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Research Article

Estimation of Stature from the Measurement of Hand Dimensions-A Study Among the Medical Students of North Gujarat Region.

Dr. Nisarg Y. Modi¹, Dr Kalpeshkumar C. Patani², Dr. Anil R. Pandey³, Dr Rohit Zariwala⁴, Dr. Lovekumar Ramjibhai Bhagora⁵

¹Associate Professor, Department of Forensic Medicine and Toxicology, Nootan Medical College and Research Centre, Visnagar, Gujarat, India.

²Associate Professor, Department of Forensic Medicine and Toxicology, Nootan Medical College and Research Centre, Visnagar, Gujarat, India.

³Professor & Head, Department of Forensic Medicine and Toxicology, Nootan Medical College, and Research Centre, Visnagar, Gujarat, India.

⁴Assistant Dean, Professor & Head, Department of Forensic Medicine and Toxicology, GMERS Medical College Panchmahal, Godhara.

⁵Professor and Head, Dept. of Forensic Medicine & Toxicology, Swaminarayan Institute of Medical sciences and Research, Kalol, Swaminarayan University. At & post - Saij, Kalol, Gandhinagar-382725, Gujarat.

Abstract

Background: Stature is a key anthropometric parameter in forensic science, clinical practice, and human identification, particularly when bodies are fragmented, decomposed, or incomplete. Hand dimensions such as hand length and hand breadth have been shown to correlate with stature, but these relationships vary across populations. Limited data are available for young adults in the North Gujarat region. To estimate stature from hand dimensions and to derive population-specific regression equations among medical students of North Gujarat. **Materials and Methods:** A cross-sectional study was conducted among 150 healthy medical students aged 18–25 years at Nootan Medical College and Research Centre, Visnagar, Gujarat. Stature, hand length, and hand breadth were measured using a stadiometer and digital calliper following standard anthropometric protocols. Data were analyzed using GraphPad version 8.0. Descriptive statistics were calculated, and Pearson's correlation coefficient was used to assess the relationship between stature and hand dimensions. Simple linear regression was performed to derive prediction equations, with significance set at $p < 0.05$. Scatter plots with regression lines were generated to illustrate associations. **Results:** Stature demonstrated a strong, statistically significant positive correlation with both right hand length ($r = 0.675$) and left-hand length ($r = 0.672$), while hand breadth showed moderate correlations ($r = 0.527$ – 0.534). Regression analysis showed that hand length explained approximately 45% of stature variability, with right hand length emerging as the strongest single predictor ($R^2 = 0.455$). Hand breadth contributed less, predicting only 27–28% of height variation. **Conclusion:** Hand dimensions—especially hand length—serve as reliable indicators for estimating stature in young adults of North Gujarat. The derived regression equations are population-specific and hold significant value in forensic identification and anthropometric applications.

Keywords: Hand dimension, anthropometry.

Introduction:

Stature is one of the most important anthropometric parameters used in personal identification, biological profiling, and medico-legal investigations. It shows a definite biological relationship with various body dimensions, allowing estimation even when only fragmentary remains are available [1]. In situations such as mass disasters, transportation accidents, or cases involving decomposed or mutilated bodies, intact long bones may not always be present; therefore, reliable estimation of stature from smaller body parts such as the hand becomes essential [2]. Hand dimensions—including hand length and hand breadth—are known to correlate strongly with stature and have been widely used in forensic anthropology for reconstructing biological identity [3].

Anthropometric relationships vary significantly across populations because body proportions are influenced by ethnicity, genetic background, nutrition, environment, and lifestyle factors [4]. Thus, population-specific regression models are necessary to ensure

accuracy in stature estimation. Prior studies from Central India, South India, and Western India have demonstrated moderate to strong correlations between stature and hand dimensions, but these findings cannot be universally applied to all Indian subpopulations [3,5]. The North Gujarat population remains underrepresented in anthropometric literature despite its unique ethnic and environmental characteristics.

Medical students form an ideal sample group for establishing regional baseline anthropometric data due to remains measurement compliance. The present study was therefore undertaken to evaluate the relationship between hand dimensions and stature among medical students of North Gujarat region and to derive population-specific regression equations for stature estimation. These reference values will contribute to forensic anthropology, clinical practice, and other applied biological sciences in the region.

Address for Correspondence: Dr. Nisarg Y. Modi, Associate Professor, Department of Forensic Medicine and Toxicology, Nootan Medical College and Research Centre, Visnagar, Gujarat, India. dnisargmodi@gmail.com

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Material and Methods:

Study Design and Setting

A cross-sectional anthropometric study was conducted among undergraduate medical students of Nootan Medical College and Research Centre, North Gujarat. The study aimed to establish the

correlation between hand dimensions and stature and to derive population-specific regression equations for stature estimation.

