

Original Research Paper

Correlation of the Dimensions of Hand & Feet with Stature of an Individual: A Study on Central Indian Adults

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Abstract

Identification of Human remains is a crucial problem and is of utmost importance to Forensic experts. Human beings are considered bilaterally symmetrical. Prediction of stature can be given from long bone measurements with certain degree of accuracy. The present study was done to find out the correlation between the Hand length, breadth & Foot length to the stature of an individual and to arrive at a regression formula. The prospective study was carried out on 230 Students (120 Male & 110 Female) between the age group of 17-25 years studying in Medical & Dental College in Sawangi (Meghe) Wardha.

To avoid diurnal variations all the measurements were taken at a particular period of time. The students born & brought up in Central India only were included in the study. The dimension of the hand which was dominant was taken. There is a definite correlation between Stature & Dimensions of Hand and Foot as is derived from a regression formula which may help the forensic experts in estimating Stature in mutilated or fragmented bodies.

Key Words: Stature, Identification, Hand length, Foot length, Fragmented remains

Introduction:

Identification forms an integral part of investigations in cases of mass disasters like Bomb blasts, Plane crash, Stampede, Terrorist attacks and in bodies which are disintegrated or mutilated or amputated in the events of murders, accidents or natural calamities. [1-3] Various methods are in use for identification of an individual. Stature is one of the important parameters in identification and can be measured using various methods in fragmented bodies. [1, 4, 5]

Hand and Foot length has been found to have a correlation with the stature of an individual. There are many studies that have been undertaken to emphasise the importance of measuring the hand length as well as foot length to estimate stature. [2-4, 6-8]

Stature which is primarily determined from body physique is known to be influenced by climatic, hereditary, nutritional & racial factors. [2, 4, 5, 8, 9]

The use of anthropometry in the field of Forensic Medicine dates back to 1882 when (Alphonso Bertillon) a French police expert invented a system of criminal identification. [3]

He suggested the use of bones for the various identification procedures. Since then anthropological assessments have formed an important aspect of Forensic investigations. Almost any or all the bones of the human body can be used for anthropometric studies and a close estimate of a persons' physique can be derived from the information derived.

The dimensions of the Hand & Feet also have a bearing on the estimation of stature of an individual. Though studies have also shown that dimensions of the Hands & Feet vary in different races and also with the dominance of the hand used, they can form a reliable source of data for a given geographical location. [5-7, 10, 11]

The variations in rate of growth in males and females during the course of development may be one area of difference; with ossification being complete and skeletal maturity attained by the age 25 years. [8]

Females tend to show higher growth rate during first half of second decade where as in males it is during the second half of second decade due to hormonal control. [8, 10] The present study is designed to correlate the stature

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of an individual with hand dimensions and foot length in adult population (17-25 years of age group) of Central India in both the sexes. Rutishauser demonstrated for the first time that the reliability of prediction of height from foot length was as high as that from long bones.

Ossification and maturation occurs earlier in the long bones & therefore during adolescent age, stature can be accurately predicted from hand & foot measurements as compared to that of long bones. [11]

There is strong correlation between stature and Foot & Hand dimensions and if either of the measurements is known the other can be calculated. With this objective the present study was designed to correlate the Hand length, breadth & Foot length with Stature of an individual and to record the standard deviation in the estimation of Stature. Also to arrive at the linear regression formula & multiplication factor for estimation of Stature which can be applied to people in Central India.

Materials & Methods:

This prospective study was carried out in the Department of Forensic Medicine, JNMC, Sawangi (Meghe) Wardha over a period of 2 years. It included 230 normal healthy adult (120 males & 110 females) students admitted to Medical & Dental College, Wardha between the age group of 17-25 years.

Only those students who were born & brought up in Central India were included in the study. Students from other regions, NRI students, those with poorly defined wrist creases, deformities of vertebral column & limbs, and history of trauma were excluded from the study. [4] After obtaining informed written consent, physical parameters were recorded at a fixed time between 2:00-4:00 pm to eliminate diurnal variations. [7, 10, 11]

Height was measured from vertex to heel in upright position with Student standing bare foot with the help of Height weight machine Design no. 1013522, Instrument marked up to 200 cm, (Photo 1) Hand length was measured as distance from L1 & L2 from Proximal crease of Wrist to tip of Middle finger & Midpoint of interstyloid line to tip of Middle finger in mm. (Photo 2 & 3)

Hand breadth was measured as B1 & B2 from Radial side 2nd metacarpopharyngeal joint to ulnar side 5th metacarpopharyngeal joint and from 1st metacarpopharyngeal joint to base of 5th metacarpal in mm using Vernier Calliper. (Photo 4 & 5) Foot length was measured as distance between anterior & posterior point of foot in mm. (Photo 6) Correlation between hand

length, breadth and foot length with the stature of an individual was evaluated by obtaining linear regression equations & multiplication factors using SPSS 17.0 software and results were assessed statistically.

