

Prediction of Stature in Males of Tamil Population from Measurements of Percutaneous Tibial Length

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Abstract

Forensic experts are often in confrontation with the challenging task of determination of stature along with race, age etc. for the purpose of establishing the identity of the deceased individual in those circumstances where only skeletal remains, mutilated or dismembered body parts, extremely decomposed body parts etc. are provided by investigating authorities. In the current study, a genuine attempt has been made to arrive at the population specific regression equation for stature prediction from the percutaneous length of Tibia. The subjects chosen for this study include 120 adult males belonging to Tamil population falling within the age range of 21 to 30 years. Stature and percutaneous lengths of right and left Tibia from each subject were precisely recorded following standard protocols using appropriate instruments and analysis of the data collected was done applying Pearson correlation through SPSS software version 26 to arrive at the regression equations for stature assessment based on percutaneous right and left Tibial lengths respectively. By comparing the regression formulae obtained from the present study with those derived from various population specific studies done on Indian population, our regression equations found to be distinctive to Tamil population and therefore can be authentically applied for calculation of stature of deceased from percutaneous Tibial length in males of Tamil population whenever skeletal remains are available.

Keywords: Stature, Tibial length, Regression equation, Males, Tamil population.

Introduction

One of the significant parameters for establishment of individuality of a person is the determination of stature from the length of long bones. In those circumstances where dismembered, putrefied human body parts or skeletal remains are available, Anatomical method¹ may be adopted for prediction of stature of the deceased if entire skeleton is provided for examination or by applying Mathematical method where taking measurement of length of a particular long bone may

help the purpose as there exists a firm relationship between stature and skeletal element. Commonly Mathematical estimates of height are derived by means of application of a single general regression formula that is population specific. The most reliable estimates have been derived by employing regression formulae based on length of long bones, especially those of lower limb. Nevertheless, it is clearly known that a regression equation that is formulated for one particular population does not automatically yield dependable results for another.²

After Femur, Tibial length measurement provides more reliable estimation of height than any other long bone. This is because of the fact that Tibia can be readily accessible for length assessment which is responsible for 22% of stature.^{3,4} Similarly, percutaneous measurement of length of Tibia in the living gives high degree of accuracy for stature prediction.⁵ In addition, Tibia plays a vital role in anthropological research as it resists

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disintegration and thereby retaining its morphology long after death.⁶⁻⁹

For stature determination from long bones, Trotter and Gleser regression formula has been frequently used. As population specific regression equations specific to Tamil population are negligible, we did the detailed study and derivation of regression formula pertaining to males of Tamil population. Different parameters gained in the current study were put into comparison with those derived by similar research studies done on various population groups in India and found to have definite statistical significance.

Materials and Method

The participants chosen for this study included 120 adult males in the age group 21 to 30 years belonging to Tamil population. The procedure, aims and objectives of the present study were clearly explained to every subject and written informed consent obtained with signature. The subjects with skeletal abnormalities involving limb, foot or spine were carefully exempted as participants of the study. To exclude possible diurnal height variation, all stature data were collected during morning hours i.e. 9 am to 11 am and to avoid any inter-observer variation, same investigator involved in taking all measurements.

Stature measurement was taken while participant standing upright on base platform of stadiometer with head held in Frankfort horizontal eye-ear plane by supporting subject's chin and living stature estimated as the distance between heel and utmost point on vertex of the head with accuracy of 0.1 cm.

For measurement of right and left percutaneous Tibial length (PCTL), standardized and commonly

applied protocol¹⁰ and techniques¹¹⁻¹⁴ were followed. The spreading caliper with accuracy of measuring up to 0.1 cm. was used and degree of arms separation of caliper was determined from its steel tape. The participant was made to sit facing the examiner in a position keeping his ankle of the measurement side relaxing on the opposite side knee exposing medial side of Tibia upwards so that Tibiale point is easily accessible. Percutaneous Tibial length is determined as the maximum distance between Tibiale, the highest point on medial condyle along its medial border and Spherion, the distal most point on medial malleolus¹⁵ after marking these two Tibial landmarks with skin marking pencil. The recorded stature and Tibial length data from all subjects were carefully analyzed using the latest SPSS software version 26 and the statistical results such as Mean, Standard deviation, Correlation coefficient and linear regression equation for stature estimation.

