



## Original Research Article

## Estimation of stature based on hand length among students of Uttar Pradesh

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## ABSTRACT

**Introduction:** Stature is one of the most useful anthropometric parameters which can be used to determine the identity of an individual. Stature and measurements of various body parts have become useful in forensic medicine and medico-legal cases to identify bodies that may have been destroyed in mass disasters like plane crashes, blasts and accidents etc.

**Aim & Objective:** The aim of this study was to determine anthropometric values for stature and hand length in Uttar Pradesh population and to estimate height from hand length with the help of a regression equation formula.

**Materials and Methods:** The present study was conducted on a sample of 400 students of Integral University (200 males and 200 females). Hand length (right and left) was measured and height was also recorded.

**Results:** In this study a significant and positive correlation was found between stature, right and left-hand length in males and females.

**Conclusion:** In the present study, we concluded that the mean stature of males was higher than females and using regression equation accurate stature can be calculated from hand length.

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## 1. Introduction

Anthropometry is a standard tool and a systematic measurement technique of physical anthropology, which provides a scientific method to estimate various measurements on the living person and skeleton of human body.<sup>1</sup>

Stature, age, race and sex are the big four anthropological parameters in forensic medicine and modern science. These parameters help in determining the biological profile and in identification of individuals.<sup>2</sup> Stature is an important and useful parameter which is considered in those cases where only fragmented and mutilated remains of an unknown person are recovered. Stature also helps in determining the personal and physical identity in such cases. Stature is also an essential parameter to assess growth and nutrition in

children.<sup>3,4</sup>

The human hand is a prehensile organ, endowed with the power of grasping, precision movements for skilled work and acts as the chief tactile apparatus.<sup>5</sup> Hand length can be an important and accurate parameter to determine stature for identification purposes.

Scientists have long established that a relationship exists between stature and hand dimensions in all populations and they have concluded that stature and its relationship with hand length varies in different ethnic groups all over the world.<sup>6</sup>

The aim of this study was to determine the anthropometric relationship between hand length and stature and to calculate a regression formula for estimation of stature from hand length.

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## 2. Materials and Methods

This study was conducted in the Department of Anatomy at IIMS & R, Integral University, Lucknow. The study group comprised of 400 students (200 males & 200 females) who were randomly selected from Integral University. Only those students who belonged to Uttar Pradesh were selected for the purpose of this study.

The study was conducted after obtaining approval from the institutional research and ethical committee. A written consent was taken from all the subjects the method was explained properly to them.

### 2.1. Inclusion criteria

1. Healthy subjects.
2. Permanent residents of Uttar Pradesh.

### 2.2. Exclusion criteria

1. Subjects with congenital or acquired anomalies of limb or vertebral column affecting stature and hand dimensions.

### 2.3. Method

#### 2.3.1. Height

Height was measured with the help of a stadiometer. The subjects were made to stand barefoot in anatomical position. Measurement was taken from highest point of the head (vertex) to the floor.

#### 2.3.2. Hand length

Hand length was measured using a Digital Vernier Caliper. The measurements were taken with the subject sitting on a chair in a relaxed position. The subject was asked to place their hand straight and in full supination with the dorsum resting on a flat table. Hand length was measured from the distal crease of wrist to the tip of middle finger (Figure 1).

### 2.4. Statistical analysis

The mean and standard deviation of all parameters was calculated. The correlation between stature and hand length was established by Pearson's correlation coefficient ( $r$ ).  $p$  value was determined and a value  $<0.001$  was considered to be statistically significant. A regression equation formula was obtained to estimate stature from calculated stature, right and left hand dimensions.<sup>7</sup>

Regression formula for stature of males and females:

$$Y = ax + b$$

Here,  $y$  is calculated stature

$x$  is hand dimension



**Fig. 1:** Measurement of hand length using a digital vernier caliper

## 3. Result

### 3.1. Stature

The mean stature of males was  $168.85 \pm 7$  cm with a maximum of 185 cm and a minimum of 149 cm. The mean stature of females was  $156.68 \pm 6.41$  cm and ranged from 176 to 138 cm. Thus, it was observed that the stature of males was greater than that of females and this difference was statistically significant (Table 1).

