Journal of Cardiovascular Disease Research
ISSN: 0975-3583, 0976-2833 VOL16, ISSUE 1, 2025

Estimation of Stature from Index Finger and Ring Finger in Bengali Population.

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Publication Date: 01/01/2025

Abstract:

Background: The identification of commingled mutilated remains is a challenge to forensic experts and hence, a need of studies on estimation of stature from various body parts in different population groups. Such studies can help in narrowing down the pool of possible victim matches in cases of identification from dismembered remains. Studies pertaining to stature estimation among adolescents are limited owing to the ongoing growth process and growth spurt during adolescent period.

Objective: In view of the limited literature on the estimation of stature in adolescent group, the present preliminary research was taken up to report the correlation between index and ring finger length and stature in a Bengali population.

Methods: Three anthropometric measurements; Stature, Index finger length (IFL) and ring finger length (RFL) were taken on the subjects included in the study.

Results: Mean stature, IFL and RFL were significantly larger in males than females. Statistically significant correlation was observed between stature, IFL and RFL in right and left hands. Pearson correlation (r) was higher among males than females. Among males and females' correlation coefficient was higher for the IFL than the RFL. The present research derives the linear regression models and multiplication factors for estimating stature from IFL and RFL and concludes that the living stature can be predicted from the IFL and RFL with a reasonable accuracy in Bengali population.

Introduction:

Stature, or body height, stands as a fundamental anthropometric parameter, holding significant importance across a multitude of disciplines, ranging from forensic science and anthropology to clinical medicine and ergonomics.[1] Its estimation from fragmented or incomplete skeletal remains is a crucial component in the identification process, particularly in forensic investigations where establishing personal identity is paramount.[2] In anthropological studies, stature reconstruction provides insights into past populations' living conditions, nutritional

status, and overall health. Furthermore, in clinical settings, accurate stature estimation aids in dosage calculations, growth monitoring, and the assessment of nutritional deficiencies. Traditional methods of stature estimation primarily rely on the measurement of long bones, such as the femur, tibia, and humerus.[3] However, these methods become inapplicable when such bones are unavailable or severely damaged. In such scenarios, the need arises for alternative, reliable, and accessible methods of stature estimation. The use of fragmented or readily available body parts, like the fingers, presents a promising avenue for addressing this challenge[4]. The human hand, with its intricate structure and readily measurable dimensions, has been increasingly recognized as a valuable tool in stature estimation. Among the various digital measurements, the lengths of the index and ring fingers have garnered considerable attention due to their ease of measurement and potential correlation with overall body height.[5] These fingers, relatively protected and less prone to significant post-mortem damage compared to long bones, offer a practical and accessible source of information. The relationship between finger length and stature is rooted in the fundamental principles of human growth and development.[6] During embryonic development, the limbs and digits undergo coordinated growth processes, influenced by genetic and environmental factors.[7] This shared developmental pathway may contribute to a proportional relationship between finger length and overall body height. However, the strength and consistency of this relationship can vary across different populations due to genetic diversity, environmental influences, and socio-cultural factors[8]. Previous studies investigating the correlation between finger length and stature have yielded varying results, highlighting the importance of population-specific research. These studies have demonstrated that regression equations derived from one population may not be directly applicable to another due to inherent anthropometric differences.[10] Consequently, the development of population-specific regression models is crucial for accurate and reliable stature estimation. The Bengali population, residing primarily in the eastern regions of the Indian subcontinent, represents a distinct demographic group with unique anthropometric characteristics. This population, with its rich cultural heritage and diverse genetic background, warrants specific investigation to establish accurate stature estimation models. Given the diverse genetic and environmental factors that can influence human growth, it is imperative to develop population-specific equations for the Bengali population. Moreover, the availability of such population-specific data holds immense practical implications within the Bengali context. In forensic investigations, particularly in regions with limited resources and challenging environmental conditions, the ability to accurately estimate stature from finger lengths can significantly enhance the identification process. Similarly, in anthropological studies focusing on the Bengali population, these equations can contribute to a more comprehensive understanding of their past and present physical characteristics. This study aims to address the existing gap in knowledge by investigating the relationship between index and ring finger lengths and stature in a Bengali population. The primary objective is to develop regression equations that can be used to accurately estimate stature from these digital measurements. By employing a rigorous methodology and robust statistical analysis, this study seeks to provide reliable and population-specific tools for stature estimation. The significance of this research extends beyond the immediate goal of developing regression equations. It also contributes to a broader understanding of the anthropometric variations within the Bengali population and the factors that influence human growth. By elucidating the relationship between finger length and stature, this study provides valuable insights into the complex interplay of genetic and environmental factors that shape human physique. Furthermore, this study underscores the importance of population-specific research in anthropometry. The findings will serve as a valuable resource for forensic scientists, anthropologists, and clinicians working with the Bengali population.

