

ORIGINAL RESEARCH

Estimation of stature using foot print length-A prospective observational study

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ABSTRACT

Background: Identification of an individual stands as a central element in forensic investigations. Assessing an individual's height serves as a vital factor in the process of identification, as it represents an intrinsic trait. Analyzing footprints offers crucial evidence during crime scene investigations, aiding in the determination of a perpetrator's stature. This proves especially valuable in situations involving mass disasters where only footprints are accessible for analysis. **Aim:** The current study aimed to investigate the correlation between footprint length and stature while also examining potential differences in estimated stature between the right and left footprints in both genders. **Materials and method:** The study encompassed a total of 200 students, with an equal distribution of 100 males and 100 females, all of whom were enrolled in our institute. The measurements taken included the length of each student's footprint and their respective height. **Results:** In both males and females, a notable and meaningful positive correlation was detected between stature and both the length of the right footprint and the length of the left footprint. Regression equations were developed for estimating stature using the right and left footprint lengths separately in both genders. Importantly, there was no statistically significant difference observed in the estimated stature when using the right and left footprint lengths in either males or females. **Conclusion:** The findings suggest that footprint length serves as a valuable method for estimating the stature of an unidentified individual.

Keywords: Stature, Footprint length, Identification

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INTRODUCTION

Identification of an individual stands as a paramount factor in both civil and criminal cases. In criminal investigations, the investigating officer must swiftly and accurately determine the identity of a suspect, often with limited information available. While several parameters aid in identifying a person, one crucial characteristic is their stature, as it is an inherent and relatively stable feature. Numerous studies have explored the estimation of stature using various body parts, such as arm length, forearm length, hand and finger dimensions, the lengths of long bones, and foot and shoe measurements. Linear regression models are commonly employed to predict an individual's height based on these body measurements. Footprint analysis plays a pivotal role in crime scene investigations, facilitating the estimation of a perpetrator's stature. Remarkably, there exists a significant and positive correlation coefficient between stature and measurements taken from footprints. When a crime is committed, there is a high likelihood that the perpetrator leaves behind

footprints at the scene, making them valuable evidence in the investigative process. The presence of an extra toe, a missing toe, or a flat foot within the foot outline can prove highly beneficial for either excluding or including specific individuals in the list of suspects. In developing countries, the analysis of bare footprints is a common practice, as footprints are frequently recovered at crime scenes. In many countries, comprehensive footprint records are maintained for all air-force flying personnel, primarily because feet often resist destruction, even when the individual is wearing shoes, in cases of aircraft accidents or fires [1]. It's important to note that despite the established relationships between various body parameters, these relationships can vary significantly from one population to another and among different ethnic groups. These variations can be attributed to factors like hereditary traits, nutrition, lifestyle, and levels of physical activity [2]. This current study aims to demonstrate a strong correlation between foot length and an individual's height, specifically within the North Indian population. The research seeks to

confirm that foot length can reliably be used to estimate an individual's height in this specific demographic.

MATERIALS AND METHOD

This prospective research was carried out at the Department of Forensic Medicine and Toxicology (FMT). The study received approval from the institutional research and ethical committee. It was conducted over one year. A total of 400 students, comprising 200 males and 200 females, enrolled in our institution, participated in this study. The study's objectives and purpose were thoroughly explained to the students, and their consent was obtained using the provided proforma.

To conduct the study, a glass plate measuring 24x24 inches was meticulously cleaned and evenly coated with a thin layer of black painter's ink, using a roller. Each student's footprint and height were measured individually. Students were instructed to wash and dry their feet to eliminate any dirt. Subsequently, they were asked to step onto the ink-coated glass plate and then walk casually onto two separate white sheets, ensuring that the prints of their right and left feet were transferred onto two distinct sheets. Particular attention was paid to preventing any potential technical dimensional artifacts. The length of the footprint was meticulously measured from the outermost edge of the heel to the tip of the furthest toe extension within the footprint, utilizing a scale, and the results were documented in centimeters. To ensure consistency and accuracy, all measurements were conducted at a consistent time frame, specifically

between 4:00 pm and 6:00 pm, with the intention of minimizing any diurnal variations in height. Furthermore, to reduce the likelihood of personal errors in the methodology, the measurements were consistently performed by the same observer throughout the study. Every student was instructed to stand barefoot in the anatomical position on the floor, ensuring that both their heels and the back of their heads (occiput) touched the wall where height measurement markings had been previously made. A thin piece of cardboard was placed horizontally at the top of the student's head (the vertex). The height was then measured in centimeters, extending from the floor up to the horizontal cardboard, capturing the student's full stature accurately.

