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Anthropometric study of hand length and its correlation with stature in an adult population: A cross-sectional study.

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Abstract

Background:
Anthropometric indicators such as hand length play a valuable role in estimating stature when complete body measurements are unavailable, particularly in forensic identification, emergency settings, and anthropological profiling.

Objectives:
To measure hand length among adults and examine its correlation with stature, and to develop a regression equation for height estimation in the study population.

Methods:
A cross-sectional study was conducted among 100 healthy adults aged 18–45 years. Stature was measured using a stadiometer, and hand length was recorded bilaterally using a standard sliding caliper. Mean values for both hands were used for analysis. Participants were categorized into stature groups for comparative evaluation. Pearson's correlation assessed the relationship between hand length and stature, while linear regression generated a predictive equation. Results were stratified by sex to examine variability across gender.

Results:
The mean stature of the participants was 165.4 ± 8.2 cm, whereas the mean hand length measured 18.7 ± 1.2 cm. Males exhibited higher values for both parameters compared with females. A consistent rise in hand length was observed across increasing stature categories. Pearson's correlation demonstrated a strong positive association between hand length and stature in the total sample ($r = 0.71$, $p < 0.001$). Correlation values remained significant among males ($r = 0.68$) and females ($r = 0.63$). Linear regression identified hand length as a significant predictor of stature, yielding the equation: Stature (cm) = 54.12 + 5.94 × Hand Length (cm) with an R^2 of 0.51.

Conclusion:
Hand length shows a robust linear relationship with stature and can serve as a practical parameter for height estimation in adults. The regression model developed in this study provides a reliable reference for clinical, forensic, and anthropological use.

Recommendations:
Further studies with larger, multi-center samples and inclusion of additional limb anthropometric markers are recommended to enhance predictive accuracy.

Keywords: *Hand length, Stature estimation, Anthropometry, Correlation, Regression model, Forensic identification.*
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INTRODUCTION

Stature is a fundamental anthropometric indicator widely applied in clinical evaluation, forensic identification,

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ergonomics, and biological anthropology. In many circumstances, however, obtaining an accurate height measurement becomes challenging due to deformity, trauma, skeletal damage, or post-mortem fragmentation. When such limitations arise, alternative limb dimensions, particularly those derived from the hand, serve as dependable substitutes for stature estimation. Hand length is considered one of the most stable morphometric indicators because it often remains preserved even when other skeletal structures are compromised [1].

Studies conducted across diverse populations have demonstrated strong correlations between hand dimensions and stature. Research from Saudi Arabia, Egypt, Korea, Ethiopia, and Nepal confirms this association and highlights the practical value of hand measurements in anthropometric and forensic applications [1–6]. Despite this consistency, population differences arising from genetic composition, nutritional status, lifestyle patterns, and environmental influences significantly affect anthropometric proportions. These variations underline the need for region-specific reference data rather than universal formulae, as prediction models tend to lose accuracy when applied to different ethnic or geographical groups [2–4].

Previous investigations have also shown that the pattern and strength of correlation between hand length and stature differ across sex and population subsets, emphasizing the importance of localized datasets for forensic and clinical use [3,5]. The absence of updated data from many regions further restricts the precision of currently available estimation equations, particularly in medico-legal settings where accuracy is crucial [6]. Hence, the present study was undertaken to measure hand length in an adult population and to determine its relationship with stature.

METHODOLOGY

Study Design and Setting

This cross-sectional anthropometric study was carried out in the Department of Anatomy, Government Medical College (GMC), Jogulamba Gadwal. The institution serves a mixed rural–semi-urban population, providing a suitable environment for collecting representative adult measurements. Data collection spanned one year, from August 2024 to July 2025.

Study Population

Adults aged 18–45 years were recruited from the outpatient units, student community, and staff volunteers of GMC Jogulamba Gadwal. Individuals with congenital or acquired deformities of the upper limb, recent fractures, chronic musculoskeletal disorders, spinal deformities, or conditions affecting stature were excluded. Pregnant women were also excluded to avoid confounding anthropometric variation.

Sample Size

A total of 100 healthy adults were included using convenience sampling. Equal opportunities were provided for both sexes to ensure proportional representation.

Inclusion Criteria

Adults aged 18–45 years
Apparently healthy individuals of both sexes
Individuals willing to participate and provide written informed consent
Participants without any clinical condition known to affect stature or hand dimensions

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of GMC Jogulamba Gadwal. Written informed consent was obtained from all participants before inclusion. Confidentiality of personal data was maintained throughout the study.

