 DOI : 10.48165/jiafm.2024.46.1.3

ORIGINAL ARTICLE

Stature from Tibia Irrespective of Sex: A Cross-Sectional Study

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Abstract:

Mutilated human remains are recovered many times and may be the only evidence of crime. Establishing the identity of the victim is of primary importance and stature assumes a prominent feature in the identification parameters. In view of this, we have taken up the present study to on Indigenous Manipuri Meitei subjects, both males and females, in the age group of 21-25 years. This is a cross-sectional study comparing the standing height of the participants with the percutaneous tibial length. The degree of correlation has been analysed and a regression formula has been estableshed irrespective of sex, i.e., which can be used on any specimen, whether male or female. A total of 75 males and 75 females were studied in Department of Forensic Medicine and Toxicology, of a tertiary health care centre in north east India. Subjects with any obvious congenital or acquired deformity of spine or extremities was not included in the study. A regression equation is established based on the tibial length of the individual, irrespective of sex has been derived as, Y= 81.90 +.85 X3 + 4.11. The equation so developed is tested by F-test and found to be very highly significant (P=<.001). In other words, the developed equation is treated as best fit to the present data and henceforth it may be used to detect the stature of person too for any given value of his/her tibial length.

Keywords: Stature; Tibia; Correlation; Meitei; Regression equation; Irrespective of sex.

Introduction:

Situations where identification is a challenge, usually arise in cases of natural disasters, rail and aircraft accidents, wars and terrorist bombings. Many times, only parts of human body, such as limbs are available for identification. "Stature is defined as natural height in an upright position".[1] Estimation of stature, therefore, plays an important role in medico-legal cases in the identification of unknown bodies, parts of bodies or even skeletal remains.[2-4] There exists a strong relationship between stature and dimensions of different body parts, particularly bone lengths, which forms the basis for stature estimation.[5] Out of various body parts, long bones play an important role for stature estimation in forensic investigations.[6] The lengths of long bones of lower limb provide better estimate of stature as compared to the bones of upper limb.[7] The tibia is ideal in this application as it resists erosion and keeps its anatomical shape for long even after burial.[8] Tibia accounts for 22% of the total body length. The present work has been carried out on indigenous Meitei subjects of Manipur. The data collected has been analyzed in the Department of Forensic Medicine and Toxicology, Regional Institute of Medical Sciences (RIMS), Imphal where all the subjects have been studied based on the findings of the lengths of tibia to generate a regression formula for estimation of stature.

Aims & Objectives: To establish a regression formula for determination of stature of indigenous Meiteis from tibial height.

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Article History
DOR : 03.03.2023 DOA : 29.09.2023

Materials and methods:

This is a cross-sectional study on indigenous Manipuri Meitei between the age group of 21-25 years. The calculated sample size is 72, considering a dropout rate of 5% a total of 75 males and 75 females were studied in Department of Forensic Medicine and Toxicology, of a tertiary health care centre in north east India. Subjects with any obvious congenital or acquired deformity of spine or extremities were not included in the study.

Standing Height (Stature) of the subject was measured in a standing position on a standard stadiometer with both feet in close contact with each other with the trunk straight along the vertical board, and the head adjusted in Frankfurt-horizontal plane (eye-ear plane). The measurement was taken in centimeters by bringing the horizontal sliding bar to the vertex. For measuring the per-cutaneous right tibial height. The study subject was asked to sit with knee placed in the semi flexed position and the foot partly inverted to relax the soft tissues and facilitate bony landmarks prominent. Then two points were marked by skin marking pencil. Upper point- The medial most point on the upper border of medial condyle of the tibia and Lower point- Tip of medial malleolus of the tibia. Distance between two points was measured with the help of Spreading Caliper to determine tibial height. All the measurements were taken by the investigator with the same instrument to avoid any technical and/or inter-observer error and to maintain reproducibility. The measurements were taken three times and their mean value was considered for estimation of height.

Statistical Analysis: Data entry was done using Windows based statistical package for social sciences [SPSS] version 21.0 (Armonk NY: IBM Corp). Statistical analysis was performed

Table 1. Demographic profile of the subjects.

Demographic profile	No. of case	Minimum	Maximum	Mean±SD
Age (yrs)	150	21.0	24.0	22.26±1.01
Tibial length (cm)	150	25.0	43.0	37.09±3.03
Stature (cm)	150	148.0	179.0	164.14±7.88

Table 2. Correlation coefficient between each demographic profile & stature of the subjects .