Results

Various statistical parameters derived based on the analysis of stature and length of either side Tibia were tabulated (Table 1) for comparative interpretation. The determined mean lengths of left and right Tibia were 37.59 cm. (Standard deviation of 1.18 cm.) and 37.62 cm. (Standard deviation of 1.16 cm.) respectively. The estimated mean stature of participants was 170.5 cm. (Standard deviation of 3.9 cm.). Pearson's Correlation coefficient (r) for height to left Tibial length was 0.757 (p<0.001) with Regression coefficient (b) of 2.51 (p<0.001). Similarly, the Correlation coefficient (r) pertaining to right Tibial length was 0.741 (p<0.001) with corresponding Regression coefficient (b) of 2.5 (p<0.001).

Table 1: Significant statistical parameters for Right and Left Tibia in Males

Parameter	Dependent Variable	
	170.5	
	Independent Variable	
	Right PCTL (cm.)	Left PCTL (cm.)
Mean Length (cm.)	37.6208	37.5973
Standard Deviation	1.161	1.179
Correlation Coefficient (r)	0.741 [p<0.001]	0.757 [p<0.001]
Coefficient of Determination (R ²)	0.550	0.573
Regression Constant	76.440	76.111
Regression Coefficient (b)	2.5	2.51
Standard Error of Estimate	2.6380	2.5639

Table 2: Regression equation for Stature estimation from PCTL in Males

PCTL	Regression equation for Stature
Right PCTL (cm.)	$y_1 = 2.5 \times \text{Right PCTL (cm.)} + 76.440$
Left PCTL (cm.)	$y_2 = 2.51 \times \text{Left PCTL (cm.)} + 76.111$

Fig. 1 and 2 are scatter diagrams prepared by means of plotting the stature data against those right and left Tibia from subjects and Table 2 shows the linear regression equations for determination of stature with respect to each side Tibia.

