

Role of Foot Length in Estimation of Stature of Central Indian Population

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ABSTRACT

Background: The work on estimation of stature from foot length was being carried out since long but data pertaining to regional variations are very few with respect to published literature. Height, like other phenotypic traits, is determined by a combination of genetic and environmental factors. It is sexually dimorphic and statistically more or less normally distributed. Estimation of stature from measurements of various long bones of the extremities has been attempted by many scientists with varying degree of accuracy. All such calculations depend on the fact that limbs exhibit consistent ratios relative to the total height of a person. **Objectives:** This study was carried out to investigate the relationship between personal stature and foot length among a group of male and female Central Indian adults and to derive a regression formula between the foot length and height of an individual. **Materials and Methods:** The subjects consist of 391 medical students from various colleges in central Indian population (Vidarbha region of Maharashtra) ranging between 18 to 22 years of age of similar socio economic status. The length of foot and the height of the subject were measured with using standard anthropometric instruments in anatomical position. Measurements were taken at fixed time to avoid diurnal variation and were carried out by a single person to eliminate the personal factor. The result obtained was analyzed and attempt was made to derive a formula between head length and the total height of an individual. **Results:** The differences of the foot length between the genders were found to be highly significant. A positive correlation between height and foot length was observed in both sexes and it was statistically significant. Regression equation for stature estimation was formulated using the foot lengths for both sexes. **Conclusion:** The results indicate that foot length provides an accurate and reliable means in estimating the stature of an unknown individual. The regression formula derived in this study will be useful for anatomists, archeologists, anthropologists and forensic scientists.

Key words: Anthropometry, Foot length, Total height, identity of individual.

INTRODUCTION

To assess the height of individual from measurement of different body parts of body has always been of particular interest to Forensic experts to establish the identity of an individual. It is also useful to Anatomists and Anthropologists to find the racial differences. The estimation of height from various parameters has been observed

by various workers. In 1961 a study was conducted and the result of study showed that the correlation between height and foot length¹. Another similar study was conducted on height and foot length and derived a correlation coefficient for foot width and foot length². Although many workers^{3,4,5,6} were derived the formula to estimate the height of the individuals from foot length but data from the central part of country is lacking. Therefore, we have planned to conduct such study to make available data pertaining to relation of foot length and height of an individual. This study is also aims to evaluate the sexual differences in the correlation and the equation of regression is derived using the data obtained.

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MATERIAL AND METHODS

The 391 young subjects included 165 males and 226 females are selected from various colleges of Vidarbha region of Maharashtra. The age ranged from 18 to 22 years and of similar socio economic status. The length of foot and the height of the subjects are measured using standard anthropometric instruments in anatomical position. Measurements are taken at fixed time (2 to 5 pm) to avoid diurnal variation and are carried out by a single person to eliminate the error due to personal factor. A written informed consent is taken by all the subjects.

Measurement of Foot Length

The subjects are made to stand on a pre-calibrated osteometric board with bare footed in such a manner that the posterior point of the heel is gently touched the backrest part of the board. A vertical stop is placed against the anterior most point of foot i.e. the tip of hallux or tip of second toe (if toe is larger than hallux)⁷. The distance between the posterior most point of the heel and anterior most point of the foot is measured as foot length in centimeters (Shown in figure I).

Figure I: Figure showing measurement of Foot length



Figure II: Figure showing measurement of total height of an individual



Measurement of Height of Individual

It is measured by the wooden height measuring instruments marked in centimeters. The subjects are asked to stand barefooted in Anatomical straight position. The sliding head plate is brought into firm contact with the vertex of the subject⁷. (Shown in figure II)

The data on the measurements of the subjects are recorded in predesigned Performa and statistically analyzed using computer software - EPI 6. The findings are presented in the tables.

RESULTS

Total 391 young subjects comprised 165 males and 226 females from various colleges of Vidarbha region of Maharashtra are included in the study. The data for personal height and foot length for both the sex are shown in Table-I. The correlation coefficient for foot length was evaluated as 0.755 for males and 0.335 for females. Using this correlation coefficient regression equation for

calculating height from foot length has been derived which is shown in table II.

On basis of regression equation the estimated height is calculated and then root mean square deviation is calculated by observed value and estimated height. The root mean square deviation is obtained as 0.35 for males, 4.35 for females and 4.71 when both males and females are combined.

significantly. This may be due to genetic differences, to childhood lifestyle differences or to both. Correlation coefficient between stature and foot length was found to be statistically significant and positive indicating a strong relationship between the two parameters. Regression equation for stature estimation was formulated using foot lengths and checked for

Table I: Showing range, mean and SD of height and foot length for males and females

Parameter	Sex	Range (in cm)	Mean	SD
Height of Subject (in cm)	Male	153.4 – 189.2	170.12	6.99
	Female	140.8 – 174.0	156.15	11.10
Foot length (in cm)	Male	22.0 – 29.4	25.83	1.27
	Female	20.5 – 27.2	23.42	1.08

Table II: Showing regression equation from foot length of males, females and combine (both male & female)

Sex	Regression Equation
Male	$y = (63.32) \pm (4.13) x$
Female	$y = (78.22) \pm (1.11) x$
Combine	$y = (44.39) \pm (4.81) x$

Where y is height of an individual and x is foot length

DISCUSSION

The present study shows a correlation coefficient of ± 0.755 for males and ± 0.335 for females which is most significant. A study was conducted by Suneel Q (1980) to develop a model for reconstruction of height from foot measurements in an adult population of northwest India and observation showed that the correlation coefficient between height and foot length in Gujarat population was shown to be ± 0.69 for males and ± 0.70 for females⁵.

The average height for each sex within a population is significantly different, with adult males on average being taller than adult females. It is stated that the gender difference in height may be attributed to sex chromosomal differences. Adult height between ethnic groups often differs

their accuracy by comparing the estimated stature and the actual stature. The results indicate that foot length provides an accurate and reliable means in reconstructing the stature of an unknown individual. Furthermore, ossification of the bones of the foot occurs earlier than the other long bones of the lower extremity. Therefore, even during adolescent age, height can be predicted more accurately from foot measurements than from the other long bones of the lower limb. Results obtained from a study that attempted to reconstruct stature from various dimensions of feet demonstrated the highest correlation coefficient and the lowest standard error of estimation between the stature and foot length.

Significant and positive correlation coefficient has been shown to exist between stature and measurements of foot length. Taken together the evidence suggests that the relationship between foot length and stature is of practical use in medico legal, anthropology and archeological studies when such evidence provides the investigator the only opportunity to gauge that aspect of an individual's physical description.

CONCLUSION

The results indicate that foot length provides an accurate and reliable means in estimating the stature of an unknown individual. The regression

formula derived in this study will be useful for anatomists, archeologists, anthropologists and forensic scientists.

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