



Original Article

Estimation of Stature from Foot Length Amongst the Indigenous Population of Meghalaya

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ABSTRACT

Background: Establishment of identity of a person is an important step in the field of forensic medical examination. The present study is unique in its sample collection in regards to selection of a rare ethnic population in northeast India as there is no existing data on the estimation of stature from foot length for this group till date.

Methodology: A Prospective cross-sectional study was conducted on healthy adults in the age range of 18-30 years. The parameters of foot length and Stature were measured and recorded according to the standard procedure. Data collected was analyzed and subjected to descriptive and inferential statistics using (SPSS) version 23. Pearson's correlation co-efficient was used to determine the correlation of stature with foot length.

Results: There were 300 participants (Males=150, Females=150) in this study. A significant positive correlation is observed between stature and foot length. Regression formula for estimation of stature from foot length for the study population is obtained for both males and females.

Conclusion: This study provides a reliable conclusion for the given population which is statistically significant and is in accord to other studies carried out earlier to estimate stature from foot length in other parts of the world.

Keywords: Stature; Foot Length; Indigenous population; Meghalaya.

INTRODUCTION

Identity is the character or phenomenon that distinguishes one person from another making him or her unique and different. The topic 'Identity' is a broad-spectrum term and there are various ways that are implemented in the process of identification which itself has many view- point and options. Every individual when born, is born with specific identity marks, even twins are also considered to be different from each other and can be identified based on the technique of dactylography or the fingerprinting. Formally we get our identity after our birth when we are given a name by our parents or family members that remains with us for the rest of our lives. Identity is important because right from our birth till the time we die or sometimes even beyond our death, our identity remains our main element of recognition.

Establishment of identity of a person is of utmost importance and in Forensic Medicine, it is considered to be an essential step. There are several parameters which help in identifying a person, like name, general appearance, facial features, race, age, sex, blood group, stature, birth marks, scar, moles, tattoos, different types of prints like finger print, foot print, lip prints etc. Stature is one of the important parameters, as" it is an inherent characteristic"¹. Even in a crime scene, "examination of footprints provides important clue and helps in estimation of stature of the culprit"². This parameter of identification ie, estimating stature from various parameters comes under Forensic Anthropology. Anthropology is the

branch of humanitarian science that study humanity by applying biology, cultural studies, archaeology, linguistics, and other social sciences. Application of biological parameters comes under Bioanthropology.

Forensic Anthropology is a sub-field of Bioanthropology where the study is carried out by applying the knowledge of skeletal analysis and techniques in archaeology to solve criminal cases. Morphology of human feet is influenced by “combined effects of heredity and lifestyle”. It has been vigorously studied internationally, but as such no study is done on the indigenous population of Meghalaya. In the present study an attempt is made to study the relation between the foot length and stature among the indigenous population of Meghalaya, using statistical consideration. Estimation of stature from foot length is easy and economical. Anthropologists, Forensic experts and even the investigating officer may use it as no expert training is required. The present study was conducted on a rare ethnic group ie, the Khasi, Jaintia and Garo tribes who are the original ethnic race of this geographical area.

AIMS AND OBJECTIVE

a) Primary objective – To determine the relationship between foot length and stature among the indigenous population of Meghalaya.

b) Secondary objective - To frame a regression formula for estimation of stature from foot length in both males and females among the indigenous population of Meghalaya.

MATERIALS AND METHODS

The present study was conducted on healthy human indigenous individuals from Meghalaya and belong to age group 18-30 years. They are the original ethnic tribe who are the original inhabitants of the place. Before conducting the study, approval was taken from the Institutional Ethics Committee. Data was collected based on a proforma that included the personal details, ancestral details to ascertain ethnicity and medical history to rule out deformity if any only after obtaining written consent from participants. Names and identity of the participants were kept anonymous. The sample size was taken to be 300 consisting of 150 male and 150 female. The technique used was very simple. Foot length was measured in centimeters “by taking the distance between pterion, which is considered to be the most backward point on the heel of the foot and acropodian, that is considered to be the most forward placed point on the toe of the foot”³. The participant was made to stand in upright position. The measurement was taken with the help of Hepburn osteometric board. Stature was measured by taking the vertical distance between the vertex, the highest point on head and foot. “The subject was asked to stand barefoot in a straight posture against the wall and both the feet kept close together while hands hanging down on both sides”². The stature was then measured with help of a stadiometer. The setting of collecting data was the Department of Forensic Medicine, NEIGRIHMS and data was collected only once from the participant. The measurements were taken at a particular time of day and conducted by a single observer to overcome bias. The data collected were then analyzed with the help of (SPSS)version 23 to know the correlation of stature with the foot length. Pearson’s correlation test was used to find out the coefficient of correlation between Stature and foot length. Simple linear regression analysis done to derive the formula to calculate Stature from foot length.

