

## ESTIMATION OF STATURE FROM PERCUTANEOUS TIBIAL LENGTH IN INDIAN POPULATION

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### ABSTRACT

**Background:** As said "to identify the individuality of human being and to reconstruct stature from different body part is his birth right" and also the stature of a person is considered as an inherent character by the anthropologists. So for establishment of the identity of a person, measurement of stature is considered as the most valuable parameter in forensic anthropology.

Present study is undertaken to derive a regression equation for estimation of stature from percutaneous tibial length.

**Material and methods:** Present study was carried out on 400 subjects (200 male and 200 female) among the population of India. The stature and percutaneous tibial length was measured and the data was analyzed statistically and the regression equation was derived.

**Result:** The linear regression equation derived from percutaneous tibial length for the measurement of height showed statistically significant relationship ( $p < 0.05$ ) in both the sexes.

**Conclusion:** The present study revealed that there is a positive correlation exists between the stature and percutaneous tibial length. Hence, this study is very much useful for forensic expert as well as for the anthropologist.

**KEY WORDS:** Anthropometry, Percutaneous tibial length, Stature.

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DOI: 10.16965/ijar.2016.278

**Web site:** International Journal of Anatomy and Research  
ISSN 2321-4287  
[www.ijmhr.org/ijar.htm](http://www.ijmhr.org/ijar.htm)

Received: 22 Jun 2016

Peer Review: 22 Jun 2016

Revised: None

Accepted: 15 Jul 2016

Published (O): 31 Jul 2016

Published (P): 31 Jul 2016

### INTRODUCTION

Anthropology is the branch of science which deals with the comparative study of human being, their origin, physical and cultural development and biological characteristics [1-3]. It also gives us knowledge about the

evolutionary history of human being, the variation in social and cultural behavior among the different race of people, the structural development and variation in physical status of different group of human population and it also proved itself as a boon for researchers [4].

The term anthropology comes from the Greek word "anthropos" meaning "human being" and "logia" meaning "study".

**Subdivision of anthropology:** Anthropology can be subdivided into the following two parts:

**Social Anthropology:** it is the branch which deals with the study of human being, their working style and the culture in the society and the variation among them is also included.

**Physical Anthropology:** it deals with the long term development of human being and the study of biological behavior of humans [5].

As said "to identify the individuality of human being and to reconstruct stature from different body part is his birth right" and also the stature of a person is considered as an inherent character by the anthropologists. So for establishment of the identity of a person, measurement of stature is considered as the most valuable parameter in forensic anthropology [1]. In the field of forensic anthropology determination of identity of an individual is considered as the most important character, specifically when a damaged body or mutilated bodies are found and also if bones are available after the death of individual at the site of crime or any other place [6].

As we know that various part of the body like head, trunk and length of upper and lower limbs are in close relation with the height of a person. So for anatomist, anthropologist, and forensic medicine experts, height estimation has become a matter of interest by measuring the different parts of the body [1,7,8].

**Stature and percutaneous tibial length:** Stature is the body height of an individual in standing position. It represents the distance between the top of the head (the vertex) and the bottom of the feet. The legs should be kept parallel to each other with both feet joined together and the great toe should face forward. The person should stand barefooted and should maintain the anatomical position of the body with the head adjusted in Frankfurt plane [9].

Percutaneous tibial length is the total length of tibia significantly presenting the distance between the medial most superficial point on the upper border of the medial condyle to the superficial lower most point (tip) of medial

malleolus of tibia, and the person should maintain the angle between flexor surface of leg and thigh at 90° [1].

The standing height is in great contribution with the lower limb length, hence the most predictive equation is based on the bones of lower extremity length like tibia, femur and fibula [10].

Tibia holds about 22% of the total human body length [11].

The height of the new generation is increasing with improved socioeconomic condition of the world. Hence the relationship between height and length of long bones is changing day by day, therefore fresh formula are needed for each generation [12]. It is also useful for medicolegal experts and anthropological studies [13,14].

## MATERIALS AND METHODS

The study was conducted on 400 subjects (200 male and 200 female) between the age group of 17 – 24 year among the population of India. The stature and percutaneous tibial length was measured. The stature was measured with the help of stadiometer and percutaneous tibial length was measured by spreading caliper.

