



ESTIMATION OF STATURE HEIGHT THROUGH MEASUREMENT OF INDIVIDUALS TIBIAL LENGTH

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

By inferring a constant correlation of the Tibia with height, most Indian scholars have developed multiplication ratios instead of coefficient of determination. This presumption is only sometimes true, though. Regression formulas generated from the primary long bones are often more accurate for studies that are legitimate. As a result, we have developed a regression model in the current work to estimate height from tibial length. Aim of the study: This study will assist prosthetic limb clinics in estimating the proper length of prostheses. The study will be useful in leprosy patients' remedial procedures and surgery involving the replacement of limbs following an accident or injury. Conclusion: The length of the Tibia provides considerable reliability in estimating height in forensic exams, it is established. In the current research, men's average tibial length is 39.65 cm on the right side and 39.55 cm on the left. In females, the average tibial length is 36.35 cm on the right side and 36.14 cm on the left. Tibial length measurements may be used to determine a person's total height.

Keywords: Stature; height; tibial length; long bone; amputation; regression.

1. INTRODUCTION

In the fields of forensic medicine and anthropology, the estimation of height is very important. The measurements of the human body and skeleton are

expressed quantitatively using a variety of systematized measuring procedures known as anthropometry. In forensic science, the ultimate goal of anthropometry is to assist law enforcement in establishing "personal identification" in cases of

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unidentified human remains [1,2]. For a long time, scientists, anthropologists, and artists have been interested in the relationship between the proportions of the various body parts and the whole body [3].

The ability to forecast the measurements of one body component from another or link the proportions of body segments is immensely important in many fields of contemporary medicine. Anthropologists compare body segments' correlations to height differences across ethnic origins [3,4].

As reported in [5], Paul Topinard, for the first time, proposed a set of anthropometric measures in 1877. However, a global agreement on human body measures was obtained in 1912. The international coalition for the uniformity of measuring 1877 the human subjects were accepted by the German Congress in 1912 [6].

A French police specialist who developed a method of verification and identification predicated on anthropometric measurements first used anthropometry in forensic science and medicine in 1882. His technique was based on three key principles [7].

A conclusive research on the calculation of stature for American whites and blacks was published in 1952 [8]. The data utilized came from World War II casualties. The Terry collection is another. The maximum lengths of all six long bones and the maximum distances between the top and bottom articulated surfaces of the Tibia and fibula were measured. Various equations for calculating height were developed for whites and blacks, as well as for men and girls [9].

For Indians (Hindus), [10] analyzed the maximum lengths of the radius, femur, carpal bones, Tibia, fibula, and ulna bones in 142 male and female corpses. Additionally, [11] provided data premised on the longest dry tibia length, expressed in inches, from which a Multiplication Factor (M.F.) was computed for each. The current research comprises estimations of the individual's height and tibia length. Comparisons between actual height and height calculated using a formula based on a person's tibial length are also possible.

This research will assist prosthetic limb clinics to determine the proper length of prostheses. The research will be useful in leprosy patients' remedial procedures and surgery involving amputation of limbs for unintentional injury. The resulting formulas may be used to compute height in cases when patients have spinal conditions such as kyphoscoliosis. The information gathered may also be helpful in future anthropological research.

2. MATERIALS AND METHODS

For the present study, 200 students without any leg deformities were chosen. (100 males and 100 females) in the age group between 18-21 years from Krishna Institute Of Medical Sciences Deemed University Karad, Maharashtra. The working protocol was submitted to the ethical committee for approval & necessary permissions were taken. All participants signed their written approval prior to the research study.

The following anthropometric measurements were taken :

- i. Right tibial length
- ii. Left tibial length
- iii. Stature

Independently for each individual as well as the stature of each subject was also recorded.

According to the methods outlined by Vallois, the parameters were measured using standardized anthropometric tools in centimetres to the closest millimetre [12]. The study's participants were healthy and devoid of any evident symptoms of lower extremity deformities.

2.1 Materials

- 1) A standard Vernier caliper (60-centimetre length with an accuracy of 0.01 cm) is used for the measurement of the length of the Tibia.
- 2) Standard flexible steel tape. They were used for the measurement of the total height of the individual.
- 3) Stadiometer or Sted ruler or tape measure placed against a wall (for measuring height).

