

Estimation of Stature from Percutaneous Length of Tibia in Natives of Gujarat

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Abstract

The Indian Constitution guarantees equal right of justice, life and liberty to all Indian citizens. Every person has freedom of expression (unlawful act committed upon him/her) and it remains when the person died by any mean. Identification of an individual is primary element to investigate both civil and criminal cases. With the time, complexity of crime advance and forensic experts' role become very crucial in investigation of crime. Crime investigation become very difficult and crucial when investigation agency find unknown mutilated body, bundle of bones or parts of bone. Without identification of dead person, investigation of crime become directionless. Key factor for identification are age, sex and stature. Many factors should be taken in to consideration to fix stature with help of bone. Many researchers had been clearly proved that long bone can be uses to estimate stature and it depend on race, ethnic and region. Very less work had been done to formulate regression formula from tibia in state of Gujarat. This study aims at formulate a regression formula to estimate stature from percutaneous length of tibia (PCTL) for native of Gujarat. This study was carried out in Department of Forensic Medicine, C.U. Shah Medical College, Surendranagar, Gujarat. Total 800 (400 male & 400 Female) undergraduate MBBS student between 18 to 25 years of age were participated in study. Their stature and percutaneous length of tibia were estimated with standard method and manner. Results are analysed and studied. Results show that there is highly significant in mean length of tibia and stature in both male and female participants ($P < 0.05$). Stature and percutaneous length of tibia has positive correlation and regression formula is obtained to estimate stature from tibial length for natives of Gujarat.

Keywords: Tibia Length; Stature; Identification; Gujarat.

Introduction

Natural and man-made disasters like earthquakes, floods, cyclones, stampede, fires, transport accidents, industrial accidents, explosions etc cause significant loss of life and mutilation of body. A murderer always tries to mutilate dead body to hinder the identification of the person.¹ Key factors for identification are Age, Sex and

Stature. Many factors should be taken in to consideration while fixing stature with help of bone. Use of anatomical measurement of body is very ancient. The word 'Anthropometry' was first used by a German physician J. Sigismund Elshwltz (1623-88).² Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are closely linked with each other and manifestation of internal structure and tissue components which in turn are influenced by environmental and genetic factors.³ Hand length, foot length, Ulna length and Tibia length can be used to determine the stature of the person whenever mutilates, bones or part of bone comes for post-mortem examination.

Percutaneous length of long bone is more convenient method for estimation of stature than dry bone as it is

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a tedious and time consuming process which involves cleaning and preparation of bones.⁴ Lower limb length plays important role in estimation of standing height of an individual hence most predictive formulas are based on length of tibia, femur and fibula.⁵ Tibia being located subcutaneously easily approachable to measure in living population.⁶ Since the relationship between long bones and stature is influenced by ethnicity and gender of an individual, there are no universally applicable formulae for stature estimation from the length of long bones.⁷ Therefore, population-specific formulae are more reliable for estimation of stature in medicolegal cases.⁸⁻¹³ This research was done in department of Forensic Medicine, C.U. Shah Medical College, Surendranagar to derive the region specific regression formula to estimate the stature from percutaneous ulnar length in natives of Gujarat.

Material and Method

This study was carried out in Forensic Medicine Department of C.U. Shah Medical College, Surendranagar, Gujarat after taking ethical approval from the Institutional Ethics Committee-CUSMC. Total 800 (400 male & 400 Female) healthy undergraduate MBBS students, age between 18- 25 years, without any physical deformity, chronic illness or any other

condition/s affecting the stature or tibia length or bone growth were included in study. Informed written consent obtained from each participant. All the measurements were taken at a fixed time between 09:00 - 11:00 hours in the morning to eliminate diurnal variation. All the measurements were recorded by the same person to minimize the bias.

Stature of the participants measured in standing posture with standing barefoot, heels touching together and back of head, head in Frankfort-Horizontal plane; shoulder blades, buttocks and feet touching the backboard using standard equipment for measuring height. Stature was taken from Vertex to floor.

Percutaneous tibia length (PCTL) was taken from the highest point on medial border of the head of the tibia to the most distal point on the medial malleolus in seating position with ankle resting on another knee. The measurement was taken for both tibia with spreading calliper.

Results

All variables were collected and analysed in IBM SPSS Statistics 23 software.

Table 1: Gender wise descriptive analysis of variables. (N=800)

		Male			Female		
		Right PCTL	Left PCTL	Stature	Right PCTL	Left PCTL	Stature
N	Valid	400	400	400	400	400	400
	Missing	0	0	0	0	0	0
Mean		39.072	38.863	169.943	37.741	35.537	159.641
Std. Error of Mean		0.2240	0.2244	0.3580	0.1563	0.1569	0.3792
Median		39.00	38.80	170.00	35.20	35.00	159.720
Mode		38.0	37.0	168.0	35.00	35.00	159.00
Std. Deviation		4.4797	4.4879	7.1598	3.1258	3.1375	7.5846

*PCTL- Percutaneous Tibia Length

Table 1 shows, for Mean Stature for Male is 169.943 cm and for Female is 159.641 cm.

