

## Determination of Personal Height from the Foot Length in Maharashtra Region

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### ABSTRACT

**Aims and objective:** In this study an attempt is made to find out the correlation between foot length and total body height in Maharashtra region and to derive a regression formula for estimation of total body height from foot length. **Materials and methods:** The study is done on 212 medical and paramedical students from Maharashtra region. The age of the subjects ranged between 18 and 25 years. The length of the foot is measured between the back of the heel and the tip of great toe or second toe whichever is longer using spreading calipers. **Results:** The results obtained were statistically analyzed and attempt was made to derive a linear regression formula between foot length and total height of an individual. The results of this study show a definite correlation between foot length and height of an individual. The data from the present work may be useful for anatomists, anthropologists, and forensic experts during forensic identification.

**Key words:** Foot length, Total height, Correlation, Regression formula, Forensic experts.

### INTRODUCTION

“Height” has remained a pertinent area of interest for researchers in the past. Height can be estimated from different parts of body. Numerous studies have reported the relation between height and different long bones of our body. These help us to find out the height of an unknown individual when only a few long bones are available for examination. This observation is very important not only for the anatomist but also for the forensic medicine experts in the analysis of medico legal cases (MLC) that are carried out routinely to establish the identity of an unknown.

When muddled (bones and masses of human body) are obtained by the police, they are invariably sent for forensic investigation to Medical Colleges as medico legal cases (M.L.C.). The medical expert is expected to comment on a series of questions put forth; such as if the bones belong to human being, the time since death, possible cause of death, any possibility of poisoning, and possible race / sex / age / height of and unknown individual. In this regard, estimation of the possible height from human remains (bones or body parts) becomes pertinent. Earlier studies by Singh & Sohal (1951)<sup>1</sup>, Singh & Singh (1956)<sup>2</sup>, Charnalia (1961)<sup>3</sup>, Ahawale (1963)<sup>4</sup>, Joshi et al (1964)<sup>5</sup>, Qamra et al (1979)<sup>6</sup>, Shroff & Vare (1979)<sup>7</sup> have reported formula for calculating the stature from bones, but no universally applicable formula has been derived, as the relationship between long bones and height differs according to race, age, sex and side of body<sup>8</sup>. However, long bones are not always available for examination. Foot measurements have been shown to be reliable parameters for the prediction of height as reported in earlier

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studies<sup>3, 6, 9-10, 13</sup> in different populations of India. It is shown that each race requires its own formula for accurate estimation of stature. For the Maharashtra population only a few studies by Chavan *et al* (2009)<sup>12</sup> conducted in the rural area of Maharashtra are available. An attempt hence is made to derive regression formula to calculate height of an individual from the foot length in a Maharashtra population.

## MATERIALS AND METHODS

In the present study the parameters like "Foot length" and "height" were considered. These were measured on 212 subjects (107 males and 105 females). The subjects included in the study were medical and paramedical students belonging to various regions of Maharashtra. The subjects were from similar socio economic background. The age group of students ranged

from 18 to 25 years. The measurements were taken between 2 to 5 p.m. to eliminate the discrepancies due to diurnal variation. The Foot length was measured using sliding calipers. The Foot length was defined as the direct distance from the most prominent point of back of the heel to the tip of the big toe or to the tip of second toe when the second toe is longer than the big toe. Foot lengths were taken independently on left and right side of each individual. The height of individual was measured using height measuring instrument. Results were analyzed to find out mean, standard deviation (S.D.), standard error (S.E.), and coefficient of correlation (r), and the regression equation to calculate height of unknown individual from foot length was derived. The regression equation for the estimation of height was derived as ' $Y = a + bX$ ', where  $Y =$  Height (cm),  $a =$  constant value,  $b =$  slope &  $X =$  Foot length.