### 3.2. Hand length

The mean right hand length of males was  $18.12 \pm 0.97$  cm (Table 1). A significant and positive correlation was found between stature and right hand length in males and the correlation coefficient ( $r$ ) was 0.57 (Table 2). The regression equation for estimation of stature from right hand length was  $4.221X + 92.34$  in males. Thus, by using this formula, we found that the calculated stature using right hand length in males was 168.82 cm (Table 3).

The mean left hand length of males was  $18.20 \pm 0.98$  cm (Table 1). The correlation coefficient ( $r$ ) between stature and left hand length was 0.53 (Table 2). It was observed that a positive correlation existed which was statistically significant. The regression equation for estimation of stature from left hand length was  $3.902X + 97.80$  in males. Thus, using this formula, we found that the calculated stature from left hand length was 168.81 cm (Table 3).

The mean right hand length of females was  $16.72 \pm 1.01$  cm (Table 1). The correlation coefficient ( $r$ ) between stature and right hand length was 0.58 in females. A positive correlation was seen between them (Table 2). The regression equation formula derived to estimate stature from right hand length was  $3.723x + 94.60$  in females. Thus, using this formula, we calculated that stature from right hand length was 156.85 cm (Table 4).

**Table 1:** Sexual dimorphism of stature and hand length

S.No.	Parameter	Gender	Side	Min-Max (cm)	Mean+SD(cm)
1	Stature	Male (200)		149-185	168.85±7.18
		Female (200)		138-176	156.86±6.41
2	Hand Length	Male (200)	Right	15.16-20.27	18.12±0.97
			Left	15.42-21.13	18.20±0.98
		Female (200)	Right	13.61-19.79	16.72±1.01
			Left	13.79-19.58	16.71±1.01

**Table 2:** Correlation coefficient for stature and hand length

Gender	Parameter	Correlation coefficient (r)	p-value
Male	Right hand length	0.569	0.000
	Left hand length	0.532	0.000
Female	Right hand length	0.581	0.000
	Left hand length	0.563	0.000

**Table 3:** Regression equation using mean hand length (Males)

Side	Regression Equation	Mean Hand Length(cm)	Actual Height(cm)	Calculated Height(cm)	Variation
Right	4.221x+92.34	18.12	168.85	168.82	0.03
Left	3.902x+97.80	18.20	168.5	168.81	0.04

**Table 4:** Regression equation using mean hand length (Females)

Side	Regression Equation	Mean Hand Length (cm)	Actual Height(cm)	Calculated Height(cm)	Variation
Right	3.723x+94.60	16.72	156.86	156.85	0.01
Left	3.551x+97.50	16.71	156.86	156.84	0.02

**Table 5:** Comparison of stature

S.No.	Author	Population	Male		Female	
			Sample Size	Stature (cm)	Sample size	Stature (cm)
1	Ozaslan et al <sup>8</sup> (2012)	Turkey	224	172.4±6.8	132	162.0±6.4
2	Uhrova P et al <sup>9</sup> (2015)	Slovakia	120	179.50±6.46	130	166.38±6.18
3	Khan MA et al <sup>10</sup> (2017)	Kashmir	100	174.73±6.37	100	158±6.06
4	Supare MS et al <sup>11</sup> (2018)	Maharashtra	219	170±9.47	181	159.46±7.66
5	Venkatachalam KSM et al <sup>12</sup> (2019)	Chennai	311	167.45±7.21	308	154.10±6.38
6	Present Study	Uttar Pradesh	200	168.85±7.18	200	156.86±6.41

The mean left hand length of females was  $16.7 \pm 1$  (Table 1). The correlation coefficient (r) between stature and left hand length was 0.56 and we found a positive correlation between them (Table 2). The regression equation for estimation of stature from left hand length was  $3.551x + 97.50$  in females and using this formula, we found that the calculated stature from left hand breadth was 156.84 cm (Table 4).

