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IP International Journal of Forensic Medicine and Toxicological Sciences

Journal homepage: https://www.ipinnovative.com/journals/IJFMTS

Original Research Article

# Identification of stature from foot length in Western Maharashtra population

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ARTICLE INFO

*Article history:*
Received 02-11-2020
Accepted 07-11-2020
Available online 07-01-2021

*Keywords:*
Foot length
Stature
Vernier caliper
Crime scene investigation
Medicolegal

ABSTRACT

**Background:** Relationship between foot length and stature exist which are useful in crime scene investigations and mass accidents where only certain parts of the body are found and positive correlation coefficient is applied for the purpose of identification.

**Materials and Methods:** The study was carried out in a population of Western Maharashtra. A total of 100 people (43 males and 57 females) in the age group of 18-30 years were part of the study. All the aims and objectives of the study were properly explained to the people. Foot length was measured from the most prominent point of the back of heel to the tip of great toe using a Vernier caliper.

**Result:** Through this study a positive correlation between foot length and stature was established and a regression equation was obtained.

**Conclusion:** Either right or left foot length may be used to predict the stature using regression formula which shall be a useful aid for Anthropologists and Medico legal experts.



## 1. Introduction

The skin patterns of toes and heels are as distinct and permanent as those of the fingers.[1] This is useful to identify foot length and ultimately determination of stature and identity of the individual. Body Measurements namely the standing and sitting heights, length and breadth of the head, breadth of the face, length of right ear, the span of outstretched arms, length of the left foot, length of the left middle finger, length of left little finger, and the length of the left forearm and hand are an important component of Anthropometry (Bertillon System) which deals with the measurements of various parts of human body.[2]

At crime scene the presence of foot impressions is of utmost importance, using them the foot length can be calculated. Usually the criminal is unknown to the investigating team and using this important clue of the foot length the stature can be calculated easily using regression formula. This will ultimately lead to establishing identification of the culprit. Identification which is an important component of crime scene investigation is strengthened by the use of anthropological knowledge. Formula is derived by population studies, by careful analysis of various population group's heights, and their foot lengths a relationship is created. At crime scene, with the help of footprint, we can calculate foot length as well as foot width. Thus, we can calculate footprint ratio and identify the sex of the person.[3] The present study is undertaken in a population of Maharashtra and using their data there is derivation of the relationship between foot length and stature.

## 2. Materials and Methods

The measurements were taken in a room with good lighting. Measurements were taken from 100 individuals between age 18-30. Consent was taken from each study individual before taking the measurements. The instrument used was a measuring tape and the measurements were recorded in centimeters. Foot lengths were measured independently from the left and right side of each individual, it was taken

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https://doi.org/10.18231/j.ijfmts.2020.028

from the most prominent point of back of heel to the tip of hallux or tip of second toe when the second toe was longer than hallux. The individuals were made to stand erect and their heights were measured in centimeters using a stadiometer. All data collected was organised in tables with names, adjacent left and right foot lengths and the individual's heights.

## 3. Observation and Results

Table 1 Shows the mean heights, foot lengths and their standard deviationvalues. In the study it was found that the mean height of the 45 males was 172.844 cm with a standard deviation of 7.37 and the mean height of 55 females was 158.489cm with a standard deviation 10.08. The mean right foot length of females was 23.460 with a standard deviation was 1.95 and that of males was 26.082 cm with a standard deviation of 1.81. The mean left foot length of females was 23.427cm with a standard deviation of 1.80 and that of males was 26.084 cm with a standard deviation of 1.80.

Table 2 Shows the overall mean heights and foot lengths and also other statistical values like median and mode. The mean height is 164.94 cm, mean right foot length is 24.640cm and the mean left foot length is 24.623 cm. It is thus observed that the left foot length is slightly smaller than the right foot length.

Chart 1 and Chart 2 show the relation between height and right and left foot lengths respectively. We can observe that stature increases with increase in foot lengths in both the charts, this establishes a linear correlation between the height and the foot lengths.