Using the footprint length, the individual's height was computed with the aid of a regression formula. This calculated height was subsequently compared to the individual's actual height, and the results yielded promising and encouraging findings.

RESULTS

Table 1 presents the correlation between the right footprint length, left footprint length, and height for a sample of 200 male students. Notably, the average left footprint length appears to be slightly smaller than the right footprint length. Upon conducting the analysis, it was evident that there exists a substantial positive correlation between the right footprint length and stature ($r=+0.62$), as well as between the left footprint length and stature ($r=0.60$). It's worth mentioning that the difference in correlation coefficients was found to be 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 \pm SD	Range	Correlation Coefficient. r value	Regression Coefficient. b-value	Regression equation
RFLP	200	24.13 \pm 1.42	24.2-26.8	0.62	2.41	Ht = 66.9+2.40(RFLP)
Actual hit	200	170.34 \pm 4.72	149-182			
LFLP	200	26.96 \pm 1.47	24-26.8	0.60	1.41	Ht = 102+1.41(LFLP)
Actual hit	200	170.34 \pm 4.72	149-182			

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

"It can be noted from this table that there is no statistically significant distinction in the lengths of the right and left footprints when comparing the two ($P>0.05$)."

In Table 2, we present the correlation between the lengths of right footprints, left footprints, and the height of 200 female students. Our analysis revealed a significant positive correlation between the lengths of

right and left footprints ($r = +0.66$ for both RFPL and LFPL) with stature. It's important to note that the difference in correlation coefficients is statistically significant ($P<0.01$). This significant correlation allows us to predict stature in girls using regression equations. For right footprint length, the equation is $Ht = 60.6 + 4.10(RFPL)$, and for left footprint length, it's $Ht = 82.8 + 3.12(LFPL)$.

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

variable	n	Mean \pm SD	Range	Correlation Coefficient. r value	Regression Coefficient. b-value	Regression equation
RFLP	200	20.61 \pm 1.51	20-25	0.66	2.1	Ht = 60.6+4.10(RFLP)
Actual hit	200	162.29 \pm 4.45	146-178			

LFLP	200	20.59±1.42	20-25	0.66	2.12	Ht = 82.8 + 3.12(LFPL)
Actual hit	200	162.29±4.45	146-178			

The following observations can be made from the current study:

Male students exhibit greater height compared to their female counterparts. Mean footprint length is higher in males than in females. There is no statistically significant distinction in the length of the right and left feet between both sexes. Stature can be accurately determined using either right or left footprint length independently for both genders. No significant difference exists in stature estimation when using right or left footprint length. The present study is statistically significant ($P < 0.01$) and demonstrates that height can be predicted through regression equations using known footprint lengths for each gender separately."

DISCUSSION

In this current study, the lengths of the right and left footprints were individually measured using a parallel axis approach for both male and female students. Subsequently, stature was determined through the application of linear regression equations. It's noteworthy that the average height varies significantly between the sexes within the population, with adult males generally being taller than adult females [3]. The findings from this study align with the aforementioned statement. Abraham Philip [4] previously estimated stature based on known foot size using regression methods. In our study, we have developed separate regression equations for predicting stature using right and left foot lengths for both genders. In the current study, which includes 200 male and 200 female students, correlation coefficients of +0.62 and +0.60 were obtained for right and left footprint lengths in males, and for females, it was +0.66 for both right and left footprint lengths. Theodoros B. Grivas (2008) [6] previously stated that both right and left foot lengths independently predict stature. These observations align with the findings of the present study.

CONCLUSION

In the current study, a significant correlation between stature and both right and left footprints has been observed ($P < 0.01$). The findings indicate that males are taller on average and have a larger mean foot length compared to females. Furthermore, there is no statistically significant difference in the length of right

and left footprints in both sexes ($P > 0.05$). This suggests that either the right or left footprint length can be utilized to predict stature using regression formulas. Separate regression equations have been developed for individual foot lengths in both males and females.

CONFLICT OF INTEREST

Nil

SOURCE OF SUPPORT

Nil

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