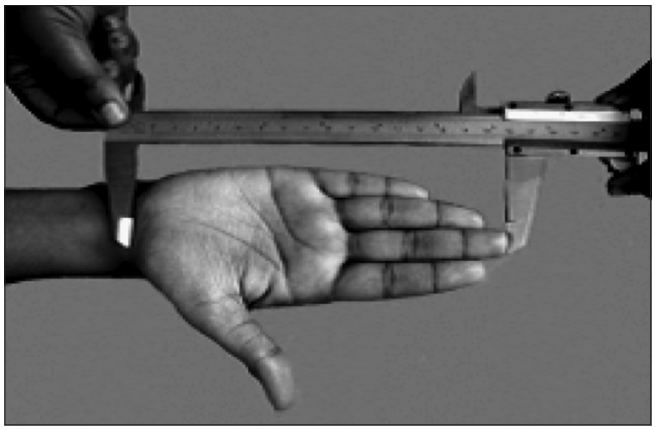

Figure 2: Measurement of hand length

Figure 3: Measurement of handbreadth

Ethical approval

In line with Belmont declaration of 1979, ethical approval was obtained from the Ethics/Research Committee of the Faculty of Basic Medical Sciences, Cross River University of Technology, Okuku Campus, Yala, Nigeria.

RESULTS

The study sample was made up of 540 males and 510 females of Cross River State Origin. Table 1 shows the mean stature, hand length and handbreadth for both sexes. Stature in male subjects had a mean value of 168.49 ± 5.53 cm while females had a mean stature of 162.99 ± 5.91 cm. Hand length in male subjects was 19.47 ± 2.00 cm whereas in females hand length measured 18.35 ± 1.03 cm. When independent sample *t*-test was performed, the results showed that the differences between males and females hand length were statistically significant ($P < 0.05$). Furthermore, the mean handbreadth in males was 8.47 ± 0.54 cm while their female counterparts had handbreadth of 7.91 ± 0.64 cm. Statistical analysis indicated that the difference in handbreadth between male and female was statistically significant ($P < 0.05$).

Table 2 shows the relationship between the different hand dimensions and stature. This relationship was studied using Pearson 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 hand length ($r = 0.614$) and the lowest by handbreadth ($r = 0.475$). In females, both hand length and handbreadth exhibited positive correlation with stature these values were statistically significant ($P < 0.01$). The maximum correlation coefficient was observed in hand length ($r = 0.621$) and the lowest was recorded in handbreath ($r = 0.395$).

Table 3 shows the linear regression equations that were formulated to estimate stature from different dimension of the hand. 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 4 shows the extent of reliability of these regression equations that we derived by comparing the estimated stature and actual measured stature. In male subjects, we observed that all values of the actual and estimated stature

Table 1: Descriptive statistics of parameters measured in male and female subjects

Sex	Stature (cm)	Hand length (cm)	Hand breadth (cm)
Male	168.49±5.53	19.47±2.00	8.47±0.54
Female	162.99±5.91	18.35±1.03*	7.91±0.64*

*Significantly different from male at $P<0.05$

Table 2: Correlation between stature and hand dimensions in male and female subjects

Variables	Male		Female	
	Correlation (*r*)	R^2	Correlation (*r*)	R^2
Hand length	0.614**	0.377	0.621**	0.386
Handbreadth	0.540**	0.292	0.496**	0.246

**Correlation is statistically significant ($P<0.01$) two-tailed

Table 3: Linear regression equations for hand dimensions studied in males and female subjects

Sex	Regression equations respectively
Male	Stature=106.463+(3.186 × hand length)±3.136
	Stature=118.693+(5.877 × handbreadth)±3.223
Female	Stature=91.879+(3.876 × hand length)±3.016
	Stature=119.661+(5.481 × handbreadth)±3.125

Table 4: Comparing the estimated stature and actual measured stature in male and female subjects

	Prediction formula	Measured stature	Predicted stature	t	Significant (two-tailed)
Male	Stature=106.463+(3.186 × hand length)±3.368	168.492±0.238	168.493±0.148	−0.010	0.992
	Stature=118.693+(5.877 × handbreadth)±3.223	168.492±0.238	168.494±0.132	−0.013	0.990
Female	Stature=91.879+(3.876 × hand length)±3.710	162.994±0.262	163.000±0.170	−0.028	0.977
	Stature=119.661+(5.481 × handbreadth)±3.000	162.994±0.262	163.001±0.141	−0.065	0.948

were all very close and independent *t*-test was done to tell whether or not the estimated and actual (measured) stature had any statistically significant difference. The result obtained showed that there was no statistically significant difference ($P > 0.05$) between the estimated and measured stature. More so, the same comparisons were carried out in the female subjects and *t*-test also revealed that there was no statistically significant difference ($P > 0.05$) between the estimated and measured stature when hand length and handbreadth were the variables.