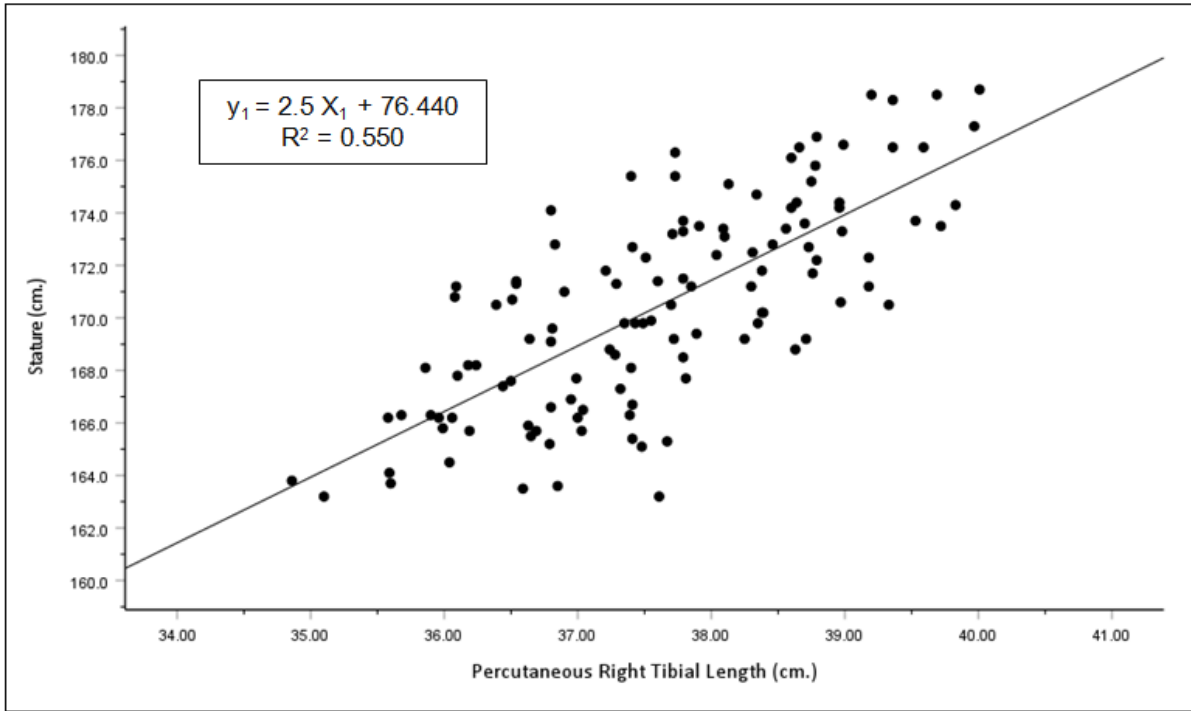


Fig. 1: Correlation between Right PCTL (X_1) and Stature (y_1) in Males

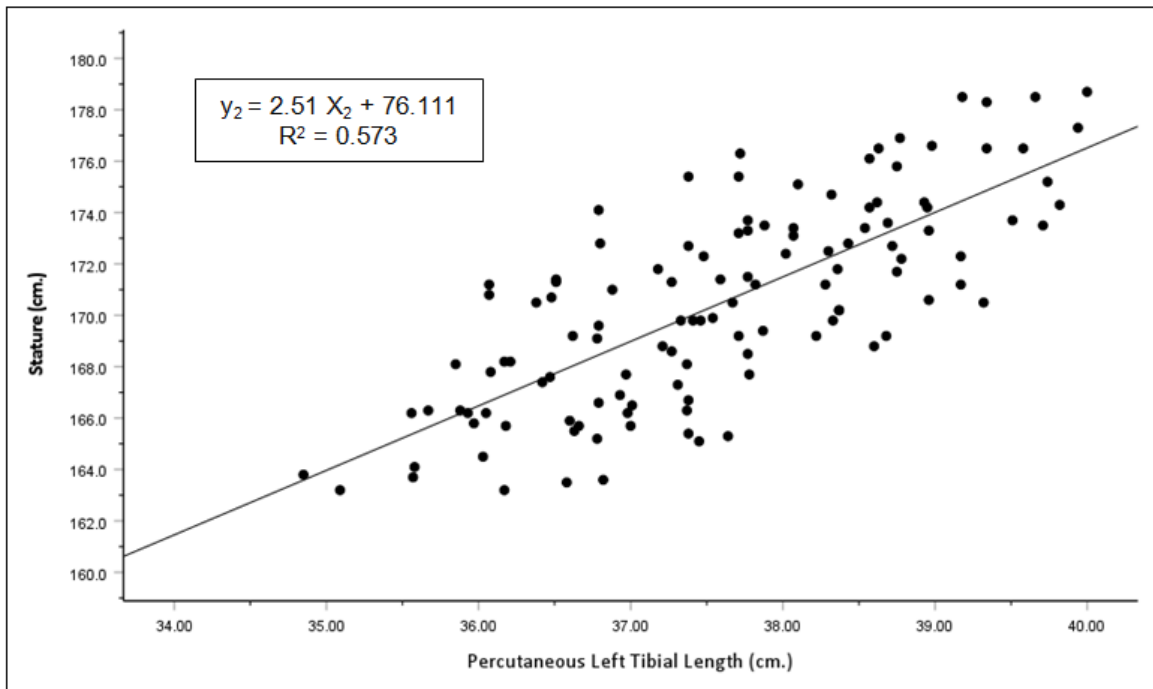


Fig. 2: Correlation between Left PCTL (X_2) and Stature (y_2) in Males

Discussion

Anthropometric measurements are generally applied for the assessment of stature of a deceased person for establishing the identification in medicolegal circumstances. Then regression formula derived from a particular population study cannot be applied for stature calculation for all population types which necessitates various baseline data have to be derived from different ethnic populations leading to more accurate equations that can be reliably applied for the stature assessment amongst them. Regression analysis leads to the derivation of formula for stature assessment that can provide 95% confidence intervals with respect to estimation of stature. The similar stature assessment techniques were advocated by different authors.¹⁶⁻²⁰

Since the actual stature of victims is commonly unknown in most of forensic cases, we did the present study focusing on this challenging problem. Therefore, we have attempted to establish the particular population specific stature formulae based on lengths of right and left Tibia. The data derived from the present investigation indicates that population specific stature regression formulae provide more reliable and accurate estimates than those from general formulae.

