Journal of Forensic Science & Criminology
Volume 12 | Issue 2
ISSN: 2348-9804

Research Article Open Access

# Normative Anthropometric Analysis of Linear Body Dimensions: A Prospective Approach to the Design of Negroid Anatomical Models

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**Citation:** PD Okoh, HB Fawehinmi, LE Oghenemavwe, LK David, MA Amadi et al. (2024) Normative Anthropometric Analysis of Linear Body Dimensions: A Prospective Approach to the Design of Negroid Anatomical Models, J Forensic Crime Stu 12(2): 201

**Received Date:** June 22, 2024 **Accepted Date:** July 22, 2024 **Published Date:** July 26, 2024

## Abstract

**Aim**: The aim of this study was to generate linear anthropometric data for the design of Negroid anatomical model for future standardization.

**Method:** The research design was cross-sectional and non-experimental design. A total number of three hundred (300) subjects were recruited between the ages of 18 to 37 years with a BMI range of 18.50 to < 30.00 for this study. Taro Yamane's formula was used to determine the minimum sample size. BMI and linear body anthropometric measurements were taken using a stadiometer, calibrated flexible meter tape, meter rule, and weighing scale. Data were analyzed using SPSS for discrete statistics and t-tests of significance.

**Results:** The linear normative average mean value of standing height was 171.16±9.54, arm length was 32±.8.863, arm span was 176.97±.25.89, forearm length was 31.16±.7.93, hand width was 8.61±.1.28, hand length was 20.27±.16.92, elbow breadth was 7.82±.10.97, wrist breadth was 7.08±.12.21, and shoulder breadth was 40.61±.8.91. Differences in the mean of males and females were statistically significant for standard height, forearm length, hand width, shoulder breadth, middle neck length, leg length, weight, and foot length. ales

**Conclusion:** The linear anthropometric data will not only provide a design for anatomical models but could also be used in forensics and medical studies.

**Keywords:** linear; anthropometric features; sexual dimorphism; anatomical modeling; Ijaw

## Introduction

By analyzing the morphological variety of the various populations, anthropologists, forensic scientists, and anatomists can make a significant contribution to the personal identification of any individual [1]. Different populations and ethnic communities have different average body sizes [2]. The Ijaw inhabit Nigeria's southern region. They make up the majority of the native population in the states of Delta, Rivers, and Bayelsa. Nigeria's economy depends on the Ijaws because they are gifted with minerals like crude oil. They reside along several marine trade routes in riverine areas [3].

Clothing, hand gloves, and biomedical prosthesis are examples of ergonomically designed items that incorporate anthropometry [4]. Its form is strongly influenced by environmental, dietary, and climatic factors. When a person's height cannot be determined directly, such as when they are bedridden, elderly, or feeble, or when they have limb and/or vertebral column deformities, an indirect calculation of their height can be made by comparing their height to another skeletal metric [5]. When creating anatomical models for the population of negroids, ethnic variations should be taken into consideration. There are many different ethnic groups within Africa, and there might be a sizable difference in physical proportions and measurements among them [6]. It is crucial to take into account both the population's variability and the mean values of body dimensions [7].

The rationale of this study was to record the typical distribution of linear anthropometric body characteristics in the Ijaw population of Nigeria. Humans have just recently evolved, yet thanks to complex culture and technology, they have been able to colonize the globe and live in a variety of conditions [8]. Despite sharing a similar genetic identity, this led to the emergence of species with highly varied morphological characteristics [9]. As a result, the aim of this study was to identify a normative anthropometric analysis of linear body dimensions, which would serve as a forward-looking strategy for the creation of negroid anatomical models. It was a collaborative research involving researchers from the fields of Human Anatomy, Fine Arts and Mechanical Engineering.

## Materials and Method

### Research Design

The research design was cross-sectional design which investigated the linear body anthropometric dimensions of the Ijaw of Nigeria resident in Port Harcourt using anthropometric standards.

### Sample Size and Sampling Technique

The sampling technique was multistage random sampling. This study was carried out in three states namely Rivers, Bayelsa, and Delta States. Using multi-stage sampling techniques subjects were randomly selected amongst males and females of Ijaw extraction residing in Port Harcourt, Rivers State of Nigeria. This study involved 300 subjects aged between 18 and 37 years. 150 were males while 150 were females with a BMI of 18.50 to 30.00kg/$m^2$. 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. It was ascertained that recruited subjects have both parents and four grandparents 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 [10]. In the inclusion criteria, 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.