Materials and Methods:

This cross-sectional, observational study aimed to establish the relationship between index and ring finger lengths of the right hand and stature in a sample of medical students aged 18 to 25 years. The study was conducted in the Department of Anatomy, GIMSH, Durgapur, India.

Materials:

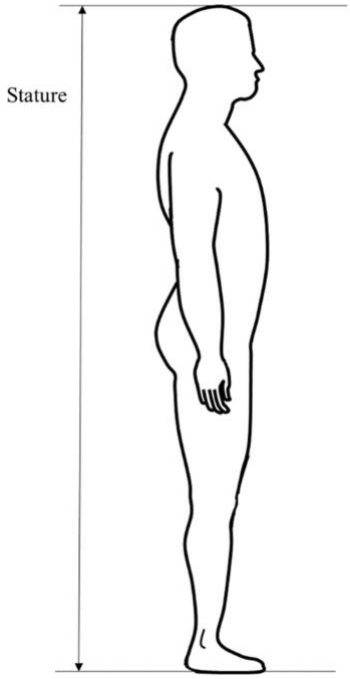
1. **Calipers:** Used for precise measurement of finger lengths.
2. **Ruler:** Employed for supplementary linear measurements, if needed.
3. **Measuring Tape:** Used to measure stature (height) accurately.
4. **Data Collection Sheet:** A standardized form for recording participant demographics (sex, age) and anthropometric measurements.

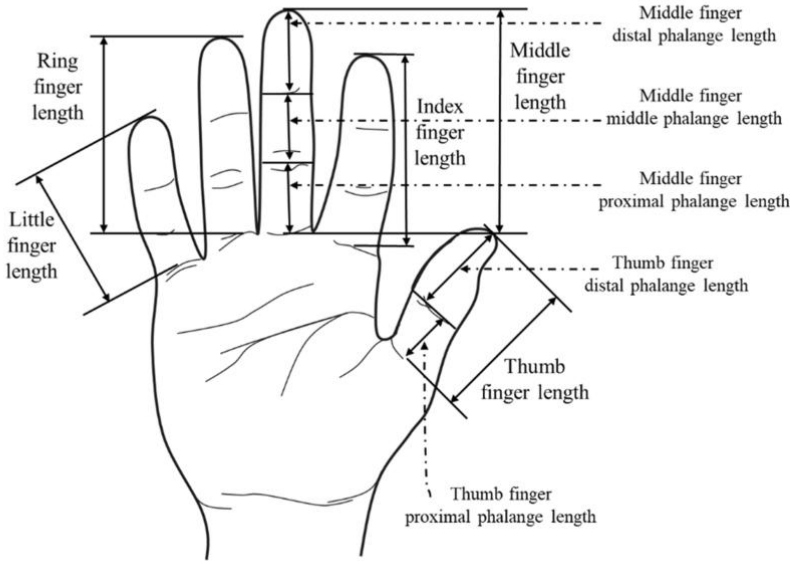
Methods:

