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Original article

Study of correlation between Human height and foot length in residents of Mumbai

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ABSTRACT

A tall person needs long foot to support body and for increased balance. Foot size and height are both based on many factors such as gender, genetics, health and environment. Foot size may be used in forensic test to estimate the height of a person whose body is no longer intact. Aim: To analyze the correlation between foot length and height in Mumbai Population. Methods: The present study was done on 298 individuals residing in Mumbai. To find out the correlation between height and foot length, the subjects were divided into 6 groups according to the height and foot length & each subject was assessed. Results: The average of mean foot length in males & females in all age groups from 11 years - 30 years (and more) is 20.80cm and 20.81 respectively .The correlation coefficient between height and length of foot also shows significant association for all the age group and sex. Conclusion: Height of an individual either male/female is 6.5 times the length of his/her foot length

1.Introduction:

Estimation of height from various long bones has been attempted by several workers with variable degree of success. However, foot dimensions have not frequently been used for this purpose. It was Rutishauser who for the first time showed in children, that the reliability of prediction of height from simple measurements like foot length was as high as that of long bones1. Difficulty to obtain accurate measurements of long bones has been pointed out by several workers. Ashizawa studied the correlation between foot length and general body size2. Nat showed that accurate measurement of length of femur was not possible because of variable position on angle of neck with shaft of femur3. Musgrave and Harneja worked out height from various metacarpals amongst British adults and found significant degrees of association in both sexes (Male : r = 0.58 to 0.67 and Female: r = 0.49 to 0.71). They also obtained successful prediction of height in 9 out of 10 subjects by using adjusted metacarpals measurement4. Rutishauser estimated height from foot length in African children aged below six years with as much success as found by Trutter and Glesser in adult American Negroes and Whites1,5. Thus the aim of this study is to find out the correlation between foot length and height in Mumbai population.

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2.Material And Method:

The measurements from 298 individuals residing in Mumbai were studied in Department of Anatomy, Terna Medical College, Navi mumbai. The subjects were divided into groups as per their age and sex:

Group 1: included children upto age of 1year in which there were 20 females &20 males.

Group2: included children only of age 11 years in which there were 20 females &20 males.

Group3: included children only of age 12 years in which there were 20 females &20 males.

Group4: included children only of age 13 years in which there were 20 females &20 males.

Group5: adults above the age of 30 years in which there were 20 females &20 males.

Group6: included students of first MBBS of age groups 17 to 19 years in which there were 52 females &46 males.

All the subjects were examined for -

a) Height - was measured on stadiometer (fig-1,fig-2) except in babies. They were made to stand against wall and height was measured.. The measurements were taken at a fixed time to eliminate diurnal variation and by the same person to avoid personal error in methodology.

b) Foot Length - nails was trimmed and measurement were taken on ruled paper in standing position. The outline was marked as it is done for shoe print. Measurements were taken between the proximal and distal points on the foot outline as under :

Proximal Point - Point of maximum curvature on the outline of the heel (Fig 3).

Distal Point Point of maximum curvature on the outline of the great toe (Fig 4).

2.1.Measurement of Foot

Procedure was explained to the subjects. They were given practice. Lined, double foolscap paper was spread on the bench. Subject stood on the paper in erect but relaxed position, avoiding undue pressure on the feet. For proximal point curve of the heel was marked by a pencil with good sharp tip, holding it at right angles to the heel. The point of maximum convexity was marked as the proximal point. Distal Point was considered on the great toe only, not taking into account the length of other digits. Curve of the great toe was marked with pencil having good sharp tip, taking care to hold it at right angle to the great toe. Mid Point of the curve was taken as the distal point. Distance between the proximal and distal point was measured with a ruler (Fig 5). The same ruler was used for all measurement in all the subjects .Statistical significance of difference between the groups was calculated by using Students "t" test. A difference between the two groups was considered to be significant when $p<0.005$

Figure 1 - Standiometer

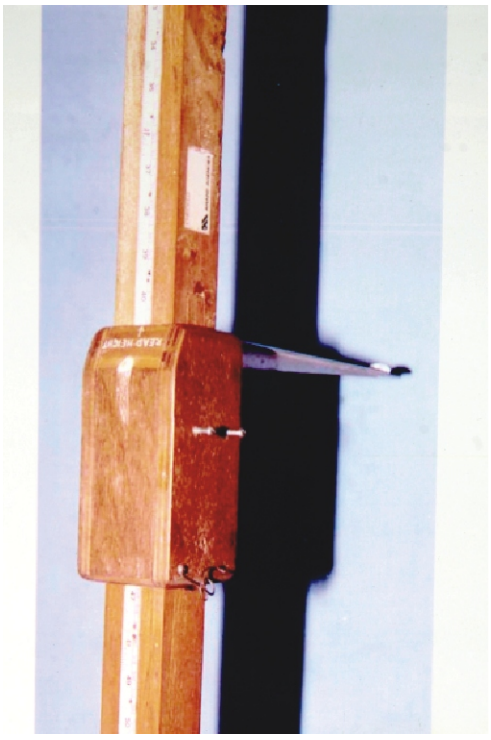
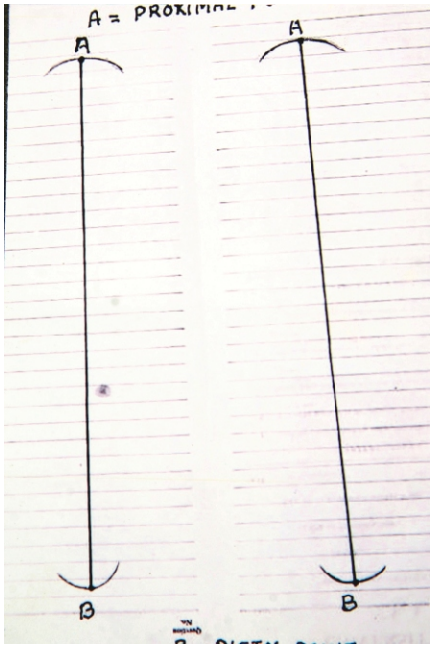


Figure 2 – Measurement of Height

Figure 3 – Marking of Proximal Point

Figure 4 – Marking of Distal Point

Figure 5 – Distance between the Proximal & Distal Points.



