Original Article

Hand Length as a Predictor of Stature: Forensic, Prosthetic and Its Clinical Implication in an Indian Population

Ashok Kumar[1], Anuj Jain[2], Monika Srivastava[3], Jyoti Sharma[4], Shashwat Singh[5], Nityanand Srivastava[6]

[1]Medical Officer, District Tuberculosis Centre Fatehpur, Uttar Pradesh, India. [2]Professor, Department of Anatomy, Uttar Pradesh University of Medical Sciences Saifai, Etawah, Uttar Pradesh, India. [3]Associate Professor, Department of Anatomy Uttar Pradesh University of Medical Sciences Saifai, Etawah, Uttar Pradesh, India. [4]Senior Resident, Department of Anatomy, Uttar Pradesh University of Medical Sciences Saifai, Etawah, Uttar Pradesh, India. [5]Junior Resident 2, Department of Anatomy Uttar Pradesh University of Medical Sciences Saifai, Etawah, Uttar Pradesh, India. [6]Professor and Head of Department, Department of Anatomy Uttar Pradesh University of Medical Sciences, Saifai, Etawah, Uttar Pradesh, India

Abstract

Background: Stature is a fundamental anthropometric parameter and an essential element in the description of the physical attributes of the human body. Its estimation is of great significance in forensic science, anthropology, archaeology, demography, and clinical settings where direct measurement is not possible. The aim is to establish a relationship between hand length and stature and to derive regression equations for stature estimation in the Indian population. **Subjects and Methods:** 240 medical and paramedical staff members and students (ages 20 to 50) at UPUMS, Saifai, Etawah, India, participated in this cross-sectional study. To prevent diurnal variation, hand length was measured at a set time using Vernier calipers in a uniform anatomical posture, and stature was recorded using a stadiometer. Correlation and regression analyses were performed using SPSS v23. **Results:** Statistically significant positive correlations were observed between stature and right hand length in males ($r=0.4584$; $p<0.00001$) and females ($r=0.5223$; $p<0.00001$), and between stature and left hand length in males ($r=0.4248$; $p<0.00001$) and females ($r=0.5351$; $p<0.00001$). Regression equations for stature were derived for both sexes and both hands. Estimated stature closely matched the measured stature values. **Conclusion:** Hand length shows a significant correlation with stature and can be reliably used for stature estimation. The regression models derived in this study may be useful in forensic investigations, anthropological research, clinical assessment, and prosthetic rehabilitation where direct height measurement is not feasible.

Keywords: Hand Length, Stature, Forensic Anthropology, Regression Analysis, Prosthetics.

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Introduction

Over a long period of early human evolution, upright posture was one of man's greatest achievements, as it freed up most of the body parameters such as the hand, arm, thigh, leg, and foot for activities other than movement.[1,2] These body segments are crucial in determining stature. Dimensional interactions between the body segments and the whole body have been of interest to artists for long time. The depiction of the standards of beauty by artists often involves the utilization of dimensional connections; thus, this has led to the development of rules regarding body proportions. The ancient Egyptians are credited with providing the earliest evidence of the application of laws of this kind.[3] In forensic science, physical anthropology, paleontology, paleoarcheology and demography, the study of the human skeleton is crucial. Within the realm of traditional biological anthropology, the field of forensic anthropology has emerged as one of the most significant in modern science. There has been an unparalleled research boom in forensic anthropology in the previous three decades.[4] The assessment of crime- related aspects such as the scene where remains are located, taphonomy, time since death, charred bones, and animal influences on bones are some of the areas of forensic anthropology that have been addressed by a variety of scholars.[5] From the time of Leonardo de Vinci (the Virtuvian man) the human hand is thought to carry a 1:10 relation with height. Hand length measurement is coming up as a basic tool in determining age-related loss of stature, in persons when direct height cannot be assessed due to physical deformities like kyphosis, scoliosis, contractures, missing limbs etc.[6] A significant number of research have been conducted on the topic of determining a person's height by measuring the length of bones such as the femur, the tibia, the humerus, the radius, or even the length of the fingers.