**Technique for measurement of stature:** The person was asked to stand erect, eyes forward and both arm by the side of the body, palm faces forward and both the leg parallel to each other, both feet are joined together and the great toe faces forward, and the head were adjusted in the frankfurt's plane. All the measurement was taken by bringing the sliding horizontal bar up to the vertex. All the measurement was taken in centimeter (Figure 1).

**Technique of measuring percutaneous tibial length:** For measuring the percutaneous length of tibia the person was asked to sit on a stool so that the thigh should be placed in a straight line, and the leg and thigh should be placed right angle to each other (maintain the angle of 90° with each other), foot was rotated laterally, so that the bony projection were prominently seen. Then proximal and distal points of tibia were marked by marker pencil. Then the two points (proximal and distal) were measured by spreading caliper. To determine the length of tibia spreading caliper was used. The length of

tibia was measured in centimeter (Figure 2).

**Proximal point:** the superficial superior most point of upper border of the medial tibial condyle was considered as the proximal point of measurement of the tibia.

**Distal point:** superficial inferior most point which is the tip of medial malleolus of tibia was considered as the distal point in measuring the tibia.

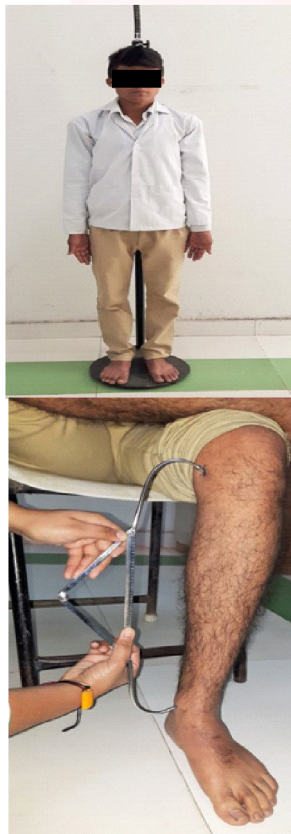
**Statistical analysis:** The data was statistically evaluated by calculating the mean, the standard deviation (SD) as well as the standard error (SE). Pearson's correlation coefficient was used to correlate between stature and percutaneous tibial length. The regression formula was derived by calculating the stature as well as the PCTL of left as well as right side of both the sexes. The regression formula used was –

$$Y = a + b (x)$$

Where, "Y" is the Height which has to be measured, "a" is the intercept ( i.e. the point between the Y- axis and the regression line ), "b" is the slope of regression line and "x" is the independent variable i.e. the PCTL.

Different parameters were compared by using student's t-test and p-value <0.05 was considered as statistically significant.

**Fig. 1:** Measurement of stature (Body Height) (cm).



**Fig. 2:** Measurement of proximal and distal point of tibia (cm).

## RESULTS

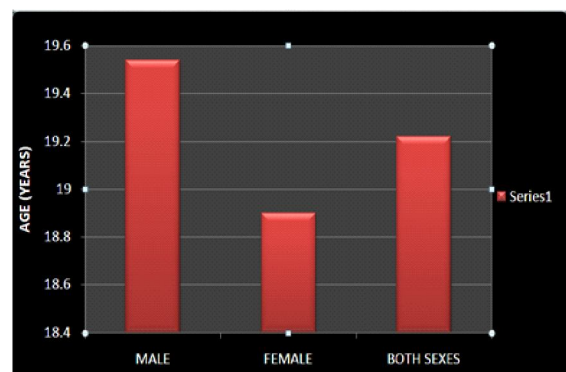
The present study was conducted on 400 subjects (200 male and 200 female) among Indian population. This study includes both the sexes between the age group of 17-24 year. The stature and percutaneous tibial length of all the subjects were measured and the statistical analyses was done by calculating the mean, standard deviation ( $\pm$ SD), standard error (SE), range ( minimum and maximum). Using Pearson's correlation coefficient and student's t-test with its p-value of significance for each parameter to find out any significant correlation between the parameters and also the regression equation was also derived.

**Table 1:** Statistical correlation between the age of the males, females and also both the sexes.

Group	Male	Female	Both Sexes
Number of Population	200	200	400
Mean	19.54	18.9	19.22
Standard Deviation ( $\pm$ )	1.83	1.14	1.55
Variance	3.35	1.29	2.4
Minimum	17	17	17
Maximum	24	24	24

Table 1 Showing that the mean age of male was 19.54 and that of the female was 18.9, and of both the sexes was 19.22 (graph 1). The standard deviation of the age of male was 1.83, female was 1.14 and of both the sexes was 1.55. The total number of population was 400 out of which 200 were male and 200 were female. The minimum age was 17 year and the maximum age was 24 year.

