Original Research Article

Estimation of stature from percutaneous length of tibia amongst Bengali population

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ABSTRACT

Background: Stature of an individual can be estimated from long bones as these have a direct correlation to the height of an individual. The standing height is mostly contributed lower limb length. Hence regression equations which are best upon length of lower limb long bones are indicative very much. Secular differences of tibial length could be the reason for need of more accurate equation of stature estimation among Bengali population.

Methods: In this present study the maximum percutaneous tibial length and the corresponding standing height of adult 260 male and 210 female Bengali subjects were taken. The data were analyzed by parametric statistics and the regression equations were derived.

Results: The mean standing height of subjects was 159.15 cm in males and 157.12 cm in females. It was determined that percutaneous tibial length and stature were positively correlated; the formulated regression equations were seen to be statistically significant (p <0.05) in both the sexes.

Conclusions: The present study revealed that there is high degree of correlation between percutaneous tibial length and standing height of Bengali subjects. Hence applicability of the present equations is critically discussed as these will be very much useful for various practical aspects.

Keywords: Anthropometry, Bengali, Percutaneous tibial length, Stature, Tibia

INTRODUCTION

Stature is defined as body height in standing position.¹ Establishing identity in mutilated corpses from body parts or skeletal remains is always a challenging task for medico legal experts.² Thus identification of an individual by stature estimation has impact in various medico-legal purposes, anthropological research and can be applied during mass disasters.

Extensive works have been conducted on different populations on stature estimation from various body parts.³,⁴ Physical anthropologists and forensic pathologists have given utmost importance to the methods of stature estimation from long bones as these have a direct correlation to the individual height.⁵ The lower limb length is the greatest contributor to the standing height; therefore the most predictive equations are based on length of lower limb bones.⁶ Works of Pearson have been monumental and invoked subsequent research on the subject.⁷,⁸ The tibia is ideal in this application as it is subcutaneous and can be measured easily.

Stature of an individual is influenced by several factors including race, geographical climate, nutrition and genetic factors.⁹ Hence the correlation factor of one region will not hold good for other; this necessitates
researches to be done for specific population. This study
was planned to establish a relationship between
percutaneous length of tibia and stature of Bengali
population and to estimate the stature from the
percutaneous tibial length.

METHODS

In this study total 470 apparently healthy Bengali
individuals (260 males and 210 females) were included
by random sampling. Only who were willing to
participate by giving proper informed consent were
included in the study. This observational study was cross
sectional in design which was conducted from March
2018 to February 2019.

Age range of 20 years - 59 years was set as inclusion
criteria which were verified by birth certificate or school
leaving certificate of the subjects. The rationale behind
selecting this age limit is that, by 20 years all the
epiphyseal growths were fused and normally no further
growth is expected. Furthermore, by 59 years the
degree of degenerative changes of vertebral column is not significant enough to affect the
regression equation. The inclusion of a wider range of
age groups could overcome the drawback for
applicability of the regression equation. Moreover, subjects were from various localities and socioeconomic
backgrounds. This multi-centric approach in will also
supplement the findings in the Bengali population in
future.

Subjects whose ethnicity is other than Bengali and those
were having grossly visible or history of trauma or
fracture leading to skeletal deformities of spine, skeleton
of limbs and pelvis were rejected beforehand from the
study. Subjects who had congenital or developmental
bony diseases, significant systemic or metabolic diseases
affecting stature, orthopaedic deformities were also
excluded from this study. In addition, individuals who
were visibly overweight were not considered due to the
difficulty for percutaneous measurement of the tibia.

The following parameters were noted- age in years,
gender, height in cm, percutaneous tibial length of right
and left side in cm. Standing height was measured by
standard stadiometer. For measuring the tibia length
subjects were asked to stand erect and then keep one foot
on a tool by flexing the knee at 90°. Then two points were
marked on the leg by skin marking pencil. Upper Point
was the medial most point on the upper border of medial
condyle of the tibia and lower point was at the tip of
medial malleolus. Tibial length was determined by
measuring the distance between these two points with the
help of a spreading calipers. The correlation coefficient
(r) was calculated to find out relationship between stature
and percutaneous tibial length. As tibial length and
stature were positively correlated, the regression
equations were formulated and tested for statistical
significance.