Observations and Results:

In our study a significant positive correlation is found between the dimensions of Hand i.e. Hand length at point 1 & 2, Hand breadth at point 1 & 2 and Foot length to that of the stature of an Individual. (Table 1, 2 & 3) with Foot length showing more correlation value of 0.83 followed by Hand breadth at point 2 (0.74) & at point 1 (0.69) & Hand length at point 2 (0.38) and at point 1 (0.35) respectively.

The gender wise comparison of all the dimensions shows higher values for male parameters as compared to females in estimating the stature from the dimensions of hand & Foot and shows a statistically significant Z value & P value. (Table 4 & Graph 4)

Discussion:

Height of an individual is an important parameter for identification in Forensic examinations. It is influenced by many factors like Nutrition, Environment, Genetics, Physical development, Gender, Muscular exercise, Age etc. Many studies have been carried out on different racial & regional groups which show there is a definite relationship between the stature and dimensions of hand and foot.

This has led many researchers to work on correlation of these parameters. This study was carried out to correlate the Hand & Foot dimensions to stature in Central Indian population. In the present study the mean stature is 165.02 & S.D is 8.41 which correspond with other studies done on Indian Population. [11, 14] The Mean hand length at point 1 & 2 is 171.13 and 182.17 respectively with S.D of 11.81 & 12.37. The mean hand breadth at point 1 & 2 is 68.04 & 79.82 and S.D of 6.47 & 8.19 respectively.

The mean of Foot length is 237.63 with S.D. of 16.66. The study shows that hand breadth is more accurate than the hand length in estimation of stature. The highest coefficient correlation of all dimensions is found in Foot length ($r=0.83$) followed by hand breadth at point 2 ($r=0.74$) followed by hand breadth at point 1 ($r=0.69$) subsequently followed by Hand length at point 2 ($r=0.38$) and hand length at point 1 ($r=0.35$).

These findings support the study carried out by Patel PN et al [2], Krishan & Sharma [5] where foot length shows more significant correlation to stature in people from Gujarat than

hand length & hand breadth; but P. Rastogi et al in their study on South Indian population [4] found that HL-2 shows highest correlation followed by HL-1 & HB.

The mean & Standard deviation for correlating the stature with the Length & Breadth of hand at point 1 & 2 respectively shows a strong correlation between Hand length, hand breadth & Foot length which is coinciding with the findings of other Researchers [1, 2, 3, 11, 12, and 14]. The linear regression formulae as given for the various dimensions is found to be significant in estimating the stature of an individual from hand length (HL), hand breadth (HB) and Foot length (FL) which is as follows-

- Height = 65.90 + 0.57*Hand Length (Point 1) L1
- Height = 65.60 + 0.54*Hand Length (Point 2) L2
- Height = 103.28 + 0.90*Hand Breadth (Point 1) B1
- Height = 104.03 + 0.76*Hand Breadth (Point 2) B2
- Height = 64.81 + 0.42*Foot Length

The comparison between studies shows that regression equation using various anatomical dimensions of one population do not apply to another. [13] Mean hand length at point 1 for Male is 179.50±8.55 and for Female it is 163.45±8.80. By using Z test for the difference between 2 means statistically significant difference is found with Z value-14 & p-value-0.000 showing high significance at point 1 in both Males & Females. Similarly it is significant for all the dimensions i.e. Hand breadth at point 1 & 2 and Foot length.

Conclusion:

The stature of an individual can be predicted if either of the dimension of Hand, i.e., length or breadth or Foot length is known and vice versa. Foot length is the most reliable predictor for estimating the stature of an Individual as observed in our study. It is an important feature of identification of an Individual. It will be of great help to the Anthropologists and Forensic experts.

