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Estimation of Stature of Adult Bangladeshi Male from the Length of the Foot

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Abstract

Context: *Estimation of stature from different parts of body is important in forensic anthropology and archaeology. The reliability of estimation of stature from length of the foot is as high as that from long bones. Even during adolescence, stature can be predicted more accurately from the length of the foot than that from the long bones of the lower limb. The relationships of stature to length of long limb bones differ among populations.*

Study design: *Descriptive type of study.*

Place and period of the study*: Department of Anatomy, Sir Salimullah Medical College, Dhaka from July 2010 to June 2011.*

Materials and Method: *A total number of 100 medical students of 3rd and 4th year were chosen by purposive sampling.*

Results: *The mean (± SD) of stature, length of the right and left foot of 100 adult Bangladeshi males were 167.97 (± 6.43) cm, 25.30 (± 1.24) cm and 25.32 (± 1.22) cm respectively.*

Both the length of the right and left foot showed significant positive correlation with the stature (r=.696, p=.000 and r=.708, p=.000 respectively). No significant difference was found between the measured and calculated stature from the length of the foot.

Key words*: Stature, Foot length, Anthropometry.*

Introduction:

Stature constitutes an essential element in the description of a human population, or an individual, for physical anthropological and bioarchaeological research[1]. The estimation of stature from incomplete skeletal and decomposing human remains is particularly important in forensic anthropology and archaeology. This can be used to help the forensic experts to solve crimes in the absence of complete evidence[2].

Stature is one of the most important elements in the identification of an individual. Establishing the identity of an individual from mutilated, decomposed, & amputed body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. It is important both for legal & humanitarian reasons[3].

Bioarchaeological research reveals the importance of accurate stature estimation. It provides relevant information on life conditions of past populations. Stature is a good indicator of health, sexual dimorphism and evolutionary trends in overall body size and proportions. In addition, accurate stature estimation is necessary for reconstructing living body mass, skeletal rigidity and activity levels[4].

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Different parts of the body can be used in the estimation of stature. Long bones & appendages can be aptly used in the calculation of height of a person. There are many examples of studies that have shown the correlation of stature with different parts (face, upper limb, lower limb etc.) of the body & with long bones[3]. The reliability of prediction of stature from foot length is as high as that from long bones. Ossification of the bones of the foot occurs earlier than the long bones of the lower extremity. Therefore, even during adolescence, stature can be predicted more accurately from the foot length than that from the long bones of the lower limb[5].

The accurate measurement of stature under field survey condition is extremely difficult but it can provide valuable information. In this type of survey, measurements have frequently to be made by staff with a minimum training. In this situation it would not be a suitable technique to measure the length of any of the long bones to predict the stature. The practicable alternative to it would be the measurement of foot length which can be made very simply and accurately[6].

The relationships of stature to length of bones differ among populations, and different regression equations are required for individuals belonging to different populations[7,8]. So, there are inter-racial & inter-geographical differences in measurements & their correlation with stature which may be true for one race or one region or which may not be true for the other[3].

Materials:

The study was carried out from July 2010 to June 2011 in the Department of Anatomy, Sir Salimullah Medical College, Dhaka. A total number of 100 medical students of 3rd and 4th year were chosen by purposive sampling for the study.

Methods:

Stature (the distance from the vertex, the highest point on the head held in the Frankfurt horizontal plane, to the sole of the foot in an upright position) of the subject was measured with the stadiometer. The subject was requested to stand barefoot on the foot place of the stadiometer but not to lean against the vertical bar with the head held in the Frankfurt horizontal plane. The heels were kept together and hands hanged down on each side with the palm facing the thighs. The heels, the buttock and the upper part of the back of the head touched the vertical bar of the stadiometer. The subject inhaled deeply and maintained this upright posture during measurement and the wooden plate was gently placed on the head and the reading was recorded on the centimeter scale keeping the eye on the same level where the vertex was in touch with the wooden plate[9]. The length of the foot was measured by a foot caliper. It was measured when the subject was sitting in a relaxed position putting same weight on both foot after taking off the shoes and the stockings. The ankle was perpendicular to the foot. The fixed jaw of the caliper was placed on pternion (most posterior and prominent point of the heel) [10] and the sliding jaw was fixed on acropodion (tip of the most protruded first or second toe) [10]. The caliper was kept parallel to the long axis of the foot[10]. Length of both right and left foot were measured. The measurement was carried out at a particular period of time of 10 am to 2 pm to avoid diurnal variation.

In vernier caliper,

length= reading of the main scale + vernier coincidence x vernier constant

+ mechanical error

(Here vernier constant = 0.01 and Mechanical error= 0)

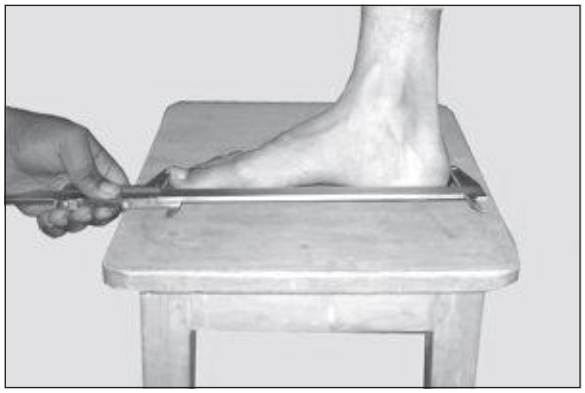

Fig.-1: *Procedure for measuring foot length by foot caliper.*

Calculation of stature using regression equation:

Stature = value of constant + regression coefficient x foot length[11]

Value of the constant and the regression coefficient were calculated using SPSS version 16.0 program.

