

Original Research Article

HAND ANTHROPOMETRY AMONG THE POPULATION OF BORDER AREAS OF PUNJAB FOR FORENSIC IDENTIFICATION

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ABSTRACT

Background: Stature is one of the various parameters of identification of the individuality of a person. Estimation of stature from various measurements of the body is of value in medicolegal investigations as well as in anthropology. The hand measurements are important in forensic field as they can be used as body height predictors for an individual. The current study deals with developing a regression equation for stature estimation from hand breadth and hand length and to find out the correlation between stature and different parameters used in the study.

Materials and Methods: The data was collected from 1000 asymptomatic, healthy adults (500 males & 500 females) belonging to border areas of Punjab region of age group ranged between 18-50 years.

Results: The correlation between hand length and stature ($r=0.403$) was more than hand breadth and stature ($r=0.249$) indicating hand length to be a better predictor of stature. Linear regression equations were derived for estimation of stature from hand breadth and hand length.

Conclusion: Both hand breadth and hand length showed positive correlation with stature as indicated by the regression coefficient. The results indicate that one can successfully estimate stature from different hand dimensions. The calculated regression formulae show good reliability and applicability of estimate which would be useful for Anthropologists and Forensic Medicine experts.

Keywords: Stature, hand length, hand breadth, Anthropometry, Forensic investigations.

INTRODUCTION

Stature is one of the parameters of identification of the individuality of a person. The stature (S) of an individual is an inherent characteristic; its estimation is considered to be an important assessment in the identification of unknown human remains. the identification of an individual is of prime and foremost signification for legal, anthropometrical and humanitarian reason in Forensic Investigations.^[1] Though every part of the human body is unique and is different in its own way still exists a relationship between each part of the body and the whole body. Therefore, many different parts of the body have been used to estimate height by different workers globally.^[2,3] Hand anthropometry is of great importance due to the complex structure and

functional dexterity of the human hand, and it plays an important role in biomechanics, prosthetic advancements, military ergonomics, wearable technology design, and biometric systems. It is also crucial in medico-legal investigations, especially in human identification, highlighting the importance of region-specific morphometric data in forensic sciences.^[4]

In the present scenario, developing countries suffer as a great impacts of disasters like, bomb blasts, air crashes, tsunami, earthquake, mass suicide, forest fires and others mutilating injuries due to the fast and rapid way of living, the identification of an individual is of prime and foremost signification for legal, anthropometrical and humanitarian reason in Forensic Investigations.^[1] India is a vast country with varied geographical conditions so it has been

emphasized that these parameters vary from population to population and ethnic origin to ethnic origin due to differences in nutrition, genetics of a person, geographical location, environment, climatic conditions and levels of physical activity.^[5] There is paucity of such studies and such data are not available for the population of border area of Punjab. Therefore, this study was carried out to investigate the relationship between the hand dimensions and stature among a group of male and female in the border areas of Punjab and also to derive regression equations for the calculation of stature from hand length and hand breadth.

MATERIALS AND METHODS

The present study was conducted on total 1000 (500 males and 500 females) asymptomatic, healthy adults age over 18 to 50 years old with no diagnosed history of any disease, surgical procedures of limbs, deformities of vertebral column, injury, fracture and amputation. A written consent form was taken in vernacular languages from the subjects. The measurements were taken between 2 to 5 pm to eliminate the discrepancies due to diurnal variations. Landmarks and technique involved in anthropometric measurements.

