Original Article

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Anatomy Section

Stature Estimation from Head Length and Breadth by Regression Analysis in Madhya Pradesh Population

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ABSTRACT

Introduction: Growth is the vital process which is recorded by measuring the stature of a person, i.e., a sum of length of certain long bones and appendages of the body. There is a definite and proportional biological relationship of stature with all body parts and this relationship helps to calculate stature from dismembered and mutilated body parts in forensic examination.

Aim: To estimate stature from Head Length (HL) and Head Breadth (HB) in living and to derive the correlation and regression formulae between them.

Materials and Methods: The present study comprised of total 300 (187F and 113M) young and healthy students in the age range 18-25 years, of different courses of first year at Index Medical College, Indore , Madhya Pradesh, India. The subjects were studied for the following parameters: Height Vertex, Maximum HL and Maximum HB. The measurements were tabulated and statistically analysed.

Results: Mean height in males were 171.33±6.89 and that in females were 157.34±5.31. Mean HL and HB in males was 18.19±0.81, 13.48±0.79 and that in females it was 17.05± 0.66, 12.81±0.67. Pearson's correlation coefficient was significant for HL and HB in female subjects and HL in male subjects whereas it is not significant for HB in male subjects.

Conclusion: Definite proportion exists between the stature and HL and HB in all individuals.

Keywords: Anatomist, Anthropologist, Human stature, Maximum head length, Maximum head breadth

INTRODUCTION

Growth is the vital process which is recorded by measuring the stature of a person, i.e., a total length of certain long bones and appendages of the body [1]. Stature is an important biological parameter in medico-legal forensic examination. It may so occur that many a times highly decomposed or mutilated bodies or fragmentary remains of skull are brought for medico-legal examination [2]. Anthropometric study of skeleton from different body parts for assessment of stature is a point of interest not only to Anthropologist and Forensic expert but also to Anatomist [3].

Stature or body height is most important parameter to determine the physical identity of an individual. There is a definite and proportional biological relationship of stature with all body parts such as extremities {humerus [4], radius [5], ulna [6], tibia [7,8], femur [9] etc.,} skull [10], vertebral column [11] and for such estimation, the best and most reliable method is regression analysis [12]. This relationship helps a forensic scientist to calculate stature from dismembered and mutilated body parts in forensic examination [13].

There are two basic methods for calculating height from skeletal remains. The mathematical method i.e., also called as regression method based on proportionality between height and the length of long bones and the anatomical method i.e., also called as multiplication method based on the measurements of the whole skeleton, including the spinal column, and adding the dimensions of the soft parts [14].

Due to scarcity of studies [2,15] on estimation of stature from skull bone in Madhya Pradesh population and its usefulness in medico–legal investigations, the present study was undertaken with an aim to estimate stature from HL and HB and to derive the correlation and regression formulae between them.

MATERIALS AND METHODS

The present cross-sectional study was carried out from September to December 2018 on total 300 (187 Female and 113 Male) young and healthy students in the age range 17-25 years, of different courses (MBBS, BDS, BPT) of first year at Index Medical College, Indore , Madhya Pradesh, India. Students having any obvious congenital physical abnormality, history of any facial surgical procedures, old fractures or any significant disease, metabolic or developmental disorders which could have affected the general or bony growth were excluded from the study.

The subjects were studied for height vertex, maximum HL and maximum HB. The measurements were taken at a fixed time i.e., between 3-5 pm, to eliminate error of diurnal variation and by the same person to avoid error in methodology [1].

The instruments used in the study were stadiometer to measure stature and spreading calliper to measure maximum HL and maximum HB. The measurements were taken using anthropometric instruments in centimetres according to methods described by Vallios HV [16]. Ethics committee approval was obtained for the study.

Measurement of Stature [16]

Stature (height) is a measure of vertical distance from vertex to floor.

Vertex: Is the highest point on the head in the midsagittal plane, when the head is held erectly or in Frankfurt's plane.

Height was measured from vertex to floor by stadiometer with subject standing barefooted, erect on an even floor, in the Frankfurt's plane. The distance was measured from the highest point on the subjects head to the ground.

Frankfurt's plane: The plane passing through the lowest points on the infraorbital margins and the tragion (the notch immediately above the tragus of the ear). This corresponds almost exactly to the plane of visual axis, which is obtained when the subject is looking straight ahead of him.

