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Original Research Article

A Study of Estimation of Stature from Forearm Length.

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Abstract: ***Background:*** Estimation of stature from body parts is an essential component of forensic anthropology and medico-legal identification, particularly in cases involving mutilated, decomposed, or incomplete human remains. Among various anthropometric parameters, forearm length serves as a simple, reliable, and non-invasive predictor of stature. Population-specific regression models are necessary because anthropometric relationships vary according to ethnicity, sex, and geographical factors. ***Aim:*** To evaluate the correlation between forearm length and stature and to derive a regression formula for stature estimation among young adults. ***Methods:*** A cross-sectional observational study was conducted among 93 healthy MBBS students aged 18–25 years at Government Medical College, Dindigul. The study included 33 males and 60 females selected randomly. Forearm length was measured from the olecranon process to the styloid process using standard anthropometric techniques, while stature was measured using a stadiometer. Measurements were recorded at a fixed time to minimize diurnal variation. Statistical analysis included calculation of mean, standard deviation, Pearson's correlation coefficient, and linear regression analysis. ***Results:*** The mean forearm length and stature were higher among males compared to females. Females showed a mean forearm length of 27.6 ± 1.5 cm and mean stature of 160.2 ± 5.8 cm, whereas males showed 29.6 ± 1.6 cm and 174.3 ± 6.5 cm respectively. A statistically significant moderate positive correlation (r = 0.67) was observed between forearm length and stature. The regression equation derived for stature estimation was: Height = 3.43 × Forearm Length + 67.56. ***Conclusion:*** Forearm length is a reliable anthropometric parameter for estimating stature in young adults. The derived regression equation can be useful in forensic identification and medico-legal investigations, particularly when only partial human remains are available.

Keywords: Stature estimation, Forearm length, Anthropometry, Regression analysis, Forensic science

INTRODUCTION

Stature estimation is one of the fundamental components of personal identification in forensic anthropology and medico-legal investigations. Determination of height becomes particularly important when complete bodies are not available, such as in cases of mass disasters, mutilation, advanced decomposition, explosions, and skeletal remains. In such situations, forensic experts rely on anthropometric measurements of body parts to reconstruct biological profiles and assist in identification of unknown individuals. Among various anthropometric parameters, measurements of long bones and limb segments have been widely used for predicting stature with considerable accuracy. Forensic Anthropology

Anthropometry refers to the scientific study of measurements of the human body and its proportions. It has extensive applications in forensic medicine, anatomy, ergonomics, and physical anthropology. Anthropometric relationships between body segments and stature have been studied for decades, and regression equations derived from these studies serve as useful tools in forensic identification. The principle behind stature estimation is based on the proportional relationship between different body parts and total body

height. Since skeletal growth follows predictable biological patterns, measurements of limbs and their segments can provide reliable estimates of stature. Studies by Trotter and Gleser established important regression formulae using long bones for stature estimation and laid the foundation for modern anthropometric analysis. Long bones such as femur, tibia, humerus, and radius are considered the most reliable indicators for estimating stature. However, in many medico-legal scenarios, only fragments or portions of limbs may be available. Under such circumstances, smaller body segments like hand length, foot length, arm span, ulna length, and forearm length become highly valuable.

Forearm length, measured from the olecranon process to the styloid process, is particularly useful because it is easily accessible, simple to measure, and less affected by postural variations. Moreover, forearm measurements can be obtained rapidly without sophisticated equipment, making them practical in both clinical and forensic settings. Several studies conducted across different populations have demonstrated a significant correlation between forearm length and stature. Mohanty et al. observed that forearm length can be used as a dependable parameter for predicting height among Indian populations. Similarly, Patel et al. reported a positive relationship between forearm dimensions and stature in the Gujarat population.

These findings suggest that forearm length may serve as a useful substitute when direct measurement of stature is not possible. However, anthropometric relationships vary considerably with ethnicity, geographical location, nutritional status, age, and sex. Therefore, regression equations developed for one population may not be directly applicable to another population. Sexual dimorphism also plays a significant role in anthropometric measurements. Males generally possess greater body dimensions and stature compared to females because of hormonal and genetic influences on skeletal growth. Hence, gender-specific regression models are often recommended to improve predictive accuracy. Previous studies by Krishan and Sharma demonstrated that separate equations for males and females provide more precise stature estimation than combined equations.