Data analysis:

The mean values and the standard deviations were calculated for stature and foot length. Correlation of the foot length with the stature was also assessed. Regression co-efficient and constant were calculated for estimating stature through regression equation from foot length. The effectiveness of using the regression equation in this calculation was tested by test of significance (Z-test).

Results:

The mean (± SD) stature of 100 adult Bangladeshi male was 167.97 (± 6.43) cm. The stature showed significant positive correlation with foot length as shown in table-I.

Table-1 shows the range and mean (± SD) of foot length, constant, regression co-efficient and r (correlation co-efficient) value with level of significance. The length of the foot of the respondents of right side ranged between 22.83 cm and 27.85 cm where as the length of the left side ranged between 22.93 cm and 27.75 cm.

The right foot length showed a significant positive correlation (r=.696, p=.000) with the stature (Fig. 2). The left foot length also showed a significant positive correlation (r=.708, p=.000) with the stature (Fig. 3). The constant and regression co-efficient value regarding right foot length were 76.826 and 3.603 respectively and left foot length were 73.406 and 3.735 respectively for estimating the stature

Table-I

Stature and length of the foot with corresponding constant and regression co-efficient:

Variables	Measurement in cm		Constant coefficient	Regression	Correlation with stature	
	Range	Mean ± SD			r	p-value
Stature	153.0-177.5	167.97 ± 6.43				
Right foot length	22.83-27.85	25.30 ± 1.24	76.826	3.603	.696*	.000^S
Left foot length	22.93-27.75	25.32 ± 1.22	73.406	3.735	.708*	.000^S

* = Correlation is significant at the 0.01 level (2-tailed), S = Significant, r = Pearson's correlation Stature (cm)

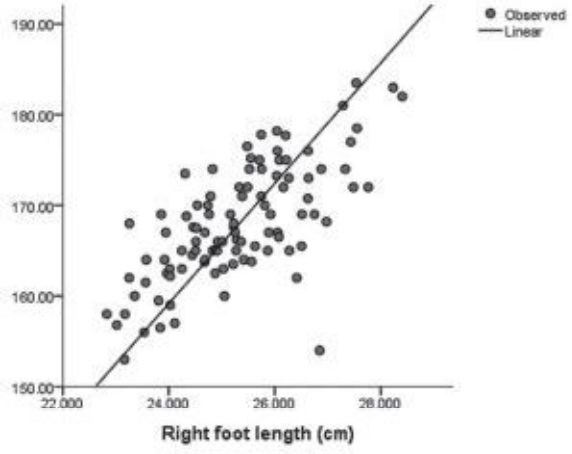

Fig.-2: *Scatter diagram with regression analysis showing significant positive correlation between the stature and right foot length (r=0.696 and p= 0.000). Stature (cm)*

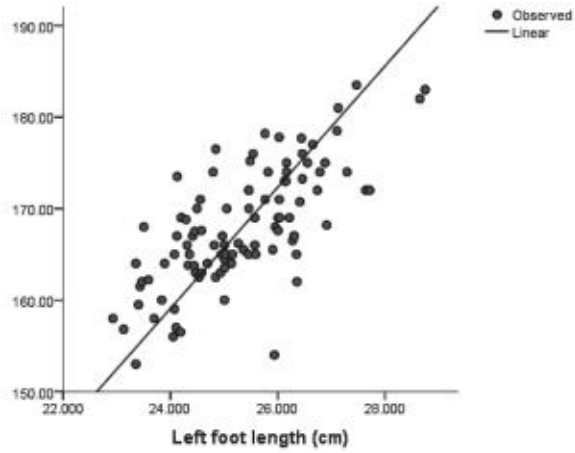

Fig.-3: *Scatter diagram with regression analysis showing significant positive correlation between the stature and left foot length (r=0.708 and p= 0.000).*

The regression equations for estimation of stature from right foot length (RFL) and left foot length (LFL) were 76.826+3.603×RFL and 73.406+3.735×LFL respectively.

Table-II

Comparison between calculated stature and measured stature*

Variables from which stature was estimated	Measured in cm		Estimated stature in cm		Significance of difference (p-value)
	Range	Mean±SD	Range	Mean±SD	
Right foot length	153 - 177.5	167.97 ± 6.43	159.08 - 179.18	167.98 ± 4.48	0.013 NS
Left foot length	153 - 177.5	167.97 ± 6.43	159.05 - 180.78	167.97 ± 4.55	0.006 NS

NS= Non-significant at 5% level of significance on two-sample Z-test, n =100 for each variable

* The calculated stature against each variable was obtained by using regression equation

Table-II shows the range and mean of calculated stature (± SD) from foot length with the difference with the measured stature with level of significance. Significance of difference was tested using the two sample Z test at 5% level of significance (p=0.05).

No significant difference was found between the measured and calculated stature from the foot length. The result indicated the effectiveness of the regression equation of estimating stature from foot length.

Discussion:

The stature had been found to have significant positive correlation with the length of right and left foot. Whether the regression equation was effective in estimating stature from the foot length, the estimated values were compared with the measured values. No significant difference was found between the measured and estimated stature. From this result inference could be drawn that the stature of an individual can be estimated from the right and left foot length.

Kanchan[10,12], Sen & Ghosh[13] and Ozden et al.[14] found significant positive correlations between the stature and right and left foot length. They estimated stature with minimum standard error from the foot length by linear and multiple regression equation.

Conclusion:

The foot length of both sides of 100 adult Bangladeshi males showed significant positive correlation with the stature. No significant difference between measured stature and estimated stature from the foot length of both sides were found as calculated through regression equation. So the foot length provided reliability and accuracy in estimating stature and regression equation can be used in this estimation process effectively.

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