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Original Research Article

Estimation of Stature from Cranial Parameters in Gujarat Population

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Abstract

Background: The height of humans has been a symbol of status and dominion over different residing beings, whether human or animal kingdoms, for all time. Estimation of stature has been defined as a fundamental examination for the identification of unknown individuals and consequently, an essential tool in forensic examination especially, while anonymous, putrid, dispersed, and disfigured human remains are worried.

Aim: This study aimed to determine data on cranial dimensions of Gujarat adolescents and to acknowledge the applied significance of the current study to forensic, plastic, and reconstructive surgery.

Materials and Methods: At the Govt. Medical College in Surat, Gujarat, 400 undergraduate medical students—200 men and 200 women—were included in the study. Each individual was healthy and free of any visible deformities. Maximum head length, maximum head breadth, horizontal circumference of the head, and stature were the measurements used in the study. All data were recorded, and using the regression coefficients, a fictitious regression equation was created.

Results: Each of the three cranial factors for both genders is positively and significantly connected with stature, according to the study's findings. Once we see the finding of males and females separately, all the three cranial parameters for females are positively and significantly correlated with stature, but in males, only MHL and HHC are positively and significantly correlated with stature. The outcomes suggest you'll be able to successfully estimate stature from various cranial parameters in situations where cephalo-facial is the only viable element remaining for identification.

Conclusion: This study has shown that cranial measurements for estimating stature are reliable and worthwhile to pursue. This can be helpful to practitioners in cases of solitary cranioids or situations in which the skull is the only remaining viable piece, giving shaky information for the identification of anonymous people.

Keywords: Stature, Cranial, Head length, Head Breadth, Head circumference.

Introduction

The height of humans has been a symbol of status and dominion over different residing beings, whether human or animal kingdoms for all time. For a very long time, anthropologists have been interested in the role that height plays in identifying people, and forensic medicine has used it for both medical and legal reasons [1].

In order to identify unknown people, estimation of stature has been described as a vital assessment. As a result, it is a crucial instrument in forensic investigation, particularly when it comes to unidentified, rotten, dispersed, and deformed human remains [2].

A good deal of research has been performed on stature estimation from numerous body parts like the independent bones, hand, foot, vertebral column, trunk, upper and lower extremities [3-10]. The determination of sex and race from the cephalic region, various techniques for reconstructing the face in either men or women from the skull bones, new data on the depth of the facial soft tissue, ultrasound, C.T. scans, and 3-D reconstruction computer databases and software are just a few of the many research areas that concentrate on other aspects of cephalo-facial identification [11-17].

Due to a lack of expertise, consistent data, and tools, forensic specialists occasionally cannot practice the facial reconstruction method. In these situations, estimation of stature from the cephalo-facial region typically helps to supplement the identification data obtained via the use of the other techniques and, as a result, speeds up the forensic investigation process.

Aim of Study

Dimensional relationship between body segments and stature has been the point of focus for scientists. The intention of the study was to analyze anthropometric relationships between Height and cranial parameters are used to understand the value of looking at forensics and cosmetic surgery, which will aid law enforcement in establishing "personal identification" in cases of unidentified human remains.

Materials and Methods

Ethical Considerations

The study was performed at Government Medical College, Surat after obtaining written permission from the Institutional Ethics Committee (Human Research). NO.MCS/STU/ETHICS/Approval/12738/14 Dated: 18 July 2014.

Study Design and Methodology

At the Government Medical College in Surat, Gujarat, 400 undergraduate medical students—200 men and 200 women—were included in this study. Each individual was healthy and free of any visible deformities. They came from various regions of Gujarat and represented various socioeconomic classes. Participants ranged in age from 17 to 25.

1. Maximum Head Length (MHL) (glabella-ion length) It is described as the straight distance between the most prominent point of the occipital bone and the foremost point on the forehead above the root of the nose (glabella). This was measured by placing the posterior calliper tip along the mid-sagittal plane of the occipital bone while allowing the anterior calliper tip to rest on the glabella until the maximum length was attained.

2. Maximum Head Breadth (maximum bi-parietal diameter) (MHB): This term refers to the largest possible separation between the lateral sites on the parietal bones. This was measured by allowing the spreading caliper's two pointers to descend along the lateral sides of the parietal bones until the largest width was noted.

3. Horizontal Head Circumference (HHC): This is the measurement from just above the glabella region to the area close to the most prominent point of the occipital bone. It is normally horizontal and starts just above the eyebrow.