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Photo 1: Measurement of Height & Foot



Photo 2: Measurement of Foot Length



Photo 3: Measurement of Hand Length (L1)

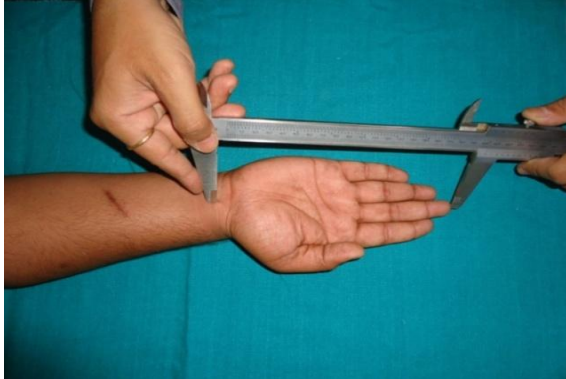


Photo 4: Measurement of Hand Length (L2)

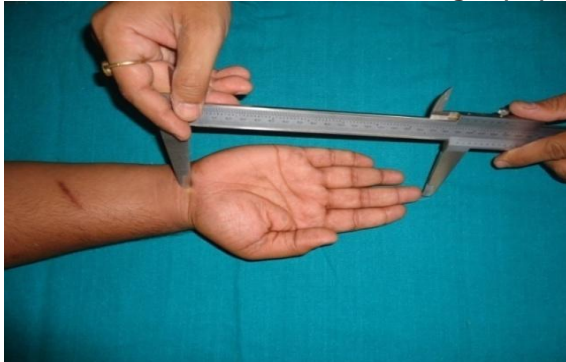


Photo 4: Measurement of Hand Breadth (B1)

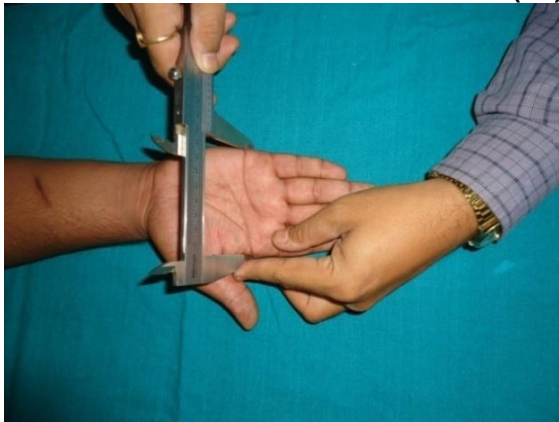
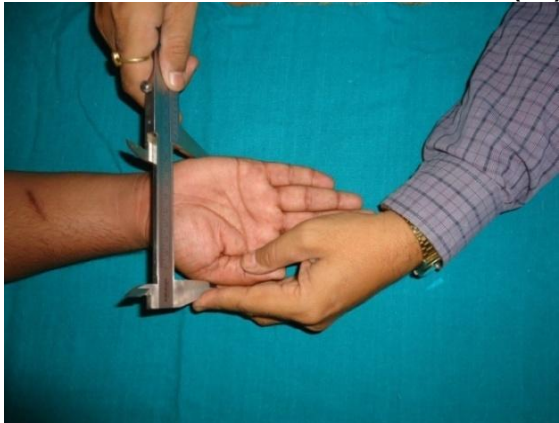
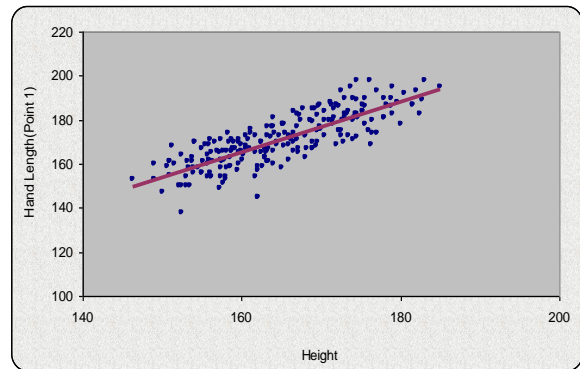


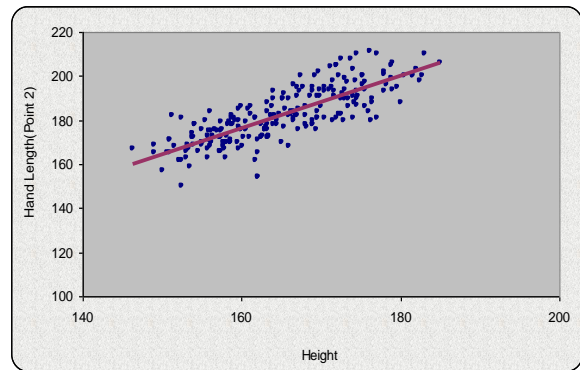
Photo 4: Measurement of Hand Breadth (B2)