**Method**: The study involved measurement of some selected linear body anthropometric variables. Fifteen (15) trained research personnel embarked on field trips to different locations in Port Harcourt, Rivers State, Nigeria and undertook the measurements. Using appropriate landmarks, the following linear measurements were taken: standing height, weight, BMI, arm span, arm length, bi-acromial breadth, upper limb length, forearm length, hand length, palmar length.

## 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 five categories (18-21, 22-215, 26-29, 30-33, 34-37) years. Similarly, body mass index (BMI) was grouped into normal weight (18.5 – 24.9) and slightly overweight (25.0 – 30.0). Independent sample t-test was thus carried out to determine significant differences in the measured anthropometric parameters according to age. The confidence interval was set at 95%, therefore $p< 0.05$ was considered significant.

Table 1. shows a descriptive statistics table of the parameters of the anthropometric linear dimension of Ijaws, which shows that standing height was 171.16±9.54, arm length was 32±.8.863, arm span was 176.97±.25.89, forearm length was 31.16±.7.93, hand width was 8.61±.1.28, hand length was 20.27±.16.92, elbow breadth was 7.82±.10.97, wrist breadth was 7.08±.12.21, and shoulder breadth was 40.61±.8.91. Table 2. shows descriptive statistics of the measured anthropometric parameters in male subjects which show that age was 23.12±.2.57, standing height was 176.71±.7.71, arm length was 32.91±.3.72, arm span was 185.13±.17.12, forearm length was 32.91±.3.72, hand width was 9.00±1.60, hand length was 20.62±.14.51, elbow breadth was 7.44±.10.74, wrist breadth was 8.06±.15.65, and shoulder breadth was 41.87±.9.51 and this shows that they are insignificant ($p<0.05$). Table 3. shows descriptive statistics of the measured anthropometric parameters in female subjects age was 22.52±.2.21 standing height was 7.62±.153.53, arm length was 32.84±.11.75, arm span was 168.46±.30.42, forearm length was 30.23±6.86, hand width was 8.23±.0.94, hand length was 19.90±.19.15, elbow breadth was 8.21±.11.22, wrist breadth was 6.05±.6.88, and shoulder breadth was 39.29±.8.05 and this shows that they are insignificant ($p<0.05$). Table 4. shows a test for sexual dimorphism in the measured parameters using an Independent t-test which indicated that all the parameters are statistically significant ($p>0.05$) except arm length, hand length elbow breadth and wrist breadth which are not statistically significant.

**Table 1:** Distribution of Variables of Linear body parameters

| Parameters | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| Standing Height (cm) | 149 | 194 | 171.16 | 9.54 |
| Arm Length (cm) | 23 | 160 | 32.87 | 8.63 |
| Arm Span (cm) | 17 | 225 | 176.97 | 25.89 |
| Forearm Length (cm) | 4.3 | 57 | 31.16 | 7.93 |
| Hand Width (cm) | 4 | 19 | 8.61 | 1.28 |
| Hand Length (cm) | 7.8 | 202 | 20.27 | 16.92 |
| Elbow Breadth (cm) | 0.6 | 145 | 7.82 | 10.97 |
| Wrist Breadth (cm) | 0.5 | 145 | 7.08 | 12.21 |
| Shoulder Breadth (cm) | 26 | 143 | 40.61 | 8.91 |

**Table 2:** Descriptive Statistics of the measured anthropometric parameters in male subjects

| Parameters | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| Ages (years) | 18 | 38 | 23.12 | 2.57 |
| Standing Height (cm) | 155 | 194 | 176.71 | 7.71 |
| Arm Length (cm) | 23 | 43.2 | 32.91 | 3.72 |
| Arm Span (cm) | 38 | 212 | 185.13 | 17.12 |
| Forearm Length (cm) | 4.3 | 57 | 32.91 | 3.72 |
| Hand Width (cm) | 4 | 19 | 9 | 1.6 |
| Hand Length (cm) | 8.7 | 202 | 20.62 | 14.51 |
| Elbow Breadth (cm) | 4.7 | 145 | 7.44 | 10.74 |
| Wrist Breadth (cm) | 4 | 145 | 8.06 | 15.65 |
| Shoulder Breadth (cm) | 26 | 143 | 41.87 | 9.51 |

