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A Model for Stature Prediction from Percutaneous Ulnar Length in Adult Males of Tamil Population

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Abstract

The objective of this study was to derive a linear regression formula for determination of stature from right and left ulnar length in males belonging to Tamil population. The subjects consisted of 112 adult Tamil males in the age group of 21 to 30 years. With the help of digital sliding caliper, length of each side ulna was measured between tip of olecranon process and tip of styloid process and for stature, using the stadiometer, the subject was asked to stand barefooted in anatomical position and distance from heel to vertex measured. The data thus collected was statistically analyzed with SPSS software (version 23) and a population specific regression equation for stature pertaining to length of right and left ulna derived respectively and statistically compared with that of other Indian populations and found to be unique for this study population group and therefore, this will be a tool of much significance for anthropologists, forensic experts and archaeologists when dealing with mutilated forearm remains from deceased Tamil males where necessity of stature estimation for identification arises.

Keywords: *Ulna, Stature, Regression formula, Males, Tamil population.*

Introduction

Identification implies fixation of personality of an individual. Establishing identity of unknown victims from skeletonized, dismembered or mutilated parts of human body remains a paramount challenging task for forensic experts in circumstances like natural disasters, aircraft or rail accidents, terrorist attacks and wars. Determination of stature is one of the many vital physical parameters applied in ascertaining the identity of unknown human corpses. On many occasions, only human limbs are available for establishing identification where determination of stature is a significant factor. There exists a mutual relationship between a person's stature and dimensions of various body parts, particularly length of long bones, which provides the basis for estimation of stature.[1] Of all the metric methods applied, regression formula for stature derived from length of long bones yield most reliable results. Estimates based on upper limb long bones are as reliable as that of lower limb long bones.

Length of ulna is commonly used for stature determination. Many researchers have provided various regression formulae based on ulnar length, nevertheless it is well established that a formula that applies to one particular population often does not give precise estimates for other populations. Researchers like Pearson (1889), Stevenson (1929) confirmed the presence of inter-population variations with respect to height estimation. Since that time, most studies have emphasized that regression equation for stature determination must be population specific.

Trotter and Gleser regression equations for stature derivation from long bones have been employed frequently. This research offers a regression equation based on ulnar length for estimation of stature in adult males belonging to Tamil population. Various parameters derived from this study were compared with those

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provided by similar studies done on different populations in India and found to be statistically significant.

Materials and Method

A total of 112 anatomically healthy adult males of Tamil population were randomly chosen and study conducted in Chennai. Those with obvious nutritional deficiencies, congenital or acquired defects in musculoskeletal development were not included. The age range of subjects was between 21 and 30 years. After brief explanation, written consent with signature was taken from every subject and prior institutional human ethical committee approval for this study also obtained. To exclude possible diurnal variation of stature, data was collected during 2 to 4 pm every day and by the same investigator to avoid inter-observer estimation errors if any.

To estimate the standing height, subject was made to stand on stadiometer platform with his arms hanging loosely on the sides of the body while the head being held in Frankfort plane and distance from the heel to vertex was noted with accuracy of up to 0.1 cm. The length of each ulna was measured by asking the subject to rest his palm over the contralateral shoulder and using digital sliding caliper with precision of measuring up to 0.01 cm., distance from the apex of styloid process to the apex of olecranon process recorded after highlighting these landmarks with the help of skin marking pencil.

The collected data was analyzed with the SPSS software (version 23) and various significant parameters such as mean, standard deviation, correlation coefficient, coefficient of determination, standard error of mean etc. were tabulated and linear regression equation for stature derived.

Results

In Table 1, various parameters derived from the analysis of stature and ulnar length of each side are exhibited for comparative interpretation. The estimated mean lengths of right and left ulna were 27.4 cm. (with standard deviation of 1.05 cm.) and 27.04 cm. (with standard deviation of 1.03 cm.) respectively. Similarly, the calculated mean stature of male subjects was 170.5 cm. with standard deviation of 4.3 cm. Pearson's correlation coefficient (r) for stature to the right ulnar length was 0.822 ($p<0.001$) with regression coefficient of 3.3889 ($p<0.001$). The similar correlation coefficient (r) with respect to left ulnar length was 0.832 ($p<0.001$) with regression coefficient of 3.5148 ($p<0.001$).