Statistical analysis

The data was computed, tabulated and statistically
analyzed using Microsoft Excel Windows 2007 and SPSS
version 20.0 software to calculate mean, sample standard
deviation, population standard deviation, correlation
coefficient, ‘t’ test for correlation coefficient, regression
coefficient, value of constant and standard error of
estimate. p value was used for the probability of
significance. For the purpose of the present study, a p
<0.05 is considered significant; and p >0.05 is considered
not-significant.

RESULTS

Descriptive statistics of the sample are shown in Table 1.
For standing height, the sample standard deviation for
both males and females closely approximated the
population standard deviation. This indicates the sample
very closely represented the actual population from
which it was drawn. Tibial length and stature were highly
correlated as correlation coefficients are approaching +1
for both males and females. Null hypothesis was set up to
test significance of correlation coefficients. The
computed value was found to be much greater than the
critical ‘t’ value at the chosen level of significance. So,
null hypothesis was rejected. The computed r for both
males and females was thus considered significant at the
0.05% of significance (p <0.05).

Table 1: Descriptive statistics of the sample.

| Statistical parameters | Males       | Females     |
|------------------------|-------------|-------------|
| Sample size (n)        | 260         | 210         |
| Age (years)            |             |             |
| Range                  | 20 - 59     | 20 - 49     |
| Mean                   | 31.3        | 27.18       |
| Standing height (cm.)  |             |             |
| Mean                   | 159.15      | 157.12      |
| Range                  | 141.6-176.2 | 139-175.5   |
| Sample S.D.            | ±7.76       | ±7.60       |
| Population S.D.        | ±7.593      | ±6.011      |
| Percutaneous tibial length (cm.) | | |
| Mean                   | 34.14       | 32.72       |
| Range                  | 27.2-41.8   | 26.8-39.8   |
| Sample S.D.            | ±3.06       | ±2.65       |
| Population S.D.        | ±2.730      | ±2.118      |
| Correlation coefficient (r) | 0.94       | 0.94        |

The regression equations as calculated are shown in
Table 2. The standard error of estimate of these equations
was quite low (males ± 0.19 and females ± 0.18). These
low values of standard error of estimate in case of males
and of females also give enough statistical justification
for the formulation of equations suggested in the present
study. To determine reliability of these equations the
confidence limits were calculated and tests of
significance were carried out. Hypothesis testing of regression coefficient was carried out. 5% significance level was chosen for testing the hypothesis. 't' value calculated for males and females was much higher than the critical values of 't' (0.05) with according degree of freedom (n-2). Hence the null hypothesis was rejected. Height is indeed related to stature in the present sample.

**Table 2: The regression equations.**

| Side                  | Male                | Female                |
|-----------------------|---------------------|-----------------------|
| Irrespective of side  | S = 77.77 + 2.38T   | S = 69.11 + 2.69T     |
| Right tibia            | S = 77.74 + 2.38T   | S = 69 + 2.69 T       |
| Left tibia             | S = 77.81 + 2.38T   | S = 69.11 + 2.69 T    |

Where, S = stature and T = tibial length

**DISCUSSION**

The main aim of the present study was to derive the regression equations to estimate the stature from the percutaneous tibial length in Bengali population. Recent studies on Indian population regarding stature estimation from percutaneous length of tibia show that Oriya female population, Gwalior female population were shorter than the present study population; whereas Oriya male population, Moradabad population were taller than the present group.10-12 This necessitates separate regression equations to be deduced for Bengali population.

This study tried to justify the formulation of two separate equations for males and females. This was important more so because most Indian researchers had formulated single regression equation or multiplying factor taking both sexes together into account.13,14 By comparing the squared standard error of males and females using an F test it was found that the computed F exceeded the critical F value. The null hypothesis was rejected and thus the regression coefficient of males was significantly (p <0.05) different from females. Thus, the same formula cannot be used and separate formulae as suggested for males and females has to be used for the estimation of stature.

The present study revealed that there is a positive correlation exists between the stature and percutaneous tibial length. Different formulae for males and females are needed for the estimation of stature. Thus, two regression equations, which has taken into consideration the racial, geographic, secular and gender differences of tibial length, could be employed for more accurate estimation of the average Bengali population. Hence, this study is very much useful for forensic expert as well as for the anthropologist.

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**Ethical approval:** The study was approved by the Institutional Ethics Committee

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