

Estimation of Stature from Foot Length of Students in Anambra State University

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ABSTRACT

Estimation of stature from measurement of various body parts is of particular interest to many anatomist and forensic scientist for its importance in medico-legal cases. Significant and positive correlation coefficient has been shown to exist between stature and measurements of foot length. The present study is based on the measurement of foot length and body height of 300 students of Anambra state university between the ages of 17 to 22. The length of the foot was measured between the most prominent points of the back of the heel to the tip of the second toe, when the second toe was larger than the hallux. Venier caliper was used to measure foot length. Obtained data was analyzed separately for male and female and attempt was made to find out the correlation and derive a regression formula between foot length and height of an individual. The values of between age and height of male and female is (- 0.141) and (0.038) respectively. The values between age foot length of male and female is (-0.209) and (0.060). The value between height and foot length of male and female is (0.629) and (0.502). Male mean height (178.04cm) was also higher than female mean height (168.20cm). The result shows that there is a definite correlation between foot length and height of an individual. Thus, the result of the present study would be useful for Anatomist and Forensic Medical Experts.

INTRODUCTION

Height is fundamental for assessing growth and nutrition, calculating body surface area, and predicting pulmonary function during childhood. Body proportions and the dimensions of various body segments, including the long bones of their limbs and the bones of the foot and hand have been used to estimate stature (Telkka, 1950).

Stature provides insight into various features of a population including nutrition, health and genetics. Various studies in past have been undertaken to study the relation between height of a person and various body parts but not much has been done to have it from the foot length. Dimensional relationship between body segments and the whole body has been the focus of anatomists, scientists, and anthropologists for many years (Charnalia, 1961).

Estimation of stature of an individual from the skeletal material or from the mutilated or from amputated limbs or from parts of limbs has obvious significance in the personal identification in the events of the murders, accidents or natural disasters mainly concerned with the forensic identification analysis. Many factors like racial, ethnic and nutritional factors play an important in human development and growth; therefore different nomograms become necessary for different population (Jasuja, 1993).

Prediction of the dimensions of body segments is useful in many areas of modern science (Athawale, 1963). The long bones of the limbs, however, have been the most widely studied (Sharma, 1978). Determination of stature from incomplete skeletal and decomposing human remains is predominantly important in personal identification. However, personal identification from foot and its segments becomes more important in cases of mass disasters, where there is always likelihood of recovering feet (often enclosed) in shoes separated from the body (Vij, 2009).

Ossification of bones of foot occurs earlier than that of long bones of lower extremities (Yaron Shor & Sarena Weisner, 1999). 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.

Furthermore, stature estimations may be made from large fragmentary long bones provided the appropriate landmarks can be located and distances between them measured. From landmarks, the maximum length of the bone is calculated using regression formulae. This method gives a fairly good ideal of height. Since this is an estimate based on an estimate, it is not expected to be as accurate as determining the stature interval using an intact (complete) long bone.

Till date, most of the workers on stature estimation have used the length of bones such as femur, tibia, humerus, radius, etc. Very little data is available on previous work done for calculation of height from foot length. Hence this study intends to fill this gap. This study looks into the possibility of estimation of stature from foot length.

MATERIALS AND METHOD

The study was carried out in Anambra State University Uli, Anambra State. Total of 300 basic medical students comprising of (150 males and 150 females) asymptomatic healthy students belonging to south-east Nigeria of Anambra state. The objective of the study was properly explained to the students. Individual student's foot length and stature were taken separately.

Height of the individual was measured standing in anatomical position with standard height measuring instrument. The measurements were taken at a fixed time between 8: 00am to 12:00pm to eliminate diurnal interference and by the same person to avoid personal error. Foot length was measured as a direct distance from the most prominent point of the back of the heel to the tip of the hallux or to the tip of second toe, when the second was larger than hallux using a Venier caliper.

Inclusion Criteria

Subjects between the ages of 17-22years of Anambra State Origin

Exclusion Criteria

Cases having any significant diseases, congenitally malformed limbs, metabolic disorders are excluded.

DATA ANALYSIS

The data obtained were subjected to statistical analysis for determining mean, standard deviation, standard error, Pearson's correlation value, and linear regression equation for males and females by using Statistical Package for Social Student (SPSS).

OBSERVATION AND RESULTS

TABLE-I: Foot Length and actual Height (Ht) in Male Students

S/N	FLM	No. of individual	Min (Ht)	Max (Ht)	Avg Ht
1	25-26	23	158	179	168.5
2	27-28	54	166.5	184	175.3
3	29-30	62	169	191	180
4	31-32	11	185	196	190.5

Table I shows the foot length and stature of 150 male students.

A linear correlation and regression analysis were done for assessing the relationship between the foot length and stature for different levels of foot length. Maximum number of 62 students with foot length 29-30 showed average height of 180 as shown in the table above. It has been shown that height increases as foot length increase as seen among the foot length of 23 student (25-26cms) with average height of 168.5cms showing positive correlation between two parameters. The average height increases 168.5cms for male foot length of 25-26cms, which increased to 190.5cms with maximum foot length of 31-32cms.