DISCUSSION

Stature estimation is useful when height cannot be measured directly due to deformities such as kyphosis, scoliosis. The human hand, for instance, is considered the most used and flexible part of the body and has been of great scientific significance to investigators in the field of anthropometry, ergonomics, and orthopedic surgery. With the alarming rate of disasters such as plane crash, terror attacks, earthquakes all over the world, estimation of stature from the hand and its dimensions becomes necessary in identification of victims especially since this is required during medico-legal examinations.[16]

Our study showed the existence of sexual dimorphism in hand dimensions in Cross River State subjects. These sex differences in physical characteristics are often related to hormonal, genetic, and environmental factors.[17] We observed that the male had higher values of hand length and handbreadth than their female counterparts, and these dimensions were all statistically significant ($P < 0.05$). This finding is in consonance with that of Numan *et al*.[7] who conducted a study on major ethnic groups in Nigeria namely Igbo, Hausa, and Yoruba. They reported significantly higher values of hand length in male when compared to female. In that work, Hausa male had longer hands than Igbo and Yoruba males. It is also noteworthy that the values of length of the hand reported by Numan *et al*.[7] for Hausa, Igbo, and Yoruba males were all higher than those obtained for Cross River State male in our study. Their study also showed that the Igbo female has longer hands than Hausa and Yoruba female, and all the dimensions of length of the hand obtained from the three ethnic groups were higher than that of the Cross River female obtained in the present work. Their findings were confirmed by Ilayperuma *et al*.[14] in their work on Sri Lankans who also reported significantly ($P < 0.01$) higher mean values of hand length and breadth in males when compared to female. The results obtained in the current study is also in agreement with the findings of Ozaslan *et al*.[10] who reported significantly higher mean values of hand length and breadth in male than in the female subjects of Turkish decent in their study. Thus, their result also reaffirmed the existence of sexual dimorphism in hand dimensions. However, we observed that the values obtained for all the Nigerian populations studied previously as well as for Cross River State subjects in the present study were higher than those obtained for the Sri Lankans and the Turks. This difference could be explained by the fact that, all the Nigerian populations studied belong to the Negroid race.

Our work has also shown that there is positive correlation between stature and dimension of the hands in Cross River State subjects. This is in agreement with results reported on some other populations in Nigeria. Positive correlation between the hand dimensions and stature was reported by Ibeachu *et al*.[15] in three major ethnic groups in Nigeria. In their study, male and female subjects from Hausa, Igbo, and Yoruba had positive correlation with stature. This was confirmed by Hasegawa *et al*.[17] also confirmed this finding when he reported that all the dimensions of the hands studied in Northern Nigerian subjects showed positive correlation with stature. The result obtained in the present study is in consonance with that of Ozaslan *et al*.[10] for Turkish subjects. They reported that the hand length had the higher correlation than the handbreadth. Other studies carried out on foreign population such as[3] Bengali adult females and[18] Bangladeshi female also confirm the existence of positive correlations between hand dimensions and stature.

SEE is an important parameter which shows the relation between real values and estimated values. This study has also revealed that hand length in male and female subjects was more reliable in estimation of stature in Cross River State. The regression equation for hand length had the lowest values of SEE. This agrees with the values obtained by Numan *et al*.[7] for major ethnic groups in Nigeria. Our values were lower than those they obtained for Hausa, Igbo, and Yoruba subjects. In their study, the Hausa males had the regression equation with the lowest SEE, followed by Yoruba and Igbo males, respectively. For the female subjects, the Yorubas had the equations with the lowest SEE, followed

by Hausa and Igbo, respectively. Regression equations for stature estimation were formulated by Ozaslan *et al*.,[10] who reported that the equation that used hand length as the variable had the lowest SEE when compared to other hand dimensions studied, which is in agreement with our findings in the present study. However, the stature estimation equations obtained in our study should be authenticated by forensic experts for it to serve as a tool in the estimation of stature.

CONCLUSION

This research work, therefore, presents the standards for stature reconstruction among adult Cross River State male and female using hand dimension as authors that will subsequently work in this field on Cross River State subjects will reference this work and find the results useful. This has contributed to establishing a database for the Cross River people. The study has also shown that hand length presents the strongest relationship with stature the most reliable for estimation of stature in both adult male and female Cross Riverians.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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