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STATURE ESTIMATION FROM BI-EPICONDYLAR DIMETER OF HUMERUS AND BICONDYLAR DIMETER OF FEMUR OF BAIGA, GOND AND ORAON TRIBES OF CHHATTISGARH

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ABSTRACT

Regression formulae for estimation of stature from bi-epicondylar and bicondylar dimeters of humerus and femur, respectively, of adult males and females belonging to Baiga, Gond and Oraon tribes of India are presented. A total of 578 adult subjects (222 Baiga, 242 Gond and 93 Oraon), ranging in age from 18-70 years, were measured for stature, bi-epicondylar diameter of humerus and bicondylar diameter of femur, using standard instruments following Weiner and Lourie (1981). Sex differences in all the three measurements were significant ($p<0.05$). Linear and multiple regression equations for estimation of stature were computed for bi-epicondylar humerus and bicondylar femur for males and females of each tribe separately. In addition, the equations were also developed for the whole samples of males and females of the three tribals. The correlation of bicondylar femur with stature was stronger for the males. On the other hand, in females the bi-epicondylar diameter of humerus provided a stronger correlation with stature. Thus, the estimation of stature is likely to be more accurate from femur bicondylar in males and bi-epicondylar humerus in case of females. The regression equations presented here can be useful for personal identification in case of dismembered bodies.

Keywords: Forensic anthropology, stature estimation, regression equations, Chhattisgarh, bicondylar femur, bi-epicondylar humerus

INTRODUCTION

Establishment of individuality is the most important job in forensic examinations. The job of personal identification is comparatively less difficult in case of living. However, this job becomes difficult and complicated in case of skeletonized, mutilated and commingled remains. Stature is one of the important parameters for identification of unidentified human remains. It is regularly employed by forensic

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anthropologists in preparing a biological profile of the deceased, which has the potential of being matched with that of a missing person for identification purposes (Gaur, 2013). In general, length of long bones or their percutaneous lengths are used in estimation of stature (Gaur *et al*., 2016). However, in severely mutilated or dismembered bodies, complete limbs or long bones may not be available. In such situations, ends of some long bones such as femur and humerus or lower parts of upper arm and thigh, have the potential of being used for stature estimation. In violent situations, such as bomb blasts or accidents involving aircrafts and trains, the bodies generally get badly dismembered and comingled and complete body parts are generally not available. In such situations, lower ends of femur and humerus can be very useful to estimate stature.

Several recent studies are available for estimation of stature from body dimensions on Indian populations (Agnihotri, *et al*., 2007; Krishan and Sharma, 2007; Kanchan *et al*., 2008; Sen and Ghosh, 2008; Jakhar *et al*., 2010; Krishan *et al*., 2012; Pandhare, 2012; Gaur, *et al*., 2013, 2016; Mohite *et al*., 2014; Malik *et al*., 2015; Rajesh *et al*., 2015; Shah *et al*., 2015; Dhanaria *et al*., 2016;Taneja *et al*., 2017). Majority of these are based on long bones or hand and foot dimensions. Data on formulae developed on the basis of lower end diameters of femur and hummers are scanty.

The present investigation is devoted to the development of regression equations for the estimation of stature from percutaneous bi-epicondylar diameter of humerus and bicondylar diameter of femur of Baiga, Gond and Oraon tribals of India. Data on stature estimation on tribal populations of India is scanty. Some of tribal areas are experiencing localised insurgencies with occasional IED or mine blasts leading to dismembering of bodies of victims. The formulae developed in this work can be useful in identification of bodies of such victims.

MATERIALS AND METHODS

The present work is based on a cross-sectional sample of 578 adult tribal subjects. Out of these, 222 were Baiga (121 males and 101 females), 242 Gonds (143 males and 99 females) and 93 Oraon (48 males and 45 females). The subjects ranged in age from 18 to 70 years. The distribution of the sample is given in Table-1. Each subject was measured for stature, bi-epicondylar diameter of humerus and bicondylar diameter of femur, using standard instruments following the methods given in Weiner and Lourie (1981). The bone diameters were taken on the left side. Individuals with physical disabilities or any serious disease were not included in the study. Besides anthropometric measurements, some general information about the subjects was also collected on a proforma specially designed for the purpose. The data were subjected to descriptive statistics, such as correlation, linear regression and multiple regression analyses, using Statistical Package for Social Sciences (SPSS). Linear and multiple regression equations for estimation of stature were computed for bi-epicondylar humerus and bicondylar femur for males and females of each tribe separately. In addition, the equations were also developed for the whole samples of males and females of the three tribals.

The data of the present study were collected from the core area of the Achanak-Amarkantak Biosphere Reserve of Bilaspur district of Chhattisgarh. The biosphere is one of the less developed and least exposed areas in Chhattisgarh and Madhya Pradesh. The biosphere is very rich in flora and fauna. It is located at the junction of hill ranges, with topography ranging from high mountains, shallow valleys and plains. The reserve is inhabited by 27 tribal and non-tribal communities in its 418 villages. The Gond are the original inhabitant of this area, whereas Baigas were brought from the nearby areas to work in the forest during colonial periods. The Oraons are the later migrants, mostly during eighties from the Sarguja District of Chattisgarh. The Gonds are basically involved in agriculture and a few other means of livelihood. Gonds have major land holding for agriculture purposes. The Baigas mostly subsist on wage labour, besides gathering of wild plants and medicines along with juhum/ agriculture mode. Traditionally, Baigas were hunter-gatherers. Even today, gathering of wild resources forms an important part of the Baiga economy. In addition, rearing of cattle and goats on sharing basis is also practiced by Baigas. The Oraon, who are the later migrants to the area, mostly engage in agriculture and wage labourer. Linguistically, Baiga dialect is classified under the Indo-Aryan language family at present. The Gonds and the Oraon generally speak the dialects of Dravidian family. In terms of economy and political power, Gonds are the dominant tribe of the area.

