ORIGINAL RESEARCH PAPER

Volume-7 | Issue-11 | November-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ESTIMATION OF STATURE THROUGH PERCUTANEOUS MEASUREMENT OF TIBIAL LENGTH IN NORTH INDIAN MALE POPULATION.

Anatomy

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ABSTRACT

Identification of unknown person/dead body is critical to solving medicolegal cases and stature is one of the important criteria for establishing the identity. Stature estimation is difficult in partially decomposed bodies which may be damaged or completely skeletonised. Bones of lower limb contribute most to the stature of an individual which increases their predictive value for stature estimation. Formulae given for stature estimation in earlier studies are specific for race & gender. In this study tibia was selected as a long bone for the stature estimation in male subjects of north India. Tibial lengths of both right and left side in male subjects were measured and stature was estimated. A comparison was also done while estimating stature from right & left tibia. This study utilized simple linear regression and multiple regression analyses to estimate stature. Regression formula and multiplication factor for tibia has been derived various combinations to reach the best estimate possible. The study gives a regression equation & a multiplication factor for Tibial length which can be used to estimate stature in north Indian male population.

KEYWORDS

Tibial length, Stature, Males

<H1> INTRODUCTION

Stature is one of the important criteria for establishing identification of unknown person/dead body. It is usually measured as standing height of the individual. But evaluation of stature is difficult when dead bodies are mutilated, burnt or skeletonised. Various formulae and equations have been proposed to reconstruct stature from long bones[1-6]. Bones of lower limb contribute most to the stature of an individual[7,8] which increases their predictive value as far as estimation of stature is concerned. In the current study we have selected Tibial length as criteria to determine the stature in male subjects. There are variations in the length of limb bones relative to stature and according to race, sex, side of body, climate, heredity, nutritional status.[5]. Various studies, done earlier, have given formulae & equations that are specific for race and gender.

An attempt has been made in the present study to reconstruct stature among male population of MMIMS&R of Mullana Ambala using body measurements pertaining to lower extremity dimensions (tibial length).

<H1>MATERIAL AND METHODS

The present study comprised of 150 male students of MMIMS&R of Mullana Ambala within the age range of 21 to 30 years. All the subjects were measured for tibial length, in accordance with the standard measurement techniques recommended.[9,10] All observations were recorded in centimetres (cm). Each subject was measured for the following percutaneous dimensions:

Stature (S): It was obtained as the vertical distance between the vertex on the head & the standing surface, using anthropometer (stadiometer).

Tibial Length (TIBL): The subject was made to sit with left knee placed in the semi flexed position and the left foot partly inverted to relax the soft tissues and render bony landmarks prominent. The length of tibia from the medial condyle (as it becomes palpable and diverges anteriorly from the articulating femoral condyle) to the tip of the medial malleolus was measured, using rod compass (spreading calliper).

The data used in this study included date of birth, stature and tibial length for each individual. All the measurements were taken at a fixed time to eliminate discrepancies due to diurnal variation. Furthermore, the measurements were recorded by the same person to minimize the errors in methodology. Each measurement was taken thrice and the mean calculated taken for further analysis. The analysis includes descriptive statistics.

For the Simple regression equations with a single independent variable(x), the regression equation is of type, y= A+Bx, the sample required for such a study is 10, as total number of independent variables in this study are 4, total sample size can be 10x4=40, however considering easy availability of samples, sample size was taken as males-150 in the current study.

METHODOLOGY:

***Inclusion criteria*:**

1. Students hailing from. MMIMS&R of Mullana Ambala
2. Chronological age group above 21 to 30 years.

***Exclusion criteria*:**

1. Students unable to stand
2. Chronological age less than 21 and more than 30 years.
3. Any pathological condition of bones and limbs e.g. fractures, dislocations, poliomyelitis, osteoporosis, rickets, scoliosis and kyphoscoliosis etc.
4. Congenital anomalies.
5. Dwarfism and gigantism, Steroid therapy.

Simple linear regression and multiple regression analyses were used in this study to estimate stature from single and combined measurements of the tibia. As these measurements are hypothesized to be predictive of stature, the regressions were performed with stature as the dependent variable and the selected measurement(s) as the independent variable(s).