Measurement of Maximum Head Length [17]

It measures the straight distance between glabella and the inion.

Glabella: The most prominent point on the frontal bone above the root of the nose, between the eyebrows.

Inion: It is the most prominent posterior point on the occipital protuberance of head in the mid-sagittal plane. This point is determined where the HL shows maximum reading.

Measurements will be taken using blunt ended spreading caliper.

Measurement of Maximum Head Breadth [17]

With the help of spreading calliper the distance between the most lateral points of the parietal bones were recorded.

STATISTICAL ANALYSIS

The measurements mentioned above were tabulated and statistically analysed. The mean and standard deviation were obtained. Pearson's correlation coefficient and linear regression equations were derived for males and females separately of study group by using Epi Info version 3.4.3 software.

RESULTS

Mean age of subjects (n=300) was 19.84 with Standard Deviation (SD) of 1.18. Minimum age of subjects was 17 and maximum age was 25. Pearson correlation coefficient was used to find the relation between head measurements and height and regression analysis was done. Statistical analysis was presented in tabular form.

[Table/Fig-1a and b] presents mean, SD, and range in male and female subjects. Mean height of males was 171.33±6.89 and that of females is 157.34±5.31. Mean HL and HB in males are 18.19±0.81, 13.48±0.79 and that in females are 17.05±0.66, 12.81±0.67.

n=187	Mean	SD	Range
Age	19.71	1.18	17-25
Stature	157.34	5.31	144.6-171.2
Head Length (HL)	17.05	0.66	15.20-18.60
Head Breadth (HB)	12.81	0.67	10.5-14.5

[Table/Fig-1a]: Shows mean, standard deviation and range in female subjects (n=187).

n=113	Mean	S.D	Range
Age	20.05	1.16	18-25
Stature	171.33	6.89	149-193
Head Length (HL)	18.19	0.81	16-20.2
Head Breadth (HB)	13.48	0.79	10.5-15.2

[Table/Fig-1b]: Shows mean, standard deviation and range in male subjects (n=113).

From [Table/Fig-2a and b] we can conclude that pearsons correlation coefficient is significant for HL and HB in female subjects, and HL in male subjects whereas it is not significant for HB in male subjects.

Female (n=187)	Pearson correlation (r)	Significance
Head Length	0.259	<0.001
Head Breadth	0.160	<0.028

[Table/Fig-2a]: Correlation of height with head length and breadth in female subjects.

Male (n=113)	Pearson correlation (r)	Significance p-value
Head Length	0.266	<0.004
Head Breadth	0.054	<0.572

[Table/Fig-2b]: Correlation of height with head length and breadth in male subject.

[Table/Fig-3a and b] shows the regression equation for calculating height from HL and HB in male and female subjects.

Female	Regression equation	SEE
Head Length	Ht.=121.88+2.08×HL	5.14
Head Breadth	Ht.=141.04+1.27×HB	5.25

[Table/Fig-3a]: Regression equation for height with head length and breadth in female subjects.

Male	Regression equation	SEE
Head Length	Ht.=130.42+2.24×HL	6.66
Head Breadth	Ht.=164.98+0.47×HB	6.7

[Table/Fig-3b]: Regression equation for height with head length and breadth in male subjects.

DISCUSSION

The present study was a cross-sectional study comprising of 300 (187 F and 113 M) young healthy students. The parameters studied are Height, HL and HB. When compared among sexes, it was found that values are higher for male and the differences were statistically significant. The result of present study showed that the stature can be estimated from the cephalic dimensions by applying regression equation. Positive correlation was found between stature and HL in males as well as female subjects which was statistically significant. Similarly significant correlation exists between stature and HB in female subjects and in male it was statistically not significant.

In present study, mean HL in males and females were 18.19 and 17.05 and HB were 13.48 and 12.81 respectively. The difference between mean head length and breadth of male and female subjects i.e. gender difference was statistically significant ($p< 0.05$) which coincides with that of previous studies [Table/Fig-4] [2,10,12,13,18-24].

