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Original Research Article

Estimation of stature from head circumference measurements in students of a tertiary care hospital

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ABSTRACT

Background: The present study was undertaken to reconstruct stature in males and females by using head circumference as a parameter.
Methods: There was paucity of students during the period of study due to unavailability of students owing to COVID restrictions on physical attendance to classes. Hence, sample size had to be curtailed to 251 students. Hence, the study was carried out on 251 medical students, 136 males, and 115 females in the department of forensic medicine and toxicology, Swami Ramanand Teerth Rural Government Medical College (SRTRGMCH), Ambajogai, Maharashtra, India. Measurements of head circumference and height were made directly on each subject. The data collected was subjected to statistical methods. The measured heights from the data for males, and females were regressed against the measured head circumference variables using linear regression analysis.
Results: Highly significant correlation was found between height and head circumference. The equation relating stature to the head circumference was derived as stature, y=97.19+1.11 HC for females and y=88.77+1.45 HC for males. The above findings may hence provide reliable method of estimation of height from skeletal remains in the forensic setup.
Conclusions: Head circumference can be used to estimate stature in Maharashtrian population using the regression equation with reasonable accuracy to estimate stature.

Keywords: Asterion, Approach to posterior cranial fossa, Mastoid process, Transverse sinus

INTRODUCTION

The anthropometry is the science of measuring the human body and its parts and craniofacial anthropometry, involves measurement of the skull and face.[1] Stature or body height is one of the important and useful anthropometric parameters that determines the physical identity of an individual.[2]

Stature estimation of unknown, highly decomposed, fragmentary and mutilated human remains is of 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. It's a well-known fact that, proportion of different body parts like head, face, trunk, and extremities has definite relationship with stature. This proportional relation helps medico legal experts to estimate stature with some 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.[3-7]

Among the common questioner of medico legal examination e.g. age, sex, and race, stature estimation becomes equally important in such cases. There is definitive biological correlation of stature with all the body

parts such as extremities, head, trunk, and vertebral column.[8] The pelvis and skull are the most reliable source among human bones.[9,10]

However, few attempts have been made to estimate body height from other body parts such as hand length, foot length, skull measurements, odontometry, cephalo-facial dimensions and spine length with variable results. Moreover, an alternative parameter is desirable in certain instances especially in cases of limb dysplasia, limb deformity and post-mortem destruction or in mutilation cases.

Various studies have also demonstrated the usefulness of measurements of various bones for estimation of stature when question of estimation of stature, age, and sex arises. Many studies have been conducted on stature from percutaneous measurements of various body parts including arm, leg, and feet.[9-16]

Hence, with this background the present study was undertaken to reconstruct stature in males and females by using head circumference as a parameter.

Aims and objectives

The aim of this study is to determine whether Head circumference can be used for estimation of stature in students belonging to Maharashtra region of India.

METHODS

Study design

The current study was an observational, cross-sectional and descriptive study with some analytical components conducted among 251 (136 male and 115 female) asymptomatic, healthy students studying in Swami Ramanand Teerth Rural (SRTR) Government Medical College, Ambajogai, Beed, Maharashtra, India under department of forensic medicine and toxicology for the period of 2 months from September 2021 to October 2021.

There was a paucity of subjects during the period of study due to unavailability of students owing to COVID-19 restrictions on physical attendance to classes. Hence, sample size had to be curtailed to 251 students.

Inclusion criteria

Healthy subjects of age above 18 years with no obvious skull or body deformity who are domicile from Marathwada region of Maharashtra and had consented for study were included in the current study.

Exclusion criteria

Subjects who were below 18 years of age and above 25 years age, who are not domicile from Marathwada region of Maharashtra and/or refused to take part in this study were excluded from this study.

Subjects with any craniofacial pathology, with history or clinical features suggestive of trauma or surgery of skull, pelvis, vertebral column, long bones, stature defects, and facial asymmetry were also excluded from current study.