The data was analyzed using SPSS version 20 software. Regression formulae and multiplication factors were developed for various combinations to reach the best estimate possible. The regression formula is of type, Y=A+B(X), it is a simple regression equation since here x is the only independent variable, where, Y= Height of individual to be estimated, A= Regression constant, B= Regression coefficient, X= Percutaneous length of the long bone (tibia).

Multiplication factor for tibia was calculated for each person and mean of all was calculated. The following equation was used to get the multiplication factor: K=H/L Where, H= Height, L = Length of long bone (tibia), K= A constant multiplication factor which was specifically determined for individual long bone from the various data so obtained.

<H1>OBSERVATIONS AND RESULTS

The study conducted among 150 male students of MMIMS&R of Mullana, Ambala aged 21 to 30 years revealed following findings. Table 1 depicts descriptive statistics of age of the population sample studied. The 150 students who were admixture of population from north India comprised of 150 males. The mean ± SD age of males was 22.31 ± 1.61 years.

TABLE 1. Descriptive statistics related to age in years of the population sample studied

Sex	N	Age (in years)	
		Range	Mean ± SD
Male	150	Min 21 Max 30	22.31 ± 1.61

Table 2 depicts descriptive statistics of stature of the population sample studied. The mean ± SD stature of males was 173.89 ± 6.77 cm with minimum of 152.4 cm and maximum of 193 cm.

TABLE 2. Descriptive statistics related to stature of the population sample studied

Sex	N	Stature (in years)		p value
		Range	Mean ± SD	
Male	150	Min 152.4 Max 193.0	173.89 ± 6.77	< 0.001

Table 3 depicts statistics of tibial lengths of the sample population studied. The mean ± SD percutaneous tibial length in males (combined right and left) was 42.57 ± 2.03 cm.

The difference between mean lengths of right and left side bones was statistically not significant (p>0.05).

TABLE 3. Statistics comparing the percutaneous tibial lengths of the two sides

Length (in cm)		Mean	SD	p value
Tibia	Right	42.59	2.03	< 0.001
	Left	42.55	2.03	< 0.001
	Combined	42.57	2.03	< 0.001

<H1>STATURE ESTIMATION FROM TIBIA LENGTH

TABLE 4. Statistical regression analysis of the percutaneous tibia length with stature of male population sample

	R	L	T
Slope	2.75	2.76	2.75
Intercept	56.78	56.63	56.72
SEE	3.83	3.83	3.82
Pearson correlation	0.826	0.825	0.826
Df	149	149	299
p value	< 0.001	< 0.001	< 0.001

Table 4 depicts regression analysis and correlation of the percutaneous tibia length with stature of the population sample studied. A positive correlation was observed between the stature and the tibia length and the correlation was highly statistically significant (p<0.001). The slope and intercept was used to devise regression equation for estimation of stature from the lengths of tibia.

TABLE 5: Regression equation for stature estimation from tibia length

Sex	Side	N	Regression equation
Males	Right	150	y = 56.78 + 2.75x
	Left	150	y = 56.63 + 2.76x
	Combined	300	y = 56.72 + 2.75x

y is Stature of individual and x is length of tibia

In males for calculating the stature the regression equation was derived for right tibia as stature = 56.78 + 2.75x tibia length, for left tibia as stature = 56.63 + 2.76 x tibia length and for both sides tibia as stature = 56.72 + 2.75x tibia length (table 5).

The derived multiplication factor (4.09) was applied on a fresh sample of MMIMSR Mullana population of north India population (sample size = 150) the average difference between actual and calculated height was <1cm. This difference was statistically insignificant (p>0.05). Thus, the derived multiplication factor is valid.

<H1>DISCUSSION

Tibia

It was observed that, though the standing height of many individuals was found to be the same, yet their Percutaneous tibial lengths differed. To overcome this biological variation and for further analysis and interpretation the relevant characters like the height and Percutaneous tibial length were averaged out. The data thus obtained were analyzed for their mean, standard deviation, and confidence interval which have been presented in Table 6.

