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Original Article

Estimation of Human Height from Anthropometric Measurements of Head amongst Madhya Pradesh Population

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ABSTRACT

Background: The stature prediction occupies a relatively central position both in anthropological research and forensic practice especially in cases where bodies are found in mutilated condition or only skeletal remains are sent for examination. It is well known fact that there is definite correlation of height with different measurements of bones. Stature varies with race, sex, climatic condition. Moreover, each race requires its own formula for height estimation because of variations exist in population of different geographical region. In India, where racial and ethnic variations are well known, region-wise study of this kind is necessary. **Aim:** Present study was done to estimate stature from skull length and breadth in Madhya Pradesh population. **Method:** Study was conducted amongst 150 males and 150 females who are of age group 18–25 years. All the participants are born and brought up in Madhya Pradesh only. Height, head length (HL) and head breadth (HB) was taken by standard anthropometric instruments and technique. **Results:** Linear regression equation for both sexes is calculated. **Conclusion:** Stature estimation can be done from HL and HB by these formulae which are specific for Madhya Pradesh population.

Keywords: Anthropology, Forensic, Head breadth, Head length, Race, Regression equation, Stature

INTRODUCTION

In Greek, anthropos means 'man' and metrons means 'measure'. So, anthropometry literally means measurement of human individual. Forensic anthropology is the application of this anthrolopological knowledge and techniques in a legal context. It can be used for identification. Personal identification is important in civil as well as criminal cases. Like name, age, sex, race, fingerprint and DNA typing, stature is one of the important parameters for identification. Stature estimation is integral part of forensic examination in unknown, highly decomposed, fragmentary and mutilated human remains[1]. It is well-known fact that stature has direct correlation with measurements of long bones. Several researchers from India, Singh and Sohal (1951) and Mehta and Thomas have developed regression equation to estimate correlation between long bones and stature[2,9]. Many studies have been conducted for sex and race determination from cephalic indices but only few studies conducted for height estimation from cephalic measurements [3,10].

From previous studies, it is clear that there is variation in the stature in relation to age, sex, race, climatic condition, nutrition and geographical area[4]. Thus, each race requires its own formula for stature estimation. In India, there is vast geographical variation. Racial and ethnic variations also exist. Dietary habits are also different region wise.

Considering all these facts, present study has been conducted to determine stature from head length (HL) and head breadth (HB) amongst Madhya Pradesh population.

MATERIAL AND METHODS

This study was carried out from February 2016 to October 2016 in the department of Forensic Medicine and Toxicology, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh. Institutional Ethical committee's permission was taken prior to the study. In present study, 300 students and staff of medical college participated, out of which 150 were males and the rest 150 were females. Age group of participants were 18–25. The age above 18 years is chosen for the reason that by this age, there is completion of skeleton growth and ossification of all bones. Upper limit of age is 25 years[5]. All the participants were born and brought up in Madhya Pradesh with ancestral origin from this region. Age of individual calculated from date of birth to date of examination.

METHOD OF DATA COLLECTION

Informed written consent of subject obtained in pre-designed consent form. Full particulars like age, sex and place to which they belong were noted in pro forma. Healthy individual without any congenital and acquired deformities were selected.

(A) Stature: Stature was measured in standing position to the vertex in Frankfurt plane by using anthropometric rod. Subjects were asked to stand barefoot on even floor, heels together and weight evenly distributed between both feet. The distance measured between highest points on subjects head to the ground.

(B) Head Length (HL): The distance between glabella (i.e. most forward projecting point in the midline of the forehead at the level of supraorbital ridge and above the nasofrontal sutures) and occiput (i.e. farthest projecting point in mid sagittal plane) was taken.

(C) Head Breadth (HB): The greatest transverse diameter on the head from euryon to euryon. Euryon is bilaterally paired point that forms terminus of the line of greatest breadth of skull, it is not a fixed point, it is measured by caliper[6].

HL and breadth was taken by spreading caliper. All the measurements were taken by the same candidate to avoid inter-observer bias and at fixed time to avoid diurnal variation. All the measurements were taken three times and mean value is taken as final measurement. All data was recorded in pre-designed and pre-tested pro forma. All measurements were tabulated and data was analysed using SPSS (version 15) to establish regression equation for male and female separately.

RESULTS

In the present study, 300 subjects were participated, 150 males and 50 females. The mean age of participants was 21.80 years. Table 1 shows age- and sex-wise descriptive statistics. The mean height of males was found to be higher than females (Table 2). Moreover, cranial length and breadth is more in males compared with females. Due to significant sex difference, data was analysed separately for computing correlation regression analysis. Correlation coefficient of stature and HL in males was found 0.36, whereas in female 0.02. Although correlation coefficient of stature and HB was found 0.17 and 0.071 respectively for male and female (Table 3), it is evident from Table 3 that HL has greater correlation coefficient '*r*' and lesser standard error of estimate (SEE) than that of HB in males. In females, HB has greater correlation coefficient and lesser SEE than that of HL in males. Thus, if fragmentary remain of skull is brought for forensic examination, HL in males and HB in females are better parameters for stature estimation. In Table 4, attempt has been made to derive multiple regression equation for

