

Footprint Length : A Legitimate Indicator for Estimation of Stature

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Abstract

Background: Identification of an individual is the mainstay in forensic investigations. Estimation of individual's stature is an important parameter for identifying a person as it is an inherent characteristic. Examination of footprint provides important evidence in a crime scene investigation as it helps in estimation of stature of a culprit and in mass disasters where only foot is available. **Aim:** The present study was carried out to know the relationship between footprint length and stature and to know if there is any difference in the stature estimated by right and left footprint lengths in both the sexes. **Materials and Method :** Total of 200 students (100 males and 100 females) studying at our institute were included in the study. The length of the footprint and the height of each student are measured. **Results :** A positive and significant correlation between the stature and right footprint length and left footprint length was observed in both the sexes. Regression equations for stature estimation were formulated using right and left footprint length separately in both the sexes. There is no statistically significant difference in the stature estimated by right and left footprint length in both the sexes. **Conclusion :** The results indicate that footprint length provides an important means in estimating the stature of an unknown individual.

Keywords: Stature, Footprint length, Identification

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Introduction

Identification of a person is of prime and foremost importance in both civil and criminal cases. Investigating officer has to make rapid and accurate assessments in identification of a culprit in criminal cases. Many factors about the culprit are usually not known while investigating a crime. Therefore identification of a person has to be established by available information. Though there are parameters which help in identifying a person, stature of an individual is one of the important parameter, as it is an inherent characteristic. Many studies have been carried out to estimate the stature from different body parts like arm length, fore arm length, hand and finger length, length of long bones, foot and shoe lengths etc. Linear regression models are widely used to predict height of an individual on the basis of their body parts. Examination of foot print provides important evidence in a crime scene investigation as it helps in the estimation of stature of a criminal. Significant and positive correlation coefficient has been shown to exist between stature and measurements of footprints. While committing a crime there is a strong possibility that the perpetrator leaves behind the footprint at the scene of crime. Extra toe, missing toe or flat foot in foot outline itself may be more useful to exclude or include some persons from the list of suspects. Analysis of bare footprints is often carried out in the

developing countries where the footprints are frequently recovered at the crime scene. In most of the countries, a footprint record is maintained for all the air-force flying personnel since feet often resist destruction (often shoe clad) by aircraft accidents, fires etc[1]. Despite of the relationships between different body parameters that have been determined, it has been emphasized that these vary from population to population and ethnic origin to ethnic origin due to differences in effects of hereditary, nutrition, living style, and levels of physical activity[2]. With this present study a good correlation between the foot length and the height of an individual could be established. The present study is undertaken to confirm that foot length is useful to determine the height of an individual in North Indian Population .

Materials and Method

This prospective study was conducted at Department of FMT, Patna, Bihar, India Medical College and Hospital, Patna, Bihar, India. The study was approved by institutional research and ethical committee. The Study was conducted over a period from June 2019 to February 2021. A total of 200 students (100 male and 100 female) studying at our institute were included in the study. The aims and objective of the intended study were properly explained to the students and consent is taken on the proforma. A glass plate of 24×24 inches is cleaned and uniformly smeared with a thin layer of black painters ink by using a roller. Individual student's footprint and stature are taken separately. Each student is asked to wash and dry his/her feet to remove the dirt. Then he/she is asked to wash on the smeared glass plate and then walk casually on two separate white sheets so that prints of right and left foot are transferred on two separate sheets. Care is taken to avoid possible technical dimensional artifacts.

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The length of the footprint is measured from outer most margin of heel to the tip of extension of the longest toe in the footprint with the help of a scale and it is recorded in centimeters. All the measurements are taken at a fixed point between 2:00 pm to 4:00 pm to eliminate diurnal variation in the height and by the same observer to avoid personal error in the methodology. Each student is asked to stand bare feet in the anatomical position on the floor with his/her heel and occiput touching to the wall where markings for measuring the height are already made. A thin cardboard is kept horizontally at the vertex of the head. The height is measured from heel to the horizontal cardboard in centimeters. With this footprint length height of the individual is calculated with the help of regression formula. The calculated height is compared

with the actual height of the individual and the results are encouraging.

Results

In **table 1** correlation between right footprint length, left footprint length and height among 100 male students are represented. It can be seen that average left footprint length is slightly smaller than right footprint length. From analysis, it was revealed that there was a significant positive correlation between right footprint length with stature (r=+0.82) and left footprint length with stature (r=0.80). The difference in correlation coefficient is statistically significant (p<0.01).

Table 1: Correlation between Right Foot print length, Left Foot Print Length and Stature in Male students.