RESULTS

The study was carried out for a period of two years. After analyzing the data with the help of SPSS version 23 following results were obtained:

- Range of height in both male and female.
- Left and right foot indices in both male and female.
- Scatter plot showing positive relation between stature and foot length.
- Regression formula for estimation of stature from foot length in both the sexes of the said population.

The total number of participants were 300 with 150 male and 150 female. Measurement of height or stature in both male and female are taken separately and also both sexes taken together. The height in male ranges from 145.00cm-178.00cm with a mean value of 162.62 and SD 6.54. In female the height ranges from 135.00cm-166.00cm. Mean height was 151.77cm with a SD of 5.85. The average height in the overall population ranges from 135.20cm-178.00cm with a mean value of 157.19 and SD 8.24 (**Table 1**): SD= Standard Deviation

	MALE N=150	FEMALE N=150	BOTH GENDER N=300
HEIGHT RANGE (cm)	145.00-178.00	135.20-166.00	135.2-178.00
MEAN HEIGHT (cm)	162.62	151.77	157.19
SD OF HEIGHT	6.54	5.85	8.24

The left foot indices in both males and females and also of the both sexes are depicted in **table 2**.

	MALE	FEMALE	BOTH GENDER
LEFT FOOT RANGE (cm)	18.5-27.00	17.00-25.00	17.0-27.0
MEAN LFL (cm)	23.12	21.22	22.17

SD OF LFL	1.49	1.47	1.75
CORREL COEFF® LT	0.63	0.61	0.75
REG COEFF(B) LT	2.79	2.42	3.51
CONSTANT(A) LT	98.17	100.48	79.28

LFL=Left foot length. Corr coeff= correlation coefficient. Reg coeff= regression coefficient.

It is seen that in case of males the left foot length ranges from 18.5cm-27.00cm with a mean value of 23.12cm and SD 1.49. In females left foot length varied from 17.00cm-25.00cm and the mean value is found to be 21.22cm with a SD of 1.47. As a whole, the left foot length varied from 17.00cm-27.00cm in the given population, the mean value being 22.17cm with a SD of 1.75. Pearson correlation test was performed and correlation coefficient® was found to be +0.63 in males, +0.61 in females, and +0.75 for both sexes. Correlation coefficient ® of Left foot length to height or stature was seen to be more in males as compared to females. Reg Coeff (B) was found to be 2.79 for males, 2.42 for females and 3.51 for both the sexes. Constant (A) for males came to be 98.17, for females 100.48 and for both sexes 79.28. With the help of these parameters, a simple linear regression equation is derived.

Table 3 depicts the right foot indices in both males and females as well as both genders taken together:

	MALE	FEMALE	BOTH GENDER
RIGHT FOOT RANGE (cm)	19.00-27.00	17.50-25.50	17.5-27
MEAN R FL (cm)	23.15	21.27	22.21
SD OF RFL	1.51	1.45	1.75
CORREL COEFF® LT	0.616	0.574	0.73
REG COEFF(B) LT	2.68	2.32	3.45
CONSTANT(A)LT	100.67	102.36	80.5

RFL=Right foot length

The length of Right foot length in male ranges from 19.00cm-27.00cm with a mean value of 23.15cm and SD 1.51, whereas in females RFL varied from 17.50cm-25.50cm. The mean value is 21.27cm with a SD of 1.45. In the overall study population(n=300) containing participants from both the sexes the maximum right foot length is 27.00cm and minimum is 17.50cm. The mean is calculated to be 22.21cm with a SD of 1.75. A comparison between the indices of left foot length with that of right foot length clearly depicts that there is asymmetry between the foot length of both males and females and right foot length predominates the left foot length. Correlation coefficient® calculated and found to be +0.616 in males, +0.574 in females, and +0.73 for both sexes. Correlation coefficient ® of Right foot length to height or stature is also seen to be more in males as compared to females. Reg Coeff (B) was found to be 2.68 for males, 2.32 for females and 3.45 for both the sexes. Constant (A) for males came to be 100.67, for females 102.36 and for both sexes 80.5. The regression equation derived from these values also shows significant positive correlation of stature to right foot length for this population.

The regression model obtained for the given population is significant and is at par with other studies (**Table 4**):

	MALE	FEMALE	BOTH GENDER
LEFT	Y=98.17+2.79X	Y=100.48+2.42X	Y=79.28+3.51X
RIGHT	Y=100.67+2.68X	Y=102.36+2.32X	Y=80.50+3.45X

Scatter plot of stature to foot length (in all categories) is obtained based on the regression formula-

$$Y=a+ b X$$

Y=Stature or Height (dependent variable), X= Foot length (independent variable) a(constant)=intercept, b (reg Coeff)=slope

The height is plotted on the y- axis and the foot length is plotted on x-axis for both males and females. It is observed that the slope was in a positive direction depicting that there is a strong positive relation between foot length and stature or height. (Fig 1, 2).