The data were collected by RS and the analysis and write up of the paper were carried out by RG.

RESULTS AND DISCUSSION

Table 2 shows the mean values of stature, bi-epicondylar humerus diameter and bicondylar femur diameter. The gender differences in stature were significant statistically ($p<0.05$), as revealed by t-test. Males were significantly taller than females in all the three tribes. This is consistent with the concept of an average human male being taller larger than an average human female (Eveleth, 1975; Pawlowski *et al*., 2000; Biernat, 1993). As can be seen in Table 2, percutaneous diameters of humerus and femur were significantly larger ($p<0.05$) in males than females in the three tribal groups, as indicated by t-test values. This conforms with the general smaller nature of human female bones. The female skeleton is, in general, 90% of human male (Krogman, 1962). There was no significant difference ($p<0.05$), in mean stature among the three tribal groups, in males as well as females. The differences in the two percutaneous diameters of humerus and femur among the three tribes in the present sample were also not significant in both sexes.

Table 3 displays sex-wise regression equations for the estimation of stature from the bi-epicondylar diameter of humerus and bicondylar diameter of femur of the Gond, Baiga and Oraon subjects in the present sample. In males, the correlation of staure was stronger with bicondylar femur as compared to bi-epicondylar humerus. The standard error of estimate was also less for bicondylar femur than that for bi-epicondylar humerus. This suggests that bicondylar femur was a better estimator

of stature than bi-epicondylar humerus. Hoever reverse was the case for females in which the correlation of bi-epicondylar humerus with stature was stronger than bicondylar femur. Even the standard error of estimate for bi-epicondylar humerus was less than bicondylar femur, indicating a more accurate estimate of stature from bi-epicondylar humerus.

Table 4 depicts the multiple regression equations for stature estimation. Due to low number of individuals, the multiple regression equations could not be computed for the Oraons. The values of standard estimate of error were less for multiple regression equations than the single ones, suggesting that the stature estimates would be better if both bicondylar humerus and bi-epicondylar humerus were used. Since there was no significant difference in stature and the two bone diameters among the three tribes, the combined regression equations can be used for any of the three tribes under study.

Since no significant data is available for staure estimation from lower ends of humerus and femur for the Gond, Baiga and Oraon tribes of Central India, the present data can serve as baseline information. The equations presented here have the potential for use in medico-legal cases for identification of unknown human remains, particularly in case of dismembered and commingled remains.

Table 1: Distribution of the sample according to tribe and sex

Tribe	*Males*	*Females*	*Total*
Baiga	121	101	222
Gond	143	99	242
Oraon	48	45	93
Combined	312	245	557

Table 2: mean (±SD) of stature, bi-epicondylar humerus and bicondylar femur of various tribes in the present sample

Tribe	*Stature (cm)*		*Bi-epicondylar Humerus (cm)*		*Bicondylar Femur (cm)*	
	Males	*Females*	*Males*	*Females*	*Males*	*Females*
Baiga	159.77±5.88	150.29±6.34* (-11.534)	6.82±0.40	6.03±0.43* (-12.351)	8.31±0.56	7.47±0.42* (-13.947)
Gond	161.85±5.86	151.29±4.75* (-14.864)	6.93±0.39	6.17±0.38* (-11.270)	8.45±0.60	7.63±0.48* (-15.024)
Oraon	161.47±6.16	151.06±5.03* (-8.029)	6.85±0.37	5.94±0.33* (-6.740)	8.29±0.45	7.62±0.50* (-12.359)
Combined	160.83±5.98	150.54±5.50* (-20.274)	6.87±0.40	6.08±0.40* (-17.970)	8.37±0.56	7.56±0.46* (-23.554)

* Significant sex difference; values in parentheses are t-values; -tive t-values indicate smaller values for females

Table 3: Regression equations for stature estimation from percutaneous dimension of bi-epicondylar humerus and bicondylar femur of Baiga, Gond and Oraon tribes of Chhattisgarh

Tribe	*Regression Equation*	*r*	R^2	*SEE*
		MALES		
Baiga	Y=131.590+4.135xHD	0.284	0.081	5.660
	Y=116.972+5.152FD	0.491	0.241	5.143
Gond	Y=127.018+5.014xHD	0.328	0.107	5.642
	Y=127.859+4.025FD	0.411	0.169	5.365
Oraon	Y=104.083+8.232xHD	0.497	0.247	5.405
	Y=81.912+9.479xFD	0.688	0.473	4.522
Combined	Y=124.425+5.297xHD	0.351	0.123	5.606
	Y=118.092+5.108xFD	0.484	0.234	5.240
		FEMALES		
Baiga	Y=108.54+6.918xHD	0.465	0.216	5.641
	Y=116.706+4.404xFD	0.296	0.088	6.087
Gond	Y=127.859+3.794HD	0.305	0.930	4.550
	Y=144.169+0.932xFD	0.094	.009	4.756
Oraon	Y=122.355+4.828xHD	0.316	0.100	4.830
	Y=115.183+4.705xFD	0.466	0.217	4.506
Combined	Y=118.486+5.325xHD	0.387	0.150	5.088

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