Mean PCTL in male is 39.072 cm and 38.863 cm

for right and left lower limbs respectively. In Female participants mean PCTL is 37.741 cm and 35.537 cm for right and left lower limbs respectively.

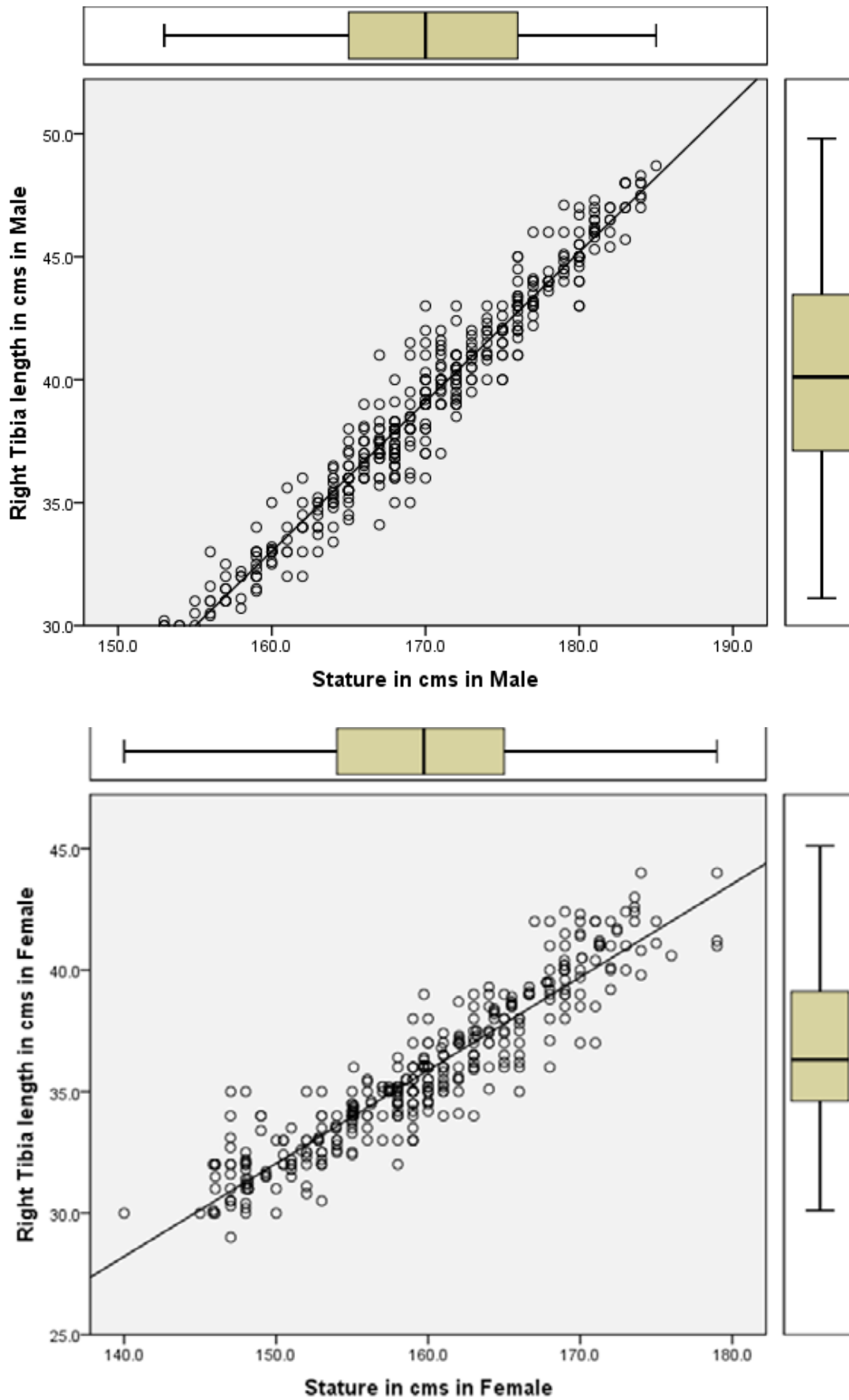


Figure 1: Shows Right PCTL in cm on X-axis and Stature in cm on Y-axis.

Z test is applied to compare Standard Error of difference between means of PCTL and Stature, found to be highly significant at P< 0.0001 level for each right

& left lower limb in male participants. Same correlation also established for female participants.

Table 2. Regression formula derivatives for calculating stature from PCTL.

	Constant (a)		Regression Coefficient (b)		Correlation Coefficient (r)		Correlation Determination (r ²)		Std. Error of the Estimate	
	Right	Left	Right	left	Right	Left	Right	Left	Right	Left
Male	108.98	109.49	1.562	1.557	0.972	0.971	0.945	0.943	1.6779	1.7094
Female	79.00	79.79	2.256	1.594	0.930	0.930	0.865	0.864	2.7946	2.8002

Table 2 shows constant (a), regression coefficient (b), Correlation coefficient (r) and correlation determination (r²) for right & left Tibia for both gender.