**Graph 1:** Bar chart showing the statistical correlation between the age of males, females and both the sexes.



**Table 2:** Descriptive statistics of the parameters of males (all the parameter were measured in centimeter).

Description	Stature (In cm*)	PCTL (In cm*)
Mean	171.23	37.81
Standard Deviation (SD)	6.3	1.98
Range	31	11.1
Minimum	155	32.6
Maximum	186	43.7
Count	200	200

Table 2 shows the descriptive statistics of male, the mean of the stature is 171.23 and that of the PCTL is 37.81. The SD of stature, PCTL is 6.30, 1.98 respectively. The minimum stature is 155 and the maximum stature is 186 and the range is 31. The minimum PCTL is 32.6 whereas the maximum PCTL is 43.7. The range of PCTL is 11.1.

**Table 3:** Descriptive statistics of all the parameters of female (all the parameter were measured in centimeter).

Description	Stature (In cm*)	PCTL (In cm*)
Mean	158.65	34.82
Standard Deviation (SD)	6.17	1.82
Range	31	8.5
Minimum	142	31
Maximum	173	39.5
Count	200	200

\* centimeter

Table 3 shows the descriptive statistics of female. The mean stature was 158.65 and the mean PCTL was 34.82. The SD of stature, PCTL was 6.17, 1.82 respectively. The maximum stature was 173 and minimum stature was 142 and the range is 31. The maximum PCTL was 39.5. The range of PCTL was 8.5.

Table 2 and 3 are showing the total count of male and female was 200 each.

**Table 4:** Regression statistics of male and female of PCTL.

Description	Male	Female
Correlation coefficient (r)	0.86	0.85
R-square	0.74	0.72
Standard error of estimation	3.17	3.25
t-value	17.1	16.1
DF	199	199
p-value	<0.05	<0.05

Table 4 shows the regression statistics of both male and female which was calculated between stature and PCTL. The value of correlation coefficient (r) varies from 0 to 1 (i.e. 0.86 in male and 0.85 in female). The value of R-square of male was 0.74 and that of female was 0.72. The standard error of estimation (SEE) in male was 3.17 and in female was 3.25. The t-value in male was 17.10 and in female was 16.10.

The degree of freedom (DF) in male and female was 199 (200-1).

It also shows a **positive correlation** between the height and the PCTL in male and female.

It shows that the relationship between the body height and PCTL length and p-value is less than 0.05 ( $p < 0.05$ ) shows significant in male and female.

We have derived the regression equation formula for both male and female separately to calculate the height from PCTL. We have considered a linear relationship between **x** and **y** and as such we have calculated a linear regression equation in the form of **y = a + bx**. The linear regression equation derived from percutaneous tibial length for the measurement of height showed statistically significant relationship ( $p < 0.05$ ) in both the sexes.

**Table 5:** Shows the Regression analysis.

Description	Male	Female
Intercept (a)	67.08	58.11
Slope of regression line (b)	2.75	2.88

For the measurement of stature '**Y**' from percutaneous tibial length we have derived the regression equations. To solve this equation we have calculated value of '**A**' and value of '**B**'. and '**x**' is percutaneous tibial length.

$$Y = A + B X$$

Where, "**Y**" is the value which has to be measured i.e. dependent variable (stature).

"**A**" is the point of cross between regression line and Y- axis (Intercept).

"**B**" is the slope of regression line (Slope).

"**X**" is the PCTL (independent variable).

The formulae have been obtained by using the statistical equation in both male and female separately, and the formula is:

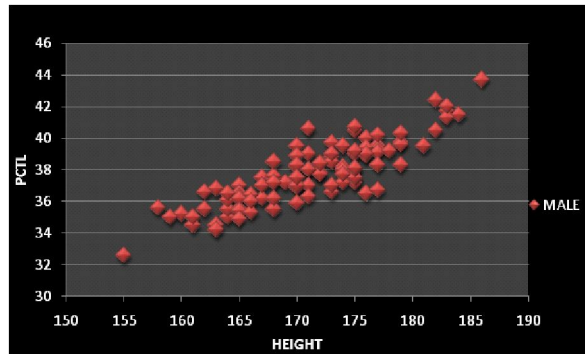


Regression Equation for male is  $Y=67.08 + (2.75)$  PCTL

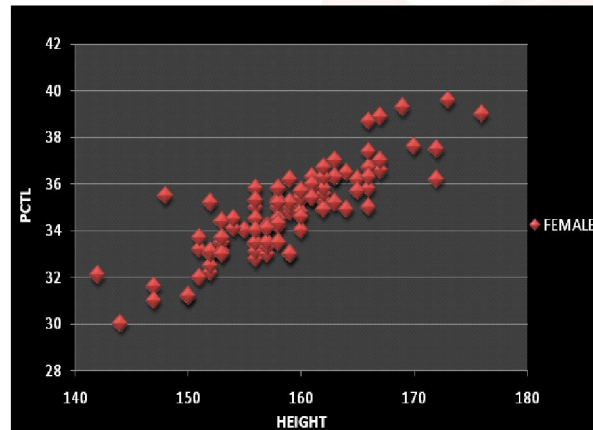
Regression Equation for female is  $Y=58.11 + (2.88)$  PCTL

PCTL\*: percutaneous tibial length.

**Graph 2:** Scatter diagram between height and PCTL in male.



**Graph 3:** Scatter diagram between height and PCTL in female.



As said **“Stature reveals identity”** and in the field of forensic anthropometry height estimation is considered as a important step for identification. The process of identification is very vast and various techniques are used in this process. Stature estimation from skeletal remain is one of them [15].

We have conducted the study in India. We have selected 400 students (200 male and 200 female) between the age group of 17 – 24 year. Then the stature and PCTL were measured and the data was calculated.

Our study was conducted among the age group of 17 – 24 years people and the similar age group was considered by Trivedi et al<sup>16</sup>, who studied the age group between 18 – 21 year. Similar age group was also considered by Kaore et al [11] Agnihotri et al [17].

In our finding the maximum number of subject was of the age group of 19 year in male and 18

year in female and after comparing the both the maximum number of subject was of the age group of 19 year, and the least number of subject was of the age group of 24 year.

In our study the stature was measured for male and female separately. The study revealed a co-relation between height and tibial length in both the genders (Graph 3,4). The stature measured for male was 171.23 cm and that of female was 158.65. Similar result was found Ashmawyet. Al [18], Kaore et al [11], Saini et al [19], Laxmi N. C. et al. [20] (Table 6,7)

**Table 6:** Showing the comparison of stature of the present study with the previous studies.

S.no	Previous studies	Year	Male stature	Female stature
1	Magdy Mohamed Ashmawy et al [18]	2006	171.48	162.42
2	AshitaKaore et al [11]	2012	170.08	156.2
3	Naha Saini et al [19]	2013	174.91	157.53
4	Laxmi N. C. et al [20]	2013	171.18	159.09
5	Present Study.	2016	171.23	158.75

Our value also matches the study of Rani et al [21], in which they had measured the stature among the population of Delhi, and found that the mean stature in male was 169.5 cm and that of female was 159.5 cm.

Similar type of result was found by Chavan et al<sup>22</sup> in which the stature of male was 167.89 cm and that of female was 151.41 cm. our study also correlate the study of Bhavna and SurenderNath<sup>23</sup> in which the male stature was found to be 167.66 cm and the female stature was found to be 154.40 cm.

Our finding nearly correlate the study of Mohanty M.K [24], in which they found the stature in male was 161.92 cm and in female was 152 cm.

**Table 7:** Shows the correlation of PCTL of male and female of previous studies with the present study.

S.No.	Previous Studies	Year	Male PCTL	Female PCTL
1	AshitaKaore et al [11]	2012	35.77	32.19
2	AkhileshTrivedi et al [25]	2014	38.26	36.1
3	Present Study.	2016	37.81	34.82

## CONCLUSION

The present study reveals that a positive and definite correlation exists between the percutaneous tibial length and the stature as well as regression equation is also established. In the

present study we have found moderate statistically significant correlation between height and PCTL and there is minimum standard error of estimation in stature.

**Conflicts of Interests: None**

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### How to cite this article:

Shahin Salma Khatun, Nidhi Sharma, Sanjeev Kumar Jain, Ashish Gupta. ESTIMATION OF STATURE FROM PERCUTANEOUS TIBIAL LENGTH IN INDIAN POPULATION. *Int J Anat Res* 2016;4(3):2571-2576. **DOI:** 10.16965/ijar.2016.278