1.Stature: The subject was asked to stand erect barefoot on a level platform against the stadiometer bar, the head was rest in a Frankfort Horizontal plane arms hanging by the side with his back, hips and heels touching the bar, the feet should touch each other. [Figure 1]

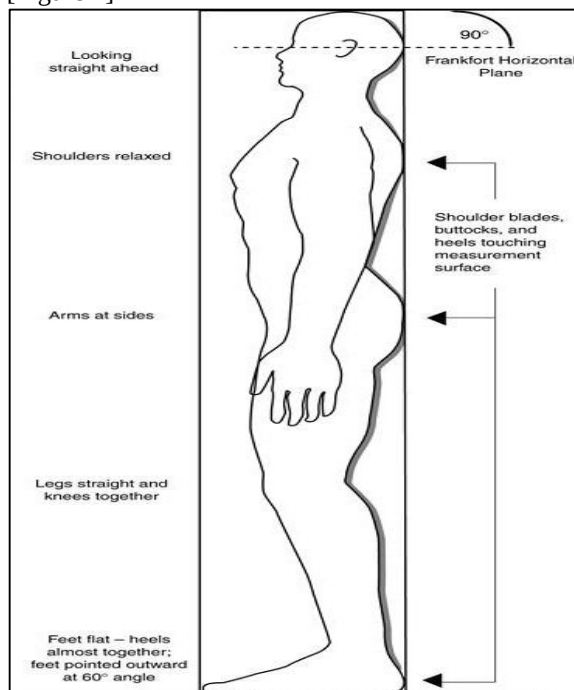


Figure 1: Measurement of the stature.

2.Hand length (HL): It is the projected distance between the midpoint of a line joining the styloid process of radius and ulna bones of forearm and the tip of third finger. [Figure 2]

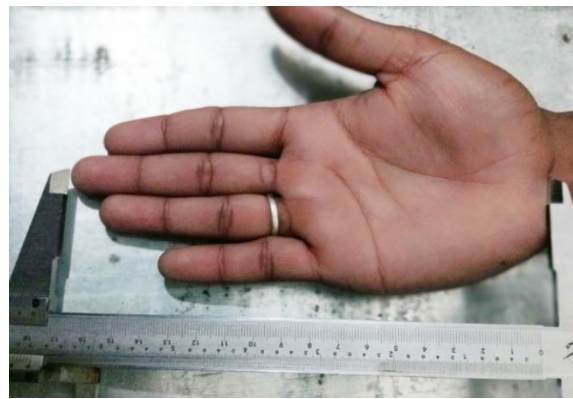


Figure 2: Measurement of Hand length with the help of Sliding Caliper

3. Hand breadth (HB): It is the distance between the most prominent point on the lateral aspect of head of second metacarpal and the most prominent point on the medial aspect of the head of fifth metacarpal. [Figure 3]



Figure 3: Measurement of Hand breadth with the help of Sliding Caliper.

Instruments used: Stadiometer was used to measure verticle height for stature estimation. The measurements were recorded in centimeters. Slidingcaliper was used for all measurements.

Inclusion Criteria

Apparently healthy, asymptomatic males and females Subject between 18 to 50 years of age. Only those who were willing to participate to study.

Exclusion Criteria

Males and females with physical deformities and history of systemic illness affecting stature and hand measurements were excluded from the study. Also the age below 18 years and above 50 years.

Statistical Analysis: The data were subjected to statistical analysis using statistical package for social sciences (SPSS21).

RESULTS

A total 1000 healthy and normal individuals were included in the study, among them 500 were males and 500 females. The age of the subjects ranged between 18 and 50 years for the prediction of stature from hand measurements. The following

observations were tabulated after statistical evaluation of the observations recorded in the study. The stature in males varied from 149.35cm to 198.13 cm (mean=171.13 cm, SD=9.76) whereas in females stature varied from 149.35cm to 192.03cm (mean=159.91cm, SD=7.25). It was observed that males have greater mean value of stature as compared to that of females. [Table 1, Figure 4]

Table 1: Comparison of stature and hand length in males and females. It interprets that males exhibit higher values for stature and hand length compared to females.