Table 1: Various statistical parameters for Right and Left Ulna in Males

Parameter	**Dependent Variable**	
Mean Stature (cm.)	**170.5**	
	Independent Variable	
	Right Ulna	Left Ulna
Mean Length (cm.)	27.40	27.04
Standard Deviation	1.05	1.03
Correlation coefficient (r)	0.822 [$p<0.001$]	0.832 [$p<0.001$]
Coefficient of Determination (R^2)	0.675	0.692
Regression Constant	77.623	75.459
Regression Coefficient	3.3889	3.5148
Standard Error of Mean	0.09971	0.09734

Scatter diagrams (Fig. 1 and 2) were made by plotting the data of stature against the length of right and left ulna from male subjects and the linear regression formulae for stature with respect to each ulna were derived (Table 2).

Table 2: Regression formula for Stature in Males

	Regression formula for Stature (y)
Right Ulna	$y_1 = 3.3889 \times$ Right Ulnar length (cm.) + 77.623
Left Ulna	$y_2 = 3.5148 \times$ Left Ulnar length (cm.) + 75.459

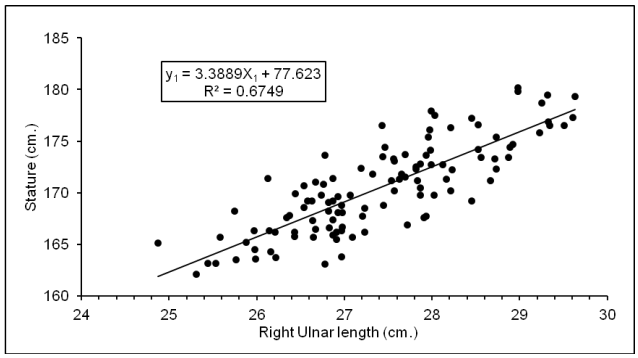

Fig. 1: Correlation between Right Ulnar length (X_1) and Stature (y_1) in Males

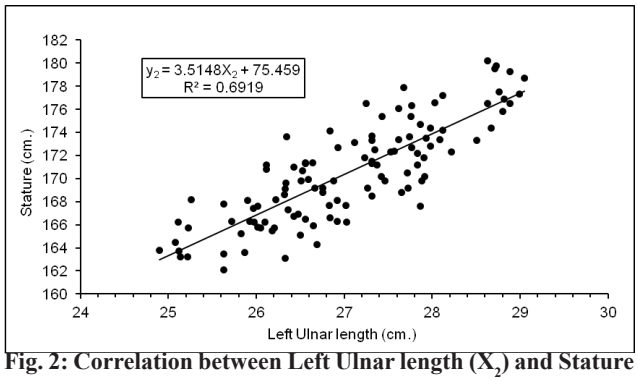

Fig. 2: Correlation between Left Ulnar length (X_2) and Stature (y_2) in Males

Discussion

Determination of stature from the length of long bones of upper limb has been studied extensively by many researchers whose observations have all clearly attested that the length of upper extremity bones are dependable and precise determinants of human height[2-7]. The current study was done to present a database for the male adults by contributing regression formulae that are specific to Tamil population. This database can be used whenever reconstruction of stature is required as an essential tool of identification of victims of various disasters as well as for biological profiling.[8,9]

Need for development of regression formula for stature estimation specific for a population has been advocated by Trotter and Gleser.[10] The basic reason for this should be proportions of various human body portions with respect to height vary in different populations because these proportions are known to be influenced by race, environmental factors, secular trends[11], nutrition, socio-economic status etc.[12] This emphasizes the need for creation of population specific nomograms.[13,14] Identification of race, gender and age are the prerequisites before applying regression equation to determine stature specific to a particular region.[10] In addition, the results from this present study involving adult males of Tamil population, because of various influencing factors modifying body proportions as mentioned earlier, indicate the requirement of developing various population specific regression formulae for stature determination in India.