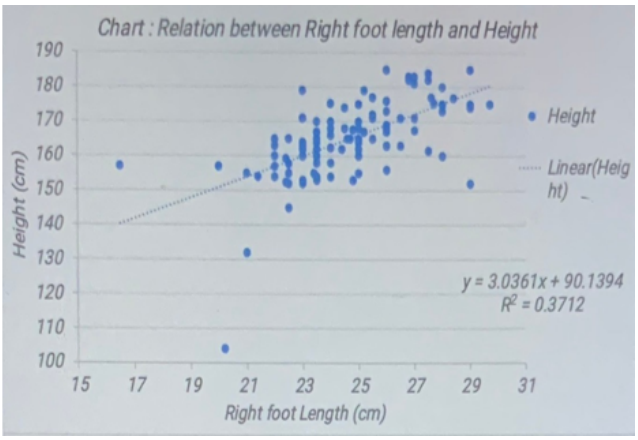


Chart 1: Right Foot length and Height Relation

Figure 1 shows the measurement of foot length from the tip of great toe to the most prominent part of the heel.

In Table 3 correlation between right foot length, left foot length and height among the population studied are represented. It was found out from the analysis that a significant positive correlation existed between right foot length with stature (r=+0.6092) and left foot length

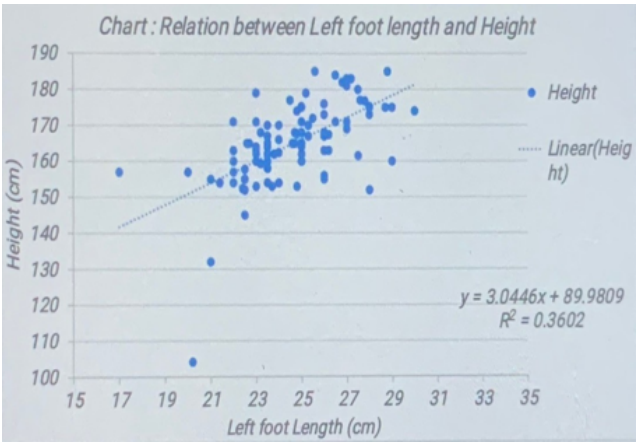


Chart 2: Left Foot length and Height Relation

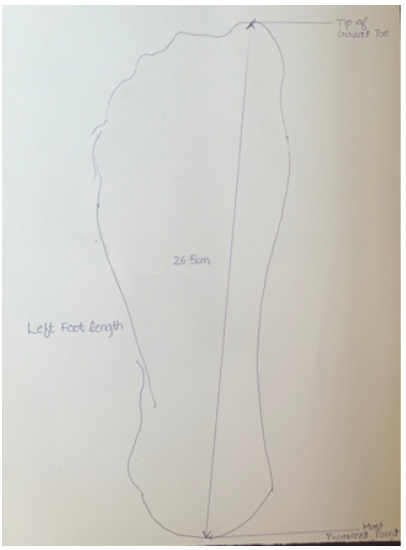


**Fig. 1:** Measurement of left foot length

with stature (r=+0.6001). The difference in correlation is statistically significant by ANOVA test (P<0.01).

Stature could be predicted from right foot length by using regression equation: Ht = 90.1 +3.303(RFPL).

Stature could be predicted from left foot length by using regression equation: Ht= 89.9 + 3.044(LFPL).

## 4. Discussion

The present study deals with correlation of stature with right and left foot length in western Maharashtra population. The right and the left foot length are measured as the first step after which the linear regression equation is applied to determine the stature.

In 1901, MacDonnel reported an equation for the calculation of height from foot,[4] similarly determination of stature has been attempted using foot and shoe stride lengths Saranabasavappa Karaddi[5] in his study on 100

**Table 1:** Mean heights, Mean Foot lengths, Standard deviationmales and females.

| Gender | | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Age | Male | 45 | 21.98 | 2.017 | 0.301 |
| | Female | 55 | 22.25 | 2.011 | 0.271 |
| Height (cm) | Male | 45 | 172.844 | 7.3718 | 1.0989 |
| | Female | 55 | 158.489 | 10.0895 | 1.3605 |
| Right foot length (cm) | Male | 45 | 26.082 | 1.8194 | 0.2712 |
| | Female | 55 | 23.46 | 1.9579 | 0.264 |
| Left foot length (cm) | Male | 45 | 26.084 | 1.8094 | 0.2697 |
| | Female | 55 | 23.427 | 1.8541 | 0.25 |

