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A Correlation Analysis for Estimation of Height from Head Breadth and Vertex Height

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Abstract : *Stature can be expressed as stable proportional relationship with other body part measurements of the human body like head, face, trunk and extremities etc. Study was conducted to estimate a correlation between Height against Head Breadth (HB) and Vertex Height (VH). Among all 200 students mean height for males was 172±0.54 cm (Mean±SEM), for females was 157±0.49 cm. The mean head breadth for males was 13.7±0.08 cm, for females was 12.7±0.07 cm. The mean Vertex height was 35.8±0.13 cm for males while it was 35.2±0.13 cm in females. In present study for HB, correlation coefficient of 0.183 with a standard error of estimate of 5.299 in males, while for females revealed a correlation coefficient of 0.338 with a standard error of estimate 4.65. The correlation coefficient of 0.13 with a standard error of estimate of 5.344 in males for VH, while for females it was -0.007 with a standard error of estimate 4.94. Linear regression equations for height from Head breadth for 'Male Stature = 153.66 + 1.31 (HB)' and 'Female Stature = 128.64 + 2.27 (HB)'. Regression equations calculated for the height from Vertex height of head for 'Male Stature = 152.69 + 0.53(VH)' and for 'Female Stature = 158.36-0.03(VH)'*

Keywords *- Head breadth, Height, Stature, Vertex height.*

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I. Introduction

Estimating stature is one of the four important parameters (identifying age, sex, stature and ancestry or race) of forensic anthropology. It helps in narrowing down the number of suspected victims in an investigation where identity is in question.[1]

Stature can be expressed as stable proportional relationship with other body part measurements of the human body like head, face, trunk and extremities etc. This proportional correlation helps a forensic scientist to calculate stature from various isolated body parts in forensic examinations. Regression method and multiplication method are the two methods that have been useful for such predictions, and it has been universally concluded that the regression analysis is better method than any other methods for predicting stature.[2-4] Although a number of long bones[5-6] are used for this purpose as they have direct relationship to height but cranial dimensions are found to be more reliable and precise for estimating stature.[7,8]

Cranial dimensions have been shown to be a reliable means in many studies predicting the stature in Italians[9], Japanese[10] and South Africans[11]. There are few studies as well, that are conducted in Indian population for predicting height from cranial measurements.[7,12,13]

There has been concern regarding the accuracy of these estimations among less related populations. These regression equations are population specific. It is obvious that one universal formula cannot be obtained but it is affected by the race, ethinicity, sex and age of subjects.[14]

Thus population specific correlational studies are needed to produce a reliable database to estimate stature from cranial parameters more precisely in different populations. Thus present study was conducted to estimate a correlation between Height against Head Breadth and Vertex Height, and find out formulae for estimation of stature from Head Breadth and Vertex Height in the population of Malwa region of Central India.

II. Material and Methods

Medical students between 18 to 22 years of age was selected from our institution, MGM Medical College, Indore belonging to Malwa region of Madhya Pradesh, India for the study which included 100 males and females each (total = 200).

Apart from Stature, Head breadth and Vertex height was measured. The measurements were taken according to the landmarks and procedures recommended by *Krishan and Kumar*[15] and *Agnihotri et. al.*[16] The anthropometric measurements are defined as:

Stature: The subject should stand on a horizontal platform with his heels together, stretching upward to the fullest extent, aided by gentle traction by the measure on the mastoid processes. The subject's back should be as straight as possible, which may be achieved by rounding or relaxing the shoulders and manipulating the posture. The marked Frankfurt plane must be horizontal. The subject's heels must be watched to make sure they do not leave the ground.

***Head breadth* (HB):** It is the maximum biparietal diameter and is the distance between the most lateral points of the parietal bones (Figure 1).

Figure 1: *Method of measuring the Head Breadth*

***Vertex Height* (VH):** It is horizontal arc of the head which is measured from right tragion (the point in the notch just above the tragus of the ear) to left tragion with the help of measuring tape passing over the vertex (Figure 2).

Figure 2: *Method of measuring the Vertex Height*

The measurements were taken with the help of an anthropometric rod, spreading caliper and measuring tape to the nearest 0.1 cm. 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.

The Head Breadth, Vertex Height and Height were calculated as range, mean, standard deviation and standard error of mean. A correlation coefficient and standard error of estimate for age, height, HB and VH were statistically analyzed and compared between male and female participants with the help of Graph prism statistical software. Correlation coefficient and regression lines for predicting age and height from HB and VH were computed for males and females separately using Word Excel & SSP softwares.

III. Observation and Results

Among all 200 students enrolled, a descriptive statistics were calculated as shown in Table-1. According to which the mean height for males was 172±0.54 cm (Mean±SEM) and for females it was 157±0.49 cm. The mean head breadth for males was 13.7±0.08 cm and for females it was 12.7±0.07 cm. The mean Vertex height was 35.8±0.13 cm for males while it was 35.2±0.13 cm in females.

