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# ESTIMATION OF STATURE FROM FOOT DIMENSIONS AMONG STUDENTS OF RIVERS STATE UNIVERSITY, NIGERIA

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## ABSTRACT

Stature estimation is a key aspect of forensic anthropology and personal identification, particularly in situations involving mass disasters or fragmented human remains. This study investigated the relationship between foot dimensions and stature among students of Rivers State University, Nigeria, with the aim of developing regression equations for stature estimation. A total of 394 healthy students (197 males and 197 females) aged 18–30 years were randomly selected. Stature, foot length, and breadth were measured using standardized anthropometric techniques. Data was analyzed using descriptive statistics, Pearson's correlation, and linear regression. The mean stature was 169.19 cm in males and 161.77 cm in females. Mean foot length was 26.32 cm in males and 24.53 cm in females, while mean foot breadth was 9.53 cm and 8.64 cm, respectively. A statistically significant positive correlation was found between stature and foot length in both sexes ($r = 0.44$, $p < 0.01$ for males; $r = 0.60$, $p < 0.01$ for females; $r = 0.62$, $p < 0.01$ combined). Foot breadth showed a significant correlation with stature in females ($r = 0.40$, $p < 0.01$) and the combined sample ($r = 0.41$, $p < 0.01$) but was not significant in males ($r = 0.10$, $p > 0.01$). Regression equations indicated that foot length is a more reliable predictor of stature than foot breadth. The study concludes that foot length provides accurate stature estimation and can be effectively applied in forensic identification within the Nigerian population.

**KEYWORDS:** Stature estimation, Foot length, Foot breadth, Forensic anthropology.

## 1. INTRODUCTION

Anthropometry, derived from the Greek words "Anthropos (man) and Metron (measure)" refers to the measurement and analysis of human body dimensions. It is a vital tool in physical anthropology, ergonomics, medicine, and forensic sciences, as it helps explain biological variation within and across populations.[1] In forensic anthropology, stature estimation is particularly important for establishing identity, especially when dealing with incomplete or mutilated remains resulting from disasters, accidents, or criminal activities.[2-3]

Stature is one of the key biological identifiers, along with age, sex, and ethnicity, and has a strong correlation with several body segments.[4] Parameters such as long bones, hand length, finger length, and foot dimensions have been used to estimate stature.[5,67] Among these, the foot is particularly reliable since its bones undergo epiphyseal fusion earlier than long bones, making it a reliable measure in young adults.[8] Furthermore, the foot is often preserved in disaster scenarios due to protection by footwear.[9]

Numerous studies across different populations have reported significant correlations between foot dimensions and stature. For example, Krishan and Sharma[10] found strong stature, foot length correlations in a North Indian population, while Oghenemavwe and Egwede[11]

demonstrated similar findings among Nigerians. Studies in Nepal, India, and Slovakia have further reinforced these findings, although variations exist across ethnicities.[12,13,14] However, variations exist across ethnic groups due to genetic and environmental influences, highlighting the importance of population-specific regression equations.[15,1]

In Nigeria, studies on different ethnic groups, including the Efik, Ibibio, and Igbo, have consistently shown that foot length is a dependable predictor of stature.[17,18,19] However, there is limited data for Rivers State populations. This study was therefore designed to investigate the relationship between foot length, foot breadth, and stature in students at Rivers State University, Nigeria, and to derive regression equations for forensic and medico-legal use.

## 2. MATERIALS AND METHODS

The study is a descriptive, Cross-sectional Design. Simple random sampling technique was used. This research work was conducted in Rivers State University, Nkpolu Mile 3, Rivers State, Nigeria. Using Yamane's formula[20], a total of 394 students (197 males and 197 females) aged 18–30 years were selected by simple random sampling.

Yamane's formula for calculating unknown population size. Sample size was determined using the following formula.[20]

Sample size for this study was calculated using the formula.

$n = z^2 \times p\,(1-p) / e^2$

Where

- n= minimum required sample size
- z= 1.96 at 95% confidence interval (standard normal deviation constant)
- p= prevalence of the research study in the population at 50%
- q= 1-p
- e= margin of error, 5% (0.05)

### 2.1 Ethical Considerations

Approval was obtained from the Department of Human Anatomy, and informed consent was secured from all participants.