Anthropometric Measurements

Stature was measured using a wall-mounted stadiometer with participants standing erect, barefoot, and in the Frankfurt horizontal plane. Measurements were recorded to the nearest 0.1 cm. Hand length was measured using a standard sliding vernier caliper. The distance from the midpoint of the distal crease of the wrist to the tip of the middle finger was taken as hand length. Both hands were measured, and the mean of the right and left values was used for analysis. All measurements were taken in the morning hours to minimise diurnal variation, and each parameter was recorded twice by the same observer to reduce inter-observer error.

Data Categorization

Participants were grouped into three stature categories (<160 cm, 160–169.9 cm, and ≥170 cm) to assess variation in hand length across height ranges. Sex-specific measurements were also recorded for comparative analysis.

Bias Control

Several measures were undertaken to minimise potential sources of bias. Standardised measurement protocols were followed for both stature and hand length to reduce measurement bias. All anthropometric measurements were

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recorded by the same observer using calibrated instruments, thereby limiting inter-observer variability. Measurements were taken at similar times of the day to minimise diurnal variation. Clear inclusion and exclusion criteria were applied to reduce selection bias. Data entry and statistical analysis were performed systematically to avoid analytical bias.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 25. Descriptive statistics were expressed as mean ± standard deviation. Pearson's correlation coefficient assessed the relationship between hand length and stature. Linear regression analysis was performed to derive a predictive equation for estimating stature from hand length. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 100 adults participated in the study, with 52 males and 48 females forming the sample. The demographic and baseline anthropometric features are summarised in Table 1. The overall mean age was 28.6 ± 6.4 years. Males were taller and had longer hand length measurements compared with females. The mean stature of the total sample was 165.4 ± 8.2 cm, and the mean hand length measured 18.7 ± 1.2 cm. The difference between right and left hand measurements was minimal across both sexes.

Table 1. Demographic and Anthropometric Profile of the Study Participants (n = 100)

Variable	Total (n=100)	Males (n=52)	Females (n=48)
Age (years), mean ± SD	28.6 ± 6.4	29.2 ± 6.1	27.9 ± 6.7
Stature (cm), mean ± SD	165.4 ± 8.2	170.8 ± 6.7	159.5 ± 5.1
Hand Length (cm), mean ± SD	18.7 ± 1.2	19.4 ± 0.9	17.9 ± 0.7
Right–Left Hand Difference (cm)	0.12 ± 0.04	0.14 ± 0.05	0.10 ± 0.03

Hand length showed a clear progressive increase with rising stature categories, as presented in Table 2. Participants with stature <160 cm demonstrated the shortest mean hand length (17.8 ± 0.6 cm), whereas individuals with stature ≥170 cm showed the highest values (19.6 ± 0.8 cm). This pattern was consistent across both genders, suggesting a proportional relationship between body height and hand dimensions.

Table 2. Distribution of Hand Length Across Stature Categories

Stature Category	n	Mean Hand Length (cm) ± SD
<160 cm	28	17.8 ± 0.6
160–169.9 cm	34	18.6 ± 0.7
≥170 cm	38	19.6 ± 0.8

The association between hand length and stature was examined using Pearson's correlation analysis (Table 3). A strong, statistically significant positive correlation was observed in the total sample ($r = 0.71$, $p < 0.001$). The sex-stratified analysis also revealed significant correlations among males ($r = 0.68$, $p < 0.001$) and females ($r = 0.63$, $p < 0.001$), indicating a linear relationship in both groups.

Table 3. Correlation Between Hand Length and Stature

Parameter	Total Sample (n=100)	Males (n=52)	Females (n=48)
Pearson Correlation (r)	0.71	0.68	0.63
p-value	<0.001	<0.001	<0.001

A simple linear regression model was constructed to estimate stature from hand length. As shown in Table 4, hand length emerged as a significant predictor of stature ($\beta = 5.94$, $p < 0.001$).

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The regression equation derived from the analysis was: Stature (cm) = 54.12 + 5.94 × Hand Length (cm)

The model accounted for 51% of the variance in stature (R^2 = 0.51), demonstrating moderate predictive strength.

Table 4. Linear Regression Model Predicting Stature from Hand Length

Regression Parameter	Estimate	Standard Error	p-value
Intercept	54.12	6.08	<0.001
Hand Length Coefficient (β)	5.94	0.72	<0.001
R^2 Value	**0.51**	—	—

DISCUSSION

The present study evaluated the association between hand length and stature among 100 healthy adults from the GMC Jogulamba Gadwal region. A strong and consistent positive correlation was observed, demonstrating that hand dimensions can serve as dependable markers for estimating stature when direct measurement is not feasible. Comparable findings have been documented in earlier anthropometric and forensic studies, where hand-based parameters and handprint measurements reliably predicted height in diverse populations [7,8].