**Table 2:** Mean, Median and Mode.

| | | Age | Height(cm) | RFL (cm) | LFL (cm) |
|---|---|---|---|---|---|
| N | Valid | 100 | 100 | 100 | 100 |
| | Missing | 0 | 0 | 0 | 0 |
| Mean | | 22.13 | 164.949 | 24.64 | 24.623 |
| Median | | 22 | 165 | 24.55 | 24.75 |
| Mode | | 21 | 160.0a | 23 | 23.5a |
| Std.Deviation | | 2.008 | 11.4542 | 2.298 | 2.2573 |
| Range | | 10 | 80.9 | 13.2 | 13 |
| Minimum | | 19 | 104.1 | 16.5 | 17 |
| Maximum | | 29 | 185 | 29.7 | 30 |

a. Multiple modes exist. The smallest value is shown

**Table 3:** Correlation between Right Foot length, Left Foot length and Stature

| Variable | N. | Mean± SD. | Range. | Cor.coeff 'r' | Reg. equation |
|---|---|---|---|---|---|
| RFL | 100 | 24.64±2.90 | 21.7-27.5 | +0.60 | Ht= 90.139+3.306(RFL) |
| Actual Height | 100 | 164.94±11.45 | 153-176 | | |
| LFL | 100 | 24.62±2.25 | 22.3-26.8 | +0.60 | Ht=89.980+3.044(LFL) |
| Actual Height | 100 | 164.94±11.45 | 153-176 | | |

male students in M.R college concluded that there was a positive correlation between foot length and stature, these findings are consistent with present study, Arun Kumar Agnihotri[6] in his study on 250 medical students(125 males and 125 females) aged 18-30 years developed a relationship between foot length and stature using linear and curvilinear regression models, GN Geetha[7] in her study on two hundred subjects in a rare tribe of Kerala concluded that there was positive correlation between foot length and stature, Kewal Krishnan[8] in his study on 149 females from the northern part of India concluded that foot measurements have a strong relationship with stature in the sub adult female population of North India, Jaydip Sen[9] in his study among 350 adult Rajbanshi and 100 adult Meche individuals from the Darjeeling district of West Bengal concluded that the study provided equations to estimate stature from the feet dimensions among the Rajbanshis,these findings of various researchers are consistent with the findings of present study.

Sreya Moitra[10] in her cross sectional study among 400 subjects in South Bengal concluded that the foot length correlated highly with stature estimation also the correlation coefficient of height with foot length was higher in males as compared to those in females, Kanwal Kamboj[11] in his study on 320 adult volunteers concluded that foot length in males and females shows highest correlation with stature and minimum standard error in the estimation of stature, Anil Sahebrao Pungle[12] in his study on400 medical students concluded that length of feet show statistically significant positive correlation with stature of an individual, Vidyullatha V Shetty[13] in hist study on 440 medical students concluded that stature can be predicted accurately by linear and multiple regression analysis even when identity is unknown from foot length, Rameswarapu Suman Babu[14] in his study on 104 individuals from Secunderabad established definite correlation between stature and foot length and also regression equations had been established in the sample studied, Renu Kamal[15] in her study on 202 individuals from the Kori population of North India concluded that stature could be successfully estimated using foot length, these results are congruous with the conclusions of present study on the western Maharashtra population.

I Illayperuma[16] in his study on 210 medical students found in his research that a positive correlation between height and foot length was observed in both sexes and the

results indicated that foot length provides an accurate and reliable means in estimating the stature of an unknown individual, Jitender Pratap Singh[17] from his study on 250 individuals established definite correlation between stature and foot dimensions, Vineet Dhaneria[18] in his research on 500 medical students concluded that foot length showed positive correlation with stature, Dayanand R[19] in his study on 120 individuals concluded that anthropometric measurements of foot length is valuable in estimation of stature, the outcomes of these studies are clearly consistent and concordat with the outcomes of present study.

## 5. Conclusion

The present study was conducted on 100 healthy individuals (43 Males, 57 Females) of Western Maharashtra population, in the age group of 18-30. From the study a regression equation was devised through which it can be concluded that a positive correlation exists between the foot length and stature of an individual. This important information can be used by Anthropologists in population studies, Forensic Medicine Experts and Legal experts in crime Scene investigations where the identity of the individual is not known.

## 6. Conflicts of interest

All contributing authors declare no conflicts of interest.

## 7. Source of Funding

None.

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**Cite this article:** Singh M, Patel U. Identification of stature from foot length in Western Maharashtra population. *IP Int J Forensic Med Toxicol Sci* 2020;5(4):117-120.