TABLE- 2: Foot length and actual Height (Ht) in Female Student

S/N	FLF	No. of individual	Min (Ht)	Max (Ht)	Avg Ht
1	23-24	13	153	167	160
2	25-26	89	158	178	168
3	27-28	44	162	178	170
4	29-30	4	180	186	183

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

Descriptive statistics of foot length and a linear correlation, regression analysis was done on the data obtained from 150 female students for assessing the relationship between foot length with stature and estimation of stature for different levels of left foot length. In this study maximum number of 89 students had foot length of 25-26cms with average height of 168. There was increase in the stature as foot length increases, showing a positive correlation between the two parameters. The average minimum height was 167cms with foot length of 23-24cms which increased to 186cms with maximum foot length of 29-30cms

Table 3: The observations made by the previous workers and their results compared with the present work

S/N	Study	Stature in males (cm)	Stature in female (cm)	Foot length in males (cm)	Foot length in females (cm)
1	Giles et al. 1980	174 ± 6.61	162.95 ± 6.52	26.77 ± 1.30	24.31 ± 1.25
2	Agnihotri et al. 2007	173 ± 6.13	159.56 ± 6.25	26.12 ± 1.09	23.33 ± 1.08
3	Sen et al. 2008	162.23 ± 5.69	149.53 ± 5.37	24.01 ± 1.09	22.27 ± 1.00
4	Krishan et al. 2008	167.4 ± 5.9	159.5 ± 5.1	26.3 ± 1.5	23.28 ± 1.1
5	Mansur et al. 2012	165.66 ± 8.34	156.70 ± 6.16	23.89 ± 2.09	22.64 ± 1.36
6	Present study	178.04 ± 7.72	168.20 ± 6.06	28.55 ± 1.57	26.24 ± 1.05

Table 3- showed variation in mean foot length between different study groups compared with the present study.

The mean and standard deviation of stature from various study groups in male ranges from 162.23 ± 5.69 to 178.04 ± 7.72 while female is 149.53 ± 5.37 to 168.20 ± 6.06 . Agniotri et al. (2008) attained 173 ± 6.13 in the mean stature of male which is nearly in line with the present study 178.04 ± 7.72 .

Table 4: Correlation coefficient (r), Regression equation to estimate stature from foot length in different study groups

S/N	Study	Male		Female	
		R	Regression equation	R	Regression equation
1	Giles et al. 1980		82.20 ± 3.447 FL		82.20 ± 3.447 FL
2	Agnihotri et al. 2007	0.72	68.58 ± 4.036 FL	0.608	77.059 ± 3.56 FL
4	Sen et al. 2008	0.623	84.07 ± 3.255 FL	0.682	68.663 ± 3.632 FL
5	Krishan et al. 2008	0.764	90.27 ± 2.93 FL	0.502	105.20 ± 2.287 FL
6	Mansur et al. 2012	0.688	100.18 ± 2.73 FL	0.587	96.4 ± 2.66 FL
8	Patel et al 2012	0.925	77.89 ± 3.55 FL	0.741	38 ± 5.192 FL
9	Present study	0.629	90.07 ± 3.08	0.502	92.03 ± 2.90

Table 4- showed the correlation coefficient (r) for correlation between foot length and stature in males of different study group.

The correlation coefficient between foot length and stature in males of different study groups ranged from 0.623 to 0.925. patel et al. (2012) showed nearly perfect correlation for males ($r= 0.925$). There is nearly attained correlation between the present work for males ($r= 0.629$) and Sen et al. (0.623) which suggests significant correlation. This means that stature can be better predicted with good accuracy using foot length.

DISCUSSION

Stature estimation is one of the most important parameter in identification of a person. Some parts of the body show biological relation with stature. Many workers use body parts or skeletal remains to estimate height. Measurement of stature by use of various long bones has been attempted by several anatomists, anthropologist and forensic scientist with variable degree of success.

The foot has been a predictor of height estimation in several studies in different ethnic groups where normograms have been derived to reconstruct stature from foot dimension (Giles & Vallandigham, 1991). Theodore (2008) stated that right foot length and left foot length is independent predictor of stature.

Some factors may affect variation in foot morphology and stature of different communities. These variations in mean stature between same sex groups of different study group are influenced by genetic and environmental factors. This is the reason for variation in mean foot length amongst individuals of same sex belonging to different endogamous groups (Tanner, 1986). Findings from the present study reveal that males had longer foot length than female. This is because the growth of feet stops about two years earlier in females than in males.

The present study revealed correlation between foot length and stature in male ($r = 0.629$) and female ($r = 0.502$) which suggest significant correlation. This suggests that foot length is a good predictor of stature. Linear regression equation for female and male subject was derived and thus employed in the estimation of stature using foot length of an individual. The regression equation has a constant and multiplication factor. The foot length is usually multiplied by the factor and added to the constant to get the stature. In the equation for foot length in male, the constant is 90.07 and multiplication factor is 3.08. Thus, for every 1 cm increase in foot length the stature increases by 3.08 in male.

CONCLUSION

In population similar to our subjects, stature and gender estimation can be done by using foot measurements and it will be helpful for Anatomists, Archeologists, Anthropologists and forensic experts to calculate stature based on foot length.

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