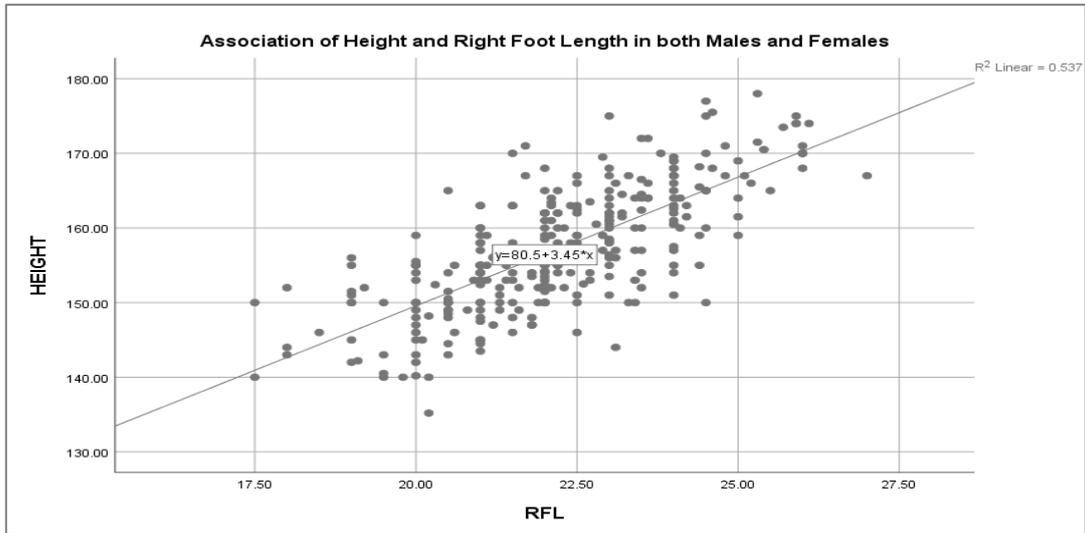


Figure 1: Scatter plot showing association of right foot length to stature.

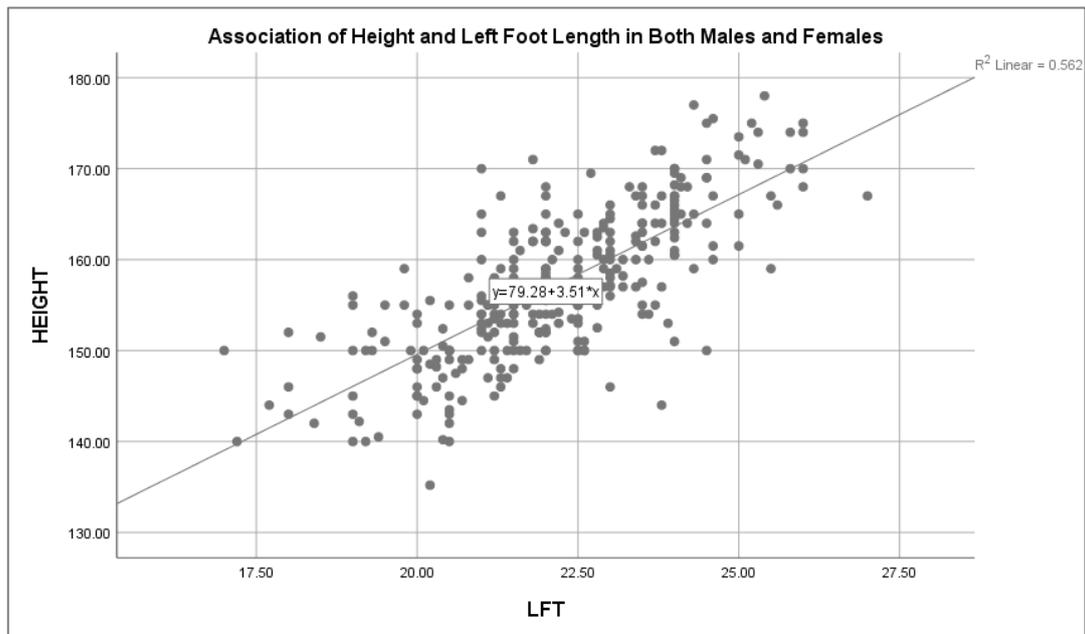


Figure 2: Scatter plot showing association of left foot length to stature.