Table 1: *Descriptive statistics of Observed Height and Head Breadth (HB) and Vertex Height (VH) of Male and Female*

Statistics	**Male (n=100)**			**Female (n=100)**		
	Height	**HB**	**VH**	**Height**	**HB**	**VH**
Minimum	159	12.3	34	148	11	32
Median	172	13.6	35.5	158	13	35
Maximum	180	15	38	166	14	38
Mean	172	13.7	35.8	157	12.7	35.2
Std. Deviation	5.36	0.745	1.32	4.91	0.733	1.3
Std. Error	0.536	0.0745	0.132	0.491	0.0733	0.13
Lower 95% CI of mean	171	13.5	35.6	157	12.6	35
Upper 95% CI of mean	173	13.8	36.1	158	12.9	35.5
Coefficient of variation	3.12%	5.46%	3.68%	3.12%	5.76%	3.70%

According to Table-2, the statistical difference of the results of student t- test between males and females for head breadth ($p<0.0001$), height ($p<0.0001$) and vertex height ($p<0.0013$) were significant in decreasing degree. The sex can be predicted from head breadth more accurately than with vertex height.

Table 2: *Student t- test between Male and Female Head Breadth (HB) and Vertex Height (VH)*

Student t- test	***Height***	***Head Breadth***	***Vertex Height***
t – value	t=19.41	t=8.877	t=3.263
p – value	<0.0001	<0.0001	0.0013
P value summary	***	****	**
Difference between means	-14.12 ± 0.7272	-0.928 ± 0.1045	-0.605 ± 0.1854
Are means signif. different? (P < 0.05)	Yes	Yes	Yes
95% confidence interval	-15.55 to -12.68	-1.134 to -0.7219	-0.9707 to -0.2393
R squared	0.6555	0.2847	0.05102

*** Significant

Regression analysis for stature from head breadth (Table-3) revealed a correlation coefficient of 0.183 with a standard error of estimate of 5.299 in males, while similar regression for females revealed a correlation coefficient of 0.338 with a standard error of estimate 4.65. Power of correlation was weak for both males and females just slightly better for females although the relation was statistically significant in both males and females ($p<0.0001$). Linear regression equations calculated for the height from Head breadths are as follows;

Male Stature = 153.66 + 1.31 (HB)

Female Stature = 128.64 + 2.27 (HB)

Regression analysis for stature from Vertex height (Table-4) revealed a correlation coefficient of 0.13 with a standard error of estimate of 5.344 in males, while similar regression for females revealed a correlation coefficient of -0.007 with a standard error of estimate 4.94. Power of correlation was weak for males and

negative for females. The correlation was not statistically significant for vertex height. Linear regression equations calculated for the height from Vertex Height are as follows;

Male Stature = 152.69 + 0.53 (VH)

Female Stature = 158.36 - 0.03 (VH)

Table 3: *Formulation of Regression equation for calculating the Stature from Head Breadth (HB) in Male and Female*

Regression Statistics of HB	***Male*** (observed ht=***171.59***cm)	***Female*** (observed ht=***157.48***cm)
Independent variable(x) = HB	***13.65***	***12.72***
Intercept (a)	***153.66***	***128.64***
Regression coefficient (b)	***1.31***	***2.27***
Correlation coefficient(r)	***0.183***	***0.338***
Coefficient of determination (R^2)	***0.033***	***0.114***
Std. error of estimate (SEE)	***5.299***	***4.65***
Significance (p)	*****	*****
Regression formula (y = a+bx)	***y= 153.66+1.31(x)***	***y= 128.64+2.27(x)***

**** Significant at p<0.0001*

Table 4: *Formulation of Regression equation for calculating the Stature from Vertex Height (VH) in Male and Female*

Regression Statistics of VH	***Male*** (observed ht=***171.59***cm)	***Female*** (observed ht=***157.48***cm)
Independent variable(x) = VH	***35.82***	***35.215***
Intercept (a)	***152.69***	***158.36***
Regression coefficient (b)	***0.528***	***-0.025***
Correlation coefficient(r)	***0.13***	***-0.007***
Coefficient of determination (R^2)	***0.0168***	***0.000***
Std. error of estimate (SEE)	***5.344***	***4.94***
Significance (p)	***Ns***	***Ns***
Regression formula (y = a+bx)	***y= 152.69+0.528(x)***	***y= 158.36-0.025(x)***

Ns- Non significant

IV. Discussion

Present study was conducted in 200 medical students of Malwa region which shows weak stature correlation to head breadth while no significant correlation of vertex height to the stature.

In present study for Head Breadth, the correlation coefficient of 0.183 with a standard error of estimate of 5.299 in males, while for females revealed a correlation coefficient of 0.338 with a standard error of estimate 4.65. Agnihotri et al shown to have 0.015 correlation coefficient with 0.896 two tailed p- values in males while same values were 0.193 and 0.100 for females respectively.[16] Results of Agnihotri et al in students of Mauritius shown lesser degree of correlations than our results.

In our study for Vertex Height, the correlation coefficient of 0.13 with a standard error of estimate of 5.344 in males, while for females it was -0.007 with a standard error of estimate 4.94. The Agnihotri et al shown correlation coefficient in males was 0.178 with a two tailed p value of 0.127 while same were 0.318 with 0.006 in females respectively.[16] These results for vertex height in Agnihotri et al were better than in our study which is contrary to finding with vertex height. In Singh[17] study the estimated head height (vertex height) correlation coefficient being 0.58 for Indian students in Uttar Pradesh which estimates far better correlation than our results.

V. Conclusion

It is concluded that there was significant statistical difference between males and females for head breadth (p<0.0001), height (p<0.0001) and vertex height (p<0.0013) in decreasing degree of statistical significant which shows that there is significant sex difference between these parameters.

It is also concluded that head breadth shown a better correlation than vertex height to the stature but neither of them shown to have very significant correlation to the stature.

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