

Morphometric Study of the Hand Length and Foot length and their correlation to Height in the Tribal population residing in the North-Eastern part of India.

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Abstract

Introduction: Measurement of height and limb lengths has been of great interest amongst people since ages, but studying the correlation between these body dimensions is less known. Therefore, the present study was conducted to study the height, hand length and foot length and their correlation in the tribal population residing in the North-eastern part of India. **Method:** Adult healthy persons belonging to the tribal community residing in Naharlagun (a small town in Arunachal Pradesh) were taken, out of which 50 were males, 50 were females. After taking informed consent, the height, hand length and foot length of both sides were measured following standard protocols. The correlation coefficient between the hand length and foot length and hand length to height and foot length to height were calculated in both the groups and the data was compared. **Result:** All the studied parameters showed extremely statistical significance ($P < 0.0001$) between the male and the female group. Linear regression analysis of hand and foot lengths produced predictive equations for height estimation with statistical significance ($P < 0.001$). The results showed a significant positive correlation between hand length, foot length and height in both the groups. **Conclusion:** From the present study it is seen that if the length of one parameter is known, the other could be accurately calculated from the regression equation. This would be very useful in identifying an individual from skeletal remains especially in forensic science and in anatomy.

Key words: Height, Hand length, Foot length, Tribal, North-eastern part of India

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I. Introduction:

Variation in physical parameters has been of great interest to the human population for ages. Physical variation depends on many factors such as environment, genetics, nutrition, lifestyles etc. Naharlagun is a small town in Arunachal Pradesh (having a population of 36,135 approximately), in the North Eastern part of India lying along the foothills of the Himalayan ranges and predominantly occupied by the tribal population. The work was undertaken to study the height, hand length, foot length and the correlation between the hand length and foot length and between the hand length with height and foot length with height in the tribal males and females residing in Naharlagun. The relationship between body segments has been used to compare and highlight variations between different ethnic groups and to relate them to locomotor patterns, energy expenditure, and lifestyle¹. Identification of a person from incomplete skeletal remains and decomposing bodies is very important for forensic science, anthropologists, and anatomists in cases of mass disasters like plane crash, bomb blasts, tsunamis, forest fires, earthquakes, accidents, suicides, murders etc. Measurement of height is important for determination of basic energy requirement, standardization, and measures of physical capacity and for adjusting drug dosages². Ascertaining sex and estimation of stature from incomplete skeletal and decomposing bodies is a recurring theme in physical anthropology and forensic science^{3,4,5}.

II. Method:

Subjects: The subjects consisted of healthy adult males (50 in number) and females (50 in number) of tribal origin residing in Naharlagun town. Measurements were taken after taking an informed consent from each subject. The age range was between 25-40 years, considering the fact that the ossification of almost all the bones in our body are completed by the age of 25 years and the individual has attained maximum height by this age and that regression of bones starts as early as 40 years. A slow decline in the height is known to occur as the age

advances⁶. The subjects were studied for six parameters i.e. body height, hand length, foot length, correlation between hand length and foot length and between hand length with height and foot length with height.

Method: The dimensions were measured in accordance with the International Biological Program Protocol (Weiner and Lourie, 1969)⁷. These included:

1. Foot Length; It is the distance from the most prominent part of the heel backward to the most distal part of the longest toe (1st or 2nd when the second toe was longer than the hallux).
2. Hand Length; is measured from midpoint of radial and ulnar tuberosities to tip of middle finger..
3. Body Height; is the vertical distance between the vertex and the heel touching the floor

Hand length – Each subject was asked to place his/ her hand on a white paper with the palm facing upwards keeping the fingers close together with the thumb lying comfortably but not tightly against the radial aspect of the hand and index finger. A tracing of the hand was made with a lead pencil. The tracing proceeded from the radial styloid process to the ulnar styloid process. A line was drawn joining the two styloid tips. This line is designated as the interstyloid line. The distance between the midpoint of the interstyloid line and the tip of the middle finger in extension was measured as the length of the hand as described by Amirshaybani et al (2001)⁸.

Foot Length: The subjects were asked to remove their shoes and socks and made to stand on a calibrated foot board with his/her back against the wall in such a manner that the posterior most point of the heel will gently touch the wall. A vertical stop was placed against the anterior most point of the foot. The distance between the posterior most point of the heel and the anterior most point of the foot (tip of the second toe) was measured as the foot length as described by Peters et al (1981)⁹. **Body Height:** The subjects were asked to remove their shoes and socks. They were asked to stand in erect anatomical posture against the wall with the feet axis parallel or slightly divergent and the head balanced on neck and the body height measurement was taken from vertex to heel of the foot with the head on the Frankfurt Horizontal Plane (Shailesh et al. 2011)¹⁰. All the Anthropometric measurements were taken in centimeters using a calibrated foot board, a standiometre and a measuring tape. The measurements were taken by the same persons to ensure uniformity of measurement.

Statistical analysis: Statistical analysis was carried out using SPSS Statistics software to calculate the mean, standard deviation, linear regression equations and compute multiplication factor for each subject in both males and females group. Paired sample t-test was calculated using Graph pad software and the significance of results was tested in which p-value of less than 0.001 was considered as significant. Pearson's correlation coefficient was calculated to establish the correlation between the hand and foot dimensions and also between hand and foot lengths to stature.