#### 4. Discussion

Anthropometric measurements are an important parameter for prediction of stature in humans. This study deals with the measurement of stature and hand length in students of Integral University. Using these anthropometric values, a regression equation for the estimation of stature was calculated. It was found that this can provide valuable and accurate data in the estimation and identification process involved in forensics and other investigative sciences.

**Table 6:** Comparison of hand length

S.No.	Author	Population	Sample Size		Hand Length (cm)			
			Male	Female	Male		Female	
					Right Mean±SD	Left Mean±SD	Right Mean±SD	Left Mean±SD
1	Danborno B et al <sup>13</sup>	Nigeria	250	150	19.85±0.86	19.93±0.93	18.51±0.66	18.52±0.77
3	Pal A et al <sup>14</sup>	Odisha, Kolkata	125	110	18.79±1.13	18.83±1.09	17.11±0.69	17.14±0.67
4	Shubashri A et al <sup>15</sup>	South India	40	60	18.9±3.1	18.5±3.0	16.5±2.8	16.1±2.7
5	Taneja C et al <sup>1</sup>	Udaipur	200	-	17.22±1.24	17.20±1.25	-	-
6	Shankar GS et al <sup>16</sup>	Bangalore	88	132	18.21±0.9	18.35±0.86	18.81±1.11	18.82±1.02
7	Venkatachalam KSM et al <sup>12</sup>	Chennai	311	308	18.74±0.9	-	17.25±0.79	-
8	Present Study	Uttar Pradesh	200	200	18.12±0.97	18.20±0.98	16.72±1.01	16.71±1.02

**Table 7:** Comparison of correlation coefficient between stature and hand length

S. No.	Author	Sample Size	Gender	Hand Length		p value	
				Right	Left	Right	Left
1	Donborno B et al <sup>13</sup>	500	Male	0.53	0.55	<0.0001	<0.0001
			Female	0.43	0.4	<0.0001	<0.0001
2	Laila SZH et al <sup>18</sup>	150	Male	-	-	-	-
			Female	0.68	0.68	0.001	0.001
3	Mulla NG et al <sup>19</sup>	200	Male	0.82	0.82	0.0001	0.0001
			Female	0.74	0.73	0.0001	0.0001
4	Taneja C et al <sup>1</sup>	200	Male	0.08	0.09	0.23	0.19
			Female	-	-	-	-
5	Moorthy TN et al <sup>17</sup>	200	Male	0.60	0.61	<0.001	<0.001
			Female	0.63	0.67	<0.001	<0.001
6	Shankar GS et al <sup>16</sup>	220	Male	0.22	0.18	0.011	0.033
			Female	0.17	0.26	0.11	0.013
			Male	0.57	0.53	0.000	0.000
7	Present Study	400	Male	0.57	0.53	0.000	0.000
			Female	0.58	0.56	0.000	0.000

**Table 8:** Comparison of regression equation between stature and hand length

S. No.	Author	Sample Size	Gender	Hand Length	
				Right	Left
1	Taneja C et al <sup>1</sup>	200	Male	1508.619+0.564*RHL	1502.008+0.603*LHL
		-	Female	-	-
2	Wakode NS et al <sup>7</sup>	94	Male	4.6783*RHL+85.6635	4.0522*LHL+97.0141
		106	Female	4.8400*RHL+76.7272	4.5353*LHL+81.0015
3	Uhrova P et al <sup>9</sup>	120	Male	93.11+4.63*RHL	96.31+4.45*LHL
		130	Female	84.69+4.75*RHL	85.16+4.72*LHL
4	Moorthy TN et al <sup>17</sup>	100	Male	94.399+4.005*RHL	92.156+4.092*LHL
		100	Female	81.423+4.415*RHL	75.897+4.765*LHL
5	Present Study	200	Male	4.221*RHL+92.34	3.902*LHB+97.80
		200	Female	3.723*RHB+94.60	3.551*LHB+97.50

Many authors have established that stature differs greatly between different populations. In the Indian subcontinent stature estimation has been studied by various authors. India is a vast country with diverse population groups who have many interracial and interethnic variations. Hence stature varies in different parts of the country. As a result of this the formulae used for stature estimation also differ in different population groups.

