ORIGINAL RESEARCH PAPER

Anatomy

ESTIMATION OF STATURE FROM HEAD CIRCUMFERENCE IN POPULATION OF MALWA REGION OF CENTRAL INDIA: A CORRELATIONAL ANALYSIS

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ABSTRACT

There are studies that estimate stature from various cephalic parameters including head circumference up to certain extent which are population, race and gender specific. This study was conducted on 200 medical students between 18 to 22 years of age which included 100 males and females each, at Indore. The height of the individual and horizontal head circumference (HC) was 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 being 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.

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 definite relationship to the stature. This proportional relation helps medico legal 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 el 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.

As shown in Figure 1, Horizontal head circumference (HC) was measured from glabella to glabella by using non-stretchable plastic measuring tape which has passed through the opistho-cranion (just above eye ridges).

The subjects were apparently healthy and those with any craniofacial deformity were excluded from the study.

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 was calculated as range, mean, standard deviation and standard error of mean. A correlation coefficient and standard error of estimate for age, height and head circumference were statistically analyzed and compared between male and female participants. Correlation coefficient and regression lines for predicting age and height from head circumference were computed for males and females separately.

RESULTS

A total of 200 volunteers participated in the study including 100 males and females each. The mean age for males was 19.9±1.14

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

Student t- test	Age	Height	Head Circumference
t – value	t=1.814	t=19.41	t=6.06
p – value	0.0711	<0.0001	<0.0001
P value summary	Not Significant	***	****
Difference between means	0.27 ± 0.1488	-14.12 ± 0.7272	-1.078 ± 0.1779
Are means signif. different? (P < 0.05)	No	Yes	Yes
95% confidence interval	-0.02346 to 0.5635	-15.55 to -12.68	-1.428 to -0.7279
R squared	0.01635	0.6555	0.1097

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 shows that HC is better estimate height in males than females with along showing a significant correlation in their own groups of male and female (p<0.0001).

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

Regression Statistics of HC	Male (observed ht=171.59cm)	Female (observed ht=157.48cm)
Independent variable(x) = HC	55.35	54.33
Intercept (a)	66.69	96.705
Regression coefficient (b)	1.895	1.119
Correlation coefficient(r)	0.542	0.332
Coefficient of determination (R2)	0.294	0.1103
Std. error of estimate (SEE)	4.53	4.66
Significance (p)	***	***
Regression formula (y = a+bx)	y= 66.69+1.895(x)	y= 96.705+1.1197(x)
Predicted ht (y)	171.59cm	157.47cm

Graph 1: Showing relation between Head Circumference (HC) and Height in Male
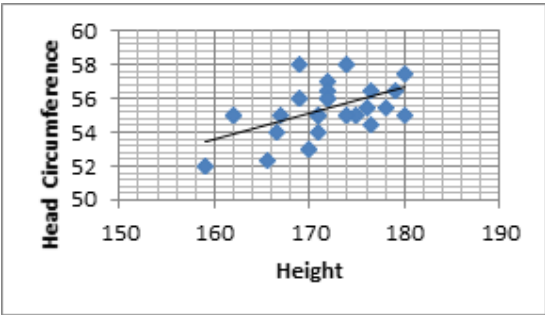
Graph 2: Showing relation between Head Circumference (HC) and Height in Female
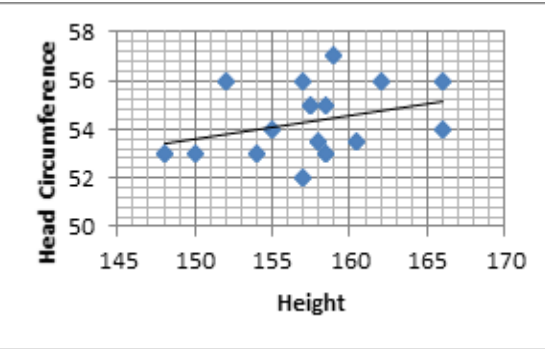
DISCUSSION AND CONCLUSION

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 Ewunonu 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 Ewunonu 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 (±4.41), 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 Eboh 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
1. Krogman WM, Iscan MY. The Human Skeleton in Forensic Medicine, Charles C Thomas, Springfield, IL, 1986.
2. Krishan K, Limb bilateral asymmetry and footprints of male adult Gujjar

populationin parts of Punjab and Haryana (Unpublished PhD Dissertation), Panjab University, Chandigarh, India, 2002.

3. Iscan MY. Forensic anthropology of sex and body size, Forensic Sci. Int. 2005;147:107–112.
4. Krishan K. Estimation of stature from footprint and foot outline dimensions in Gujjars of North India. Forensic Sci Int. 2008 ;175(2-3):93-101.
5. Krishan K. Determination of stature from foot and its segments in a north Indian population, Am J Forensic Med Pathol. 2008;29(4):297-303.
6. Kumar J, Chandra L. Estimation of stature using different facial measurements among the Kabui Naga of Imphal Valley, Manipur. Anthropologist 2006;8(1):1-3.
7. Krishan K, Kumar R. Determination of stature from cephalo-facial dimensions in a North Indian population. Leg Med (Tokyo) 2007;9(3):128-33.
8. Krishan K. Estimation of stature from cephalo-facial anthropometry in north Indian population. Forensic Sci Int 2008;181(1-3):52.e1e6.
9. Pelin C, Zağyapan R, Yazici C, Kürkçüoğlu A. Body height estimation from head and face dimensions: a different method. J Forensic Sci. 2010 Sep;55(5):1326-30.
10. Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE. Gray's Anatomy: The anatomical basis of medicine and surgery. 38th Ed. New York, Churchill Livingstone, 2000.
11. Krishan K and Sharma A. Estimation of stature from dimensions of hands and feet in a North Indian population. Journal of Forensic and Legal Medicine. 2007, 14(6):327-332.
12. Ewunonu EO, Anibeze CIP. Estimation of Stature from Cephalic Parameters in South-Eastern Nigerian Population. J Sci Inno res 2013;2(2):425-32.
13. Chiba M and Terazawa K. Estimation of stature from somatometry of skull. Forensic Science International. 1998, 97: 87-92.
14. Patil KR and Mody RN. Determination on sex by discriminant function analysis and stature by regression analysis: A lateral cephalometric study. Forensic Science International. 2005, 147:175-80.
15. Agnihotri AK, Kachhwaha S, Googoolye K, Allock A. Estimation of stature from cephalo-facial dimensions by regression analysis in Indo-Mauritian population. J Forensic Leg Med. 2011 May;18(4):167-72.
16. Eboh DE, Igbigbi PS. Stature estimation from cephalometric parameters of young adults in five Nigerian ethnic groups. Ital J Anat Embryol 2017;122(2): 98-109.