3.Result and discussion:

The present study shows that mean height of age group one year in male child was 68.35 ± 2.32 cm. and female child was 69.1 ± 1.97 cm. Mean height of age group eleven years in male child is 132.75 ± 5.95 cm. and female child is 132.77 ± 5.97 cm, group twelve years in male child is 135.22 ± 5.91 cm. and female child is 138.85 ± 7.80 cm, group thirteen years in male child is 137.57 ± 6.22 cm. and in female child is 139.15 ± 7.27 cm, age group seventeen to nineteen years in male child is 171.23 ± 6.07 cm and in female child 156.81 ± 5.25 cm and in age group above thirty years in male child is 164.72 4: 7.19 cm. and in female is 150.78 ± 2.90 cm (table1). Patel S. M found that the mean height was 170.96 cm in males and 156.14cm in females in age group 17 to 22 years 6. Mean length of foot in age group up to one year in male child was 11.42 ± 0.47 cm. and in female child was11.56 ± 0.56 cm. Mean length of foot in male child of eleven years was 20.80 ± 1.28 cm. in female child is 20.81 ± 1.29cm, male of age group of twelve years was 21.055 ± 1.05 cm. and in female was 21.52 ± 1.19 cm, age group thirteen years in male child is 21.42 ± 1.17 cm. and in female child 21.475 ± 1.04 cm, male of age group of seventeen to nineteen years male child is 25.92 ± 0.96cm. and in female child is 23.49± 1.33 cm and in age group above thirty years in male was 24.67± 1.19 cm. and in female 22.08± 1.11 cm. In the living there is a definite proportion between the foot length and height (Table2) Patel S. M found that the mean foot length was 22.44 cm in males and 22.34 cm in females in age group 17 to 22 years 6. Our study reveals that mean value of the ratio between height and foot length in males is 6.52 excluding group I, mean value of the ratio between height and foot length in females is 6.57, excluding group 1 (table3). The correlation coefficient between height and length of foot also shows significant association for all the age group and sex(table4). Rutishauser found the correlation coefficients for the data of all three groups of African children of different ethnic origin are similar (0.90-0. 98) and indicate a highly significant (p<0 001)9. degree of association between height and foot length1. Charnalia showed the significant correlation between height and foot length7. Qamra et al derived a regression equation between foot length and height in North West India population 8. There correlation coefficient between foot length and height was, +0.69 in male and +0.70 in female Danborno found strong significant relationship between hand and foot length and height (P<0.001). hand and foot lengths were compared to height and it was found that the relationship was stronger in the males than in the females

Table 1 . Mean height of study cases according to Age-Groups

Age Groups (years)	Male	Female
Upto-1	68.35 ± 2.32	69.1 ± 1.97
11	132.75 ± 5.95	132.72 ± 5.97
12	135.22 ± 5.91	138.85 ± 7.80
13	137.52 ± 6.22	139.15 ± 7.27
17 to 19	171.23 ± 6.07	156.81 ± 5.25
Above 30	164.72 ± 7.19	150.78 ± 2.90

Table 2. Average length of Hand according to Age-Groups

Age - Group In Years	Mean Length of Foot (X± SD)	
	Male	Female
1	11.42 ± 0.47	11.56 ± 0.56
11	20.80 ± 1.28	20.81 ± 1.29
12	21.055 ± 1.05	21.52 ± 1.19
13	21.42 ± 1.17	21.475 ± 1.04
17- 19	25.92 ± 0.96	23.49± 1.33
> 30	24.67± 1.19	22.08± 1.11

Table 3: Mean ratio of Height And Length of foot according to Age-Groups

Age Groups (years)	Male	Female
Upto-1	5.99±0.29	5.97±0.22
11	6.37±0.25	6.39±0.22
12	6.43±0.25	6.45±0.19
13	6.43±0.20	6.48±0.19
17 to 19	6.70±0.61	6.69±0.43
Above 30	6.68±0.23	6.84±0.28

4.Conclusion:

The mean height of female up to age-group of 13 years were on higher side as compared to male students. But among the 17 - 19 years and 30 years of group cases of male had more height than female. The average of mean foot length in males & females in all age groups from 11 years - 30 years (and more) is 20.80cmand 20.81 respectively. Height of an individual either male/female is 6.5 times the length of his/her foot length.

Table 4 : Correlation and Regression equation o f height (Y) and foot length (X) of cases according to Age

Age Groups	Sex	No. of Cases	Correlation coefficient (2)	Regression Rgh Y = a + bx
1	M	20	0.169	0.169
	F	20	0.721	0.721
11	M	20	0.808	0.808
	F	20	0.816	0.816
.12	M	20	0.681	0.681
	F	20	0.852	0.852
13	M	20	0.826	0.826
	F	20	0.835	0.835
17 - 19	M	46	0.588	0.588
	F	52	0.442	0.442
>30	M	20	0.732	0.732
	F	20	0.618	0.618

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