Measurements	Stature		Hand Length			
	Males	Females	Males (N=500)		Females (N=500)	
			Rt side	Lt side	Rt side	Lt side
Mean	171.13	159.91	18.51	18.49	17.17	17.14
Std.Deviation	9.76	7.25	1.12	1.15	0.88	0.87
Minimum	149.35	149.35	12.00	12.30	12.20	12.20
Maximum	198.13	192.03	21.40	21.00	19.80	19.90

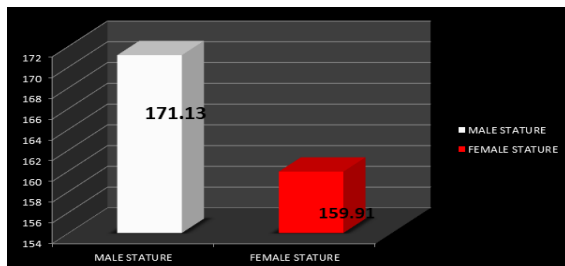


Figure 4: Showing bars for comparing averages of the male and females stature.

In males, the right hand length (RTHL) ranged from 12.00cm to 21.40 cm (mean=18.51cm and SD=1.12 cm) and left hand length (LTHL) ranged from 12.30 cm to 21cm (mean=18.49 cm and SD=1.15 cm). In females the right hand length (RTHL) ranged from 12.20cm to 19.80cm (mean= 17.17cm and SD=0.88cm) and left hand length (LTHL) ranged from 12.20 cm to 19.90cm. (mean= 17.14 cm and SD=0.87 cm). [Table 1, Figure 5]

Descriptive statistics shows that In males, right hand breadth varied from 5.10cm to 10.10cm (mean= 8.24) and left hand breadth ranged from 4.80 cm to 10 cm with the mean of 8.18 cm and std. deviation of 0.72

and 0.77 cm respectively. In females, right hand breadth varied from 5.60 cm to 9.10cm and left hand breadth ranged from 5.50 cm to 9.10cm with the mean of 7.4 cm and std. deviation of 0.48 cm respectively. (Figure 6) The comparison of respective readings of various parameters studied shows that all parameters have higher values in males than in females. [Table 2, Figure 7]

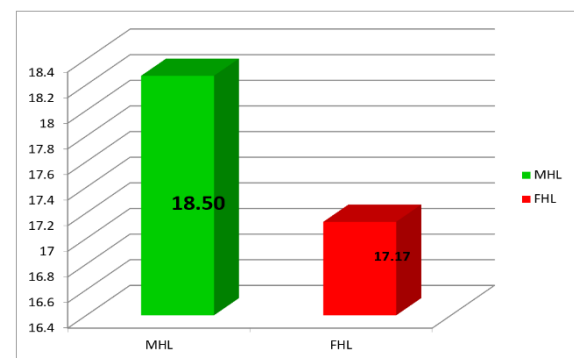


Figure 5: Showing bars for comparison of averages of the male and females hand lengths.

MHL=Male hand length, FHL=Female hand length.

Table 2: Shows descriptive statistics of hand breadth in males and females. It interprets that males exhibit higher values for hand breadth as compare to females

Measurements	Hand Breadth			
	Males (N=500)		Females (N=500)	
	Rt side	Lt side	Rt side	Lt side
Mean	8.24	8.18	7.46	7.41
Std.Deviation	0.72	0.77	0.48	0.49
Minimum	5.10	4.80	5.60	5.50
Maximum	10.10	10.00	9.10	9.10

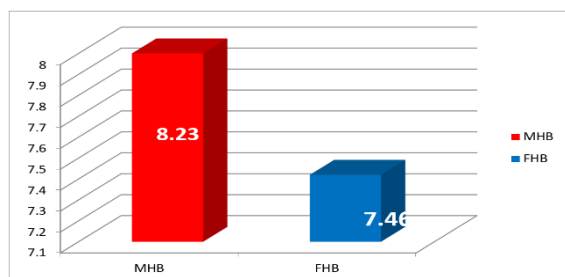


Figure 6: Showing bars for comparing averages of the hand breadths for male and females

MHB =Male hand breadth, FHB=Female hand breadth

[Table 3] depicts correlation between the stature of individual and various parameters studied. All the parameters exhibit statistically highly significant ($p < 0.001$) positive correlation with the stature. Correlation co-efficient of the length measurements is higher than that of breadth measurements. It is also observed that in males highest correlation is exhibited by the right hand length ($r=.403$) and the lowest by the left hand breadth ($r=.212$). In females highest

correlation is exhibited by the right hand length ($r=.348$) and lowest by right hand breadth($r=.174$).