## RESULTS

**Table I: Descriptive statistics for foot length and height in males (n= 107)**

Parameters	Foot length(cm)	Height (cm)
Range	23.0 -27.7	160-178
Mean	25.46	170.09
S.D.	1.02	5.19
S.E.	0.09	0.50
Correlation-coefficient (r)	0.530	

Table I shows the descriptive statistics for foot length and height and the correlation coefficient between the foot length and height in males. The range of foot length in male is 23.0 to 27.7 cm and for height is 160 to 178 cm. The mean foot length is 25.46 cm and of the mean height is 170.09 cm. The Correlation Coefficient factor (r) for males is found to be 0.53.

**Table II: Descriptive statistics for foot length and height in females (n= 105)**

Parameters	Foot length(cm)	Height (cm)
Range	20.5-26.5	142-172
Mean	22.90	155.80
S.D.	1.26	6.63
S.E.	0.12	0.64
Correlation-coefficient (r)	0.705	

Table II shows the descriptive statistics for foot length and height and the correlation coefficient between the foot length and height in females. The range of foot length in female is 20.05 to 26.5 cm and for height is 142 to 172 cm. The mean foot length is 22.90 cm and means height is 155.80 cm. The Correlation Coefficient factor (r) for females is found to be 0.70.

**Table III: Descriptive statistics: Foot length & height in males & females together (n= 212)**

Parameters	Foot length(cm)	Height (cm)
Range	20.0-27.7	142-178
Mean	24.19	163
S.D.	1.71	9.30
S.E.	0.11	0.63
Correlation-coefficient (r)	0.840	

Table III shows the descriptive statistics for foot length and height and the correlation coefficient between the foot length and height when the data is considered together for both males and females. The range of the foot length is 20.0 to 27.7 cm and for height is 142-178 cm. The mean foot length is 24.19 cm and means height is 163 cm. The Correlation Coefficient factor(r) is found to be 0.84 Mean foot length and stature in males is found to be larger than females.

### REGRESSION FORMULA FOR STATURE ESTIMATION FROM FOOT LENGTH

For males:  $Y = 101.61 + 2.69$  (Foot length)

For Females:  $Y = 71.53 + 3.68$  (Foot length)

For both male and female (combined):

$Y = 52.7 + 4.56$  (Foot length)

### DISCUSSION

The correlation coefficient between stature and foot length was found to be statistically significant and positive indicating strong relationship between the two parameters. Regression equation for estimation of height was formulated later on using foot length in our study. The result indicates that the foot length provides reliable means in reconstructing the height of an unknown individual. The results from the present study shows that the correlation coefficient factor for male is 0.53, for female are 0.70 and 0.84 for males and females combined, which are similar to that reported in the past studies. The results obtained from various studies that attempted to reconstruct stature from various dimensions of feet demonstrated a higher correlation coefficient and a lower standard error of estimation between the stature and foot length. A study carried by Charnalia (1961)<sup>3</sup> in Pondicherry state shows a significant correlation between height and foot length, where correlation coefficient was 0.46. Qamara et al (1980)<sup>6</sup> have conducted study in northwest India and derived a correlation coefficient for males (r=

0.69) and females (r= 0.70). A study done by Krishna & Sharma (2007)<sup>9</sup> in North Indian Rajput population shows a correlation coefficient for males (r=0.732) and females (r= 0.739). Similarly Kanchan et al<sup>11</sup> have reported a significant correlation between stature and foot length in North Indian Gujjar population for males and females and for males and females taken together. Our findings with regard to the correlation for male and females together were similar to that reported by Kanchan et al<sup>11</sup>. Kanchan (2010)<sup>13</sup> has reported the utility of universal regression formula in stature estimation from foot lengths. Another study carried in Sri Lankan population by Ilayperumaet et al (2008)<sup>14</sup> shows a positive relation between height and foot length where the correlation coefficient for male and female was 0.724 and 0.719 respectively. Thus, findings of our study are in accordance with that shown in earlier studies that show statistically significant correlation between height and foot length.

### CONCLUSION

Correlation coefficient between height and foot length was found to be statistically significant and positive indicating a strong relationship between the two parameters. Hence, it can be concluded that the foot length provides reliable means of reconstructing the height of an unknown individual. The regression models derived in our study can be applied successfully for estimation of personal height in Maharashtra population.

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