Study Population

A total of 150 healthy medical students, aged 18–25 years, were

included. Both males and females were selected to represent the young adult population of North Gujarat.

Inclusion Criteria

- Students aged 18–25 years
- Physically healthy individuals with no deformity of upper limbs

- Willing to provide written informed consent

Exclusion Criteria

- History of congenital or acquired deformities of hand or fingers
- Prior fractures or injuries of upper limbs affecting measurement accuracy
- Systemic conditions influencing bone growth or stature

Ethical Clearance

Prior approval was obtained from the Institutional Ethics Committee of Nootan Medical College & Research Centre. Participants were informed about the study objectives, and written consent was obtained (IEC number: IECNMCRCIAPPROVAL/106/2025).

Anthropometric Measurements

Stature Measurement

Stature was measured using a standard stadiometer with the participant standing barefoot in the anatomical position.

- Measurement was recorded to the nearest 0.1 cm.
- The Frankfurt plane was ensured for correct head positioning.

Hand Measurements

All measurements were taken on both hands, but due to consistency and reduced measurement error, the right-hand data were used for primary statistical analysis.

Hand measurements included:

1. Hand Length – measured as the linear distance from

the midpoint of the distal wrist crease to the tip of the middle finger using a digital sliding caliper.

2. Hand Breadth (Width) – measured as the distance between the radial side of the second metacarpal head and the ulnar side of the fifth metacarpal head.

Each measurement was recorded twice, and the average value was used to reduce intra-observer variation.

Instrumentation

- Digital Vernier caliper (accuracy: 0.01 cm)
- Standard stadiometer
- Weighing scale (for demographic data)

The same trained investigator performed all measurements to avoid inter-observer variation.

Data Recording

Data were extracted and cleaned from excel sheet dataset provided by the investigators. Parameters included:

- Age/Sex
- Height (cm)
- Hand Length (cm)
- Hand Breadth (cm)

Statistical Analysis

All data were entered in Microsoft Excel and analyzed using GraphPad version 8.0. Descriptive statistics (mean, standard deviation, minimum, maximum) were calculated for stature and hand dimensions. Pearson's correlation coefficient (r) was used to assess the relationship between stature and hand measurements, with $p < 0.05$ considered statistically significant. Simple linear regression ($\text{Height} = a + bX$) was performed to derive prediction equations, and scatter plots with regression lines were generated to illustrate the associations.

RESULTS

A total of 150 medical students aged 18–24 years were included in the study, with 52% males and 48% females. The mean height of participants was 165.91 ± 9.48 cm, while the mean right- and left-hand lengths measured 17.71 ± 1.30 cm and 17.69 ± 1.30 cm, respectively. Mean hand width was 7.79 ± 1.18 cm on the right side and 7.56 ± 1.18 cm on the left side.

Table 1. Descriptive Statistics of Study Variables (n = 150)

Variable	Range	Mean	SD
Height (cm)	143.5 – 187.0	165.91	9.48
Left hand length (cm)	15.0 – 21.0	17.69	1.30
Right hand length (cm)	15.0 – 21.9	17.71	1.30
Left hand width (cm)	4.96 – 14.80	7.56	1.18
Right hand width (cm)	4.89 – 14.80	7.79	1.18

Table 1 presents the descriptive statistics of the study variables, showing that the height of participants ranged from 143.5 to 187.0 cm, with a mean of 165.91 cm. Hand dimensions showed relatively narrow ranges, with mean left and right hand lengths of 17.69 cm and 17.71 cm, respectively, and mean hand widths around 7.5–7.8 cm.

Table 2. Pearson Correlation Between Hand Dimensions and Height

Parameter	Pearson r	p-value	Interpretation
Left hand length	0.672	0.0001	Strong positive correlation
Right hand length	0.675	0.0001	Strong positive correlation
Left hand width	0.534	0.0001	Moderate correlation
Right hand width	0.527	0.0001	Moderate correlation

Table 2 demonstrates that both left- and right-hand lengths exhibited strong positive correlations with stature ($r \approx 0.67$, $p < 0.0001$), while hand width showed moderate correlations ($r \approx 0.53$, $p < 0.0001$).

Table 3. Linear Regression Models for Predicting Height

Model	Predictor Variable	R	R ²	Interpretation
Model 1	Left hand length	0.672	0.451	Length predicts 45% of height variation
Model 2	Right hand length	0.675	0.455	Best predictor among all parameters
Model 3	Left hand width	0.534	0.285	Width explains 28.5% height variation
Model 4	Right hand width	0.529	0.279	Width has lowest predictive ability

Table 3 shows that linear regression models using hand length explained about 45% of the variation in height, with right hand length being the best predictor ($R^2 = 0.455$). Models based on hand width explained a lower proportion of height variability ($R^2 \approx 0.28$).