From Table 3, it is obvious that notable variations exist involving mean stature and mean right and left ulnar length with respect to various population groups in our country and it can be presumed to be due to multiple modifying factors like heredity, dietary habits influencing nutritional status, physical stress affecting lifestyle, geographical, environmental factors etc. Therefore, if these inter-population differences in stature and ulnar length are presumed to be due to racial, genetic or geographical factors, then it can be said that there cannot be any change with these and results will remain constant at any given period of time. However, if the variations are supposed to be secondary to influences of plastic ones like nutrition, lifestyle, physical stress etc., then it can be safely suggested that the various anthropometric data reference standards must be collected and analyzed in regular time intervals in a specific population so that they can be applied with authenticity.

Table 3: Comparison of Mean Stature and Mean Ulnar length in Males

Name of the Researcher	Year	Population for study	Mean Stature (cm)	Mean Ulnar length (cm)	
				Right	Left
Present Study	2019	Tamil Nadu	170.5	27.40	27.04
Anuj Jain[15]	2019	Uttar Pradesh	168.92	27.95	27.68
Chintala Durga Sukumar[16]	2017	Vijayawada	165.72	29.84	29.78
Acharya Veena Anand[17]	2016	Gulbarga	172.13	28.1	27.69
Avantika Bamne[18]	2015	Maharashtra	172.31	27.9	27.75
Balkrishna Thummar[19]	2011	Gujarat	169.87	28.48	28.39
Malay Kumar Mondal[20]	2009	West Bengal	164.31	27.13	27.01

Table 4: Comparison of Regression Formula for Stature (y) in Males from length of Right Ulna (X_1) and Left Ulna (X_2)

Name of the Researcher	Year	Population for study	Regression Formula	
			Right Ulna	Left Ulna
Present Study	2019	Tamil Nadu	$Y_1=3.3889X_1 + 77.623$	$Y_2=3.5148X_2 + 75.459$
Anuj Jain[15]	2019	Uttar Pradesh	$Y_1=2.92X_1 + 87.22$	$Y_2=2.85X_2 + 89.98$
Chintala Durga Sukumar[16]	2017	Vijayawada	$Y_1=1.80X_1 + 111.8$	$Y_2=1.79X_2 + 112.13$
Acharya Veena Anand[17]	2016	Gulbarga	$Y_1=3.65X_1 + 69.4$	$Y_2=3.90X_2 + 64.1$
Avantika Bamne[18]	2015	Maharashtra	$Y_1=3.81\ X_1 + 65.77$	$Y_2=3.89\ X_2 + 64.17$
Balkrishna Thummar[19]	2011	Gujarat	$Y_1=3.117X_1 + 81.11$	$Y_2=3.667X_2 + 64.1$
Malay Kumar Mondal[20]	2009	West Bengal	$Y_1=4.19X_1 + 50.642$	$Y_2=3.26X_2 + 76.289$

Based on the various regression formulae derived from different Indian populations that were tabulated in Table 4, it is certain that all these researchers have found out a positive correlation between stature and right and left ulnar length which ascertains there is existence of strong and dependable relationship between stature and ulnar length.

Conclusion

Determining identification of a dead individual is a vital component of Corpus delecti i.e. facts that are helpful to prove a crime, for example, murder. Regression formulae deduced from this study are fairly accurate and can be confidently applied to estimate the stature from right or left ulnar length of deceased adult males belonging to Tamil population especially in cases where amputated or mutilated extremities alone are provided for establishing identification which will certainly be a demanding task for forensic experts and anthropologists. We would like to advocate for conduction of similar studies in future comprising larger samples in males of various age groups belonging to Tamil population, to boost the accountability of the regression formula for stature estimation based on the length of ulna bone and therefore can be reliably employed for determining identity in mass disasters and similar medico-legal situations.

Conflict of Interest: None

Source of Funding: None

Informed Consent: Obtained

Ethical Clearance: Necessary ethical approval was obtained from the Institutional Ethics Committee, Chettinad Academy of Research and Education, Kelambakkam – 603103.

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