Data collection

For stature measurement, standing height of each subject was recorded using standard anthropometric stadiometer mounted on the wall. The subject was asked to stand barefooted close to wall looking straight forward, with stable head, the measuring tape of stadiometer was slide down to make contact with the subject skull, the reading for stature was noted. Three readings were taken by same investigator at fixed time duration to avoid diurnal variation and average was recorded as final stature reading.

Head circumference

Horizontal head circumference (HC) was measured from glabella to glabella by using non-stretchable plastic measuring tape, which passes through the opisthocranion (just above eye ridges).

Ethical approval

Ethical clearance was obtained from institutional ethics committee of SRTR Government Medical College, Ambajogai before the commencement of the study.

Statistical analysis

Data was analysed using statistical package for the social sciences (SPSS) software version 26.0; results were expressed as mean±standard deviation (SD).

RESULTS

Total 251 students' measurements were taken out of which there were 115 female and 136 male students (Figure 1).

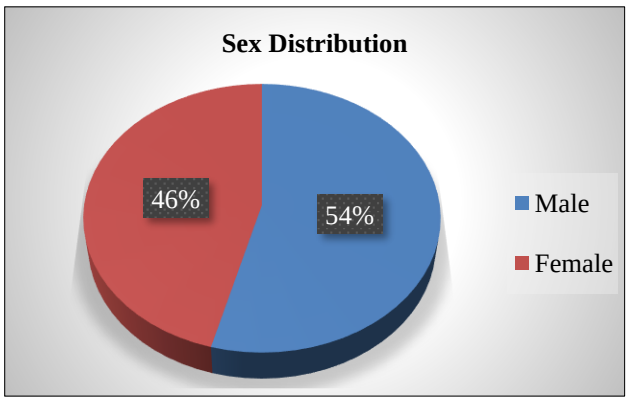

Figure 1: Sex distribution of study subjects.

The mean and standard deviation of head circumference measurements, age and stature of the subjects are presented in Table 1. Independent sample t-test was conducted to compare means between the male and female subjects, and indicated significant gender differences in all the parameters. The male subjects had significantly greater head circumference (p<0.001) and stature (p<0.001) when compared to the females.

Table 1: Age, stature and head circumference measurements of study subjects in cm.

Measures	Female	Male	P value
Age	21.52±1.33	21.99±1.17	0.003
Stature	158.08±6.05	170.45±5.83	<0.001
Head circumfer	54.88±1.39	56.29±1.47	<0.001

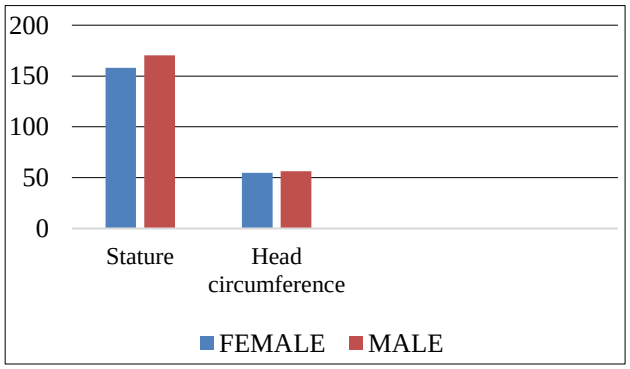

Figure 2: Stature and head circumference measurements of study subjects.

Table 2 shows Pearson's correlation test to determine the strength of relationship between stature and head circumference. The scatter plot is shown in Figure 3. The results indicated low but significant association between stature and head circumference in females (r=0.255; p<0.05) and in males (r=0.367; p<0.001).

Table 2: Correlation coefficient between stature and head circumference measurements in study subjects.

Measurements	Females		Males	
	Correl-ation	P value	Correl-ation	P value
Stature versus head circumference	0.255	0.006	0.367	<0.001

Table 3: Regression equation for estimation of stature from head circumference measurements.