Author	Place	Year	Age group	Gender	Mean Head length	Mean Head Breadth
Krishan K [13]	North India	2008	18-30	M	17.83±0.89	13.92±0.62
Ilayperuma I [10]	Srilanka	2010	20-23	M	18.02±1.12	14.01±1.06
				F	17.19±1.01	13.61±1.10
Agnihotri AK et al., [12]	Indo-Mauritian	2011	20-28	M	18.66±0.79	15.45±0.76
				F	18.13±0.91	14.48±0.81
Ewunonu EO et al., [18]	South Eastern Nigeria	2013	12-45	Both	18.82±0.80	15.03±0.76
Kumar M et al., [19]	Haryana	2013	18 and above	M	18.75±1.4	13.11±1.1
				F	17.75±0.84	12.95±0.83
Singh R [20]	UP	2013	17-26	M	17.0±0.7	13.1±0.6
				F	16.0±0.8	12.5±0.6
Agarwal S [21]	Western UP	2014	17-25	M	18.24±0.64	14.86±0.71
				F	17.39±0.62	14.13±0.54
Shah T et al., [22]	Gujarat	2015	21-50	M	17.79±1.52	13.72±1.52
				F	16.01±1.60	12.38±1.54
Wankhede KP et al., [2]	Central India	2015	18-24	M	18.5±0.72	14.64±0.63
				F	17.53±0.81	14.16±0.66
Kamal R et al., [23]	Kori Population of North India	2016	20-40	M	18.43± 1.05	13.3±0.64
				F	17.63±0.86	13.02±0.65
Thoudam BD et al., [24]	Manipuri Muslims	2017	20-60	M	19.41±0.04	15.41±0.03
Present study	Madhya Pradesh	2019	18-25	M	18.19±0.81	13.48±0.79
				F	17.05±0.66	12.81±0.67

[Table/Fig-4]: Comparison of mean head length and head breadth [2,10,12,13,18-24].

Over many years, a close relationship between stature and various body segments are reported and the results are frequently used in medico legal investigation. [Table/Fig-5] shows studies [2,10,12,13,15,18,21,23,24] in which an attempt has been made to establish the correlation between stature and skull dimensions.

Author	Country/ Region (sample drawn)	Gender	Correlation coefficient		Regression Equations	
			HL	HB	HL	HB
Krishan K [13]	North Indian	M	0.775	0.682	88.67+4.64 HL	98.06+5.32 HB
Ilayperuma I [10]	Srilankan	M	0.715	0.470	101.83+3.69 HL	111.6+3.84 HB
		F	0.312	0.454	226.6+3.86 HL	111.76+3.33 HB
Agnihotri AK et al., [12]	Indo-Maurition	M	0.331	0.015		
		F	0.159	0.193		
Ewunonu EO et al., [18]	South Eastern Nigerian	Both	0.34	0.39	102.75+3.4 HL	105.59+4.07 HB
Agarwal S et al., [21]	Western UP	M	0.215	0.232	109.97+3.18 HL	107.64+4.19 HB
		F	0.341	0.291	121.54+2.03 HL	114.88+2.58 HB
Wankhede KP et al., [2]	Central India	M	0.279	0.053	122.32+2.63 HL	162.63+0.57 HB
		F	0.206	0.262	133.76+1.49 HL	123.9+2.33 HB
Kamal R et al., [23]	Kori Population of North India	M	0.182	0.085	142.7+1.19 HL	152.5+0.91 HB
		F	0.355	0.162	112.2+2.20 HL	168.3+1.33 HB
Thoudam BD et al., [24]	Manipuri Muslims	M	0.343	0.168	98.45+3.38 HL	135.37+1.86 HB
Jehan M et al., [15]	Malwa region of MP	M	0.159	------	149.65+1.19 HL	------
		F	0.516		96.31+3.59 HL	
Present study	Madhya Pradesh	M	0.266	0.054	130.42+2.24 HL	164.98+0.47 HB
		F	0.259	0.160	121.88+2.08 HL	141.04+1.27 HB

[Table/Fig-5]: Showing correlation and linear regression equation of stature with head length and breadth [2,10,12,13,15,18,21,23,24].

LIMITATION

Body ratios within specific population groups also changes over time due to changes in diet, lifestyle and socio- economic status, and therefore the present regression formulae may need readjustment over time.

CONCLUSION

Present study proves that stature could be estimated using HL and HB (skull dimensions). The mean values of males were higher than those of females. Variations in regression equation by various workers may be due to genetic differences, isolation differences, differences in bio-cultural history. Regression formulae are population and sex specific.

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