

## Original Article

# Estimation of Stature by Measuring Tibial Length in Young Adults: A Community-Based Approach

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## ABSTRACT

**Background:** The “anatomical” and “mathematical” methods are the two main types of adult stature estimation methods available. Stature is considered one of the “big four” parameters for profiling individuals in cases of forensic anthropology. However, the most reliable available methods for stature estimation require the preservation of long bones. Lower extremities length assumes a significant part in the assessment of the height of an individual. **Aim:** Measurement of tibial length to estimate the stature in young adults. **Material & Methodology:** A correlation study was conducted with the approval from the institutional ethics committee during the period of October 2014 to May 2017 among 500 adults. All the right-handed males and females in the age group of 22–40 years were included in the study. **Results:** In the study, the mean tibial length in males was  $37.04 \pm 1.00$  cm and in females was  $35.30 \pm 1.97$  cm. Males had an average height of  $162.51 \pm 7.56$  cm, whereas females had an average height of  $153.59 \pm 5.21$  cm. The study also reveals that tibial length is a better predictor among males than females to estimate stature. **Conclusion:** Tibial length is a reliable measurement for estimating stature with quite a good correlation coefficient value of 0.623.

**Keywords:** Stature, Tibial length, Identification

## INTRODUCTION

Disasters management usually involves a four-phase cycle including mitigation, preparedness, response, and recovery. Disaster response includes risk management, resource management, impact reduction, search, rescue, and the crucial phase of recovery of the dead and disaster victim identification. Disaster Victim Identification is the method used to identify victims of mass casualty incidents, either man-made or natural.

The correct identification of a decedent is vital not only for humanitarian and emotional reasons for the next of kin but also for legal and administrative ones.

Determination of sex, age, and stature is the principal task for setting up the natural profile of a person, which helps to establish a positive individual identification<sup>[1]</sup>. Stature is considered as one of the “big four” parameters for the biological profiling of individuals in cases of forensic anthropology. However, the most

reliable available methods for stature estimation require the preservation of long bones [2]. Since the relation between long bones and height is impacted by nationality and sexual orientation of a person, there are no all-around pertinent formulae for height assessment from the length of long bones [3,4]. Irrespective of various hereditary and sex varieties seen in India, an endeavor has been made in the current investigation for assessment of stature in a village area of Dakshin Karnataka [5]. Lower extremities length assumes a significant part to assess the stature of an individual and subsequently most prescient equations are based on the length of the tibia, femur, and fibula [6,7]. This research was done in collaboration with the Department of Community Medicine and Forensic Medicine, Yenepoya Medical College, Mangalore, to determine the stature of the individual by using percutaneous tibial length among the local community.

## MATERIALS AND METHODS

A cross-sectional study was directed in Harekela town with the endorsement of the institutional Ethical Committee among 500 adults comprising 250 males and 250 females between the age group of 22–40 years. To ascertain the sample size, the correlation coefficient value (*r*-value) was chosen, which was the least among every one of the past studies. The correlation coefficient value found was 0.546 at 5% of the level of significance with the power of study as 90% [8]. Considering the *r*-value as 0.546, the sample size was discovered to be 152. The study correlation coefficient value was expected as 0.3 at a 5% level of significance at 80% of the power. The sample size was discovered to be 438, however, for better result round figure of 500 example size was taken where 250 were males and 250 were females.

The sample size of the present study was calculating using the following formulae:

$$n = \frac{2[Z_{\alpha} + Z_{\beta}]^2}{C^2} + 3$$

Where

$Z_{\alpha} = 1.96$  at 5% level of significance

$Z_{\beta} = 0.8416$  at 80% power

$C = 0.5 \ln \left( \frac{1+r}{1-r} \right)$

$r = 0.30$

All the right-handed males and females in the age group of 22–40 years were included in the study; a systematic random sampling method was adopted to select the participants for the study [9]. Individuals having congenital defects on the right lower limb, pregnant women, previous history of fracture in the lower limb, or any bony malformation were excluded from the study.

The procedure and purpose of the study were thoroughly informed and explained to the study population in their language. The information sheet was given to the study group where detailed information regarding the importance of the study was mentioned and written informed consent was taken from all study subjects. Measurements of female participants were taken in the presence of a female colleague. Data were collected by using stadiometer and digital sliding caliper.

## Techniques of Estimating Stature

Stature was estimated precisely by utilizing a stadiometer where participants were made to remain in erect posture on the board of a standard stadiometer platform by keeping the foot in close contact with no footwear and arms hanging by the side, the trunk braced along the vertical board and eyes gazing directly ahead and face in Frankfurt plane. The measurement was taken as the longest distance from the floor to the vertex of the head by carrying the flat sliding bar to the vertex [10].