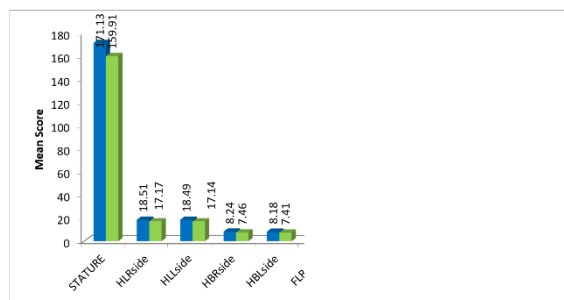


Figure 7: Comparison of mean score of all parameters studied.

(Blue colour indicated male cases and green colour for females cases).

Its tabulated that linear regression analysis of the observations were performed separately for each sex and also for each parameter studied. The equations also exhibit standard error of estimation (SEE). The SEE predicts the deviations of the estimated stature from the actual stature. In males, it ranges between ± 4.5 to ± 6.6 . For females SEE ranges from ± 4.8 to ± 6.0 . [Table 4]

The accuracy of the regression equations was verified by comparing the estimated stature with actual stature. The estimated stature values are found very closer to actual stature value in both male and females. [Table 5]

Table 3: Showing Karl Pearson's Correlation Coefficients between the stature and various parameters studied in males and females. It also shows the p-values to reveal the relationships between specific measurements and stature. All the measurements were positive as well as a statistically significant correlated with the stature.

S.NO	Study Parameters	Karl's Pearson Correlation	Sig (2-tailed) (p<0.05)	Karl's Pearson Correlation	Sig (2-tailed) (p<0.05)
		MALE SAMPLE		FEMALE SAMPLE	
1	Right Hand Length	.403	.000*	.348	.000*
2	Left Hand Length	.374	.000*	.346	.000*
3	Right Hand Breadth	.249	.000*	.174	.000*
4	Left Hand Breadth	.212	.000*	.191	.000*

* statistically significant value

Table 4: Linear Regression equations to determine stature from different parameters in sample.

S.no	Parameters	Linear Regression Equations	SEE**
FEMALE SAMPLE			
1	Right Hand Length	$S=110.47+2.88 \times RHL$	5.9
	Left Hand Length	$S=110.47+2.88 \times LHL$	6.0
2	Right Hand Breadth	$S=138.04+2.84 \times RHB$	4.8
	Left Hand Breadth	$S=138.04+2.84 \times LHB$	4.8
MALE SAMPLE			
3	Right Hand Length	$S=106.32+3.50 \times RHL$	6.6
	Left Hand Length	$S=112.60+3.165 \times LHL$	6.5
4	Right Hand Breadth	$S=143.37+3.37 \times RHB$	4.8
	Left Hand Breadth	$S=149.11+2.691 \times LHB$	4.5

RHL=Right hand length, LHL=Left hand length, RHB=Right hand breadth,LHB=Left hand breadth

Table 5: Difference of Mean Actual Stature (171.39) and Mean Estimated Stature in Males and females. By putting the values of hand breadth and hand length in regression equations, we found some estimated statures which were correlate with the measured stature.

