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Prediction of Stature by the Measurement of Lower Limb Length And Foot Length

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ABSTRACT

Aims: Present study was carried out to assess and correlate the length of lower limb and foot and the stature and to predict the stature of an individual by length of lower limb and foot using regression analysis.

Materials & Methods: 200 male asymptomatic apparently healthy subjects were included to participate in study. Present study was conducted at Department of Anatomy, SMMH Medical College, Saharanpur, UP, India. Lower extremity length, Foot length and Stature were measured according to standard methods.

Results: Linear regression analysis was done to estimate the stature from foot length & lower limb length as independent variables. Pearson's correlation coefficient was used to find the relationship between the foot length & personal height and between lower limb length & personal height. The stature ranged from 156 to 182 cm. Mean lower limb length and foot lengths were 96.68 and 25.69, respectively. Statistically significant correlation was observed between stature and lower limb length and foot length. Pearson correlation (r) for stature and lower limb length and foot length was 0.87 and 0.75, respectively. Linear regression equations were determined for estimation of stature.

Conclusion: The present study has established definite correlation between stature and foot-length & lower limb length and also regression equations have been established. If either of the measurement (foot length, lower limb length or total height) is known, the other can be calculated and this would be useful for Anthropologists and Forensic Medicine experts. There are lot of variations in estimating stature from limb measurements among people of different regions & races.

KEYWORDS: Stature, Lower limb length, Foot length, Regression equation.

INTRODUCTION

Estimation of stature has a significant importance in the field of forensic anthropometry. To assess the height of an individual, from measurements of different parts of the body, has always been of immense interest to Anatomists, Anthropologists and Forensic experts. Physical anthropologists have been mainly concerned with the study of the human origin and human evolution as well as the varieties of mankind in different parts of the world.[1,2] Estimation of stature of an individual from the skeletal material or from the mutilated or amputated limbs or parts of limbs has obvious significance in the personal identification in the events of the murders, accidents or natural disasters mainly concerns with the forensic identification analysis.[3] Whenever case materials such as skeletal remains and body parts are discovered, a forensic examiner is asked to opine about recognition for deceased.[4] Stature along with age, race and gender, the big four parameters, are considered to develop the anthropometrical databases. These data can confirm the process of identification.[5]

The relationship between specific body dimensions / proportions can be used to help solve crimes in the absence of complete evidence. For example, it has been proved that stature can be estimated from imprints of the hand, foot or footprints or from a shoe left at the scene of a crime.[6]

Similarly, the stature of a victim can be estimated when a part of body, such as a long bone, or hand, is all that remains.[7] Relationships between body parameters vary from population to population and ethnic origin to ethnic origin due to differences in nutrition and levels of physical activity.[8]

Although several studies have been done for finding a relationship between stature and bone measurements, there are limited reports regarding present study population. Therefore, this study was carried out to assess and correlate the length of lower limb and foot and the stature and to predict the stature of an individual by length of lower limb and foot using regression analysis.

MATERIALS AND METHODS

200 male asymptomatic apparently healthy subjects were included to participate in study. Present study was conducted at Department of Anatomy, SMMH Medical College, Saharanpur, UP, India. The age ranged between 18 – 25 years.

A slow decline in the height is known to occur as the age advances and therefore older subjects were not studied. The left foot was selected for measurement as per recommendation of the international agreement for paired measurements at Geneva (1912).

Lower extremity length was measured in centimeter as the distance between iliac crest to the floor. Cases were in standing position whereas back of the shoulders, buttocks, and heels were close to the wall without any rotation. Foot length was measured as a direct distance from the most prominent posterior point of back of the heel to the tip of hallux or to the tip of second toe (when the second toe was longer then hallux).

Stature was measured in centimeter. Each subject was asked to stand barefoot on a flat surface. Upright height was taken from the vertex to the floor according to the anatomical position and Frankfurt Plane. The measurements were taken at fixed time between 2 to 5 p.m. to eliminate the discrepancies due to diurnal variation and by the same person to avoid personal error in methodology. To minimize subjective errors, all the measurements were taken three times and then mean was taken.