This study aims to determine which of the two parameters—right hand length or left hand length—is better for estimating stature.

Address for correspondence: Dr. Jyoti Sharma
Senior Resident, Department of Anatomy, Uttar Pradesh University of Medical Sciences Saifai, Etawah, Uttar Pradesh, India.
E-mail: jigarnm28@gmail.com

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Materials and Methods

The Uttar Pradesh University of Medical Sciences' Department of Anatomy in Saifai, Etawah, Uttar Pradesh, India, is where this study was carried out. Prior to the study, ethical approval was acquired from the college's ethics committee. This research was cross-sectional. At UPUMS, Saifai, Etawah, UP, India, 240 medical and paramedical students and staff members between the ages of 20 and 50 participated in the study. Participants with paralysis, orthopedic disabilities, or serious illnesses were not allowed to participate in the study. Additionally, study participants who did not consent to participate were not included in the study.

Inclusion Criteria:

- Medical and paramedical students and staff of Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etawah, India
- Age group 20–50 years
- Individuals providing informed consent to participate in the study

Exclusion Criteria:

- Subjects with any significant systemic diseases affecting growth or stature
- Individuals with orthopedic deformities of the spine or limbs (e.g., kyphosis, scoliosis, contractures, limb abnormalities)
- Cases with neurological or muscular paralysis affecting posture or hand measurement
- Participants with history of trauma or surgery involving upper limbs or spine that could alter measurements
- Participants in the study refusing to give their consent

Ethical and Data Analysis: The UPUMS, Saifai, granted the researcher permission. Vernier Calipers were used to measure the person's hand length, and Stadiometers were used to measure their height. Stadiometers can measure to the nearest 0.1 cm, and vernier calipers can measure to the nearest 0.02 mm. SPSS Software V.23.0 was used to enter all of the data. The correlation coefficient was also computed after the data was analyzed [Figure 1,2].

Methodology: From the midpoint between the styloid process of radius and ulna to tip of middle finger with hand and forearm straight in position and metacarpophalangeal joints and interphalangeal joints are in fully extended position. To prevent diurnal variation, the subjects' hand length was measured at a set time and in a similar anatomical position. By having the subject stand upright on a horizontal resisting plane without shoes, with their buttocks touching the wall and their shoulder blocks in place, stature was determined as the vertical distance from vertex to floor. It was necessary to point the fingers horizontally downward and turn the palms of the hands inward. The anthropometer was positioned in front of the subject in a straight vertical position, with the head in the Frankfurt plane (eye-ear-eye).

The Anthropometer's movable rod was brought into contact with the mid-saggital plane vertex [Figure 3&4].

