

Research Article

Estimation of stature by foot length in males

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Abstract

Examination of footprint 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 foot prints. The study was carried out in Mahadevappa Rampure Medical College, Gulbarga. Total of 100 male students from 1st semester to 5th semester are included in the study. The aim and objective of the intended study were properly explained to all the students and consent is taken on the proforma. Individual student's foot length and stature are taken separately.

The length of foot is measured from outer most margin of heel to the tip of extension of longest toe in both the feet with the help of a verniers caliper and it is recorded in centimeters. In the present study a significant correlation of stature with right and left foot length has been observed ($P < 0.01$). The results show that there is no statistically significant difference in right and left foot length in male students ($P > 0.05$). Either right or left foot length may be used to predict the stature by regression formula.

Keywords: Stature, foot length, Verniers calipers

1. Introduction

Identification of a person is of prime and foremost importance in both civil and criminal cases. Though there are several parameters which help in identifying a person, stature is one of the important parameter 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. Many factors about the culprit are usually not known while investigating a crime. There may be few witnesses; perpetrator seldom leaves behind specific identifying information. Therefore identification of the person has to be established by available information.^{1,2}

Many studies have been carried out to estimate the stature from different body parts like arm length, forearm 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 footprint 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 foot prints. Ossification of bones of foot occurs earlier than that of long bones of lower extremities³. Even during adolescent age, the height can be predicted more accurately from foot measurements than long bones of lower limb. Taken together, evidences suggest that relationship between foot length and stature is of practical use in medico legal cases, anthropology and archeological studies; when such evidence is provided to the investigator, it helps to establish the individual's physical description. Footprints are also used for identifying newborn babies in hospitals.

2. Aims and objectives of the study

1. To study the relation between human foot length and stature in males.
2. To compare between the stature estimation by right foot length and stature estimation from the left foot length.

3. Methodology

The study was carried out in Mahadevappa Rampure Medical College, Gulbarga. Total of 100 male students from 1st semester to 5th semester are included in the study. The aim and objective of the intended study were properly explained to all the students and consent is taken on the proforma. Individual student's foot length and stature are taken separately.

The length of foot is measured from outer most margin of heel to the tip of extension of longest toe in both the feet with the help of a verniers caliper and it is recorded in centimeters.

Each student is asked to stand bare feet in anatomical position on the floor with his heel and occiput touching to the wall where markings for measuring the height are already made. Student is instructed not to move the head while measuring the height. 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 foot 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.

Any student with abnormality of foot/lower limb or any spinal deformities are not included in the study.

4. Observations and Results

Table-1: Right Foot Length and Actual Height (Ht) in Male Students

Sl. No.	RFL	No of individuals	Min Ht	Max Ht	Avg Ht	S.D
1	22 – 23	09	159	170	162.11	3.44
2	23.1 – 24	20	160	175	168.15	4.38
3	24.1 – 25	20	169	177	173	5.42
4	25.1 – 26	17	168	180	173.05	5.24
5	26.1 – 27	28	171	182	175.92	4.35
6	27.1 – 28	06	177	184	180.66	3.26

Table no.1 shows the right foot length and corresponding actual height of 100 male students. A linear correlation and regression analysis were done for assessing the relationship between right foot length with stature and estimation of height for different levels of right foot length. In our study the maximum number of 28 students were having right foot length of 26 – 27cms and their average height is 175.92 cms with Standard Deviation of 4.35 as shown in this table.

Right foot length varied among these individuals from 22-28cms. It can be seen that height increases as the right foot length increases showing positive correlation between the two parameters. The average height was 162.11cms for males with right foot length of 22-23cms, which increased to 180.66cms with maximum right foot length of 27 - 28cms.

Table-2: Left Foot Length and Actual Height in Male Students

Sl. No.	LFL	No of individuals	Min Ht	Max Ht	Avg Ht	S.D
1	22 – 23	10	159	170	161.9	3.77
2	23.1 – 24	19	162	174	169.2	4.72
3	24.1 – 25	22	168	177	172	4.28
4	25.1 – 26	18	170	180	174.16	3.83
5	26.1 – 27	26	171	182	175.84	4.12
6	27.1 – 28	05	177	184	181	3.12

RFL– Right foot length; LFT – Left foot length; Min Ht – Minimum height; Max Ht – Maximum height; AvgHt – Average height; SD – Standard Deviation

Table-2 represents the distribution of male students with mean heights for corresponding levels of left foot length.

Descriptive statistics of left foot length and a linear correlation, regression analysis was done on the data obtained from 100 male students for assessing the relationship between left foot length with height and estimation of stature for different levels of left foot length. In this study maximum number of 26 students had left foot length of 26-27cms their mean height was 175.84cms with Standard Deviation of 4.12.