TABLE 6. Estimated stature from tibia length in the population sample using different formulae

Author	Population (race/ region)	Equation for stature from Tibia		Mean	SD	95% CI
Pearson [1] (1899	British	Males: S=78.66+3.378(TIBL)		222.81	7.08	0.69
Trotter and Gleser[5] (1952)	American whites	Males: S=78.62+2.52(TIBL)		186.15	5.28	0.52
Singh and Sohal[11] (1952)	East Punjab	Multiplication factor 4.18	Male	178.36	8.76	0.86
Present Study Regression equation	MMIMSR, Mullana	Males: S=55.747+2.777(TIBL)		173.89	6.77	0.57
Present Study Multiplication Factor		Males S = 4.09 x		174.52	8.56	0.84

It was observed that the relative dispersion of tibial length over the height was absolutely negligible, which indicate about the direct relationship of tibial length to the height. The correlation coefficient (*r*) value between the tibial length and height of the individuals was highly significant. Since there was a high correlation between the percutaneous tibial length and stature, a simple regression analysis was done between each bone length and standing. Regression equations were fit to predict the stature when the percutaneous tibial length is available. The statistics reveal that regression coefficient which represented as a change in standing height per unit change in the tibial length is highly significant. Thus the predicted height could be approximated when the percutaneous tibial length is given within the observed range. The multiplication factors when applied to the present study sample (n=150) showed a mean difference between actual height and estimated height is less than 1 cm (p>0.05). Therefore, the derived multiplication factors are valid and applicable to the present study. In present study the multiplication factor for tibia was calculated and was found to be 4.09 x (TIBL) with 95% Confidence interval to be 0.84 respectively.

Due to strong influence of genetic and environmental factors on the height of the individual homogeneity of the study population is vital in formulating the regression equations. The multiplication factors when applied to a fresh population of MMIMSR Mullana sample (n=150) showed a mean difference between actual height and estimated height is less than 1 cm (p>0.05). Therefore the derived multiplication factors are valid and applicable to the students of MMIMSR Mullana population .

To use the mathematical method, the bone length measurement is substituted into a regression equation. The outcome of the equation calculated gives either the total skeletal height or the living stature. This depends upon the equation(s) employed and whether the soft tissue and ageing correction factors were included into the equation. The obvious advantage of this method is that a single bone can be used to estimate the stature of an individual. The main disadvantage of the mathematical method is that different regression formulae are required for different populations, for each different bone.Regression formulae derived from the major long bones are generally considered to be more accurate than those utilizing other bones such as the skull or hand and foot bones. Long bones that make up the greatest proportion of stature, that is, the femur and tibia, are also more accurate than other long bones

Bilateral symmetry In the current study it was observed that there was no statistically significant difference (p>0.05) between the measurements of tibia of right and the left side (Table 3). These findings are similar to that of Turkish study[12], who has quoted that the difference between the length of bones of left and right side to be negligible. Our findings are also similar to that of Agnihotri et al[13],who

observed that there was no statistically significant difference in the length of right and left tibia in males. However, our observation is in contradiction to observation made by Rani et al [14] who concluded that left tibia is longer than right tibia in both Similarly, Trotter and Gleser[15] expressed that bones of upper extremity are longer on right side and all bones of lower extremity are longer on left side.

CONCLUSIONS

There is a positive correlation between the length of tibia with that of stature; bilateral symmetry is present in the tibial length. Race and gender specific regression equation and multiplication factor are needed for the accurate stature reconstruction. We have come out with new set of regression equations and multiplication factors. The regression equations and multiplication factors of present study can be used upon the students of MMIMSR Mullana region of north Indian population with fair degree of accuracy (table 7).

TABLE 7;The derived regression formulae and multiplication factor

Sex	Bones	Regression equations	Multiplication factors
	Tibia	S=56.72+2.75x TIBL	4.09 x TIBL
Males			

Stature estimated by derived regression formulae for length of Tibia was similar to average actual stature with an error of less than 1cm which was statistically insignificant ($p > 0.05$).

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