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Estimation of Stature from Shoeprint Length in Central Indian Population

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Abstract

Shoeprints are one of the important trace evidences that are often overlooked at the crime scene. They may provide investigative leads in identification of the accused. This study aims to determine the relationship between shoeprint length and stature amongst Central Indian population. A total of 500 subjects comprising 250 males and 250 females, aged between 18 to 50 years, natives of Madhya Pradesh, a Central Indian state were selected for this study. The height and length of their shoeprints were recorded and a regression equation was devised along with multiplication factors. We found that as the length of the shoeprint increased there was an increase in the height of the individual representing a positive correlation between the two variables (r = +0.757 for males and r = + 0.887 for females).

Keywords: Stature; Shoeprint Length; Central India.

Introduction

Shoeprints left behind by the criminals at the crime scene can provide valuable evidence for the investigative agencies. Miscreants frequently wear gloves and masks to hide their identity, but hardly make any endeavor to conceal their footwear. Estimation of height of an individual from their footlength is more reliable compared to shoe prints, however in reality it is rare to find bare footprints at the scene of crime. Hence, in such circumstances we have to solely depend upon shoe prints for evidence instead.

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Cassidy in his study provided male height equivalents for calculating height from shoesize [1]. Eugene presented and evaluated newly determined percentages and linear regressions for measuring height from foot-length in young adults based upon U.S. army anthropometric databases [2]. In India, Raju showed significant correlation between the stature and shoe print length in females while walking [3].

According to 2004 London Metropoliton Police Report, the evidence recovery rate for shoeprint was 12.4% as opposed to 19% for fingerprints. The report also stated that with greater attention the recovery rate for shoeprints could be raised to 30% in case of burglaries [4]. Researchers have shown various methods for chemical enhancement of footwear impressions obtained at the crime scene [5,6]. In this study we have evaluated the relationship between shoeprint length and stature amongst Central Indian population.

Materials and Methods

The prospective cross-sectional study was carried out at the department of Forensic Medicine, Sri Aurobindo Institute of Medical Sciences, Indore, Madhya Pradesh, a state in Central India, over a

period of 1 year from July 2015 to June 2016. A total of 500 subjects comprising of 250 males and 250 females, all natives of Madhya Pradesh were randomly selected for the study. All the participants were above 18 years of age.

The participants were asked to stand firmly for 10 seconds on his/her right foot on a flat surface of a wooden box covered with thick cloth soaked in blue ink, ensuring every segment of shoe-sole was immersed and stained with ink. Then they were instructed to take a step on a thick white paper sheet placed over a wooden weighbridge. The length of the shoeprint was then measured from heel to toe. The height of the participants was calculated by asking them to stand erect on a stadiometer bare-footed. Both shoeprint length and height were measured in centimeters to the nearest millimeter. Data analysis was done by using Statistical package Microsoft Excel 2007 and regression formulae were calculated for various combinations to reach the best estimates.

Results

In the present study, shoeprint length of males ranged from 26 cms to 30.8 cms (Table 1) with a mean of 28.37 cms and S.D. of ±1.22 cm. The height of the male participants ranged from 167.2cms to 188.5 cms with a mean of 175. 52 cms and S.D. of ± 4.75cms (Table 2). For females, shoeprint length ranged from 21.4 cms to 28.1 cms (Table 3) with a mean of 24.508 cms and S.D. of ±1.55cm. The height of female partcipants ranged from 148 cms to 177.5 cms with a mean of 159.082cms and S.D. of ±6.33cms (Table 4).

Table 1: Shoeprint length and actual stature in males (n = 250)

Shoeprint length (cms)	Subjects	Mean Height (cms)	S.D.
26 – 27	28	168.99	1.16
27.1 – 28	87	172.83	2.43
28.1 – 29	61	175.73	2.30
29.1 – 30	40	179.94	2.69
30.1 – 30.8	34	182.17	3.40

Table 2: Correlation between shoeprint length and stature in males (n = 250)

Variable (cm)	N	Mean: ± S.D	Range	r – value Coefficient of correlation	b – value Regression coefficient	Regression equation
Shoeprint length	250	28.37 ± 1.22	26 – 30.8	+0.889	3.46	Height = 77.36 +3.46 (SPL)
Actual height	250	175. 52 ± 4.75	167.2 – 188.5			

*SPL – Shoeprint length

Table 3: Shoeprint length and actual stature in females (n= 250)

Shoeprint length (CMS)	Subjects	Mean Height (cms)	S.D.
21.4 – 23	50	153.05	3.18
23.1 – 24	67	155.30	3.10
24.1 – 25	42	158.34	2.54
25.1 – 26	46	162.40	2.88
26.1 – 27	29	166.61	2.41
27.1 – 28.1	16	172.46	3.87