It is clear from an exhaustive review of literature that in India, the stature of males and females from Kashmir is greater in comparison to the findings of the present study.<sup>10</sup> When we compared the stature in our study group with other studies in populations of Delhi, Himanchal Pradesh, Jodhpur, Odisha and Kolkata, we found that stature of all these populations were similar.<sup>3,14,20,21</sup>

In our study, we found that the mean stature of males and females was  $168.85 \pm 7.18$  cm and  $156.86 \pm 6.41$  cm respectively and the correlation coefficient between them was found to be statistically significant.

In previous studies the mean stature of males was found to be higher in comparison to females. The same results were found in our study although the value of mean stature differed from data obtained by other researchers. Ozaslan et al found that the height of Turkish males and females was 172.4 and 162 cm respectively.<sup>8</sup> This finding was significantly higher than the results obtained by us. Consistent with the findings of various previous studies, males showed higher mean values of stature in comparison to females. This is because genetically males are taller than females. This difference can also be attributed to variations in ossification, influence of hormones, environment and skeletal maturity during development. Table 5 shows a comparison of stature as per findings of various other authors in different population groups.

In the present study it was observed that the mean right and left hand length of males was 18.12 cm and 18.20 cm respectively.

Subashri A et al in their study on South Indian population found that the mean right and left hand length of males was 18.9 and 18.5 cm respectively.<sup>15</sup> This finding was similar to the findings of the present study. In the present study, in females, the length of right hand was 16.72 cm and that of left hand was 16.71 cm. Subashri A et al found that the mean right and left hand length of females was 16.5 cm and 16.1 cm respectively.<sup>15</sup> This finding was also similar to the findings of the present study.

Danborno B et al conducted a similar study on Nigerian population and found that the mean right and left hand length of males was 19.85 cm and 19.93 cm respectively. In females, the mean right and left hand length was 18.51 cm and 18.52 cm respectively.<sup>13</sup> In our study, we observed that the mean hand length of males and females was significantly lower in comparison to that of the Nigerian population. This difference can be attributed to overall larger built and stature

of Africans.

Taneja C et al in their study on males of Udaipur found that the mean right and left hand length was 17.22 cm and 17.20 cm respectively.<sup>1</sup> This finding was lower than the values obtained in the present study. Table 6 shows a comparison between the hand lengths obtained by other authors and the values obtained in the present study.

Further we obtained values for correlation coefficients between hand length and stature in both sexes and compared the findings with those of previous authors. This is represented in a comparative format in Table 7.

According to the Uhrova P et al, the regression equation for estimation of stature of males from right and left hand lengths was  $93.11 + 4.63 \times \text{RHL}$  and  $96.31 + 4.45 \times \text{LHL}$  respectively whereas that for females was  $84.69 + 4.75 \times \text{RHL}$  and  $85.16 + 4.72 \times \text{LHL}$ . The regression equations for estimation of stature from hand breadth in Slovak population as given by Uhrova P et al. were  $84.69 + 4.75 \times \text{RHL}$  and  $85.16 + 4.72 \times \text{LHL}$ . When compared with the findings of our study, we found that the regression equation for estimation of stature differed in both males and females.<sup>9</sup> When compared with the findings by various authors we observed that no two regression equations are the same.<sup>1,7,17</sup> Thus it is evident from the fact that the regression equation is specific to a certain population and gender and hence cannot be used interchangeably. This also leads us to conclude that regression equations for estimation of stature should be calculated separately in each population group so that a baseline database can be established.

## 5. Conclusion

The present study was conducted to estimate stature from hand length in 400 (200 male and 200 female) students of Integral University who belonged to the state of Uttar Pradesh. And it can be concluded that the mean stature was higher in males than in females.

Males have larger hand size as compared to females and right hand dimensions can be utilized more accurately to estimate stature in comparison to left side in both sexes. Further, using regression equation, stature can be calculated from hand length with significant accuracy.

## 6. Source of Funding

None.

## 7. Conflict of Interest

None.

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