### 2.2 Methods of Collections

### 2.3 Measurement of Stature

Stature was measured as the vertical distance from the vertex of the head (Frankfurt plane) to the floor using a stadiometer, following International Biological Programme guidelines.[21]

**Fig 1: Measurement of Height.**

### 2.4 Measurement of Foot Length

Foot length was measured from the pternion (heel) to the acropodion (tip of the longest toe). Each foot was traced on A4 paper and measured with a meter rule to the nearest 0.1 cm.[22]

### 2.5 Measurement of Foot Breadth

Foot breadth was measured as the transverse distance between the medial head of the first metatarsal and the lateral head of the fifth metatarsal, using the method of Agnihotri et al.[23]

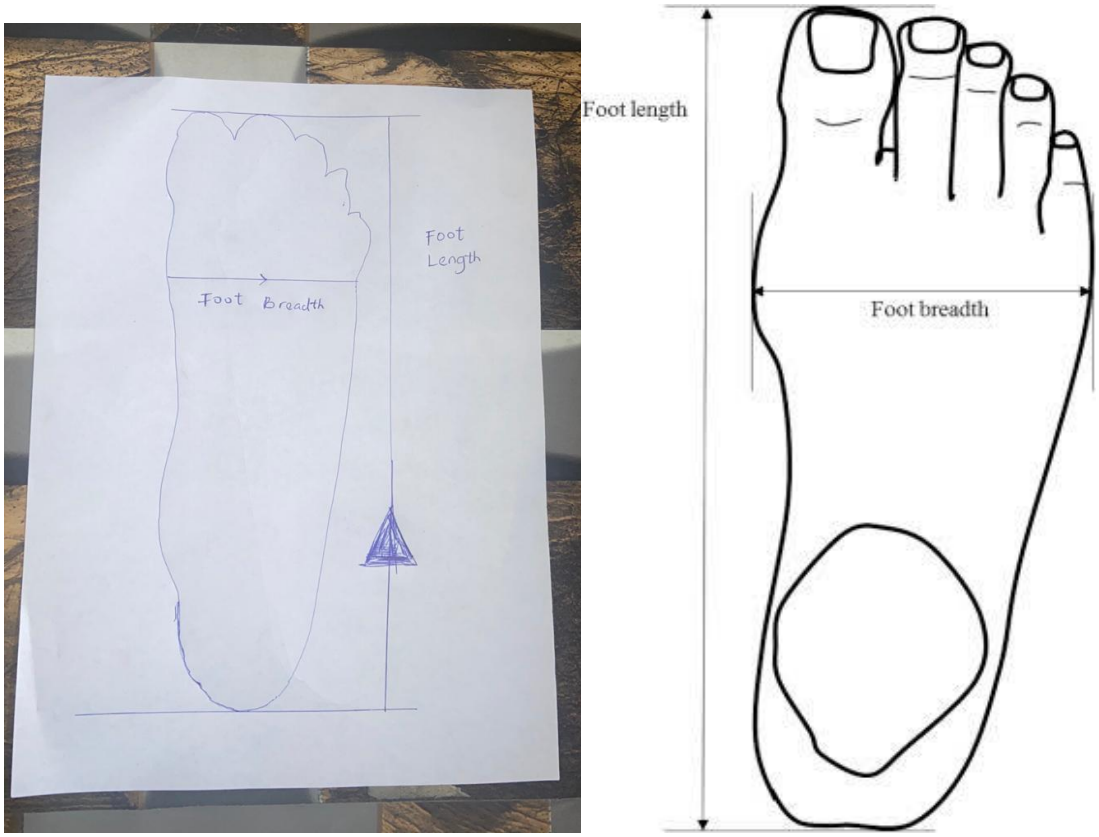


**Fig 2: Measurement of foot Length and foot breadth.**

### 2.6 Statistical Analysis

Data were analyzed using SPSS version 25. Descriptive statistics were expressed as mean ± ****SEM. Pearson correlation tested relationships between stature and foot dimensions, and regression equations were derived using linear regression. Significance was set at p <.

## 3. RESULTS AND DISCUSSION

3.1 The Results are presented in tables 1-6.

**Table 1: Descriptive statistics of males' foot length, foot breadth, and stature (n = 197).**

| Parameter | Mean ± SEM | Minimum | Maximum |
|---|---|---|---|
| Stature (cm) | 169.19 ± 0.62 | 150.00 | 193.04 |
| Foot length (cm) | 26.32 ± 0.10 | 22.65 | 29.00 |
| Foot breadth (cm) | 9.53 ± 0.05 | 8.95 | 10.75 |

**Table 2: Descriptive statistics of females' foot length, foot breadth, and stature (n = 197)**

| Parameter | Mean ± SEM | Minimum | Maximum |
|---|---|---|---|
| Stature (cm) | 161.77 ± 0.52 | 144.78 | 180.34 |
| Foot length (cm) | 24.53 ± 0.08 | 22.00 | 27.30 |
| Foot breadth (cm) | 8.64 ± 0.04 | 7.80 | 10.20 |

**Table 3: Correlation coefficients (r) and significance (p) between stature and foot dimensions.**

| Group | Foot length (r) | p-value | Foot breadth (r) | p-value |
|---|---|---|---|---|
| Males | 0.44 | p < .01 | 0.10 | p > .01 |
| Females | 0.60 | p < .01 | 0.40 | p < .01 |
| Combined | 0.62 | p < .01 | 0.41 | p < .01 |