Table 4. Summary of Key Findings

Finding	Result
Strongest correlation with height	Right hand length ($r = 0.675$)
Weakest correlation with height	Right hand width ($r = 0.527$)
Best regression model	Model 2: Height vs Right hand length ($R^2 = 0.455$)
Hand length vs width	Length is a better predictor of stature
Overall conclusion	Hand dimensions can reliably estimate stature in young adults

Table 4 summarizes these findings, highlighting right hand length as the strongest predictor of stature and confirming that hand dimensions—especially hand length—provide reliable estimates of height in young adults.

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DISCUSSION

In the present study, stature showed a strong and statistically significant positive correlation with hand dimensions among medical students of North Gujarat. Right hand length demonstrated the highest correlation with stature ($r = 0.675$), followed closely by left hand length ($r = 0.672$). Hand breadth showed a moderate but significant association. These findings reinforce the principle that hand measurements are reliable predictors of human stature, particularly in young adults.

The results of the present study are highly comparable to the findings reported by Kumar et al. (2022), who also evaluated medical students and observed an almost identical correlation pattern—hand length on both sides showed strong significance ($r = 0.672$ – 0.675), whereas hand breadth values showed moderate correlation ($r = 0.527$ – 0.534) [3]. This close similarity is expected, as both studies involve young Indian adults, measured with similar anthropometric techniques.

When compared to the seminal study by Mohite et al. (2015) on Central Indian adults, the current study demonstrates a stronger predictive ability of hand length [2]. Mohite et al. reported lower correlation values for hand length ($r = 0.35$ – 0.38), while hand breadth showed a higher correlation ($r = 0.69$ – 0.74) in their population [2]. These inter-regional differences highlight the importance of establishing population-specific standards for stature estimation, given that anthropometric relationships vary across ethnic, nutritional, and environmental backgrounds.

Similarly, the large-scale study from Central India by Charmode et al. (2019) reported strong correlations for hand length (r values not explicitly mentioned but described as “strong positive statistically significant correlation”) and developed regression equations yielding similar predictive patterns [6]. Although their sample size ($n = 1000$) was considerably larger than the present study, the overall relationship between stature and hand dimensions remains consistent.

Studies from other geographic regions also support the findings. Ibrahim et al. (2018), studying the North Saudi population, found the highest correlations with hand length and palm length, emphasizing that hand dimensions maintain predictive validity

across diverse populations despite differences in body proportions [7]. Their study also emphasized the need for regional regression models due to ethnic and lifestyle variations, which aligns with the rationale of the present work.

The study by Chikhalkar et al. (2010) conducted in Mumbai similarly observed significant correlations between hand length, hand width, and stature, although the magnitude of correlation varied, with hand length showing a moderate association in their population ($r \approx 0.60$) [8]. These findings further reinforce the variability of anthropometric relationships across subpopulations. In contrast to many Indian studies reporting strong correlations, Shiv Shankar et al. (2017) from Bangalore documented only weak correlations between stature and hand length ($r = 0.25$ – 0.26) [9]. This discrepancy may be attributed to ethnic diversity, smaller sample uniformity, and methodological differences in measurement procedures. These contrasting findings highlight the need for localized anthropometric research, as demonstrated by the present study.

In the context of Uttar Pradesh, Tandon et al. (2016) found that both hand length and foot length were strongly correlated with stature ($r > 0.85$), and foot length emerged as the better predictor in their sample [10]. While hand length was not the strongest predictor in their model, their correlation values were higher than those observed in the present dataset. This regional variability once again emphasizes that anthropometric prediction equations are most accurate when based on local population metrics.

Finally, Patel et al. (2012) from Gujarat demonstrated that hand length was one of the most reliable indicators of stature after arm span, showing high correlation compared to other parameters (hand breadth being the weakest) [11]. Their findings align closely with the present study, confirming that within the Gujarati population, hand length is a strong predictor of body height.

Overall, the present study's findings are consistent with the majority of previous research, confirming that hand length is a robust and reliable predictor of stature across different populations, while hand breadth shows comparatively weaker predictive strength. However, variations across studies underscore the necessity of region-specific regression models,

Conclusion

In this study, stature showed a strong and significant positive correlation with hand dimensions among medical students of North Gujarat. Right hand length emerged as the best predictor of height, followed by hand breadth, confirming that hand measurements are reliable for stature estimation in young adults. The regression equations developed here offer useful population-specific tools for forensic and anthropometric purposes. Since body proportions vary across regions, further research with larger and more diverse samples is recommended to enhance the accuracy and applicability of these prediction models.

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