Variable	n	Mean ± SD	Range	Correlation Coefficient. r-value	Regression Coefficient. b-value	Regression equation
RFLP	100	25.13±1.42	22.2-27.8	0.82	3.4	Ht = 86.9+3.40 (RFLP)
Actual Ht	100	172.34±4.72	159-184			
LFLP	100	24.96±1.47	22-27.8	0.8	2.41	Ht = 112+2.41 (LFLP)
Actual Ht	100	172.34±4.72	159-184			

RFLP = Right Foot Print Length LFLP = Left Foot Print Length Ht = Height

With this significant correlation stature could be predicted from right footprint length in boys by using regression equation.
 Ht = 86.9 + 3.40(RFPL)
 And from left footprint length by using regression equation.
 Ht = 112 + 2.41(LFPL)
 It can be observed from this table that there is no statistically significant difference in right footprint length and left footprint length when both are compared (P>0.05). In **table 2** correlation between right footprint length, left footprint length and height among 100 female students are represented. From analysis, it was revealed that there was a significant positive correlation between right

footprint length and left footprint length (r = +0.88 for both RFPL and LFPL) with stature. The difference in correlation coefficient is statistically significant (P<0.01).
 With this significant correlation stature could be predicted from right footprint length in girls by using regression equation.
 Ht = 70.6 + 4.10(RFPL)
 And from left footprint length by using regression equation.
 Ht = 92.8 + 3.12(LFPL)
 It can be observed from this table that there is no statistically significant difference in right footprint length and left footprint length when both are compared (P>0.05).

Table 2: Correlation between Right Foot print length, Left Foot Print Length and Stature in Female students

Variable	n	Mean ± SD	Range	Correlation Coefficient. r-value	Regression Coefficient. b-value	Regression equation
RFLP	100	22.61±1.51	20-25	0.88	4.1	Ht = 70.6+4.10 (RFLP)
Actual Ht	100	163.29±5.45	148-176			
LFLP	100	22.59±1.62	20-25	0.88	3.12	Ht = 92.8+3.12 (LFLP)
Actual Ht	100	163.29±5.45	148-176			

RFLP = Right Foot Print Length LFLP = Left Foot Print Length Ht = Height

Comparing Right Foot Print length and Left Foot Print Length Z = 0.83 and P > 0.05.
 Following points can be observed from the present study
 Male students are taller than female students.
 Mean footprint length is more in males than females. There is no statistically significant difference in right and left foot length in both the sexes. Stature can be determined by right or left footprint length separately in both the sexes. There is no statistically difference in stature estimated by right footprint length and left footprint length.
 The present study is statistically significant (P<0.01) and shows that height can be predicted by regression equation by known footprint lengths separately in both the sexes.

Discussion

In the present study, the right footprint length and left footprint length were measured by parallel axis separately for male and female students and then by applying linear regression equations the stature is determined. Average height for each sex within a population is significantly different with adult males on an average being taller than adult females[3]. The results obtained in this study are in agreement with the above statement. Abraham Philip[4] estimated stature from known foot size by regression method. In the present

study regression equations are derived to predict stature separately for right foot length and left foot length for both sexes. Devesh VO et al (2006)2, Danborn B et al (2008)[7] and Vidya CS et al (2009)9 observed that mean foot length is more in males than in females. The findings are similar to present study. Agnihotri Arun Kumar et al[5] in his study included 125 male and 125 female students for estimation of stature by left foot length. General multiple linear regression model was highly significant (P<0.001) and multiple correlation coefficient (r) was 0.877. In present study where 100 male and 100 female students are included correlation coefficient of +0.82 and +0.80 respectively obtained for right and left footprint lengths in males and for females it was +0.88 for both right and left footprint length. Theodoros B Grivas (2008)[6] stated that right foot length and left foot length is independent predictor of stature. These findings are supported by the present study.
 Raju M (2009)8 obtained a statistically significant relation between bare foot length while walking and stature (P<0.001). In his study he included only male individuals. He developed a regression formula for estimating the stature. In our study we included both male and female students. Regression equations are developed separately for right and left foot length in both the sexes. The results

are significant. Deopa Deepa (2010)[10] also observed a significant and positive correlation between foot length and height in individuals of Uttarakhand region. The results of the present study are quite encouraging and would ultimately help the investigating officer and Forensic experts to estimate stature of a person by foot length. In fact the aim of taking present study was to help the concerned authorities to restrict their field of investigation by including or excluding few subjects from list of suspects.

Conclusion

In the present study a significant correlation of stature with right and left foot print length has been observed ($P < 0.01$). The results show that males are taller and their mean foot length is larger than that of females. There is no statistically difference in right and left footprint length in both the sexes ($P > 0.05$). Either right or left footprint length may be used to predict the stature by regression formula. Regression equations are derived separately for individual foot length in both the sexes.

Estimation of stature from footprint is easy, economical and convenient. No specialized equipment or training is required. Anthropologists, forensic experts and investigating officers may use this method to their added advantage.

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