4. Stature (HT): Using a standing height measurement device, the height of the subject was determined between the vertex and the ground while the subject was standing straight, in anatomical position, and with the head in the Frankfort plane. The closest 0.1 cm were used to measure height.

Maximum Head Length (MHL), Maximum Head Breadth (MHB), and Horizontal Head Circumference (HHC) measurements were made with participants seated in chairs, relaxed, and with their heads in anatomical positions. The measurements were made using callipers and measuring tape in centimetres to the nearest millimetre (0.1 cm). The authors' recommended landmarks, methodologies, and procedures were used to measure all of the cephalic dimensions.[2]

The head was kept inside the Frankfurt plane by identifying the anatomical features that were employed. The chosen participants' permission was obtained before the measurements were conducted. There was no indication of any medical or surgical intervention for craniofacial malformations, and all the participants were in good health and free of apparent cephalic abnormality.

Statistical Analysis

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) for Windows XP-Professional. The data collected were entered into a database and subjected to measures of mean, standard deviation (S.D.), the Student t-test, Karl Pearson's correlation coefficient (r), regression analysis, and standard error of estimate.

Thereafter, a hypothetical regression equation was formulated using the regression coefficients as follows: S = a + bx

Where, S = stature, i.e. the dependent variable.
x = any cranial measurement, i.e. independent variable.
a = the regression coefficient of dependent variable.
b = the regression coefficient of independent variable.

Results

Table 1: Descriptive Statistics of the Cranial Parameters (cm) of Gujarat Residents

Parameters	N	Min.	Max.	Mean	S.D.	S.E.M.
Age	400	17	20	17.64	0.630	0.031
HT	400	146	188	165.87	8.84	0.442
MHL	400	15.5	22.5	19.92	1.01	0.051
MHB	400	12.5	22	16.70	0.88	0.044
HHC	400	50	60	55.27	1.84	0.092

For cranial anthropometry, the complete sample (N=400) had a mean age of 17.64 0.630 years and a mean height of 165.87 8.84 cm. Table 1 displays the mean, standard deviation, minimum and maximum values for age, height, and cranial factors.

Table 2: Pearson Correlation Coefficient between Stature and Cranial Parameters

Measurements	N	Pearson Correlation Coefficient (r)	p- value
MHL(cm)	400	0.352	0.000
MHB(cm)	400	0.232	0.000
HHC(cm)	400	0.450	0.000

The Pearson Correlation coefficients between stature and cranial parameters are shown in table 2.

Table 3: Constant, Regression coefficient and Variation explained (R2) of Cranial parameters

Measurements	Constant	Regression Coefficient (r)	R^2	p - value
MHL(cm)	104.61	3.07	0.124	0.000
MHB(cm)	127.17	2.32	0.054	0.000
HHC(cm)	46.05	2.17	0.204	0.000

Height was positively linked with the MHL, MHB, and HHC (P 0.05; r = 3.07, r = 2.34, and r = 2.17, respectively). According to the linear regression equations created for the cranial characteristics associated with stature, the constants for MHL, MHB, and HHC were respectively 104.61, 127.17, and 46.05. The substantial regression coefficients (3.07, 2.32, and 2.17, respectively) show that they are involved in the prediction of stature. According to the variation explained (R2 x 100), MHL, MHB, and HHC, respectively, contribute 1.2%, 0.5%, and 2% of stature (Table 3).

Table 4: Minimum, Maximum, Mean and standard deviations of the predicted Values of stature by regression functions with the cranial parameters

Measurements	Min	Max	Mean	SD	N
MHL(cm)	152.27	173.80	165.87	3.11	400
MHB(cm)	156.14	178.15	165.87	2.05	400
HHC(cm)	154.55	176.12	165.87	3.99	400

The average stature projected (estimated) by the regression function matched the average stature observed (real) value (Tables 4). This is because the measures of central tendency were used to build the regression equations, but the minimum and maximum values showed that there were discrepancies between the predicted and observed values.