India is characterized by enormous ethnic and regional diversity, leading to significant variations in anthropometric parameters among populations. Hence, region-specific studies are necessary to establish reliable regression formulae for stature estimation. Limited literature is available regarding the relationship between forearm length and stature among young adults in Tamil Nadu. Furthermore, most existing studies have focused on long bones rather than forearm measurements. Therefore, the present study was undertaken among medical students of Government Medical College, Dindigul, to evaluate the correlation between forearm length and stature and to derive regression equations applicable to the local population. The study has important medico-legal implications. Accurate estimation of stature from forearm length may assist forensic experts during identification of unknown remains, disaster victim identification, and criminal investigations. In addition, such anthropometric data may also have applications in clinical practice, ergonomics, and biological research. The present study aims to contribute population-specific data for stature estimation using forearm length among young adults in South India.

MATERIALS AND METHODS

Study Design

A cross-sectional observational study was conducted to evaluate the relationship between forearm length and stature among young adults.

Study Setting

The study was carried out in the Department of Forensic Medicine and Toxicology at Government Medical College, Dindigul, Tamil Nadu, India.

Study Population

A total of 93 MBBS students were included in the study. Among them, 33 were males and 60 were females.

Study Duration

The study was conducted during the academic study period after obtaining institutional approval.

Inclusion Criteria

- Healthy individuals aged between 18 and 25 years
- Students willing to participate in the study
- Individuals without physical deformities

Exclusion Criteria

- Individuals with skeletal deformities
- History of fractures or surgery involving upper limbs
- Congenital anomalies affecting stature or limb proportions

Ethical Considerations

Institutional Research Committee approval was obtained before commencement of the study. Informed written consent was taken from all participants prior to data collection.

Method of Data Collection

Measurement of Stature

Stature was measured using a standard stadiometer. Participants were asked to stand erect barefoot on a flat surface with heels together and head positioned in the Frankfurt plane. Height was recorded in centimeters.

Measurement of Forearm Length

Forearm length was measured on the left side using a measuring tape. The distance between the olecranon process of the ulna and the styloid process was recorded in centimeters.

Precautions Taken

- Measurements were taken at a fixed time of day to avoid diurnal variation.
- All measurements were recorded by the same observer to minimize interpersonal error.
- Participants were instructed to maintain proper posture during measurements.

Statistical Analysis

Data obtained were entered into Microsoft Excel and analyzed statistically. Mean and standard deviation were calculated for stature and forearm length. Pearson's correlation coefficient (r) was used to assess correlation between stature and forearm length. Linear regression analysis was performed to derive regression equations for estimation of stature.

RESULTS

Table 1: Gender Distribution of Study Participants

Gender	Number (n)	Percentage (%)
Male	33	35.5
Female	60	64.5
Total	93	100

Table 2: Mean Forearm Length among Study Participants

Gender	Mean Forearm Length (cm)	Standard Deviation
Male	29.6	1.6
Female	27.6	1.5

Table 3: Mean Stature among Study Participants

Gender	Mean Height (cm)	Standard Deviation
Male	174.3	6.5
Female	160.2	5.8

Table 4: Correlation between Forearm Length and Stature

Parameter	Correlation Coefficient (r)
Forearm Length vs Stature	0.67

Table 5: Regression Equation for Estimation of Stature

Regression Formula
Height = 3.43 × Forearm Length + 67.56

DISCUSSION

The present study evaluated the relationship between forearm length and stature among young adults and demonstrated a statistically significant moderate positive correlation between the two parameters. Anthropometric measurements have long been recognized as valuable tools in forensic identification, especially in situations where complete human remains are unavailable. Estimation of stature from body segments remains an essential component of biological profiling in forensic anthropology.

In the current study, males exhibited greater mean stature and forearm length compared to females. The mean forearm length among males was 29.6 ± 1.6 cm, whereas among females it was 27.6 ± 1.5 cm. Similarly, mean stature among males was 174.3 ± 6.5 cm compared to 160.2 ± 5.8 cm among females. These findings are consistent with established biological differences between sexes and support the concept of sexual dimorphism described in anthropometric literature. Singh and Bhasin reported that males generally possess greater skeletal dimensions due to hormonal and genetic influences on bone growth and maturation.