III. Result:

In the present study, the difference in the height between the males and females was found to be extremely statistically significant ($p < 0.0001$) in which the mean height of tribal males was found to be 168.04 ± 7.8 , compared to that of the tribal females which was 156.62 ± 5.47 (Table 1). The difference in the other parameters like the right hand length, the left hand length, the right foot length, the left foot length between the males and females was also found to extremely statistically significant ($p < 0.0001$, Table 1). The mean right hand length and the mean left hand length in males was found to be 18.38 ± 0.96 and 18.52 ± 0.92 respectively, whereas in females it was 17.22 ± 0.55 and 17.10 ± 0.64 respectively. The mean right foot length and the mean left foot length in males was seen to be 25 ± 1.28 and 25.06 ± 1.23 , respectively and in females it was seen to be 22.54 ± 0.79 and 22.54 ± 0.87 , respectively (Table 1).

The observation showed a positive correlation between the hand length and foot length which was highest in the male group ($r = 0.726$, Table 2) and was statistically significant ($p < 0.001$, Table 2). Positive correlation was also observed between hand length with height and foot length with height in both the groups with extremely statistical significance ($p < 0.0001$, Table 3) in males, where correlation coefficient ($r = 0.789$) between the hand length and height and that between the foot length and height was ($r = 0.7163$) (Table 3). Whereas, in females, only the correlation between the foot length and height was found to be statistically significant ($p < 0.001$, $r = 0.5733$, Table 3). Regression equations were formulated which gave predictive value of hand length, foot length and height (Table 2 and 3).

IV. Discussion:

In the present study, all the parameters which included height, hand length and foot length of both sides, were found to be extremely statistically significant ($p < 0.0001$, Table 1), when compared between the male and female groups. In both the groups, the parameters were seen to be having greater values in males compared to females (Table 1). This may be attributed to the early maturity of females than males and the males having two more years of physical growth than females. Similar studies of sexual dimorphism in the hand and foot length and widths were also reported earlier and that these parameters were larger in the males than in the females^{3,11,12}. In a study by GN Geetha et al. (2015)¹³ on a tribal population of Kasargod district of Kerala state, males showed higher mean values in all the parameters studied than among females and the difference was

found to be highly statistically significant. Analysis of genetically disparate population by Saxena (1984)¹⁴ and Lundy and Feldsman (1987)¹⁵ revealed a clear pattern of sexual dimorphism, with women consistently having smaller hand proportionate to stature than men. Krishna et al. 2007¹¹ stated that stature provides insight into various features of a population including nutritional health and genetics.

The observation showed a positive correlation between the hand length and foot length and between the height with hand length length and height with foot length in both the groups with extremely statistical significance in most parameters ($p < 0.0001$, Table 2 and 3). This suggests that a taller person will have longer hand and foot length. Similar Studies conducted by A. O. Ibegbu et al. 2015¹⁶, showed that hand length could be used to predict height, together with age, weight and BMI and also there was a 2-tailed significant correlation between hand length and age, weight, height and BMI in both male and female Nigerian school children of Gbagyi tribe of Abuja. Gauld et al. (1996)¹⁷ also observed that the hand length was a reliable and precise means in predicting the height of an individual. Stature has been considered as one of the parameters for personal identification⁶. Establishing personal identification of the victims and the estimation of stature from extremities and their parts plays an important role in identifying the dead in forensic examinations^{18,19}.

V. Conclusion

From the present study, it is concluded that the comparison of the height, hand length and foot length was extremely statistically significant between the males and females amongst the tribal population of the North eastern part of India. The positive correlation between the hand length and foot length and between the height with hand length and height with foot length in both the groups, suggests that a taller person will have a longer hand and foot length. Hence it is concluded that if the length of one body part is known, the length of the other could be accurately calculated from the regression equations, which could be of great help in identifying a person from incomplete skeletal remains. This is especially useful in forensic science, anatomists and anthropologists.

Conflict of interest:

The authors have non to declare.

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ANALYSIS:

Table 1: Comparison of the body dimensions between the male and female groups:

Subject	Male (Mean ± sd)	Female (Mean ± sd)	t-test	p- value
Height (in cm)	168.04±7.8	156.62 ± 5.47	5.9936	<0.0001**
Right hand length (in cm)	18.38±0.96	17.22 ± 0.55	5.2423	<0.0001**
Left hand length (in cm)	18.52±0.92	17.10 ± 0.64	6.3352	<0.0001**
Right foot length (in cm)	25 ± 1.28	22.54 ± 0.79	8.1773	<0.0001**
Left foot length (in cm)	25.06 ± 1.23	22.54 ± 0.87	8.3633	<0.0001**

*Statistically significant

** Extremely statistically significant

Table 2: Correlation between hand length (HL) to foot length (FL):

Parameter	Hand length and foot length		
	Correlation Coefficient (r)	Regression equation	p-value
Tribal male	0.726	HL=0.955+7.374 FL	0.001*
Tribal female	0.478	HL=0.681+10.837FL	0.018*

*Statistically significant

** Extremely statistically significant

Table 3: Correlation between hand length (HL) and Height (H) and between foot length (FL) and Height (H).

Parameter	Hand length (HL) and Height (H)			Foot length (FL) and Height (H)		
	Correlation Coefficient (r)	Regression equation	p-value	Correlation Coefficient (r)	Regression equation	p- value
Tribal male	0.789	H=0.094+2.564 HL	0.0001**	0.7163	H=0.1129+6.0189 FL	0.0001**
Tribal female	0.478	H=0.681+10.837HL	0.018*	0.5733	H=0.0876+8.7945 FL	0.001*

*Statistically significant

** Extremely statistically significant

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