**Table 3:** Descriptive Statistics of the measured anthropometric parameters in female subjects

| Parameters | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| Ages (years) | 18 | 29 | 22.52 | 2.21 |
| Standing Height (cm) | 149 | 186 | 7.62 | 153.53 |
| Arm Length (cm) | 24 | 160 | 32.84 | 11.75 |
| Arm Span (cm) | 17 | 225 | 168.46 | 30.42 |
| Forearm Length (cm) | 4.34 | 49 | 30.23 | 6.86 |
| Hand Width (cm) | 5.8 | 11 | 8.23 | 0.94 |
| Hand Length (cm) | 7.8 | 183 | 19.9 | 19.15 |
| Elbow Breadth (cm) | 0.6 | 92 | 8.21 | 11.22 |
| Wrist Breadth (cm) | 0.5 | 50 | 6.05 | 6.88 |
| Shoulder Breadth (cm) | 29 | 95.9 | 39.29 | 8.05 |

**Table 4:** Test for sexual dimorphism in the measured parameters using an Independent t-test

| Parameters | MD | S.E. D | df | t-value | P-value | Inference |
|---|---|---|---|---|---|---|
| Ages | 0.6 | 0.27 | 323 | 2.25 | 0.03 | S |
| Standing Height | 11.35 | 0.85 | 325 | 13.37 | 0 | S |
| Arm Length | 0.07 | 0.96 | 325 | 0.07 | 0.94 | NS |
| Arm Span | 16.67 | 2.72 | 325 | 6.14 | 0 | S |
| Forearm Length | 1.81 | 0.87 | 312.81 | 2.09 | 0.04 | S |
| Hand Width | 0.75 | 0.14 | 325 | 5.52 | 0 | S |
| Hand Length | 0.72 | 1.87 | 325 | 0.38 | 0.7 | NS |
| Elbow Breadth | -0.77 | 1.22 | 322.58 | -0.63 | 0.53 | NS |
| Wrist Breadth | 2.02 | 1.35 | 324 | 1.49 | 0.14 | NS |

| | | | | | | |
|---|---|---|---|---|---|---|
| Shoulder Breadth | 2.58 | 0.98 | 324 | 2.64 | 0.01 | S |

## Discussion

The normative anthropometric analysis produces negroid anatomical models helps to maintain standardization and avoid potential inaccuracies that could result from assumptions about a particular race or ethnic group's physical traits. Captivating into an explanation the individual features among this heterogeneous demographic, this strategy reassures a true description of negroid population.

In the present study, standing height was 171.16±7.54. This is in agreement with the findings of Okoh and Amadi,[11] Popovics et al.[12], and Gardaseric[13]. This however varied from that of Singh et al,[14] Arm span in this present study (76.97±25.89) is at variance with the findings of Okoh and Amadi,[11]and Singh et al.[14]. This variation could be attributed to ethnic and racial variations.

The mean arm length (33.07±8.93) was not statistically significant ($p>0.05$) when compared between sexes which is inconsistent with the findings of Mulu et al. [15] and Sharma et al.,[16] whose findings showed a significant difference in Ethiopian and Australian populations.

Body parameters have a lot of relevance. They have been used in height estimation. For, instance forearm length was utilized by Potdar et al. [17] to calculate height. In our study, forearm length showed sexual dimorphism. Similarly, hand width when compared between sexes, was statistically significant ($p >0.05$). This agrees with the submissions of Chia and Anyanwu,[18] and Yeasmin et al. [19] study on hand measurements.

Chen et al. [20] Investigated body measurements in African Americans. They pointed out that body measurements of the negroid population could be used to create anatomical models. The anthropometry of the linear body dimensions and its significance with other related literature were some of the parallels and differences observed in this study. This may be related to the age range used, methodology, race, nationality, and environment.

## Conclusion

The normative anthropometric analysis of linear body dimensions will be essential in the design of anatomical models that accurately represent the negroid population. By studying and quantifying variations in body measurements, designers can create anatomical models that reflect the unique body proportions and dimensions specific to individuals of negroid descent. This prospective approach involved collecting data from a diverse group of negroid individuals and considering both mean values and variability in body measurements.

## Acknowledgement

Our sincere appreciation goes to the Tertiary Educational Trust Fund (TETFUND) for their complete funding of this study and to all respondents who gave their consent for this study.

## Conflict of Interest

None

## Funding

Tertiary Educational Trust Fund (TETFUND)

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