Study of relation of stature and percutaneous tibial length in natives of Gujarat

Gaurang Algotar¹, Utsav Parekh², Reekee Patel³, Uttam Solanki⁴, Kamesh Modi⁵, Pratik Patel⁶

¹Assistant Professor, Dept. of Forensic Medicine & Toxicology, C U Shah Medical College, Surendranagar.
²Assistant Professor, Dept of FMT, Pramukh Swami Medical College, Karamsad.
³Assistant Professor, Dept of FMT, GAIMS, Bhuj.
⁴Assistant Professor, Dept of FMT, GMERS, Gotri.
⁵Tutor, GMERS, Dept of FMT, Gandhinagar.
⁶Professor & Head, Dept of FMT, Smt. N. H. L. Municipal Medical College, Ahmadabad.

ABSTRACT

BACKGROUND: Identity of an individual is very much important in Indian legal system. Stature is important parameter for establishment of identity. Stature of an individual depends up on various external and internal factors. Estimation of stature from percutaneous length of long bones widely use in different parts of world. Regression formula for stature estimation should be population-specific. In Gujarat state, no much standard anthropological regression formulas have been established. This study was carried out in Smt. N H L Municipal Medical College, Ahmedabad on 500 individuals from different parts of Gujarat state, between aged of 17-50 years. The study was showing a good correlation between stature and percutaneous tibial length (p value < 0.001). A gender specific regression formula for estimation of stature from percutaneous tibial length in natives of Gujarat was derived.

Key Words: Identification, Percutaneous tibial length, Regression Equation, Stature.

INTRODUCTION

Natural and man-made disasters like earthquakes, floods, cyclones, fires, transport accidents, industrial accidents, explosions etc cause significant loss of life and mutilation of body to hinder the identification of the person. In addition to this, various criminals also take cover by doing dismemberment of body to prevent identification. Whenever unknown and mutilated bodies are brought for post mortem examination, apart from cause of death, estimation of stature forms the important part of identification. In above mentioned cases, stature is a key factor, often used by medico legal experts, for identification of the person with the help of anthropological parameter. Estimation of stature from percutaneous length of long bones widely use in different parts of world. While calculating the stature, it is seen that estimates from bones of lower extremities are more accurate than from the bones of upper extremities. Next to femur the tibial length measurement gives better estimation of stature than any other long bone measurement because tibial length itself is a part of stature. Since quite a good number of authoritative works have been done in this field using the surface length of long limb bones for the purpose of calculation of body height. It is a known fact that various factors which include age, sex and nutritional status influence stature and body dimensions. Racial and ethnic variations are also known to exist in the population. In a country like India where racial and ethnic variations in different regions are well known, a region wise study becomes necessary. Most studies since that time have stressed that regression formula for stature estimation should be population-specific. So it is necessary to derive a population based and gender specific linear regression equations to estimate the stature from variables like lower limb bone for the natives of Gujarat state.

*Corresponding author
Dr. Gaurang Algotar
Assistant Professor,
Dept. of Forensic Medicine & Toxicology,
C U Shah Medical College,
Surendranagar
Email: g.algotar@gmail.com
The aim is to study the relation of stature with percutaneous length of tibia according to gender in natives of Gujarat state and to derive the linear regression equations for the same.

**MATERIALS AND METHODS**

A cross sectional study was done among five hundred (500) healthy adults (260 Males and 240 Females) aged between 17-50 years at Smt. N. H. L. Municipal Medical College, Ahmedabad who are natives of Gujarat state since last three generations. Exclusion criteria include subjects with chronic diseases or deformities of vertebral column or limbs or subjects who are not natives of Gujarat state since last three generations. Informed written consent of participant was taken. Body height was measured using the methods described by Cameron et al. Stature of the subject was measured in standing posture. The subject was instructed to stand barefooted on the board of a standard stadiometer with both feet in close contact with each other, trunk braced along the vertical board and head oriented in ear-eye plane by keeping the lateral palpebral commissure and tip of auricle of the pinna in a horizontal plane parallel to feet. The measurement was taken in centimeters by bringing the horizontal sliding bar to the vertex. For tibial length, the technique by Martin et al. was used. Percutaneous Tibial length was taken using spreading caliper from the medial condyle of tibia to the tip of medial malleolus with knee in semi-flexed position and foot partly inverted, to render the bony landmarks more prominent. The shaft of the anthropometer was maintained parallel to the long axis of the tibia. For uniformity, left tibia of all the subjects was measured. All the measurements were taken by the same observer and with the same instrument, to avoid any technical and/or inter-observer error and to maintain reproducibility. To eliminate discrepancy due to diurnal variation the measurements were taken at fixed time between 2pm - 5pm. Data so collected were entered in a master chart and were analyzed using the Statistical Package for Social Sciences for Windows, Version 8.0.