Table 4: Correlation between shoeprint length and stature in females (n= 250)

Variable (cm)	N	Mean: ± S.D	Range	r – value Coefficient of correlation	b – value Regression coefficient	Regression equation
Shoeprint length	250	24.508 ± 1.55	21.4 – 28.1	+ 0.887	3.61	Height = 70.609 +3.61(SPL)
Actual height	250	159.082 ± 6.33	148 – 177.5			

*SPL – Shoeprint length

Table 5: Prediction of stature for different shoeprint length in males

Shoeprint length (cms)	Predicted height (cms)	Range	
		Min	Max
26	167.32	162.57	172.07
27	170.78	166.03	175.53
28	174.24	169.49	178.99
29	177.70	172.95	182.45
30	181.36	176.61	186.11

Table 6: Prediction of stature for different shoeprint length in females

Shoeprint length (cms)	Predicted height (cms)	Range	
		Min	Max
22	150.02	143.69	156.35
23	153.63	147.30	159.96
24	157.24	150.91	163.57
25	160.85	154.52	167.18
26	164.46	158.13	170.79
27	168.07	161.74	174.40
28	171.68	165.35	178.01

A regression equation was devised and values for a coefficient of co-relation was calculated for assessing the relationship between shoeprint length and height of an individual. We found that as the length of the shoeprint increased there was an increase in the height of the individual representing a positive correlation between the two variables (r = +0.889 for males and r=+0.887 for females). Height could be estimated by the regression equation - [Height (for males) = 77.36+3.46 x shoeprint length] and [Height (for females) = 70.609+3.61 x shoeprint length] (Table 2 and 5). Prediction of stature for different shoeprint length for both the sexes have been shown in Table 5 and 6.

Discussion

In Forensic Anthropology, estimation of stature plays a significant role in establishing the identity of a person. Our study has shown that as the length of the shoeprint increased there was an increase in the height of the individual representing a positive correlation between the two variables. A rapid classification of such shoeprints would assist investigative agencies not only to link different crimes but also to identify suspected criminals [7]. Bodziak has described the process of detection, recovery and examination of footwear impression evidence by manual human shoeprint classification [8]. Girod revealed that 35% of crime scenes in several jurisdictions of Switzerland had shoeprints usable in forensic science [9]. He also found that 30% of all burglaries provide usable shoeprints and proposed a semi-automatic scheme for classifying shoeprints from burglars [4]. Each sole was described by a number of geometric patterns which must be determined by a human expert. Examples of such pattern include zigzags, circles, squares and letters. A database of known shoe types was established using these geometric patterns and unknown shoeprints could be compared to shoeprints in the database to try and find a match.

In present study, regression equation for estimation of height from shoeprint length was 77.36+3.46 x (shoeprint length) for males. This slightly differs from Eugene's regression equation for estimation of height which was 82.206+3.447 x (foot length) [2]. Later on, he calculated height directly from shoe print length by the same regression equation replacing foot length by shoeprint length on a length 25.4 mm less than shoeprint length [2]. He proposed the height spread of ±6.35 cm and presumed that it would include 70% of men for that particular shoeprint length. Standard deviation of the present study was more precise and we found a significant positive coefficient of correlation for males - r = + 0.889. Subjects of this study were from a normal population as compared to Eugene's samples which consisted of healthy individuals from the U.S. army.

For females, regression equation for the estimation of stature was 70.609 + 3.61 x (shoeprint length) in our study. Raju estimated the height of females from their shoeprint length by the regression equation 91.4 + 3.09 x (shoeprint length) [3]. They measured a mean shoeprint length of 24.12 cms with a S.D. of ± 1.75cms

and a mean height of 165.87 cms with a S.D. of ± 9.05cms. Standard deviation of our study was closer to the mean with a coefficient of correlation r = + 0.887 as compared to Raju which was r = + 0.69, indicating a strong positive association. No equation has been prepared by Eugene for females [2]. Raju had selected the subjects for his study from Southern Indian population. The difference in results could be due to genetic and geographical variation.

Conclusion

Shoeprints are found virtually at every crime scene. They are often unnoticed, even though criminals presumably leave impressions routinely while entering and exiting crime scenes. Analysis of such traces more reliably would enable the judges to attach more weight to this evidence in assessing the probability of guilt. Further study and research will enhance the value of shoeprint evidence and its use in the identification of potential criminals. Nevertheless, we need to keep in mind that people from different ethnic origins and geographic regions have their own variations.

Declarations of Interest: None

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