## Technique of Measuring Tibial Length

The tibial length was estimated utilizing a computerized sliding caliper where subjects were made to sit on a

chair with the knee in semi-flexed position and the foot was inverted incompletely to loosen up the delicate tissues which assist with making the bony milestone more conspicuous, at that point tibial length was estimated from most prominent palpable portion of medial epicondyle of the tibia to tip of the medial malleolus [11].

## RESULTS

The Table 1 shows the mean and standard deviation of tibial length and stature for males and females. The mean tibial length in males was  $37.04 \pm 1.00$  cm and in females was  $35.30 \pm 1.97$  cm. Males had an average height of  $162.51 \pm 7.56$  cm, whereas females had an average height of  $153.59 \pm 5.21$  cm. The Table 2 shows that tibial length is having a significant correlation with stature among study participants. The Table 3 reveals that both males and females are having a significant correlation between stature and tibial length. Table 3 shows the *R* square value of predictor for tibial length. In the case of males, it is 42% and for females

**Table 1: Sex-wise distribution of TBL and stature with mean and standard deviation**

Variables	Mean (cm)	Standard deviation	P-value
TBL			
Male (n=249)	37.04	1.00	<0.001
Female (n=251)	35.30	1.97	
Total (n=500)	36.16	1.79	
Stature			
Male (n=249)	162.51	7.56	<0.001
Female (n=251)	153.59	5.21	
Total (n=500)	158.03	7.87	

Abbreviation: TBL, Tibial length

**Table 2: Correlation of stature with tibial length**

Tibial length	Karl–Pearson Correlation Coefficient	P-value
Stature	0.623	<0.001

**Table 3: Correlation of stature and tibial length according to gender**

Sex	R	R Square	Adjusted R Square	ANOVA P value
Female	0.478 <sup>a</sup>	0.228	0.225	<0.001
Male	0.648 <sup>a</sup>	0.420	0.417	<0.001
Total	0.623 <sup>a</sup>	0.388	0.387	<0.001

22.8%. For the whole population, the *R* square value is found to be 38.8%. Here, it is seen that for males tibial length is a better predictor.

The Table 4 generated stature estimation from tibia using regression analysis as follows:

- In case of males, Stature =  $4.923 \times$  Tibial length – 19.819.
- In case of females, Stature =  $109.023 + 1.262 \times$  Tibial length.
- In case of whole population, Stature =  $58.822 + 2.743 \times$  Tibial length.

## DISCUSSION

The current study was conducted among 500 individuals from the rural Mangalore population, which showed a mean age of  $31 \pm 5$  years, out of those 249 were males and 251 were females with a mean age of  $31 \pm 5$  years, and  $32 \pm 6$  years, respectively. According to a study done by Bardale et al. for measuring stature which reveals the mean age of the male population was 21.52 years and the mean age of the female population was 20.08 years [12].

We found that in our examination mean stature among 500 individuals was  $158.03 \pm 7.87$  cm. Stature among males was found to be  $162.51 \pm 7.56$  cm and in females it was  $153.59 \pm 5.21$  cm. A study conducted by Shivakumar et al. among the South Indian population and Chikhalkar et al. among the population of Mumbai showed that mean stature was very high as compared with the present study, which was  $167 \pm 0.10$  cm and

**Table 4: Stature estimation from tibia using regression analysis among gender**

Sex		Unstandardized coefficients		Standardized coefficients	T	SIG
		B	Standard error	Beta		
Females	(Constant)	109.023	5.198	0.478	20.973	.000
	TBL	1.262	0.147		8.586	.000
Males	(Constant)	-19.819	13.647	0.648	-1.452	.000
	TBL	4.923	0.368		13.366	.000
Total	(Constant)	58.822	5.590	0.623	10.523	.000
	TBL	2.743	0.154		17.770	.000

Abbreviation: TBL, Tibial length.