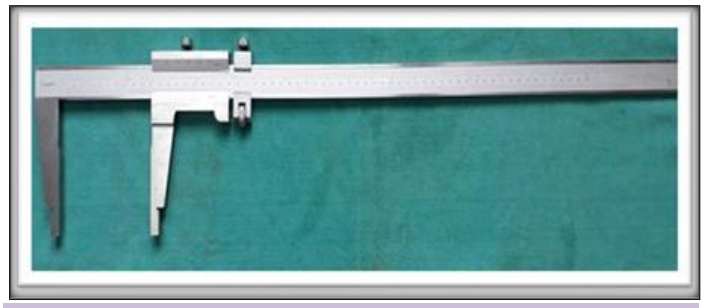

Figure 1: Vernier Caliper

Figure 2: Stadiometer

Figure 3: Measurement of Hand Length Using Vernier Calliper

Figure 4: Measurement of Height (Stature) Using Stadiometer

RESULTS

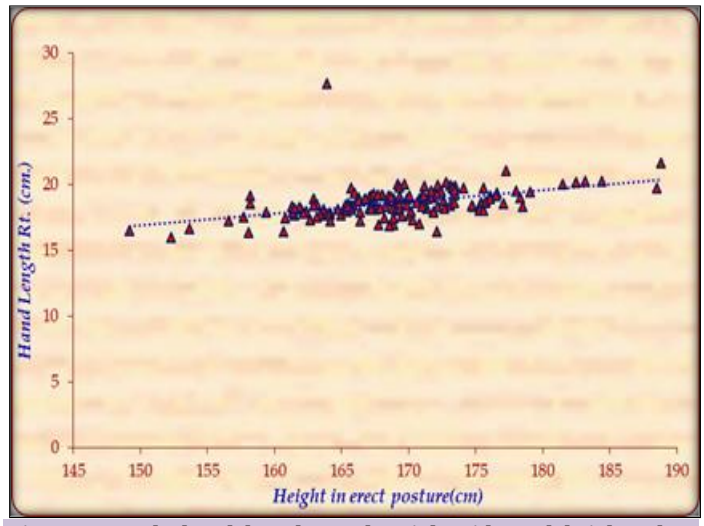

Figure 5: Male hand length on the right side and height when standing

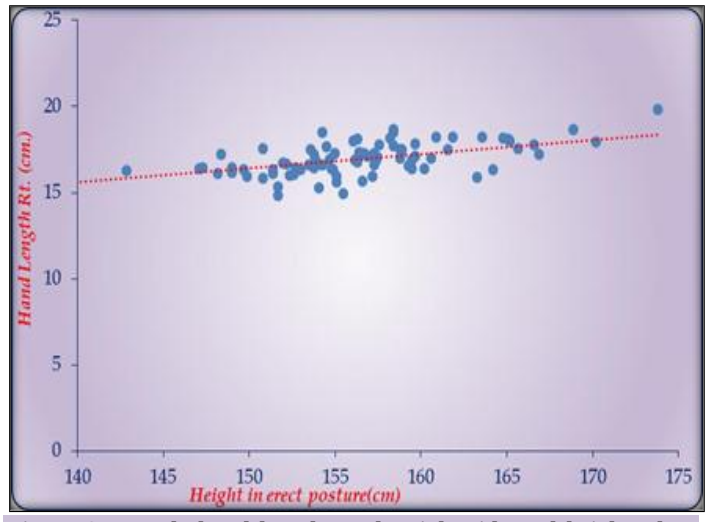

Figure 6: Female hand length on the right side and height when standing

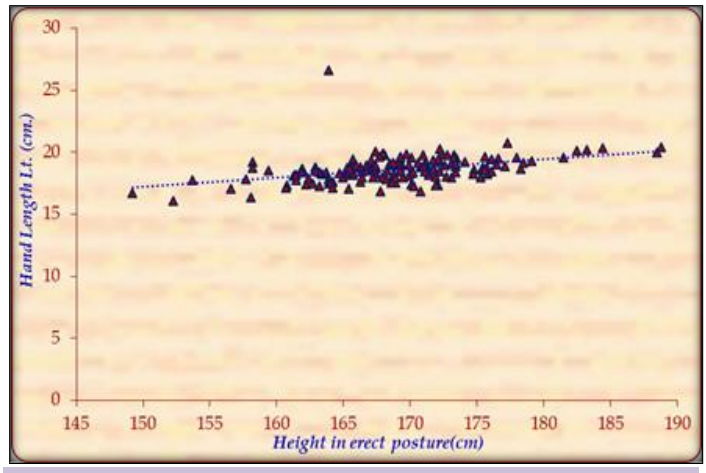

Figure 7: Male hand length on the left side and height when standing

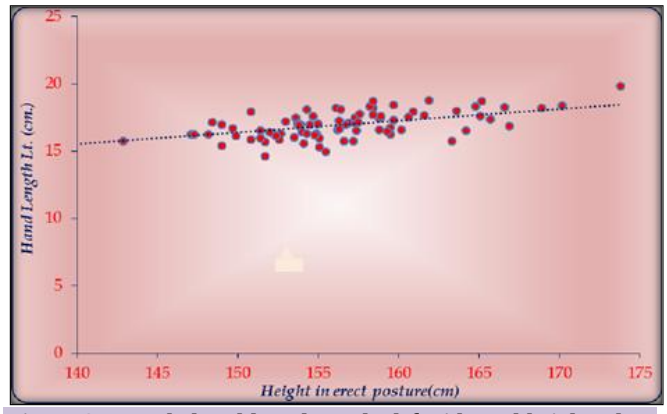

Figure 8: Female hand length on the left side and height when standing

According to the study's findings, the average height of male participants was 168±6.18 cm, while that of female participants was 156.35±5.99 cm., For example, the average length of the male hand was 18.59±1.19 cm, and the average length of the female hand was 16.94±0.92 cm. The average length of the left hand was 18.60±1.07 cm, and the average length of the female hand was 16.94±0.97 cm.

Right hand length and height showed statistically significant positive correlations for both males (r=0.4584; p-value<0.00001) and females (r=0.5223; p-value<0.00001) and pearson's correlation coefficient revealed a relationship between Females (r=0.5351; p-value<0.00001) and males (r=0.4248; p-value<0.00001) had different left hand lengths and heights.

Both male and female subjects showed a linear relationship between height and the length of their right hand, and both male and female subjects showed a linear relationship between height and the length of their left hand [Table 1&2, Figure 5 -8]. We can forecast one variable's values based on another variable by using regression analysis. The current study's regression equation was computed using SPSS software (version 23.0).

With b = regression coefficient, a = constant (cm), and H = height (cm), and P=Hand Length (cm.) as variables, the straightforward linear regression formula H=a+bP was obtained. The following regression equations were developed for stature:

H = 124.56+2.39P for right hand length of males

- H = 98.75+3.40P for right hand length of females
- H = 123.23+2.46P for left hand length of males
- H = 100.43+3.30P for left hand length of female

Height Calculation:

(1) From a man's right hand length:

P=18.334 H=124.56+2.39x18.334

168.30 cm is the calculated height.

168.3 cm is the measured height.

(2) From a female's right-hand length: length:P=17.078 H=98.75+3.40x17.078

Calculated Height =156.81 cm. Measured Height=156.9 cm.

(3) From left hand length in male: P=17.912 H=123.23+2.46x17.912

Calculated Height=167.23 cm. Measured Height=167.2 cm.

(4) From left hand length in female:

P=16.308 H=100.43+3.30x16.308

Calculated Height=154.26 cm. Measured Height=154.3 cm.

The estimated statures for males and females, which were determined using regression equations of both right- and left-hand length, are found to be roughly in line with their measured values.

Table 1: Analysis of stature and gender-specific measurements

Stature	Minimum (cm.)	Maximum (cm.)	Mean (cm.)	SD (cm.)
Male (n=155)	149.2	188.8	168.92	6.18
Female (n=85)	134.9	173.8	156.35	5.99

(SD=Standard deviation)

Table 2: Hand length measurements and analysis by gender

Ulna Length	Minimum (cm.)	Maximum (cm.)	Mean (cm.)	SD (cm.)	r	p-value
Right side (Male)	15.962	20.63	18.59	1.19	0.4584	<0.00001
Right side (Female)	14.812	19.812	16.94	0.92	0.5223	<0.00001
Left side (Male)	16.018	21.598	18.60	1.07	0.4248	<0.00001
Left side (Female)	14.608	19.822	16.94	0.97	0.5351	<0.00001

(r=Pearson's correlation coefficient, p-value=Probability)

Table 3: Regression coefficient comparison between our study and other research conducted on various populations

Study	Region	Hand of Male		Hand of Female	
		Right	Left	Right	Left
Present study	Different parts of India	2.39	2.46	3.40	3.30
Pratik R. Varu et al [6]	Gujarat	4.452	4.079	3.880	3.656
Sangeeta Dey et al [7]	Rajasthan	2.710	2.686	4.168	4.132
A N Kavyashree et al [8]	South India Population	2.52	1.18	2.72	2.71