The mean height of male subjects with corresponding various levels of left foot length varied among these subjects from 22–28cms. We can notice that stature increases as the left foot length increase showing positive correlation between the two parameters.

The average height was 161.9cms for left foot length of 22-23cms, which increased to 181cms with maximum left footprint length of 27-28cms.

Comparing Right Foot Length and Left Foot Length $Z = 0.83$ and $P > 0.05$

Table-3: Correlation between Right Foot Length, Left Foot Length and Stature in Male Students

Variable	n	Mean \pm SD	Range	Cor. Coeff. r-value	Reg. Coeff. b-value	Reg. Equation
RFL Actual Ht	100 100	25.13 \pm 1.42 172.34 \pm 4.72	22.2–27.8 159 - 184	+ 0.82	3.4	Ht = 86.9 + 3.40 (RFPL)
LFL Actual Ht	100 100	24.96 \pm 1.47 172.34 \pm 4.72	22–27.8 159 – 184	+ 0.80	2.41	Ht =112 + 2.41 (LFPL)

RFL = Right Foot Length; LFL = Left Foot Length; Ht = Height

In table-3 correlation between right foot length, left foot length and height among 100 male students are represented.

It can be seen in this table that average left foot length slightly smaller than that of right foot length.

From analysis, it was revealed that there was a significant positive correlation between right foot length with stature ($r=+0.82$) and left foot length with stature ($r=+0.80$). The difference in correlation coefficient is statistically significant ($P<0.01$). With this significant correlation an attempt was made to estimate stature based on any given right foot length and left foot length.

Stature could be predicted from right foot length in boys by using regression equation.

$$\text{Ht} = 86.9 + 3.40(\text{RFPL})$$

And from left foot 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 foot length and left foot length when both are compared ($Z = 0.83$ and $P > 0.05$).

Correlation and regression analysis were applied to know the relationship between right foot length with stature and left foot length with stature. An attempt is made to predict the stature from a known right or left foot length.

Following points can be observed from the present study:

- There is no statistically significant difference in right and left foot length.
- Stature can be determined by right or left foot length separately in males.
- There is no statistically significant difference in stature estimated by right foot length and left foot length.
- The present study is statistically significant ($P < 0.01$) and shows that height can be predicted by regression equation by known foot lengths in males.

5. Discussion

Present study deals with observations on the correlation of standing height with right foot length and left foot length in male students studying in M.R. Medical College, Gulbarga.

Once the right foot length and left foot length were obtained then by applying linear regression equations the stature is determined. There is no statistically significant difference in the lengths of right foot and left foot ($Z = 0.83$, $P > 0.05$).

Vidya CS⁴ in her study concluded that left foot is slightly lengthier than that of right foot in both the sexes. In the present study even though there is no statistically significant difference in right and left footprint lengths, right foot is slightly lengthier than left foot in male students.

Theodoros B Grivas⁵ (2008) stated that right foot length and left foot length are independent predictor of stature. These findings are supported by the present study.

Abraham Philip⁶ 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.

Agnihotri Arun Kumar⁷ 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 was (r) 0.877. In present study where 100 male students are included correlation coefficient of +0.82 and +0.80 respectively obtained for right and left footprint lengths in males.

In a study by Devesh (2006)⁸ correlation coefficient (r) of 0.698 for males was obtained between stature and left foot length. In present study, correlation coefficient obtained separately for right foot and left foot in male students. Correlation coefficient is + 0.82 for right foot and + 0.80 for left foot.

Raju M⁹ (2009) obtained a statistically significant relation between bare foot length while walking and stature ($P < 0.001$). In his study he included male individuals. He developed a regression formula for estimating the stature. Regression equations are developed separately for right and left foot length in male students. The results are significant.

Deopa Deep¹⁰ (2010) 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 the list of suspects. Investigating officer sometimes depend on the eye witnesses to get rough idea about the height of the person which is not reliable. If foot length is available at the scene of crime stature could be predicted. This study has proved that stature could be predicted by a known foot length.

6. Conclusions

In the present study right foot length, left foot length and heights of 100 male students studying in M. R. Medical College are taken.

Though there are several parameters which help in identifying a person, stature of an individual is one of the important parameter, as it is an inherent characteristic. There is an established relationship between stature and dimensions of various parts of the body allowing the Forensic expert to estimate the stature from available data. 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 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 foot.

In the present study a significant correlation of stature with right and left foot length has been observed ($P < 0.01$). The results show that there is no statistically significant difference in right and left foot length in male students ($P > 0.05$). Either right or left foot length may be used to predict the stature by regression formula. Regression equations are derived separately for individual foot length.

Estimation of stature from foot length 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. Thus this study is able to add another method to estimate the stature from foot length in male individuals.

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