Between	Stature & Tibial length	Stature & Age
Correlation coefficient (r)	85**; P<0.001	.08; P=.323

***: Correlation is significant at the 0.01 level (2-tailed);*
ρ: Spearman's rank correlation coefficient

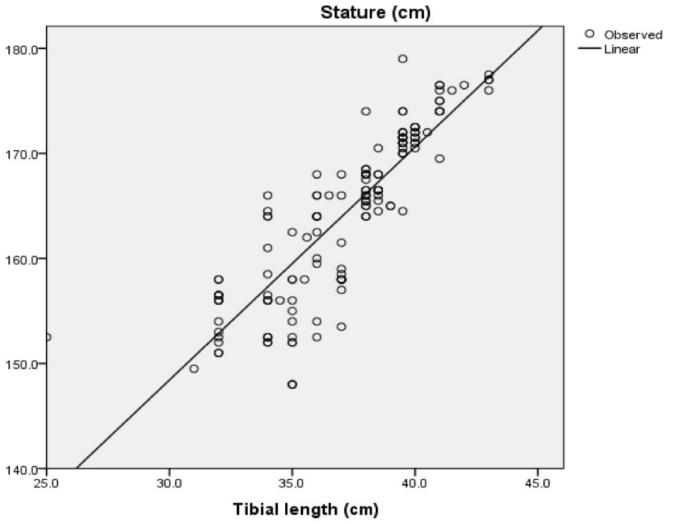

Figure 1. Showing average relationship between stature of an individual and tibial length through fitted regression line.

with the appropriate statistical test including chi- square test for categorical data and student 't' test for numerical data.

Descriptive statistics like mean used for socio demographic variable like age, sex, education etc. A P–value of 0.05 or less was considered significant. The data obtained was compared with the other similar studies.

Ethical issue: Coding was used for collection of cases and no cases in the study were identified from the data. Written informed consents were or consent was obtained from the participants regarding collection of data, and the approval from the Research Ethics Board (REB), Regional Institute of Medical Sciences (RIMS), Imphal was sought. The findings are recorded in proforma and the results are analyzed. The data obtained were kept in the department of Forensic Medicine, RIMS, Imphal. Access to the data will be restricted to the investigator and the guides, and members of REB (Research Ethics Board) when they demand.

Results and observations:

The following sections are discussed under the heading of "Results & Observations" viz.,

I. Patients' profile,

II. Correlation analysis,

III. Simple linear regression analysis.

I. Patients' profile: The present sample consists of 50% each for male and female, and all of them are in the age range of 21-25 years. The demographic parameters considered in the present study are age (yr), tibial length (cm) and stature (cm) of the subjects. Table-1 deals with descriptive information of the demographic profiles whilst table-2: Correlation coefficient between each demographic profile & stature of the subjects.

Table 3. Simple linear regression equation of stature on tibial length (PCTL).

Regression Statistics	Person irrespective of sex
Independent variable (X = PCTL)	X3= PCTL for person
Intercept (β0)	81.90
Regression coefficient (β1)	.85
Correlation coefficient (r)	.85**
Coefficient of determination (R2)	.72
Std. error of estimate (SEE)	4.11
P-value	<.001
Regression equation (Y= β0+ β1 X + ε)	Y= 81.90 +.85 X3 + 4.11
F-value	398.920
P-value	<.001

***: Correlation is significant at the 0.01 level (2-tailed);*

It is observed from the table-1 that, irrespective of sex, average age of the subjects considered in the present study is found to be 22.26 years with a standard deviation of 1.01 years. The youngest and oldest ages of them are 21 years and 24 years respectively. Mean and standard deviation (SD) of tibial length (cm) / per-cutaneous length of tibia (cm) are 37.09 cm and 3.03 cm with minimum and maximum values of 25 cm and 43 cm respectively. The average stature is noticed as 164.14 cm with SD of 7.88 cm. The shortest stature in the sample is found to be 148.0 cm as against the tallest of 179.0 cm.

II. Correlation analysis: As stature, tibial length and age are quantitative data and therefore their correlation is measured by Karl Pearson' coefficient of correlation (r). Table-2 highlights that there is direct/ positive correlation between their tibial length and stature. There is no significant positive correlation between stature and age as evident by insignificant P=0.323 even at 5% probability level. This insignificant correlation might have happened as age is restricted within 21-25years (where all the subjects are closed to growth) in the present study.