Discussion

Because of the stronger correlation, determining a person's height from their bones, particularly the longer ones, is the method of choice when trying to determine their identity. The current study contributes significant new information regarding the hand length of adult Indians and how that length is related to the participants' overall stature. We discovered that the most promising and validating model was a generic linear regression model, and this held true for both male and female participants. The relationship between the lengths of the right and left hands, with male height, has a correlation coefficient (r)

of 0.4584 and 0.4248, respectively. This suggests that measuring the length of the right and left hands may be a good way to gauge a man's height. It was determined through the application of Pearson's correlation that there was a statistically significant connection between the height of the subjects and the length of their hands. This suggests that there is a relation (P less than 0.00001) between the length of a man's right hand and his height, as well as a relation (P less than 0.00001) between the length of a man's left hand and his height, in the case of males. The right and left hands may be useful tools for estimating a woman's height, according to the correlation coefficients (r) of 0.5223 and 0.5351 between the length of the right and left hands and height in females. According to the interpretation provided by the relationship between hand length and height, the left hand length can measure height more accurately than the right in men, according to the correlation coefficient (r). while the right hand length is capable of providing a more accurate measurement of height in the case of females. According to the research conducted by Pratik R. Varu (2015),[7] Males' right hand length and left ulna length had correlation coefficients (r) of 0.639 and 0.0.604, respectively, while Gujarati females' right hand length and left hand length had r values of 0.571 and 0.0.556, respectively. This specific value of (r) indicated a positive correlation, indicating a extremely significant (P 0.001) correlation between height and hand length. In the research conducted by Sangeeta Dey and colleagues (2015),[8] it was found that When comparing the lengths of the right and left hands in males, the correlation coefficient (r) was 0.539 and 0.532, respectively, and in females from the state of Rajasthan, it was 0.698 and 0.673, respectively. According to the findings of this study, the length of one's hand can accurately estimate one's height due to the extremely high significance of the correlation that exists between hand length and height.In the study of Sangeeta Dey et al,[8] (2015) they found that the correlation coefficient (r) for males' right and left hand lengths was 0.539 and 0.532, respectively, while for females in Rajasthan, it was 0.698 and 0.673, respectively. Because of the highly significant relationship between hand length and height, this study demonstrated that hand length could provide an accurate estimate of height. This was also similar to the findings of the study conducted by A N Kavyashree et al (2015),[9] who found that the South Indian males' right hand length and left hand length had correlation coefficients (r) of 0.414 and 0.256, respectively; for females, the correlation coefficient was 0.412 and 0.392, respectively. According to the findings of this study, the length of one's hand can accurately estimate one's height due to the extremely high significance of the correlation that exists between hand length and height. Regression coefficient (b), as stated by Lal and Lala,[10] is a more accurate reference for calculating the height of a person when that person's identification is unclear [Table 3].

Conclusion

Adult male subjects totaling 155 and adult female subjects totaling 85 were analyzed for height as well as the length of both their right and left hands. There is a correlation that is statistically rather high and significant between the height and these metrics. According to the results of this study, there is a clear and significant relationship between an individual's height and the length of their right hand as well as their left hand across all genders. These measurements served as the basis for the equations of regression, which were then constructed. H equals constant, an equals regression coefficient, and P equals hand length in the regression formula for estimating stature in people of both sexes based on both left- and right-hand length, where H equals height, an equals regression coefficient, and P equals hand length. The participants for this study come from all around India, so it can draw conclusions about the country as a whole. In situations where just fragments of a body have been located, such as in medicolegal investigations, this will be of great assistance in determining the identity of the deceased person. When only portions of deceased people or indigenous people from anyplace in the world are accessible, the facts that were presented in this study will be of the utmost interest to anthropologists who are looking for racial differences and for medical and legal purposes.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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