Table 5: Regression Equation for Estimation of Stature from Cranial Parameters

Regression Equation	R	SEE
HT = 104.61 + 3.07 (MHL)	0.352	8.28
HT = 127.17 + 2.32 (MHB)	0.232	8.60
HT = 46.05 + 2.17 (HHC)	0.452	7.84

A regression method for estimating stature from cranial characteristics is shown in Table 5. It is possible to estimate stature from a specific section of the head using different equations for positively associated cranial characteristics. Regression analysis is used to calculate the values of the constants and the regression equations. The usual equation of regression was modified by adding the proper values for constants a and b to create the regression equations from cranial parameters. The standard error of estimate (SEE) and multiple regression coefficients are also displayed in the table (R). SEE tends to highlight the discrepancy between projected and actual stature, i.e., the potential inaccuracy in assessing stature [18]. A lower SEE number represents a high level of reliability, whereas a higher SEE value shows a lower level of reliability. One of the metrics used to assess the suitability of a model is R (the multiple correlation coefficient values). The dependent variable's R is the correlation between the fitted values and the observed values [19].

Discussion

In forensic investigations, a precise calculation of stature from the dispersed body parts is crucial. Regression analysis is regarded as the best and most reliable method for this type of estimation. According to the findings of the current investigation, each of the three cranial parameters significantly and positively correlates with stature ($p<0.05$). (Table 2). Similar stature observations have been made across racial groups. The findings imply that when cephalo-facial remains are brought in for forensic tests, one can effectively estimate stature from various cranial parameters. However, it must be remembered that accurate stature prediction from cranial factors may be an impractical and unrealistic goal; there will always be centimeter-sized estimation mistakes.

Table 6: Comparison of S.E.E. for stature estimation studies

Study	Element Used	Range of S.E.E.
Chiba and Terazawa(1998)	Cranium	6.97
Patil and Mody(2005)	Cephlometric study	3.71
Ryan and Bidmos (2007)	Cranium	4.37 – 6.24
Krishan and Kumar(2007)	Cephalo-facial measurements	4.41–7.21
Kewal Krishan(2008)	Cephalo-facial measurements	3.726 – 5.820
Ekezie J(2015)	Cephalo-facial anthropometry	6.93 – 9.03
Elizabeth Richards	Cranium	5.64 – 7.53
Present Study(2015)	Cranial Parameters	7.84 - 8.60

Table 6 shows the Standard Error of Estimate from the various studies done by various researchers and in the present study range of S.E.E. is 7.84 - 8.60.[20]

Table 7: Comparison of Actual stature and stature estimated from the cranial parameters

Estimated stature using regression equations for	Min Estimated Stature	Max Estimated Stature	Mean estimated stature
MHL	152.19	173.68	165.76
MHB	156.17	178.21	165.91
HHC	154.55	176.25	165.98
Actual stature	146	188	165.87

The accuracy of the regression formulas was verified. A comparison between real stature and stature inferred from cranial characteristics using regression analysis is shown in Table 7.

Estimated stature was obtained by substituting the minimum, maximum, and mean values of the measurements in their respective regression equations. The table clearly shows that the lowest predicted stature for each cranial parameter is greater than the actual minimum stature of 146 cm. The greatest predicted stature figure, on the other hand, understates the actual stature by 188 cm in each measurement situation. The mean estimations (mean estimated stature) are, nonetheless, quite accurate measures of actual stature. This is because the regression equations are constructed using measurements of central tendency.

Limitations

The very last sample was smaller than desired despite efforts to expand the sample size. Adolescence in Gujarat might require a much larger sample with sufficient regional and social variability or a nationwide test that assesses all communities. Equations are specific to the people of Gujarat, hence it is important to understand that they should not be applied to other communities. The multiplication factors created for our study group differ from those created for other Indian ethnicities. The current study also demonstrates that secular trends have a significant effect, and as a result, multiplication factors developed for a population must be altered at least once every ten years to improve the predictability of stature among the living populations.

Conclusion

When a single isolated skull is all that can be recovered in an unidentified person, it is critical to have tools for estimating their biological profile. This study has solved the question of whether it is possible to estimate stature from the cranium in the Gujarat population by determining the degree of association between particular cranial parameters and stature. This research sought to establish a link between Gujarati population height and cranial characteristics.

As a result of this investigation, it has been determined that when isolated cranium remains are brought in for forensic analysis, the Cranial parameters can also be utilised to estimate stature. The generated regression formulas demonstrate good applicability and dependability, it is found. The Multiplication Factor for the cranial parameters was more precisely discovered. These findings can aid in more accurate measurement of a person's height using a single bone with less bias.

This study has shown that cranial measurements for estimating stature are reliable and worthwhile to pursue. This is useful information for identifying unknown people and will be useful to practitioners in circumstances of isolated crania or cases where the cranium is the only remaining viable piece.

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