2.2 Methods

2.2.1 Standing height (stature)

Standing height is defined as the greatest distance between the ground as well as the upper end of the head. In comparison, the person is looking straight ahead. When being measured, the wearer should have their shoes removed, their feet together, their arms at their sides, buttocks as well as their upper back, and heels in alignment with the wall.

Reliability: Height measurements might change throughout the day, often being taller in the morning. Thus it is important to take them at the same time of day to ensure accuracy.

Procedure: The woman was made to stand straight on a horizontal resistive plane, barefoot, with her buttocks contacting the wall and her shoulder blocks protruding. The fingers were horizontally extending downward with the palms inwards. The height was measured in cm using a normal flexible steel tape, with one end positioned at the head and the other touching the floor.

The following equation can obtain the height or stature:

$$\text{Height} = a (\text{constant}) + b (\text{slope}) \times \text{tibial length} \pm \text{standard error}$$

The height of the individual can be calculated by using the right tibial length (*RtTL*) by following the formula in males:

$$\text{Height} = 86.93 + (2.11 * \text{RTL} \pm 4.53)$$

The height of the individual can be calculated by using left tibial length (*LTL*) by the following formula in males:

$$\text{Height} = 88.26 + (2.08 * \text{RTL} \pm 4.45)$$

The height of the individual can be calculated by using the right tibial length by the following formula in females:

$$\text{Height} = 61.05 + (2.65 * \text{Rt.TL} \pm 3.59)$$

The height of the individual can be calculated by using left tibial length by the following formula in females:

$$\text{Height} = 62.53 + (2.63 * \text{Lt.TL} \pm 3.81)$$

where T.L. is tibial length (right or left)

Daytime fluctuations in actual height, as well as spinal stability, are noticeable. From a supine to an upright position, changes in posture have an impact on body height. The changes that take place in the cervical, lumbar, and thoracic portions of the spine seem to be the cause of the daytime fluctuations. In teenagers and young adults, the spinal column length shifted the most. Within three hours of awakening in the morning, the height is lost, with a total loss of around 15 millimetres. In order to prevent inaccuracies, each person's measurement was taken between 2 and 5 p.m.

2.2.2 Measurement of the length of the Tibia

Medial to the fibula is the Tibia. The shaft features a triangular cross-section, enlarged ends or condyles

proximally, and a smaller distal end with a prominent medial malleolus that extends distally. The anterior boundary is subcutaneous, acute, and medially curving toward the medial malleolus.

To relax the soft connective tissue and make bone landmarks more noticeable, the participant sat with their left knee slightly bent and their left foot somewhat reverted (outwards). At the same time, measurements were taken [13]. A sliding calliper is used to take measurements of the Tibia from the tip of the medial malleolus to the most conspicuously palpable part of the medial condyle.

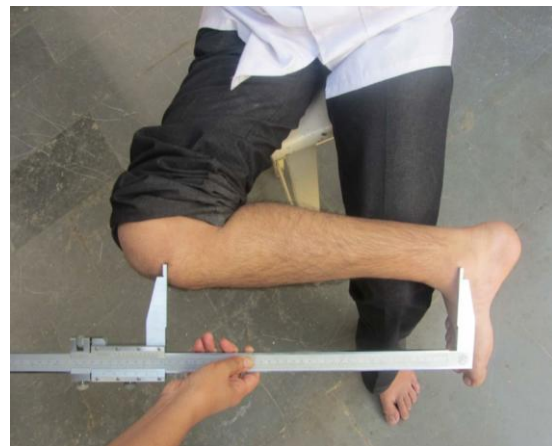


Fig. 1. Measurement of the length of the Tibia

After data collection was subjected to statistical analysis, they were recorded and tabulated.

3. RESULTS

The following anthropometric parameters were studied: a) Stature, b) Right tibial length and c) Left tibial length. These data were analyzed using Microsoft Excel 2010. The table below (Table 1) demonstrates that there is no considerable variation between the male's right and left tibial lengths.