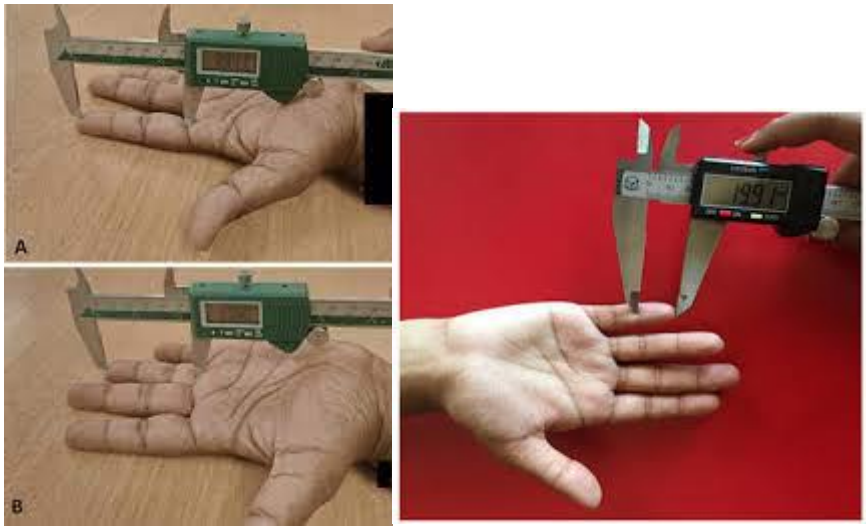
1. **Sample Selection:**
    - A total of 300 medical students (150 males and 150 females) were recruited for the study.
    - The age range of participants was 18 to 25 years, representing young adults.
    - Participants were selected from the GIMSH.
    - Participation was voluntary, and informed consent was obtained from all participants prior to data collection.
2. **Data Collection:**
    - All measurements were taken by trained personnel to ensure consistency and accuracy.
    - **Stature (Height):** Measured using a calibrated measuring tape, with participants standing erect, heels together, and looking straight ahead. Measurements were recorded in centimetres (cm).
    - **Index Finger Length (IFL):** Measured on the right-hand using callipers. The measurement was taken from the tip of the index finger to the basal crease at the base of the palm. Measurements were recorded in centimetres (cm).
    - **Ring Finger Length (RFL):** Measured on the right-hand using callipers. The measurement was taken from the tip of the ring finger to the basal crease at the base of the palm. Measurements were recorded in centimetres (cm).
3. **Data Analysis:**
    - The collected data was analysed using appropriate statistical software.
    - Descriptive statistics (mean, standard deviation, range) were calculated for stature, IFL, and RFL for both males and females.
    - Pearson correlation analysis was performed to determine the strength and direction of the relationship between stature and finger lengths (IFL and RFL).
    - Linear regression analysis was conducted to develop predictive models for estimating stature from IFL and RFL.

- Independent t-tests were used to compare the mean values of stature, IFL, and RFL between males and females to determine if there were statistically significant differences between the sexes.
- A p-value of less than 0.05 was considered statistically significant.

4. **Model Development:**
   - Based on the linear regression analysis, regression equations were derived to predict stature from IFL and RFL.
   - Multiplication factors were also derived, in order to provide a simple alternative method for estimating stature.
5. **Model Validation:**
   - While the provided text mentions model validation, it does not specify whether this was completed. In a full research paper, a separate dataset would be used to validate the model. If this was completed, the methods used for that validation would be included in this section.







Results:

This study investigated the relationship between index finger length (IFL), ring finger length (RFL), and stature in a bengali population, aiming to develop predictive models for stature estimation. The results demonstrated clear sexual dimorphism in anthropometric measurements, with males exhibiting significantly larger statures and finger lengths compared to females. The stature of male participants ranged from 137.2 cm to 178.5 cm, while female stature ranged from 139.9 cm to 166.4 cm. The mean stature was significantly higher in males, with a statistically significant difference ($P < 0.001$), underscoring the typical growth patterns observed during adolescence. Analysis of finger lengths revealed that RFL was consistently larger than IFL in both sexes. In males, the mean IFL was 6.95 cm on the right hand and 6.97 cm on the left hand. For females, the mean IFL was 6.53 cm on the right and 6.55 cm on the left. The mean RFL in males was 7.23 cm on the right and 7.26 cm on the left, while in females, it was 6.73 cm on both hands. These measurements highlight the subtle bilateral symmetry in finger lengths, with minimal variations between right and left hands. Statistical analysis revealed a strong positive correlation between stature and both IFL and RFL in both sexes and on both hands. Pearson correlation coefficients (r) were calculated to quantify these relationships. Notably, the correlation coefficients were consistently higher in males compared to females, suggesting a stronger association between finger length and stature in males. Furthermore, IFL demonstrated a higher correlation with stature than RFL in both males and females. This indicates that IFL may be a more reliable predictor of stature in this population. Linear regression models were developed to estimate stature from IFL and RFL. These models, derived separately for males and females, provided equations that could be used to predict stature based on finger length measurements. The accuracy of these models was assessed, and they showed a reasonable degree of predictability within the studied adolescent population. Additionally, multiplication factors were also generated to provide a simplified method of stature estimation. The significant correlations and the derived regression models provide valuable tools for forensic applications, particularly in cases involving fragmented or commingled remains. The observed differences between male and female measurements highlight the importance of sex-specific models in stature estimation. The higher correlation of IFL with stature suggests that it may be a more reliable predictor than RFL in this population.

In conclusion, the results of this study demonstrate a statistically significant relationship between finger lengths and stature in North Indian adolescents. The derived regression models and multiplication factors offer practical tools for stature estimation, contributing to forensic identification processes. The observed sexual dimorphism and the stronger correlation of IFL with stature provide valuable insights for future research and applications in forensic anthropology.

Discussion:

This study successfully demonstrated a statistically significant relationship between index and ring finger lengths and stature in a bengali population, specifically medical students aged 18-25. The findings contribute valuable data to the field of forensic anthropology, particularly in the context of stature estimation from fragmented remains.

The observed sexual dimorphism in stature and finger lengths is consistent with established growth patterns. Males exhibited significantly larger statures and finger lengths compared to females, reflecting the influence of hormonal differences and developmental trajectories during adolescence. This highlights the importance of developing sex-specific predictive models for accurate stature estimation.

The significant positive correlations between stature and both IFL and RFL confirm that finger lengths can serve as reliable predictors of stature. The higher correlation coefficients observed in males suggest a stronger linear relationship between these variables in this group. Furthermore, the consistently higher correlation of IFL with stature compared to RFL indicates that IFL may be a more accurate predictor in this population. This may be related to the more consistent growth patterns of the index finger compared to the ring finger.

The derived linear regression models and multiplication factors provide practical tools for stature estimation. These models can be particularly useful in forensic investigations involving dismembered or commingled remains, where traditional methods of stature estimation are not feasible. By utilizing easily measurable finger lengths, investigators can narrow down the pool of potential victims and aid in the identification process.

The study's limitations should be acknowledged. First, the sample was drawn from a specific population of medical students in durgapur, which may limit the generalizability of the findings to other populations within bengal or beyond. Further research involving larger and more diverse samples is needed to validate these findings and develop population-specific models. Second, the study focused solely on finger lengths and did not consider other potential predictors of stature, such as hand breadth or other limb segment lengths. Incorporating these variables in future studies may improve the accuracy of stature estimation. Third, while the provided text stated model validation, the methods used to do so were not present. A full research paper would include a validation of the models on a separate dataset.

Despite these limitations, this study provides valuable insights into the relationship between finger lengths and stature in an adolescent population. The findings underscore the importance

of population-specific studies in forensic anthropology and highlight the potential of using finger lengths as reliable predictors of stature. Future research should focus on validating these findings in diverse populations, exploring the influence of other anthropometric variables, and refining the predictive models for improved accuracy. The application of these models in real-world forensic cases will further validate their utility and contribute to the advancement of forensic identification techniques

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