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Original Article

ESTIMATION OF STATURE FROM FRAGMENT OF FEMUR (POPLITEAL LENGTH) IN BENGALEE POPULATION

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ABSTRACT

Introduction: Of the mathematical methods, regression equations have been successfully used for estimation of stature. Population specific formulae produce more accurate results. The present investigation was designed to estimate stature from fragment of femur obtained from a collection of Bengalee population of the state of West Bengal of India.

Materials & Methods: The fragment of the femur (Popliteal length of femur) was measured by a vertical length from the point where the distance between external borders of both linea aspera lips becomes 10 mm (it was considered as the lower end of linea aspera, where the two lips diverges below), to the ground where lower surfaces of both the condyles were in contact.

Results: The following regression equation was obtained: Stature in feet = 0.127[20.1184 + 1.6890x]. ('x' stands for popliteal length of femur in centimeter.)

Discussion: This would help in identification of unknown skeletal remains, as estimation of stature is an important part in establishing the biological profile of skeletal remains.

KEY WORDS: Human identification, fragment, femur, stature, Bengalee, Regression.

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INTRODUCTION

Physical anthropologists and forensic pathologists have given utmost importance to the methods of stature estimation from long bones. The bones of the lower extremity namely the femur and tibia have yielded consistent and good results. Works of Pearson (1899) and thereafter Trotter & Glesser (1952) have been monumental and invoked subsequent research on the subject [1,2]. Since morphology of selected bone vary in different regions and races, it is necessary to work out different regression equations for separate groups. Researchers have clearly indicated that population specific formulae are appropriate and produce more accurate results. Several such works have been documented. Works on South Africans of European descent by Chibba & Bidmos and Turkish population by Pelin are remarkable [3,4].

Mubarak Ariyo Bidmos (2008) used six variables measured on each femur which included the vertical neck diameter, upper breadth of femur, epicondylar breadth, bicondylar breadth, lateral condyle length, and medial condyle length [5]. Regression equations for the estimation of stature were presented. The range of standard error of estimate for these equations was slightly higher than those obtained for intact long bones. The conclusion, therefore, suggested that in the absence of intact femur, regression equations could provide a reliable estimate of adult stature.

Group specific works were done by Duyar Izzet et al to further reduce the error of estimate [6]. As a long bone of the lower extremity, the femur has drawn considerable attention of workers like Steele D.G. et al [7]. Even earlier works from India by Pan on Hindus of Bengal, Bihar and Orissa are noteworthy [8]. Fragments of tibia were also used in some studies on European and African population [2,3,4].

In India, studies have been reported on regression equation of fragment of other bones (radius and humerus) using collection from the southwestern part of the country (Mahasrashtra State) by Mysorekar N L et al [9].

In another work, Shroff et al calculated the percentile length of each segment and compared to total length [10]. Previous study by Dan et al on tibia of Bengalee population showed satisfactory results [11]. In another study Mukhopadhyay et al [12] established the correlation between epicondylar breadth and maximum femoral length and subsequently its application in stature estimation in Indian Bengalee population. The regression equations were calculated to estimate total length of femur from its segments. They observed that regression coefficient in each case was highly significant. The length of femur was estimated by the equation which was fairly accurate with a possible error of 0.5 to 1 cm. Height can thus be calculated with the help of a small fragment of femur.

In both archeological and forensic practice, fragments of long bones (because of injury, mutilation, destruction, or post mortem gnawing by wild animals) are often presented as the only available source to establish identity. Estimation of stature becomes the most important job in such a setting. Absence of entire skeleton, long bone (with intact ends) can be overcome by applying the derived method to the available fragment of bone. This will help to solve medico-legal problems giving due consideration to regional factors.

The present study was designed to derive a population specific formula (Regression Equation) to estimate stature from fragment of femur obtained from a collection of Bengalee population of the state of West Bengal of India. This method would be of help when regional problems of identification of unknown skeletal remains or of archeological works are encountered.

MATERIALS AND METHODS

One hundred forty eight dried and completely ossified adult specimen of human femur (Male-76; Female-72) were collected from different Medical Colleges of West Bengal, India during the period from February, 2014 to January, 20015. 85 were of the right side and 63 were of left. Bones with any marks of injury, deformity or artifact were discarded. The dried bones were from the collections of the osteology sections or museum specimens in the Department of Anatomy. These bone sets are usually prepared from cadavers donated to the Department of Anatomy from the surrounding area and belonged to the population of eastern part of India, particularly Bengalee of West Bengal State of India. Measurements were taken using anthropometric set consisting of osteometer and calipers. Record was in centimetre (cm.) and the measurement was up to one decimal place (nearest millimetre).