The obtained data was analyzed to find out mean, standard deviation (S.D.), coefficient of correlation. Regression equations were derived to calculate height of unknown individual from foot length and hand length.

Table 1: Descriptive statistics of present study.

Variable	Range	Mean	SD
Stature	156 - 182	173.46	5.46
LLL	91-108	96.68	1.37
FL	22- 29	25.69	1.19

LLL: Lower limb length (cm), FL: Foot length (cm)

Table 2: Pearson correlation(r) and linear regression equation.

Variable	r	P-value	Regression equation
LLL	0.87	<0.05	S=113.084+2.89×LLL (cm)
FL	0.75	<0.05	S=81.13+3.48×FL (cm)

LLL: Lower limb length (cm), FL: Foot length (cm)

Table 3: Comparison of the variables of present study with similar studies.

Study	Country	Stature	LLL	FL
Moshkdanian G et al.[9]	Iran	174.04	97.54	26.22
Ahmed et al.[10]	Saudi Arabia	-	-	26.53
Mansur et al.[11]	Nepal	165.66	-	21.85
Kumar Jakhar et al.[12]	India	173.48	-	25.44
Hairunnisa M et al.[13]	Malaysia	164.8	-	23.2
O¨ zaslan et al.[7]	Turkey	171.97	-	24.9
Krishan et al.[14]	India	172.54	96.09	-
Present Study	India	173.46	96.68	25.69

RESULTS

Linear regression analysis was done to estimate the stature from foot length & lower limb length as independent variables. Pearson's correlation coefficient was used to find the relationship between the foot length & personal height and between lower limb length & personal height. The stature ranged from 156 to 182 cm. Mean lower limb length and foot lengths were 96.68 and 25.69, respectively.

Descriptive statistics of stature, lower limb length and foot length are shown in Table 1. Statistically significant correlation was observed between stature and lower limb length and foot length. Pearson correlation (r) for stature and lower limb length and foot length was 0.87 and 0.75, respectively (Table2) Linear regression equations were determined for estimation of stature. Linear regression equations derived for reconstruction of stature are shown in Table2. Lower limb length and foot length showed a significant correlation with the stature (P<0.05).

DISCUSSION

In forensic examinations and anthropological studies, prediction of stature from incomplete and decomposing skeletal remains is vital in establishing the identity of unknown individual.[16] Height estimation by measurement of various long bones, head measurements, hand, foot length etc. has been attempted by several workers with variable degree of success. Between two basic methods of estimating stature, mathematical

method is more available than anatomical method. So, regression equations can be useful. Despite of the acceptable progression in different fields of forensic medicine, less attention has been paid to estimation of the body stature from the skeletal remains. In the present study, the linear regression was formulated for estimation of stature from lower limb length and foot length in the male subjects. It is worthy to note that there are some various factors such as genetic, nutrition, geographical location, physical activity and various races which affect the anthropometric data.[17]

In present study, the mean length of lower limb was 96.68, which is comparable with Krishan et al.[15] in Indian population. (Table 3) The reported foot length in our study was approximately similar to other studies which are mentioned in Table 3 except in Nepal population.[11]

The correlation coefficient (r) between stature and length of foot was 0.75 in the current study. According to our results, lower limb length (r=0.87) can be a more logical predictor of stature for males in comparison with foot length (r=0.75) as reported by Krishan et al. for Indian population.[15] In view of the fact that Indian populations have diverse ethnic variations, it is expectable to have different anthropometric features in different geographical regions. Consequently, the linear relationship of the stature with body parts of the individuals can be different. Hence, the regression equations derived for defined geographical region should not be applied to another region.

This study has shown significant correlation between stature and dimensions. Also, the regression equation is developed. So the lower limb length and foot length provided the reliability and accuracy in estimating stature with the use of regression equation. In spite of that further researches, especially on different races must be carried out to prepare extensive information for forensic experts for stature estimation.

CONCLUSION

The present study has established definite correlation between stature and foot-length & lower limb length and also regression equations have been established. If either of the measurement (foot length, lower limb length or total height) is known, the other can be calculated and this would be useful for Anthropologists and Forensic Medicine experts. There are lot of variations in estimating stature from limb measurements among people of different regions & races.

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