INTRODUCTION

Stature estimation of unknown, highly decomposed, fragmentary and mutilated human remains is prime forensic importance. Forensic experts are often needed to establish the identity of the deceased from such remains. Stature establishment narrows down the identification process, and thus very useful for investigation of crime. Proportion of different body parts i.e. head, face, trunk, extremities etc has a definite relationship to the stature. This proportional relation helps medicolegal experts to estimate stature with certain certainty. Regression analysis and multiplication method are two methods that have been used, and among these two, regression analysis provides best estimates for stature reconstruction.1–5

There are studies that estimate stature from various cephalic parameters including head circumference up to certain extent i.e. Jibon Kumar et al have studied relation between stature and different facial measurements among the Indians population, Krishna et al and Krishna successfully derived equations for estimating stature in north Indian population while Pelin et al. does not found the relation between the stature and the head and face dimensions to be reliable.6–9

There has been concern regarding the accuracy of these estimations when less related populations. These correlations are population specific. It is obvious that one universal formula cannot be obtained but it is affected by the race, sex and age of subjects.10

Thus population specific correlational studies for stature estimation from cranial parameters in different populations are needed. Thus present study was conducted to estimate a correlation between height and head circumference, and find out formulae for estimation of stature from head circumference in the population of Malwa region of Central India.

MATERIAL AND METHODS

The study was conducted on 200 medical students between 18 to 22 years of age which included 100 males and females each, at MGM Medical College, Indore, MP, India.

The height of the individual was measured between vertex and the floor with the subject standing erect and in anatomical position while head was kept in Frankfurt Plane during measuring height using standing height measuring instrument. Height was measured to the accuracy of 0.1 cm.

All the measurements were taken at fixed time between 02:00-04:30 PM to eliminate discrepancies due to diurnal variation. All the measurements were taken by the same person and repeated thrice and a mean was taken. The head circumference and height were measured to established correlation between them. The mean height for the males was 172±0.54 cm (Mean±SEM) and 157±0.49 cm for females. The mean head circumference was measured to be 55.3±0.15 cm in males and was 54.3±0.15 cm in female participants. Results of regression analysis for finding correlation between HC and height, correlation coefficient (r) was 0.542 with a standard error of estimate 4.53 for males while in females correlation coefficient is 0.332 with a value of standard error of estimate 4.66. The linear regression equations for males and females were 'Height = 66.69+1.90(HC)' and 'Height = 96.71+1.12(HC)' respectively. Head circumference have significant correlation to male height in Malwa (Madhya Pradesh) region.

KEY WORDS: Central India, Height estimation, Head circumference.
years while for females was 20.2±0.96 years. The mean height for the males was 172±0.54 cm (Mean±SEM) while 157±0.49 cm for females. The mean head circumference was measured to be 55.3±0.15 cm in males and was 54.3±0.15 cm in female participants.

Table 1: Student t- test between Male and Female Head Circumference

<table>
<thead>
<tr>
<th>Student t- test</th>
<th>Age</th>
<th>Height</th>
<th>Head Circumference</th>
</tr>
</thead>
<tbody>
<tr>
<td>t – value</td>
<td>t=1.814</td>
<td>t=19.41</td>
<td>t=6.06</td>
</tr>
<tr>
<td>p – value</td>
<td>0.0771</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>P value summary</td>
<td>Not Significant</td>
<td>***</td>
<td>****</td>
</tr>
</tbody>
</table>

There was no statistically significant difference between males and females as far as age distribution is concern (p<0.05). Distribution of height was statistically different between males and females, where male group shown to have significantly (p<0.0001) higher stature measure than females. As far as head circumference is concern it was also significantly (p<0.0001) different in two groups of males and females (Table-1).

Results of regression analysis for finding correlation between HC and height while HC is independent variable (x) and later is dependent variable (y) are shown in Table-2 and Graph 1 and 2. In males, correlation coefficient (r) is 0.542 with a standard error of estimate 4.53, while in females correlation coefficient is 0.332 with a value of standard error of estimate being 4.66. The linear regression equations for males and females are as follows:

**Male Height** = 66.69+1.90(HC)

**Female Height** = 96.71+1.12(HC)

Comparison between correlation coefficients of males and females with a value of standard error of estimate being 4.66. The linear regression equations for males and females are as follows:

Male Height = 66.69+1.90(HC)

Female Height = 96.71+1.12(HC)

Table 2: Formulation of Regression equation for calculating the Stature from Head Circumference (HC) in Male and Female

<table>
<thead>
<tr>
<th>Regression Statistics of HC</th>
<th>Male (observed ht=171.59cm)</th>
<th>Female (observed ht=157.48cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variable(x) = HC</td>
<td>55.35</td>
<td>54.33</td>
</tr>
<tr>
<td>Intercept (a)</td>
<td>66.69</td>
<td>96.705</td>
</tr>
<tr>
<td>Regression coefficient (b)</td>
<td>1.895</td>
<td>1.119</td>
</tr>
<tr>
<td>Correlation coefficient(r)</td>
<td>0.542</td>
<td>0.332</td>
</tr>
<tr>
<td>Coefficient of determination (R2)</td>
<td>0.294</td>
<td>0.1103</td>
</tr>
<tr>
<td>Std. error of estimate (SEE)</td>
<td>4.53</td>
<td>4.66</td>
</tr>
<tr>
<td>Significance (p)</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Regression formula (y = a+bx)</td>
<td>y = 66.69+1.895(x)</td>
<td>y = 96.705+1.119(x)</td>
</tr>
<tr>
<td>Predicted ht (y)</td>
<td>171.59cm</td>
<td>157.47cm</td>
</tr>
</tbody>
</table>

Graph 1: Showing relation between Head Circumference (HC) and Height in Male

**DISCUSSION AND CONCLUSION**

Stature estimation has been considered as one of the parameters of forensic anthropology and will assist in establishing the biological profile of a person.11 The results in the present study (Table 2) shows that Head Circumference is positively and significantly correlated (r = 0.542 for males and r=0.332 for females) with stature (p < 0.0001). In a multi-parametric study conducted by Ewunon et. al. in South-Eastern Nigerian Population, they found that the regression equation calculated for the Head Circumference gives a higher degree of reliability and accuracy in the estimation of stature than any of the Head Length and Head Breadth.12 Our study shows a lower SEE value than Ewunon et. al. which indicates higher reliability and accuracy while the higher value of SEE denotes less reliability of prediction.11 Krishan and Kumar studied male Koli adolescents from the North Indian population, reported that Maximum Head Circumference has the least value of Standard error of estimate (±4.11), an indication that prediction of stature from this measurement is higher than that from any other cephalo-facial measurement and comparable to our results.7 Moreover, it is of great interest to note that the result of the present study better than previous studies on mixed population which reported higher SEE for the cephalic parameters including HC,13,14

A study of 14 variable by Agnihotri et. al revealed HC (r=0.494, p<0.0001) of three cephalo-facial variables as major predictors for stature estimation among males, while 3rd important predictor stature of among females after physiognomic facial length and bizygomatic breadth.15 These results again comparable to present study but was not significant in our study.

In a study Ebboh et. al., declared that head circumference showed positive and significant correlation with stature except among males of Ukwuani ethnic group.16 Although Chiba et al. found correlation between head circumference and stature as not statistically significant.13 Krishan however found that head circumference correlated significantly with stature.8 Thus it is concluded that Head circumference have significant correlation to male height in Malwa (Madhya Pradesh) region while female height have shown lesser degree of correlation.

Reference

2. Krishan K, Limb bilateral asymmetry and footprints of male adult Gujar.