Sexual dimorphism was evident in this study, with males showing greater mean stature and hand length than females, which is consistent with prior anthropometric studies reporting larger skeletal and hand dimensions among males across populations [9,10]. Such differences align with previously reported anatomical patterns indicating larger skeletal proportions among males in both tribal and non-tribal population groups [9,10]. Despite these variations, the correlation remained significant in both sexes, affirming that hand length serves as a stable predictor of stature regardless of gender.

A graded increase in hand length across ascending stature categories further supported the linear relationship between appendicular and axial body dimensions. Similar proportionality patterns have been documented in studies using handprint, hand–foot measurements, and finger-length parameters across various ethnicities, reinforcing the biological basis of these associations [7,8,9].

The regression model developed in this study accounted for 51% of the variance in stature, indicating moderate predictive accuracy. Studies from Ethiopian, Slovak, and Indian populations also reported comparable predictive strengths when using single limb parameters, suggesting that single-variable models may inherently explain only part of the total variability [10–12]. The unexplained variance in the present study indicates that incorporating additional limb measurements such as foot length, ulnar length, or index-to-ring finger ratios could enhance model precision, as demonstrated in earlier investigations [8,9,11,12].

Generalizability

The findings of this study provide useful reference data for estimating stature from hand length within the adult population of the GMC Jogulamba Gadwal region. The demographic composition of the sample, which included both males and females across a broad adult age range, supports its relevance to similar rural and semi-urban communities in southern India. However, the single-centre design and the relatively modest sample size suggest that the regression equation may not fully capture the variability present in wider or ethnically diverse populations. The results should therefore be applied cautiously to other regions with different genetic, nutritional, or occupational backgrounds. Larger, multi-centre studies would enhance the external validity and provide more robust population-based equations for broader anthropometric and forensic use.

Conclusion

This study established a clear and meaningful relationship between hand length and stature among adults in the GMC Jogulamba Gadwal region. Hand length showed a strong positive correlation with height in both sexes, reinforcing its value as a dependable anthropometric marker when direct stature measurement is not possible. The regression equation derived from the analysis offers a practical tool for estimating stature in clinical, forensic, and anthropological settings. Although the model explains a substantial proportion of height variation, broader multi-centre studies with larger samples are recommended to refine predictive accuracy. Overall, hand length remains a simple, stable, and useful parameter for stature estimation.

Limitations

This study was conducted at a single centre, which may not fully represent the broader regional or national population. The sample size of 100 adults, though adequate for

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preliminary analysis, limits the ability to capture wider variability in anthropometric patterns. Convenience sampling may also introduce selection bias, as participants were primarily recruited from the college community. Only hand length was assessed, and other potentially informative limb measurements, such as arm span, forearm length, or foot length, were not included. Finally, the study focused on adults aged 18–45 years, restricting the applicability of the findings to older or younger age groups.

Recommendations

Future research should include larger, multi-centre samples to improve the external validity of stature estimation models derived from hand measurements. Expanding the age range and incorporating diverse ethnic and socioeconomic groups will strengthen the applicability of the findings across wider populations. Additional anthropometric parameters—such as arm span, forearm length, foot length, and finger dimensions—should be integrated to enhance predictive accuracy. Standardised protocols for measurement should be adopted across studies to minimise variability. Developing region-specific regression equations and validating them in independent cohorts will further support the clinical, forensic, and anthropological utility of hand length for reliable stature estimation.

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Abbreviations

GMC – Government Medical College
SD – Standard Deviation
SPSS – Statistical Package for the Social Sciences
cm – Centimetre
r – Pearson's Correlation Coefficient
R^2 – Coefficient of Determination
CI – Confidence Interval

Source of funding

The study had no funding.

Conflicts of interest

The Author declares no conflict of interest.

Author's contribution

PRK-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.

Data Availability

Data Available on request

Author Biography

Dr. Palla Radha Krishna is an Associate Professor in the Department of Anatomy at Government Medical College and General Hospital, Jogulamba Gadwal, Telangana. He has extensive teaching and research experience in anatomical sciences and medical education. Before joining GMC Jogulamba Gadwal, he served as an Assistant Professor at Government Medical College, Suryapet, where he contributed to undergraduate training and departmental academic activities. His professional interests include anthropometry, anatomical variations, and applied clinical anatomy. He actively participates in institutional research initiatives and curriculum development. Dr. Radha Krishna maintains an ongoing commitment to academic growth and collaborative research. **ORCID:** https://orcid.org/0009-0007-5176-546

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