*p < .01 considered significant*

**Table 4: Regression equations for stature estimation from foot length and foot breadth.**

| Group | Predictor | Regression equation (stature in cm) | r |
|---|---|---|---|
| Males | Foot length | H = 95.89 + 2.79 | 0.44 |
| Males | Foot breadth | H = 161.61 + 0.79 | 0.10 |
| Females | Foot length | H = 71.82 + 3.66 | 0.60 |
| Females | Foot breadth | H = 111.88 + 5.78 | 0.40 |
| Combined | Foot length | H = 76.99 + 3.48 | 0.62 |
| Combined | Foot breadth | H = 120.21 + 4.80 | 0.41 |

**Table 5: Comparison of mean foot length with previous studies.**

| Author/Year | Population | Male (cm) | Female (cm) |
|---|---|---|---|
| Bobmanuel et al. 2008 | Nigeria | 26.92 | 25.00 |
| Egwu et al. 2012 | Nigeria | 27.13 | 25.47 |
| Tobias et al. 2014 | Nigeria | 26.80 | 24.70 |
| Dhaneria et al.2016 | India | 24.71 | 23.56 |
| Present study | Nigeria | 26.32 | 24.53 |

**Table 6: Comparison of regression equations with previous studies.**

| Author/Year | Population | Sex | Regression equation (stature in cm) | r |
|---|---|---|---|---|
| Egwu et al. 2012 | Nigeria | M | H = 152.56 + 0.79 (FL) | 0.47 |
| Egwu et al. 2012 | Nigeria | F | H = 87.65 + 3.11 (FL) | 0.75 |
| Tobias et al. 2014 | Nigeria | M | H = 71.19 + 3.86 (FL) | 0.70 |
| Tobias et al. 2014 | Nigeria | F | H = 73.15 + 3.58 (FL) | 0.80 |
| Okafor et al. 2017 | Nigeria | M | H = 90.07 + 3.08 (FL) | 0.63 |
| Okafor et al. 2017 | Nigeria | F | H = 92.03 + 2.90 (FL) | 0.50 |
| Oghenemavwe & Egwede 2022 | Nigeria | M | H = 909.54 + 3.17 (FL) | 0.68 |
| Oghenemavwe & Egwede 2022 | Nigeria | F | H = 1093 + 2.29 (FL) | 0.54 |
| Present study | Nigeria | M | H = 95.89 + 2.79 (FL) | 0.44 |
| Present study | Nigeria | F | H = 71.82 + 3.66 (FL) | 0.60 |

*FL: Foot Length*

## DISCUSSION

The present study demonstrated significant correlations between stature and foot length in both males and females, confirming earlier findings in Nigerian and global populations. Females showed a stronger correlation (r = 0.60) compared to males (r = 0.44), suggesting that foot length is a more reliable predictor in females. This agrees with[17] among the Efik and[18] among the Ibibio, both of whom reported sex-related differences in predictive reliability.

The regression equations derived in this study are generally consistent with previous Nigerian studies, although some variations were observed. For example, the regression coefficients for males (2.79) and females (3.66) are lower than those reported by[24], but closer to the findings of.[25] These differences may be attributed to genetic diversity, environmental influences, or differences in methodology.[15,16]

A comparison of mean foot length with earlier studies revealed that the present results (26.32 cm in males, 24.53 cm in females) closely resemble those of[26], who reported 26.92 cm in males and 25.00 cm in females. This suggests a degree of consistency in Nigerian populations over time. Similar findings in previous studies also reported similar values, although slightly higher than those observed in the present study[19] and.[24]

Interestingly,[9] working with an Indian population, reported lower mean foot lengths (24.71 cm in males and 23.56 cm in females), highlighting ethnic and geographical differences that emphasize the need for population-specific regression models. Reliability of foot length in stature estimation among Uturu indigenes in Nigeria, were higher than those obtained in the present study.[11] These variations again underscore the influence of population characteristics on anthropometric data.

Foot breadth showed limited predictive value in the present study, being insignificant in males but significant in females. This aligns with[27], who noted that breadth measurements are generally less reliable than length. However,[19] suggested that in some male populations, foot circumference could outperform length, indicating population- variability.

Internationally, comparable findings have been reported in Nepal[12], India[13,9] and Slovakia[14], where foot length was a stronger predictor of stature than foot breadth. Together, these results support the universal applicability of foot length as a stature predictor, while reinforcing the necessity of region-specific regression equations.

## CONCLUSION

The present study established that foot length is a reliable predictor of stature in both males and females among

students at Rivers State University, Nigeria. Females showed stronger correlations and predictive values compared to males. Foot breadth demonstrated weaker predictive capacity, being insignificant in males but significant in females. The regression equations derived provided population-specific models that can aid forensic experts, anthropologists, and medico-legal practitioners in stature estimation when only foot measurements are available.

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