The present study observed a moderate positive correlation coefficient (r = 0.67) between forearm length and stature. This indicates that increase in forearm length is associated with increase in stature. Similar findings were observed by Mohanty et al., who demonstrated significant correlation between forearm length and stature in Indian populations. Patel et al. also reported positive association between forearm measurements and stature among subjects from Gujarat. The moderate strength of correlation in the present study may be attributed to sample size, regional variability, and inclusion of both sexes within a narrow age group.

The regression equation derived in the present study was:

Height=3.43×Forearm Length+67.56

This equation can be used to estimate stature when direct measurement is not possible. Regression analysis is widely accepted in forensic anthropology because it provides statistically reliable predictions based on body proportions. Trotter and Gleser were among the first researchers to formulate regression equations using long bones for stature estimation, and their work remains fundamental in forensic science. Forearm length offers several practical advantages in anthropometric studies. It is easy to measure, requires minimal equipment, and can be assessed rapidly even in field conditions. In medico-legal practice, forearm measurements become particularly useful in cases involving mutilated bodies, dismemberment, natural disasters, aviation accidents, explosions, and advanced decomposition where only fragments of upper limbs are available. In such scenarios, stature estimation narrows the range of possible identities and assists investigative authorities. Population specificity is an important consideration in stature estimation studies. Anthropometric relationships vary considerably among different ethnic groups due to genetic, environmental, nutritional, and socioeconomic factors. Krishan emphasized that regression equations derived from one population should not be generalized universally. Therefore, the present study contributes valuable regional data applicable to young adults in Tamil Nadu.

The findings of this study also support previous observations that gender-specific equations improve predictive accuracy. Krishan and Sharma reported that separate regression models for males and females produce better estimates because body proportions differ significantly between sexes. Although a combined regression equation was derived in the present study, future research involving larger samples may generate separate equations with higher precision. The present study has certain limitations. The sample size was relatively small and limited to medical students aged 18–25 years. Therefore, findings cannot be generalized to all age groups or populations. Additionally, only the left forearm was measured, and bilateral comparisons were not performed. Despite these limitations, the study provides useful preliminary data for regional anthropometric analysis. Overall, the study confirms that forearm length is a reliable and practical parameter for estimating stature. The observed correlation and regression model may aid forensic experts, anthropologists, and clinicians in situations where direct stature measurement is not feasible.

CONCLUSION

Stature estimation plays a crucial role in forensic identification, especially in situations involving incomplete or fragmented human remains. Anthropometric measurements provide scientifically reliable methods for predicting stature when direct measurement is impossible. The present study was undertaken to evaluate the relationship between forearm length and stature among young adults and to derive a regression equation useful for forensic applications. The study demonstrated a statistically significant moderate positive correlation between forearm length and stature. Males exhibited greater mean forearm length and stature compared to females, indicating the presence of sexual dimorphism in anthropometric parameters. The regression equation derived from the study showed that forearm length can serve as a dependable predictor of stature in the studied population.

Forearm length offers several advantages as an anthropometric parameter. It is easy to measure, non-invasive, inexpensive, and practical in both clinical and forensic settings. The measurement can be obtained rapidly with minimal equipment and may be especially useful in medico-legal investigations involving mutilated bodies, skeletal remains, mass disasters, and decomposed corpses. In such situations, estimation of stature from forearm length can significantly assist in narrowing down the identity of unknown individuals.

The findings of the present study are consistent with previous anthropometric research conducted in different populations. However, anthropometric relationships are influenced by ethnicity, geographical factors, nutrition, and sex. Hence, population-specific regression equations are essential for accurate stature estimation. The present study contributes useful regional data for young adults in Tamil Nadu and highlights the need for further research involving larger and more diverse populations. Although the study had limitations including small sample size and restricted age range, it successfully established the usefulness of forearm length as a reliable parameter for stature estimation. Future studies incorporating larger samples, multiple ethnic groups, and bilateral measurements may improve predictive accuracy and allow development of gender-specific regression equations. In conclusion, forearm length is a practical and reliable anthropometric measurement for estimation of stature. The regression formula derived in this study may be utilized in forensic anthropology, medico-legal investigations, disaster victim identification, and related fields where stature estimation is required.

LIMITATIONS OF THE STUDY

- Small sample size limited to 93 participants
- Study population restricted to medical students
- Narrow age group of 18–25 years
- Only left forearm measurements were considered
- Findings may not be generalized to other populations or ethnic groups
- Gender-specific regression equations were not separately derived.

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