Regression formula to estimate Stature from Tibia length are as follow:

For Male:

(a) Stature in cm = 108.99 + 1.562 × (Right PCTL) ± 1.68

(b) Stature in cm = 109.49 + 1.557 × (Left PCTL) ± 1.71

For Female:

(a) Stature in cm = 79.00 + 2.256 × (Right PCTL) ± 2.79

(b) Stature in cm = 79.79 + 1.594 × (Left PCTL) ± 2.80

Discussion

In the first study of this kind, Rollet assessed the correlation between stature and long bone length in adult French cadavers and published a report with the method of measurement, the individual measurements and tables of stature estimations.¹⁴ This study shows that the stature is significantly correlated to percutaneous tibial length in both gender in natives of Gujarat.

Pearson (1899) used Rollet’s data to create regression formulae for estimating stature. He used only long bone lengths of the right side. Pearson contributed greatly to the advancement of stature estimation.

Table 3: Mean stature, Tibia length and Regression formula derived for different regions of India

Region	Study	Male/Female/Combine	Stature cm	Tibia Length cm	Regression Formula S=Stature in cm T= Tibial Length in cm
Delhi (Shia Muslims)	Bhavna et al. ²¹	Male	167.66	36.48	S = 84.74 + 2.27 (T) ± 3.67
		Female	154.40	33.66	S = 75.66 + 2.34 (T) ± 3.42
Gwalior	Trivedi A. et al. ²²	Male	164.50	38.24	S = 105.971 + 1.53 (T) ± 7.452
		Female	155.30	36.06	S = 103.76 + 1.43 (T) ± 4.69
Haryana	Gaur R. et al. ²³	Male	167.21	38.26	~~
		Female	154.72	35.26	~~
Kori Population, North India	Renu Kamal, Praveen Kumar Yadav ²⁴	Male	164.63	42.42	S = 139.80 + 0.58 (T)
		Female	151.00	40.00	S = 108.1 + 1.07 (T)
Maharashtra	Chavan S. K. et al. ²⁵	Male	167.89	37.32	S = 81.30 + 2.32 (T) ± 3.56
		Female	151.41	34.44	S = 95.28 + 1.63 (T) ± 3.69
Tamil Nadu	Anitha MR et al. ²⁶	Combine-Right	161.93	37.43	S = 94.5 + 1.8 (T)
		Combine –Left	161.93	37.50	S = 88.55 + 1.95 (T)
West Bengal	Anirban D. et al. ²⁷	Male	164.06	35.99	S = 71.2333 + 2.5792 (T)
		Female	156.38	33.83	S = 65.345 + 2.6914 (T)
West Bengal (South)	Mantotosh Banerjee et al. ²⁸	Male	164.3	35.99	S = 71.361 + 2.575 (T) ± 2.943
		Female	156.38	33.83	S = 65.344 + 2.691 (T) ± 1.974
Gujarat	Present study	Male (Right)	169.94	39.07	S = 108.99 + 1.562 (T) ± 1.68
		Female (Right)	159.64	37.74	S = 79.00 + 2.256 (T) ± 2.79

According to Trotter and Gleser world population is getting taller and therefore the relationship between height and length of long bones is changed and fresh formulae are needed for each generation, hence they attempted to find out fresh formula for Indians.¹⁵

The Stature differs in different part of India and world.¹⁶ Indian population is mixture of various religion, castes, tribes, culture and geo-environmental regions. Indian built and stature found different in different parts of the country. The stature not only differs from region to region but also varies based on different castes and tribes. Estimated mean stature of Barelas (tribe) as 161.5 cm and that of the Bhils (tribe) 160 cm, in same state of Madhya Pradesh.¹⁷ Bose reported mean status in west Bangal is 166.6 cm.¹⁸, Mohanty reported the stature for male Oriya population as 162.2 cm. Kolte PM et al. estimated average statures of male in Marathwada region of Maharashtra was 163.7 cm.¹⁹ whereas Patil T.L. et al found average status as 161.9 cm for male in Vidarbha region of Maharashtra.²⁰

Table 3 shows that different regions of same country has different height and length of tibia. Table also shows that regression formula to estimate stature from tibia length is different and specific to each region. Mean stature of male and Female of Gujarat 169.94 cm and 159.64 cm respectively, which is highest of all the studies mentioned in table 3. Which is near to 173.40 cm for male previously calculated by M.P. Patel in Gujarat.²⁹

Mean length of tibia of both male & female is highest for Kori population of North India, i.e. 42.42 cm in male and 40.00 cm in female.

This clearly proves that regression coefficient of one region is not applicable for another region.

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Conclusion

Establishment of identity is utmost important in both civil and criminal cases. Stature is one of the key indicator to established identity. Present study proves that stature and PCTL has positive correlation and regression formula is formed to estimate stature from

ulna length.

There are different study throughout world to estimate stature from long bones, but there are vast variation in formula derived. With changing world, body parameters are also changing. Hence, it is necessary to research more among population of different regions, ethnic groups to obtain a reliable formula to estimate stature.

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