Table 1. Male tibial length parameter

Parameter	Tibial length	
	Right	Left
Number	100	100
N mean	39.65	39.55
S.D.	2.17	2.23
Maximum	45.4	45.7
Minimum	35.52	34.82

The table below shows no significant difference in females' tibial length on the right and left sides.

Table 2. Female tibial length parameter

Parameter	Tibial length	
	Right	Left
Number	100	100
N mean	36.35	36.14
S.D.	1.89	1.85
Maximum	41.5	40.5
Minimum	32	31.99

The mean estimated value using tibial length in the case of males is nearly equal, so we can use the derived regression formula for the approximate evaluation of stature (see Table 3).

Table 3. Comparison of Mean measured stature and Mean estimated stature using tibial length in male

	Right tibial length	Left tibial length
Mean estimated stature	168.82	168.85
Mean measured stature	170.64	

Table 4. Comparison of Mean measured stature and Mean estimated stature using tibial length in females

	Right tibial length	Left tibial length
Mean estimated stature	156.07	155.98
Mean measured stature	157.51	

Table 5. Sidewise comparison of tibial length in both sexes

	Male Right Vs Female Right	Male Left Vs Female Left
p-value	0.0021	0.05
Std. error of means	0.28	0.29
Degree of freedom	198	198
t value	11.64	11.94
test significant or not	YES	YES

It was found that there is a statistically highly significant difference between the tibial length of females and males on both sides (see Table 5).

Males' measured and actual heights varied on average by 1.80 cm, while females' measured and actual heights varied by 1.49 cm (see Table 6).

Thus, it can be said that the Actual Height is equal to 4.3 times to that of Tibial Length (Table 7).

4. DISCUSSION

Since the proportion of the Tibia to height is assumed to be constant, the majority of Indian scholars have developed multiplication factors instead of regression coefficients. Although, [13] had demonstrated that the Tibia was significantly allometric with height, this notion, however, may not always be true. Numerous researchers, including [14], came up with the same regression equation. A multiplication factor that is solely relevant to men was obtained by [9–12]. Nat claims that the multiplier for men is 4.48. Regression formulas generated from the primary long bones are often thought to be more accurate for studies that are legitimate. As a result, we have developed a regression model in the current work to estimate height from tibial length.

Males' average right and left tibial lengths in the current research were 39.65 cm and 39.55 cm, respectively. Our results agree with the research of [15]. 110 male individuals from the Turkish community made up his study. In this work, he introduced the Group Specific Formula, a novel technique for estimating height using tibia length.

Both assessed heights determined from the length of the dried Tibia as well as from the mean percutaneous tibial length were compared by [16]. The estimated height based on two distinct sets of Tibia did not vary. For the male population in Britain, the average height was 170.06 cm. In contrast, in the current research, we determined that the typical male Indian is 170.64 cm tall. According to the research above, the regression coefficient that Allbrook (as reported in [11]) developed for calculating height in the British population is inapplicable for assessing stature in the Indian population [17].

Table 6. Difference between estimated & actual height in both sex

Sex	Actual height (cm)	Estimated height (cm)		Difference (cm)		Mean Difference (cm)
		Right	Left	Right	Left	
Male	170.64	168.82	168.85	1.83	1.78	1.80
Female	157.51	156.07	155.98	1.45	1.53	1.49

Table 7. Relationship between tibial length & actual height

Sex	Actual height (cm)	Tibial length(cm)		Ratio (Ht/T.L.)	
		Right	Left	Right	Left
Male	170.64	39.65	39.55	4.30	4.31
Female	157.51	36.35	36.14	4.33	4.35

5. CONCLUSION

The length of the Tibia provides considerable reliability in estimating height in forensic exams, it is established. Men's average tibial length in the current research is 39.65 cm on the right side and 39.55 cm on the left. In females, the average tibial length is 36.35 cm on the right side and 36.14 cm on the left. Tibial length measurements may be used to determine a person's total height. Patients with spine diseases like kyphoscoliosis might have their stature calculated using a regression equation built from other data. Leprosy patients who need corrective surgery may find the various formula useful. In the current research, a person's entire height is 4.3 times their Tibia's length. Additionally, it has been shown that a sole anthropometric quantification of the Tibia may very accurately predict the height of an unidentified individual.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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