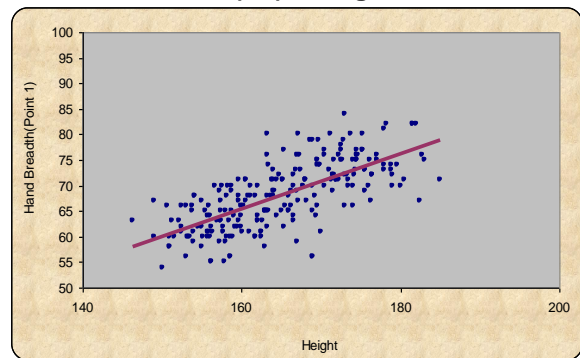
Graph 1.1: Correlation between Hand Length at point 1 (L1) & Height



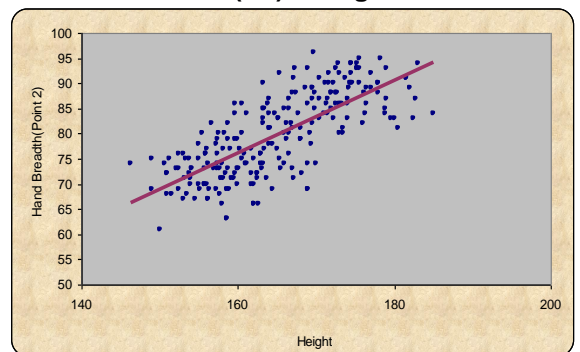
Graph 1.2: Correlation between Hand Length at point 2 (L2) & height



Graph 2.1: Correlation between Hand Breadth at Point 1(B1) & Height



Graph 2.2: Correlation between Hand Breadth at Point 2(B2) & Height



Graph 3: Correlation between Foot Length and Height

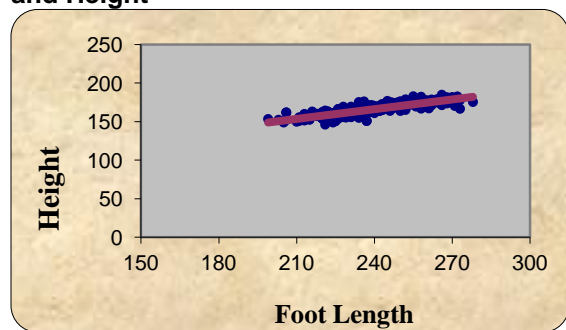


Table 1: Correlation between Hand Length and Height

	Mean	SD	N	Correlation 'r'	p-value
Height	165.02	8.41	230	-	-
Hand Length – Point 1	171.13	11.81	230	0.35	0.000 S, p<0.05
Hand Length – Point 2	182.17	12.37	230	0.38	0.000 S, p<0.05

Line of Regression:

- Height = 65.90 + 0.57*Hand Length (Point 1) L1
- Height = 65.60 + 0.54*Hand Length (Point 2) L2

Table 2: Correlation between Hand Breadth and Height

	Mean	Std. Deviation	N	Correlation 'r'	p-value
Height	165.02	8.41	230	-	-
Hand Breadth – Point 1	68.04	6.47	230	0.69	0.000 S, p<0.05
Hand Breadth – Point 2	79.82	8.19	230	0.74	0.000 S, p<0.05

Line of Regression:

- Height = 103.28 + 0.90*Hand Breadth (Point 1) B1
- Height = 104.03 + 0.76*Hand Breadth (Point 2) B2

Table 3: Correlation between Foot Length and Height

	Mean	SD	N	Correlation 'r'	p-value
Foot Length	237.63	16.66	230	-	-
Height	165.02	8.41	230	0.83	0.0 S, p<0.05

Line of Regression: Height = 64.81 + 0.42*Foot Length

Table 4: Gender Wise Comparison of Parameters

	Male	Female	z-value	p-value
Hand Length- Point 1	179.50±8.55	163.45±8.80	14.00	0.000,S, p<0.05
Hand Length-Point 2	191.10±9.21	174±8.70	14.43	0.000,S, p<0.05
Hand Breadth-Point 1	73.06±4.28	63.45±4.39	16.78	0.000,S, p<0.05
Hand Breadth-Point 2	86.45±5.09	73.74±5.24	18.64	0.000,S, p<0.05
Foot Length	258.62±70.30	226.72±11.14	4.70	0.000,S, p<0.05
Height	171.12±6.26	159.43±5.87	14.59	0.000,S, p<0.05

Graph 4: Gender Wise Comparison of Parameters