Estimated Stature using Regression Equations for	Mean Estimated Stature (in Cm)	Difference Between Means= Mean Actual Stature – Mean Estimated Stature
Male Mean Actual Stature (171.39)		
Right Hand Length	171.11	0.02
Left Hand Length	171.09	0.04
Right Hand Breadth	171.11	0.02
Left Hand Breadth	171.12	0.01
Female Mean Actual Stature(159.91)		
Right Hand Length	159.75	0.1
Left Hand Length	159.83	0.08
Right Hand Breadth	159.86	0.05
Left Hand Breadth	159.36	0.8

DISCUSSION

The stature estimated in the present study in males varied from 149.35 cm to 198.13 cm (mean-171.13cm) whereas in females stature varied from 149.35cm to 192.03cm(mean 159.91cm).These values are very similar to the earlier mentioned study of Ilayperuma, Nanayakkara and Palahepitiya, Patel

S. M et al,Arti L et al and Rameswarapu Suman Babu.6-9 The stature estimated by different authors such as O.P. Jasuja, Sunil et al, GN Geetha et al.,Mohanty & Aggrawal, Singh JP et al and Vineet Dhaneria et al., Manpreet Kaur et al, Giles E reported, Karaddi et al differs from present study due to racial differences.^[1,10-17]

The measurements exhibited statistically significant correlation with stature. For stature estimation, the

best correlation coefficient was detected in males and females is for hand length ie +.403 and +.348 respectively. Correlation coefficients of the length measurements were higher in comparison to breath in males. Correlation coefficient(r) for males between stature and hand length was obtained by Geetha et al In a tribal group was $r = 0.479$, this value was similar to present study.^[11]

Value of correlation $r = 0.502$ was reported in Jatt Sikh population, 0.578 was declared in Turkish subjects, 0.58 noticed in Sri Lankan adults, $r = 0.589$ mentioned by a study in Punjab, 0.6 given by Sunil et al, $r = 0.69$ noticed in males of Maharashtra, $r = 0.72$ given for adults of Nagpur region, all these measurements were higher than present study.^[1,5,6,10,15,18] As literature indicates that very little work has been done for estimation of stature from hand breadth. The measurements of a study performed by Nasir Ahemed ($r = 0.284$) was found to be similar with present study ($r = 0.212$).

The regression equations for the estimation of stature from the hand measurements is one of the easiest and

the reliable mathematical method. If either of the measurement is known the other can be calculated and this would be useful for forensic medicine experts and anthropologists. It will also help in establishing identity in certain civil cases.^[19] The different regression equations of various studies has been derived by different researchers globally.^[20] These formulae population specific because of many factors like racial, ethnic and nutritional factors and geographical variations, which play an important role in human development and growth. Sen & Ghosh in 2008, recommended that it would be unwise to use same equations for stature estimation in both the gender.^[21] one should derive the different equations for male and females.^[22] It is concluded that, hand length is a reliable and strong parameter to estimate stature of an individual. There is necessity for the different regression equations for both genders because of difference in gender stature and hand length. [Table 6]

Table 6: Showing summarizes the work done by various authors on Hand dimensions along with the mean values compared with the present study.