**Observations and Discussion**

Total 500 subjects were included in the study. Out of this 260 (52.00%) were Males and 240 (48.00%) were Females with the Male: Female ratio being 1.08:1.

**Table 1 : Distribution of Age & Stature according to Gender**

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Age in years</th>
<th>Stature in cms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Number</td>
<td>260</td>
<td>240</td>
</tr>
<tr>
<td>Mean</td>
<td>27.07</td>
<td>26.64</td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>0.549</td>
<td>0.572</td>
</tr>
<tr>
<td>Median</td>
<td>23.5</td>
<td>23</td>
</tr>
<tr>
<td>Mode</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>8.848</td>
<td>8.856</td>
</tr>
<tr>
<td>Minimum</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Maximum</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

The Range of Age for the study subjects was from 17-50 years. Mean Age of Males was 27.07 years with Standard Deviation (SD) of 8.848 whereas Mean Age of Females was 26.64 years with Standard Deviation (SD) of 8.856. This difference in age was statistically not significant with p>0.05.

Stature in Males varied from 153 cm to 185 cm with Mean value of 169.36 cm and Standard deviation (SD) of 8.098 cm. Median of stature being 169 cm. Stature in Females varied from 146 cm to 176 cm with Mean value of 160.39 cm and Standard deviation (SD) of 8.427 cm. This difference in Mean stature between Males and Females was statistically highly significant (p<0.001)

**Fig 1: Stature and tibial length in male and female**
Relation of stature and percutaneous tibial length in natives of Gujarat

Percutaneous Tibial length in Males varied between 30 to 49 cm with Mean value of 38.72 cm and Standard deviation of 5.05 cm. Median was 38.35 cm. In Females range of Percutaneous Tibial length was from 30 to 43 cm with Mean value and Standard deviation of 36.10 cm and 3.56 cm respectively. Median was 36 cm. This difference observed in Mean Tibial length was statistically highly significant (p<0.001).

Graph 1 showing scattered diagram of Tibial length versus Stature in Males and Females. $R^2$ linear was 0.960 for Males, 0.887 for Females and 0.873 for both Males and Females. Graph showing a positive correlation. The independent t-test for correlation coefficient is applied to test statistical significance of correlation and

Fig 2 Scattered diagram of Tibial length versus Stature in Males and Females

for both two variables namely tibial length in males and tibial length in females with stature. Pearson’s correlation coefficient was used to examine the relationship between tibial length and height according to the gender. The independent t-test for statistical significance of correlation showed p Value <0.001 in Males and Females. The values were calculated as statistically highly significant indicating very strong positive correlation between Stature and Tibial length in both males and females.

Table 2: Linear regression values of Stature versus percutaneous Tibial length in Males and Females

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Male (cms)</th>
<th>Female (cms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept (a)</td>
<td>108.52</td>
<td>79.88</td>
</tr>
<tr>
<td>Regression coefficient (b)</td>
<td>1.571</td>
<td>2.231</td>
</tr>
<tr>
<td>Correlation coefficient (r)</td>
<td>0.98</td>
<td>0.942</td>
</tr>
<tr>
<td>Coefficient of determination ($r^2$)</td>
<td>0.960</td>
<td>0.887</td>
</tr>
<tr>
<td>Standard error of estimate</td>
<td>0.775</td>
<td>1.871</td>
</tr>
<tr>
<td>t value</td>
<td>140.02</td>
<td>42.69</td>
</tr>
<tr>
<td>Significance (p Value)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Simple regression formula is $Y = a + bX$ therefore, where Y is dependent variable that is Stature and X is independent variable is Tibial length. 
1. Stature of Males for Tibial length is $Ytm = 108.52 + 1.571 \times Xtm$
2. Stature of Females for Tibial length is $Ytf = 79.88 + 2.231 \times Xtf$

Standard error estimation was also done so as to find out 95% confidence limit for both variables as follows:
1. Stature of Males for Tibial length $Ytm = 108.52 + 1.571 \times Xtm \pm 1.519$
2. Stature of Females for Tibial length $Ytf = 79.88 + 2.231 \times Xtf \pm 3.67$

CONCLUSIONS

From the present study, it is concluded that mean values of stature and percutaneous length of tibia are found to be greater for Males than Females with statistically significant intersex difference. Length of Tibia shows a positive correlation with stature which is indicated by the correlation coefficient (r) in both the genders. Thus Length of Tibia is a good predictor of Stature in Natives of Gujarat state. Simple Linear Regression Equation has been derived to estimate the stature from Length of Tibia for both the genders who are natives of Gujarat State. However the formulae derived cannot be generalized to all population groups, hence it is necessary to derive regression equations which are population specific. Therefore
other studies in different parts of the world are required to confirm whether it would be equally applicable elsewhere.

**References**