In our study, the total length and the fragment length (Popliteal length) of the same bone of both right and left was considered.

Total length of femur: It was the vertical length measured from the uppermost part of the head of femur to the ground where lower surfaces of both condyles were in contact.

Length of the fragment of femur: The posterior border of femur is represented by linea aspera, a prominent crest in the middle-third of the shaft where it acts as a buttress to resist the compre-

-ssive forces for the anterior bowing of femur. The linea aspera has got two lips and an intermediate area; and the two lips of linea aspera diverge below and form a triangular popliteal surface in the lower-third of the shaft of femur in between medial and lateral supra-condylar lines.

So, the popliteal length of femur was measured by a vertical length from the point at the lower end of linea aspera, where the two lips diverges below as inter condylar lines (where the distance between external borders of both linea aspera lips becomes 10 mm), to the ground where lower surfaces of both the condyles were in contact.

The measurements obtained were analyzed statistically using "MedCalc Statistical Software" for windows. The correlation was made between the fragment of femur and the total femoral length. Regression equation with the femoral fragment as the independent variable was obtained using the total sample of both left and right femur (n= 148). Twenty (n=20) randomly selected femurs were taken to test the validity of the equation that was derived. The observed length and the estimated length were recorded and tested for the accuracy and validity using Mann-Whitney test. The difference between mean of estimated and observed values of the total length was by chance indicating the validity of the regression equation.

Subsequently formula for estimation of stature was derived from the result of the regression equation. The method of Pan was found useful as a simple multiplying factor of 3.82 and was used after suitable conversion of the units (from cm to feet) of measurement to get the stature in feet [8].

RESULTS

From the measurements it was seen that the total length of the femur correlates (Table 1 and Fig.1) well with the fragment. The values of regression (Table 2), regression equation (Table 3) and analysis of variance (Table 4) are also shown along with the regression line with scatter diagram (Fig. 2).

Thus, the regression equation for femoral length (n=148): y=20.1184 +1.6890x**;** where "x" is the fragment length (Popliteal length of femur in centimetre.) and "y" is the total femoral length (in centimeter).

From the equation the values were obtained for 20 bones. These were compared with the observed length of femur (n=20) and test of significance was done. By Mann-Whitney test it was seen that the results were consistent and accurate. Differences between the means of the observed and estimated values were by chance.

Table 1: Showing correlation.

Variable Y	Total length of femur in cm (FL)
Variable X	Popliteal length of femur in cm (PL)
Sample size	148
Correlation coefficient r	0.8082
Significance level	P<0.0001
95% Confidence interval for r	0.7438 to 0.8577

Fig. 1: Shows correlation scatter diagram. (PL-Popliteal length of femur; FL-Total length of femur).

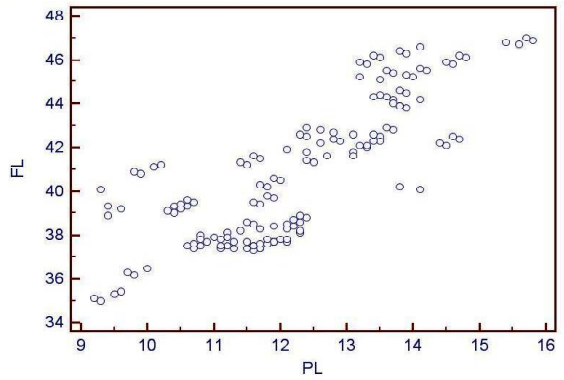

Table 2: Showing regression.

Dependent Y	Maximum length of femur in cm (FL)
Independent X	Popliteal length of femur in cm (PL)
Sample size	148
Coefficient of determination R^2	0.6532
Residual standard deviation	1.8628

Table 3: Demonstrating regression Equation.

Sample size	148
Coefficient of determination R^2	0.6532
Residual standard deviation	1.8628

Fig. 2: Shows regression line with scatter diagram. (PL-Popliteal length of femur ; FL-Total length of femur).