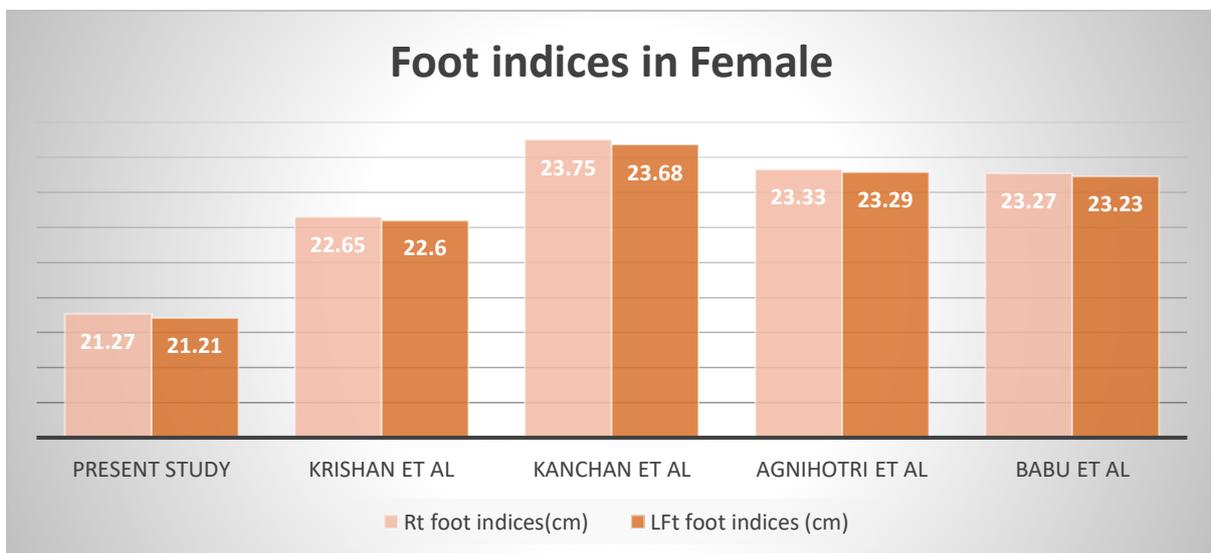


Figure 3: Bar diagram showing comparison of foot indices in female in various population.

DISCUSSION

Stature is considered to be an inheritant character² and in our study population the **height of male predominates the female** which is at par with other studies^{1,4,5,6}. The measurements of parameters like left and right foot indices, are found to be **more in males than in females** in our study and a difference in foot indices between the sexes is observed. Similar observation was done by Kanchan et al, where they conducted a study on 100 male and 100 female on the Gujjars of North India. The present study reveals that there is a **strong positive correlation between stature and foot length** which is significantly in agreement with the various previous studies that was carried on in different populations in different parts of the world^{1,4,5,6,7}. Many researchers have taken other parameters also like “breadth and length of hand, breadth of foot”⁴. But it is observed that “foot length is the best parameter for estimating stature”². Krishan et al in their study on Rajputs of Himachal Pradesh have mentioned that “foot length depicts higher correlation coefficients with stature than that of any other measurements”¹.

In our study the **correlation coefficient® was seen to be more in males than in females** and the maximum correlation coefficient was exhibited by the left foot length of males ($R=0.63$). It is in agreement with the study of Kanchan et al. where the highest was seen for left foot length in males ($R=0.764$). Similar results were found in the studies of Krishan and Sharma where it is observed that the highest “correlation coefficient was exhibited by left foot length in males” ($R=0.741$)¹. However, in the studies of Babu et al on the population of Secundrabad it was found that “correlation coefficient was more in females as compared to the males”⁵. The present study also reveals **the predominance of right foot indices over the left foot indices**. Similar results were found by other researchers. Karaddi et al in his study on his study population found out that “average left foot length is slightly smaller than that of right foot length”². In the studies of Krishan and Sharma, only the “hand breadth showed statistically significant asymmetry and right side showed predominance over left side”¹. Since every race or population has its own distinct characteristics, such population-based regression equation will help and facilitate the experts to come to a reasonable conclusion. Present study deals with the observation of correlation of height with the foot length of the given population of Meghalaya and it is seen that there is a strong positive correlation between height and foot length. Height can be estimated from either of the foot length in males and females with the help of the regression equation for the given population and it is statistically significant. The present study included all the three ethnic groups of Meghalaya, i.e., the Khasi, Garo and Jaintia considering the geographical demarcation that makes it a broad-spectrum study. It can be further narrowed down if we consider evaluating the three different ethnic group individually considering the fact that they are descended from different origins with different food habits and culture. This may further provide with a more narrowed down regression equation for the individual race making it more specific. However, the present study provides a reliable conclusion for the given population which is statistically significant and is in accord to other studies that were carried out to estimate stature from foot length in other parts of the world.

CONCLUSION

Identification of human is one of the vital functions of Forensic Medicine experts. Establishing Stature for identification is one of the traditional methods. Since it is population specific research the findings are helpful for the said population only. The above results have been obtained with the view that it will help the forensic experts and investigating officers to find height when only foot or foot print is available in the said population of this geographical part of India.

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