Authors	Parameter	Male	Female
1. O.P.Jasuja et al (2004) 60 Jat Sikh of northern India	1.Height 2.Hand length 3. Correlation coefficient. 4.Regression equation	175.2 ± 5.24 19.80± 0.73 0.502 S= 130.95 + 1.612 ± 5.061	159.7 ± 5.17 17.51± 0.81 0.529 S=130.03 + 1.660 ± 5.064
2. Sunil et al (2005) 150 individuals of Delhi(75 males and 75 females)	1.Height 2.Hand length 3.Hand breadth 4. Correlation coefficient 5. Regression equation	169± 7.8 19.5± 1.2 ----- 0.6 S= 85.84+ 4.32 (HL)	158± 5.8 18.1± 1.0 ----- 0.7 S= 80.94+ 4.40 (HL)
3.Ilayperuma, Nanayakkara and Palahepitiya (2009)	1.Height 2.Hand length 3. Correlation coefficient 5. Regression equation	170.14± 5.22 19.01± 5.22 0.58 S= 103.732+ 3.493(HL)	157.55± 5.75 17.62± 0.93 0.59 S= 93.689+ 3.625(HL)
4.Laila et al 150 Bengali Muslim females	1.Height 2.Hand length 3. Correlation coefficient		156.02± 6.12 16.34± 0.80 0.6
5.Nasir Ahemad and RumaPurkait 503 men from Madhya Pradesh	1.Height 2.Hand length 3.Hand breadth 4. Correlation coefficient	167.8 ± 55.8 177.06 ± 7.47 83.12 ± 5.38 0.558	
6. AjeetJaiswal 215 student(112 males and 103 females) of Puducherry	1.Height 2.Hand length 3. Hand Breadth 4.Regression equation	172.65±7.25 18.89 ± 0.88 8.45 ± 0.40 S= 94.835 + 4.187HL	158.46 ±6.85 17.22 ± 0.92 7.48 ± 0.38 S= 74.404 + 4.945HL
7.Manpreet Kaur et al 400 medical students (200 males and 200 females) of North India	1.Height 2.Hand length 3. Correlation coefficient 4. Multiplication Factor	175.98± 6.76 18.80± 1.09 0.589 S= 130.90 + 2.398 (HL)	160.91± 5.75 18.54± 10.72 0.550 S= 160.41 + 0.027 (HL)
8.Agrawal J et al 200 students of Jodhpur (100 males;100females)	1.Height 2.Hand length 3.Multiplication Factor	170.71 ± 8.572 19.594 ± 1.115 8.835	161.6±7.627 19.673±1.1377 8.215
9. GN Geetha et al 200 tribals (100 males and 100 females) of Kerala	1.Height 2.Hand length 3. Hand Breadth 4.Correlationcoefficient 5.Regression equation	157.95±6.42 182.45±10.87mm 83.43±5.16 0.479(HL), 0.388(HB) S= 106.306 +.283 HL±5.66 S= 117.798 +.48HB ±5.95	148.70±7.57 169.10±8.25 75.74±4.84 0.949(HL), 0.470 (HB) S= 1.454 +.871 HL ± 2.39 S= 140.696 +.104 HB ±7.51
10.Rati Tandon 238 males and 259 females of Uttar Pradesh.	1.Height 2.Hand length 3. Hand breadth 4. Correlation coefficient 5. Regression equation	172.742± 6.110 19.364± 1.097 8.312 ± 0.414 0.224 y = 3.16x + 111.5	157.199 ± 6.244 17.33 ± 0.997 7.247 ± 0.457 0.313 y = 3.504x + 96.46
11.Pungle and Munjamkar	1.Height 2.Hand length	172.10 ± 6.479 18.96±1.189	158.58±12.268 17.64±0.834

200 Male and 200 Female medical students of nagpur	3. Correlation coefficient 4. Regression equation	0.72 S= 98.108 + 3.903	0.71 S= 83.260 + 4.269
12. Anil Sahebrao Pungle et al 400 Adults (200 Male and 200 Female) of Nagpur, Maharashtra	1. Hand length 2. Correlation coefficient	18.96 ± 1.189 0.69	17.64 ± 0.834 0.73
13. Present study 1000 adults (500 males and 500 females) of border areas of punjab	1. Height 2. Hand length 3. hand breadth 4. Correlation coefficient 5. Regression equation	171.13 ± 9.75 18.50 ± 1.12 8.23 ± 0.76 0.403 S=106.323 + 3.502 X HL S=143.376 + 3.370 X HB	159.91 ± 7.24 17.17 ± 0.87 7.46 ± 0.48 0.348 S= 110.482 + 2.879 X HL S= 140.47 + 2.60 X HB

CONCLUSION

The present study is unique in its sample selection, as no such type of study has been documented earlier in border area population of Punjab. There is paucity of researches who have considered hand breadth for stature estimation. The correlation coefficient (r) derived from these two parameters for both the gender, in the current study are slightly lower but comparable with other studies. The procedure of measuring hand length, to use in appropriate regression equation for determining the stature is simple and important tool in mass disasters or accidents where fragmented or mutilated remains are recovered. The regression equation formulated in present study for border area people showed variation from that of the regression equations derived for other Indian population. The present study also indicates that regression equations are statistically better and more reliable method than others for stature estimation.

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