167.26 ± 8.494 cm, respectively [13, 14]. According to the study done by Bardale *et al.* showing that the mean stature among men was 171.6 cm and mean stature among females was 157.3 cm [12]. Rahule *et al.* revealed that the mean height of males was 169.97 ± 5.71 cm and among females mean height was 154.20 ± 7.15 cm among the tribal population of a district of Madhya Pradesh [15]. Gupta *et al.* found that mean height among the North Indian population was 168.56 cm [16]. The mean stature among males in Orissa was found to be around 162 cm and 152 cm for females in the study led by Mohanty *et al.* [11] and Saini *et al.* found mean stature in males to be 174 ± 6.57 cm and mean stature in females to be 157.53 ± 4.77 cm among the population of Rajasthan [17]. Chandravadiya *et al.* showed that normal stature in males was 171.185 ± 6.34 cm and in females was 159.095 ± 6.75 cm [18]. Studies done on a worldwide level also showed changing outcomes like in the study done by Habib *et al.* revealed that the mean height in Egyptian males was 174.61 ± 7.34 cm and among Egyptian females was 160 ± 5.45 cm [19]. Ahmed *et al.* discovered that mean height among Sudanese males to be 174.71 ± 5.72 cm and 160.43 ± 5.49 cm among Sudanese females [20]. Carretero *et al.* led an examination in Spain and noticed that normal height among males and females was found to be 175.5 ± 7.0 cm and 162.1 ± 7.3 cm, he likewise discovered normal height among SH hominins, Neandertals, and early-present day people to be 163.6

cm, 160.6 cm, and 177.4 cm, respectively [21]. Pelin and Duyar conducted a study among the Turkish population, where the mean height among study members was 174.7 ± 88.30 cm, whereas Jervas *et al.* and Sarajlic *et al.* showed that the mean stature for the Negro population and the Bosnian population was 167.55 ± 9.00 cm and 175.24 ± 7.77 cm, respectively [22, 23, 24]. Trotter and Gleser discovered the mean stature among military White males to be 173.899 ± 6.626 cm, whereas in military Negroes mean stature was 172.11 ± 8.43 cm [25].

In our study, mean tibial length was found to be 36.16 ± 1.79 cm. Mean tibia length among males was 37.04 ± 1.0 cm, whereas among females was 35.30 ± 1.97 cm. A statistically significant difference was found in tibial length across the gender ( $P < 0.05$ ). Similar results were noticed in various other studies done in the Indian setting. In a study conducted by Gupta *et al.*, mean tibial length was found to be 31–35 cm [16]. Similarly, the mean tibial length among males in the study conducted by Mohanty *et al.*, Chandravadiya *et al.*, Trivedi *et al.*, and Chavan *et al.* were found to be 37.08 ± 2.34 cm, 37.23 ± 2.08 cm, 38.24 ± 2.343 cm, and 37.32 ± 2.18 cm, respectively. The mean tibial length among females in the study conducted by Mohanty *et al.*, Chandravadiya *et al.*, Trivedi *et al.*, and Chavan *et al.* were found to be 35.03 ± 2.60 cm, 33.94 ± 2.06 cm, 36.064 ± 2.464 cm, and 34.44 ± 2.10

cm, respectively [11, 26, 27]. But in the study conducted by Saini et al, the mean tibial length was found to be a little higher, among males which was  $40.90 \pm 2.48$  cm as compared with females which was  $38.09 \pm 2.39$  cm [17]. Trotter and Gleser conducted a study in 1952 among Negro and White subjects and they found that mean tibial length among Negro males and White males was  $38.606 \pm 0.322$  cm and  $37.826 \pm 2.179$  cm, respectively, whereas in Negro females and White females it was found to be  $34.53 \pm 2.098$  cm and  $33.18 \pm 2.091$  cm, respectively [25]. Mahakkanukrauh *et al.* found the mean tibial length among Thai females to be  $33.88 \pm 1.94$  cm, whereas among Thai males to be  $36.10 \pm 1.99$  cm [28]. Similarly, Ahmed et al. found the tibial length to be  $41.53 \pm 2.09$  cm and  $38.31 \pm 2.05$  cm among Sudanese Arabs males and females, respectively [20]. In a study, conducted by Dayal *et al.* mean tibial length in South African males and females was  $38.25 \pm 2.36$  cm and  $35.2 \pm 1.99$  cm, respectively [29].

## CONCLUSION

Based on the examination findings, we conclude that:

- Tibial length is a reliable measurement for estimating stature with quite a good correlation coefficient value of 0.623.
- The tibial length shows higher and better correlation coefficient values among males as compared with females.
- By using regression analysis, stature estimation from tibial length among males and females.
- Stature =  $4.923 \times$  Tibial length – 19.819 (males).
- Stature =  $109.023 + 1.262 \times$  Tibial length (females).

## Limitations of Study

India is an immense country and has an extremely huge populace. The common conditions and financial status are typically generally extraordinary among locale/states. Accordingly, there are clear varieties in the

degree of advancement for grown-ups. Since this examination was done distinctly in one district of Karnataka, the outcome cannot be summed up by the entire populace of India. Subsequently, further examinations must be accomplished for refining the outcomes.

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