The derivation of stature needs special attention in those cases where corpses are found in extremely decomposed, mutilated state or only fragmentary remains of skeleton are available. The present study was done on living adult male subjects belonging to Tamil

population to correlate body height with percutaneous tibial length in various ethnic populations. Simple population specific linear regression formulae for stature corresponding to right and left Tibia were derived that can be applied for determination of stature.

It is obvious from Table 3 that minor variations pertaining to mean right and left percutaneous Tibial lengths and mean height when these data are compared in different ethnic populations in India and these variations may very well be assumed as the result of multiple factors affecting a person's growth and body proportions viz. dietary habits affecting nutritional status, heredity, physical stress modifying life style, environmental conditions, geographical factors etc. If we assume these minor variations with respect to stature and PCTL existing in different populations are the result of above-mentioned influencing factors, then the results will remain unchanged when statistical studies done in various populations at any given point of time due to the fact that those influencing factors do not lead to different modifications in different populations. Nevertheless, if such variations in results are presumed to be due to influencing factors of plastic ones like lifestyle, physical stress, nutritional status etc. then we can safely propose that the different anthropometric data as reference standards should be measured, recorded and analyzed periodically at constant time intervals in every population so that the results can very well be employed with high accuracy and reliability.

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

Name of the Researcher	Year	Population for study	Mean Stature (cm.)	Mean Tibial length (cm.)	
				Right	Left
Present Study	2020	Tamil Nadu	170.5	37.6208	37.5973
Kavyashree AN ²¹	2018	Karnataka	170.88	38.52	38.56
Anitha MR ²²	2016	South India	161.93	37.43	37.50
Prerna Gupta ¹³	2014	Uttar Pradesh	168.56	37.23	37.33
Akhilesh Trivedi ²³	2014	Madhya Pradesh	164.5	38.26	38.22
Ashita Kaore ²⁴	2012	Karnataka	170.08	35.77	35.73

Table 4: Comparison of Regression Formula for Stature (y) in Males from length of Right Tibia (X₁) and Left Tibia (X₂)

Name of the Researcher	Year	Population for study	Regression formula	
			Right Tibia	Left Tibia
Present Study	2020	Tamil Nadu	$Y_1 = 2.5 X_1 + 76.44$	$Y_2 = 2.51X_2 + 76.11$
Kavyashree AN ²¹	2018	Karnataka	$Y_1 = 1.52 X_1 + 112.20$	$Y_2 = 1.56 X_2 + 110.56$
Anitha MR ²²	2016	South India	$Y_1 = 1.8 X_1 + 94.5$	$Y_2 = 1.95 X_2 + 88.55$
Prerna Gupta ¹³	2014	Uttar Pradesh	$Y_1 = 2.37 X_1 + 80.03$	$Y_2 = 2.39 X_2 + 79.26$
Akhilesh Trivedi ²³	2014	Madhya Pradesh	$Y_1 = 1.40 X_1 + 110.76$	$Y_2 = 1.59 X_2 + 103.71$
Ashita Kaore ²⁴	2012	Karnataka	$Y_1 = 1.84 X_1 + 104.42$	$Y_2 = 1.85 X_2 + 104.08$

On comparison of different regression equations for stature prediction derived from various ethnic populations of our country, as shown in above Table 4, we can very well presume that all these investigators have made out the existence of obvious positive correlation between percutaneous right and left Tibial lengths and stature which clearly proves that there remains a stronger and reliable relationship between person's height and Tibial length.

Conclusion

The derived regression equations for stature assessment have been found to be fairly accurate for males belonging to Tamil population based on the fact that estimated stature were within the range of error and found to be in close approximation with that of the observed stature and therefore the derived regression equations for stature assessment for males based on percutaneous length of Tibia in males belonging to Tamil population and can be employed with authentication whenever the determination of height of deceased person arises with respect to highly putrefied bodies, skeletons, dismembered limbs are available for the establishment of identity of deceased which in turn leads to the establishment of corpus delicti i.e. facts suggestive of criminal offence where personal identification is one of the significant fact. Based on the results of the present study, we highly recommend that several similar studies among Tamil population involving different age groups to arrive at the specific regression formulae which will be of immense help to forensic experts and anthropologists for population specific stature estimation and subsequent establishment of identity of individual in mass disasters and other above mentioned challenging forensic circumstances.

Conflict of Interest: None declared.

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Informed Consent: Obtained from all subjects.

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

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