III. Simple linear regression analysis: In order to establish average relationship between stature and tibial length, in terms of their original unit of measurement i.e., cm, a simple linear regression equation of stature on tibial length (PCTL) is developed taking stature as dependent variable while tibial length, independent variable. The proposed equation is given by

$$Y= \beta_0+ \beta_1 X + \varepsilon;$$

where Y is dependent variable/ predicted value; X, independent variable; β0, Y-intercept; β1, regression coefficient/ slope of the regression line; ε; Standard error of estimate (SEE)/ residual.

In the table-3, relevant regression statistics are depicted along with developed regression equation based on the present data for a person (irrespective of sex).

A regression equation is established based on the tibial length of the individual, irrespective of sex.

$$Y= 81.90 +.85 X_3 + 4.11$$

The general difference of 81.90 cm. between stature of person

 DOI : 10.48165/jiafm.2024.46.1.3

and his/ her tibial length as depicted by β_0=81.90, and β_1=.85 demonstrates further that there is an increment of 0.85 cm in stature of the person when one cm enhances in their tibial length. And residual "ε" is found to be 4.11cm. Here, R^2 is also found to be 0.72 which is highly significant (P=<.001) and it highlights that the variation of stature of person can be explained by 72% of his/ her tibial length through the developed equation. The equation so developed is tested by F-test and found a very highly significant (P=<.001). In other words, the developed equation is treated as best fit to the present data and henceforth it may be used to detect the stature of person too for any given value of his/her tibial length.

In Fig-1, average relationship between stature of an individual and tibial length is shown through fitted regression line.

Discussion:

In the present study, correlation between percutaneous tibial length and stature is established irrespective of sex by framing regression equation among living indigenous Meitei population in the state of Manipur. Until now no studies have been done so far on this topic.

In the present study, in order to establish average relationship between stature and tibial length, in terms of their original unit of measurement i.e. cm, a simple linear regression equation of stature on percutaneous tibial length (PCTL) is developed taking stature as dependent variable while tibial length as independent variable. Similar study has also been conducted by Ghosh T and Konar S.[9]

In the present study the sample consists of 50% each of indigenous Meitei male and female; and all of them are in the age range of 21-25 years. The demographic parameters considered in the present study are age (yr), tibial length (cm) and stature (cm) of the subjects. Males out numbered females in terms of average height with mean height of 170.09 cm with a standard deviation of 4.37 cm and mean percutaneous tibial length of 39.24 cm with a standard deviation of 1.75 cm which is similar to the study conducted by Sume BW,[10] Moitra S,[11] Sangeetha V and Khan TA[12] & Martula et al.[13] which concluded that height of an individual can be calculated from percutaneous tibial length.

The present study findings are also similar to the findings of Anitha MR et al.,[14] Banerjee M et al.,[15] Sheikhazadi A et al.,[16] Trivedi A et al.[17] & Sah RP & Shrestha I[18] where they also conducted a study on group of population of certain age group on both male and female sex .

In our study, a regression equation is established based on a person's tibial length, irrespective of sex.

$$Y = 81.90 + .85X + 4.11$$

Where X is the tibial length irrespective of sex.

As stature, tibial length, and age are quantitative data and therefore their correlation is measured by Karl Pearson' coefficient of correlation ®. The present study highlights that there is direct/positive correlation between tibial length and stature which is similar to the studies conducted by Mohanty NK et al.,[19] Yayim Y[20] & Steele D.[21]

Since there is a need to derive separate regression equation for estimation of stature using the per-cutaneous tibial height for the specific castes, tribes and regions,[22,23] a regression equation has been derived for estimation of stature from percutaneous tibial length among the indigenous Meitei population of Manipur. The results of the present study validate and support the hypothesis that, there exists a strong relationship between stature and the percutaneous length of tibia. The present study also clearly demonstrates that the derived regression equation can be used for the estimation of stature from percutaneous length of tibia in indigenous Meiteis of Manipur, irrespective of sex.

Conclusion:

Stature is an important tool in identification and in analyzing the health and nutrition, stress, social and economic conditions, climate, changes in body proportions over time and between populations and genetic variations.[13,18,19] Tibia being subcutaneous is accessible for measurement in living subjects. Studies have also reported significant differences in the proportion of limb dimensions due to hereditary, environmental, ethnic and dietary factors which influence the stature of the person. Many authors have also established that the regression equation provide greater reliability in estimating stature. In the present study, correlation between percutaneous tibial length and stature is established by framing regression equation among living indigenous Meitei population in the state of Manipur. In our study, a regression equation is established based on person's tibial length, irrespective of sex, which has not been done before in this region.

Ethical clearance: Taken

Conflict of interest: Nil

Source of funding: Nil

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