Table 1: Descriptive age and sex-wise statistics

Sex	*N*	Mean Age	±SD	Median	Minimum	Maximum	Mode
Male	150	22.37	1.94	22	19	26	25
Female	150	21.26	1.06	21	19	24	22
Combined	300	21.80	1.65	22	19	26	22

Table 2: Descriptive statistics for height, head length (HL) and head breadth (HB) (in cm)

Sex	Variable	*N*	Mean	SD	Minimum	Maximum	Median	CV (%)
Male	Height	150	170	6.88	155	189	172	4.04
	HL	150	19.17	0.75	17	21.2	19.15	3.91
	HB	150	14.41	0.82	12	18.7	14.3	5.6
Female	Height	150	157.8	5.38	148	169	157	3.4
	HL	150	17.61	0.69	15.9	19.1	17.8	3.9
	HB	150	13.40	1.002	11	17	13.4	7.4

CV – coefficient of variation, SD – standard deviation.

Table 3: Statistical analysis with derivation of linear regression equation

Sex	Variable	*b*	*r*	*P* Value of '*r*'	SEE	*a*	Regression Equation
Male	HL	3.33	0.36	0.0015	±6.45	106.91	$S = 106.91 + 3.33 \times HL$
	HB	1.42	0.17	0.15	±6.83	150.4	$S = 150.4 + 1.42 \times HB$
Female	HL	0.16	0.02	0.045	±5.41	155.03	$S = 155.03 + 0.16 \times HL$
	HB	0.38	0.071	0.53	±5.40	152.7	$S = 152.7 + 0.38 \times HB$

b – Regression coefficient-correlation coefficient, *a* – intercept, SEE – standard error of estimate, HL – head length, HB – head breadth.

Table 4: Multiple regression equation for height estimation

Sex	Equation	SEE	*R*
Male	68.95 + 3.76(HL) + 2.06(HB)	6.27	0.441
Female	149.15 + 0.196(HL) + 0.392(HB)	5.43	0.076

SEE – standard error of estimate, R – correlation coefficient.

male and female separately with both the parameters, that is HL and HB.

DISCUSSION

The present study was done to establish correlation of stature with HL and HB amongst Madhya Pradesh population. The linear regression formula has been derived which is the best criterion to estimate stature when fragmentary remains of bones brought for medico-legal examination[7]. In our study, regression equation for stature estimation from HL is

In male, Stature (S) = 106.91 + 3.33 × HL

In female, Stature (S) = 155.03 + 0.16 × HL

In a similar study done by Wankhede *et al.* amongst medical students in Central India, stature was estimated from HL as follows[6].

In males, Stature (S) = 122.32 + 2.63 × HL

In female, Stature (S) = 133.76 + 1.49 × HL.

SEE was 6.54; correlation coefficient of HL with height was 0.279 for males. In our study, SEE was 6.45 and correlation coefficient is 0.36 for males, which is found nearly similar. In females, SEE was 5.77 and correlation coefficient of HL with height was 0.206. In present study, standard error was 5.41 and correlation coefficient was 0.02, which is also found nearly similar. Bardale *et al.* in their study found that correlation coefficient for HL with height was 0.39 with SEE of 6.08 in males, whereas in female, correlation coefficient was 0.32 and SEE was 5.67[8].

In our study, regression equation for stature estimation from HB is

In male, Stature (S) = 150.4 + 1.42 × HB

In female, Stature (S) = 152.7 + 0.38 × HB

Similar study done by Wankhede *et al.* stature was estimated from HB[6].

In males, Stature (S) = 162.63 + 0.57 × HB

In female, Stature (S) = 123.9 + 2.33 × HB.

In the present study, in the case of stature from HB in males, the SEE was 6.83 and in females, it was 5.40. The correlation coefficient in male was 0.17, whereas in female, it was 0.071.

Wankhede *et al.* found SEE as 6.80 and 5.69 in the case of male and female, respectively, which was nearly similar to our study. Although correlation coefficient was 0.053 in males, it was 0.262 in females, which is different from our findings[6]. Bardale found correlation coefficient of HB with height as 0.26 and SEE for regression formula was 6.40. For female, the correlation coefficient of HB with height was 0.23 and SEE was 5.81 which are different from our findings.

Thus, for highly correlated varieties, linear regression equation is useful in stature estimation from measurements of fragmentary remains.

From this, we can say that regression formula differs for different population residing in different geographical location.

Multiple regression equation can also be derived for both the sexes if both dimensions taken (i.e. HL and HB).

CONCLUSION

1. All the measurements were found to be more in males compared with females.
2. Significant positive correlation was present between height and HL and HB.
3. HL is more reliable dimension for height estimation than HB in males, whereas in females, HB is more reliable.
4. Estimation of stature from HL and breadth is important tool for stature estimation when other long bones are not available for examination.
5. Regression equation thus derived is population specific and may not give exact result when applied to population from other parts of India.

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