Measure-ments	Regression equation for males	SEE	P value
Stature versus head circumference			
Females	$y = 97.19 + 1.11\ HC$	5.87	0.006
Males	$y = 88.77 + 1.45\ HC$	5.45	<0.001

SEE-Standard estimation of error

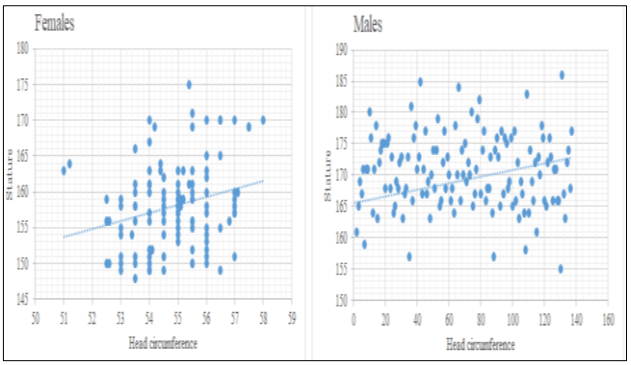

Figure 3: Scatter plot of head circumference measurements in females and males.

In Table 3, stature was estimated from individual head circumference measurements using the linear regression equation;

$$Stature = a + bx$$

Where, 'a' is the intercept and 'b' is the regression coefficient of the independent variable; 'x' is the head circumference measurement.

DISCUSSION

The study consists of 251 healthy subjects of which 136 (54.18%) were males and 115 (45.81%) were females. The age-related data is presented in Table 1. The descriptive statistics for the head circumference measurements recorded in the sample are shown in Tables 1 and 2. In the sample, the average height of male and female was 170.45 (±5.83) cm and 158.08 (±6.05) cm respectively. The results show that the differences between all male and female variables exhibited statistically significant differences (p<0.001). The regression equations were derived and shown in Table 3. There is separate equation for males and females. As for the regression of the head and skull measurements, a similar study in 1998 was conducted directly on cadavers by Chiba and Terazawa.[17] Present study included the soft tissue overlying the skull in contrast to the study by Chiba. The regression equations have been calculated by regression analysis of the data and the values of constants 'a' and 'b' are calculated; where 'a' is regression coefficient of the stature and 'b' is the regression coefficient and x is head circumference measurement. Therefore, stature is given by the formula given below, where x is parameter taken in study.

$$Stature = a + bx$$

In previous studies by Saxena et al on Agra population, Jadav et al on Gujarat population, Sudhir et al on Maharashtra population, Seema et al on Punjab population, Santosh et al on Rajasthan population, Richards et al on an American White population, and Ryan et al on South African population have shown correlation coefficients between stature and head length as +0.2048,

0.53, 0.62, 0.52, 0.94 (males), 0.85 (females), ranging from 0.343 to 0.447 for females and 0.285 to 0.357 for males and ranged between 0.40 and 0.54 respectively.[18-24] In the present study, correlation coefficient between, stature and head length is 0.34. Thus, significant positive correlation coefficient is evident. The results indicated low but significant association between stature and head circumference in females ($r=0.255$; $p<0.05$) and in males ($r=0.367$; $p<0.001$). The standard error of estimate (SEE) in present study is 5.87 for female subjects and 5.45 for male subjects is low which indicates that the regression equation derived show's high reliability and accuracy in estimation of stature.

Limitations

This study was conducted on smaller sample size owing to COVID-19 restrictions. More such studies are required with larger sample size with same population group for more accurate and reliable formulae.

Percutaneous measurements cannot be used in case of skeletons and bones accurately owing to difference in measurements.

CONCLUSION

Head circumference can be used to estimate stature in Maharashtra population using the regression equation. Head circumference parameter can be used with reasonable accuracy to estimate stature. Since the formulae for stature estimation are area, ethnicity specific, more studies with different regions and ethnicities are needed in order to make height estimation more reliable.

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