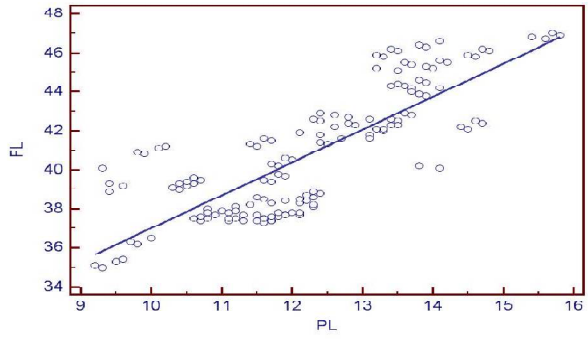

Table 4: Shows analysis of variance.

Source	DF	Sum of Squares	Mean Square
Regression	1	954.1532	954.1532
Residual	146	506.6362	3.4701
F-ratio	274.9633		
Significance level	P<0.001		

DISCUSSION AND CONCLUSION

In the present series one parameter was used. The fragment of the femur (Popliteal length of femur) was measured by a vertical length from the point at the lower end of linea aspera, where the two lips diverges below as intercondylar lines, to the ground where lower surfaces of both the condyles were in contact.

The measurements of both sides were done but the results pooled to obtain the regression equation. Separate equation could have been done with larger available sample. The sexual dimorphism of human femur was not considered in the present series owing to the small sample size. Contrary to earlier works of Steele DG et al [7] where prehistoric specimen were used, the present series estimated on a modern sample of Bengalee Indians from the state of West Bengal, northern part of India.

The derived regression equation from the series was: y=20.1184 +1.6890x to calculate the total length from where we can estimate statue by using appropriate formula (multiplying factor). Since the present work was contemplated on Bengalee population, the method of Pan was applied with the multiplying factor of 3.82. The combined formula works out to be:

Stature in feet = 3.82 [20.1184 +1.6890x]/30.1

Or Stature in feet=0.13[20.1184 +1.6890x].

('x' stands for popliteal length of femur in centimetre.)

The present study, being a preliminary work, can be considered as a pilot study in obtaining the regression equation. Being population specific, it can be applied in case studies pertaining to the local problems of identification of human remains. The results are reliable, but further works need to be designed to get more accurate estimates in population considering the age, sex and nutritional status.

Conflicts of Interests: **None**

REFERENCES

[1]. Pearson K. Mathematical contributions to the theory of evolution. V. On the reconstructions of the stature of prehistoric races. Philos Trans Series R Soc 1899; 192: 169-244.

[2]. Trotter M, Glesser GC. Estimation of stature from long bones of American whites and Negroes. Am J Phys Anthropol 1952; 10(1): 463-514.

[3]. Chibba K, Bidmos MA. Estimation of stature and maximum long bone length of the tibia from fragments of the tibia in South Africans of Europian descent. Forensic Sci Int 2007; 69(2): 145-51.

[4]. Pelin IC, Duyar I. Estimating stature from tibia length: a comparison of methods. J Forensic Sci 2003; 48(4): 708-712.

[5]. Bidmos MA. Stature reconstruction using fragmentary femora in South Africans of European descent. J Forensic Sci 2008; 53(5): 1044-1048.

[6]. Izzet D, Pelin C. Body height estimation based on tibia length in different stature groups. Am J Phys Anthropol 2003; 122(1): 23-27.

[7]. Steele DG, McKern TW. Method for assessment of maximum long bone length and living stature from fragmentary long bones. Am J Phys Anthropol 1969; 31(2): 215-227.

[8]. Pan N. Length of long bones and their proportion to body height in Hindus. J Anat 1924; 58(4): 374-378.

[9]. Mysorekar N L, Verma PK, Nandekar AN, Sharma TSR. Estimation of stature from parts of bones: lower end of femur and upper end of radius. Med Sci Law 1980; 20 (4): 283-286.

[10]. Shroff AG, Panse AA, Diwan CV. Estimation of length of femur from its fragments. J Anat Soc India 1999; 48 (1): 1-5.

[11]. Dan U, Mukhopadhyay PP, Ghosh TK, Biswas S. Estimation of stature from fragment of long bone (tibia) in Indian Bengalee population. J Anat Soc India 2009; 58(2): 169-172.

[12]. Mukhopadhyay PP, Ghosh TK, Dan U, Biswas S. Correlation between Maximum Femoral Length and Epicondylar Breadth and Its Application in Stature Estimation: A Population Specific Study in Indian Bengali Males. J Indian Acad Forensic Med 2010; 32 (3): 204-07.

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