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Original Research Paper

Anatomy

PREDICTION OF HEIGHT BY HEAD LENGTH IN THE POPULATION OF MALWA REGION OF CENTRAL INDIA

Dr. Rajendra Singh Marko — Assistant Professor, Department Of Anatomy, M.G.M. Medical College, Indore.

Dr. Aprajita Awasthi* — Demonstrator, Department Of Anatomy, Government Medical College, Datia.* Corresponding Author

Dr. Massarat Jehan — Assistant Professor, Department Of Anatomy, M.G.M. Medical College, Indore.

ABSTRACT

There is a well-known correlation between the height of the person and various parts of the body like head, trunk and lengths of extremities which has been used to compare and highlight variations between different ethnic groups. The height and head length of the 200 medical students (100 males and 100 females) at Indore, India was measured. Regression analysis was done to produce correlation coefficient and regression equation for height. The mean height for males was 172±0.54 cm (mean±SEM) while 157±0.49 cm for females while mean head length (HL) for males was 18.4±0.07 cm and was 17.1±0.07 cm for females. Male and female were statistically similar for age, although height and head length both were statistically different (height = $p<0.0001$, HL = $p<0.0001$). Linear regression analysis of height for head length shown that correlation coefficient for males was r=0.159 while r=0.516 for females. Correlation for both males and females were highly significant ($p<0.0001$). The regression equation of height for HL in males was 'Height = 149.65+1.19(HL)' and 'Height = 96.31+3.59(HL)' for females.

KEYWORDS : Central India, Height estimation, Head length, Regression equation.

INTRODUCTION

Anthropometry is the science of measuring the human body, including craniometry, osteometry, and height and weight measurements.[1] Estimating stature is one of the main parameters apart from age, sex, and ancestry or race in forensic anthropology. Stature estimation can narrow down number of possible victim matches in any ongoing investigation.[2]

There is a well-known correlation between the height of the person and various parts of the body like head, trunk and lengths of extremities. The relationship between body parts has been used to compare and highlight variations between different ethnic groups.[3,4]

Establishment of identity is very important in forensic examination where only some parts or fragments of the body are available. Such scenarios are seen in disasters like earthquake, bomb blast, aeroplane crash, mutilation by animal etc. In such cases estimation the stature can be a major breakthrough in establishing personal identity of a victim. Many studies have covered estimation of the stature from various body parameters such as long bones, foot length, arm span, hand length, hand breadth etc. Similarly it has been found that cranial dimensions are even more reliable in predicting the stature correctly.[5] Although many correlations for stature estimation have been proposed, there is concern regarding the accuracy of the use of population specific formulae on other human populations. It is obvious that there are no universally applicable formulae as the relationship between head dimensions and cranial capacity is influenced by the race, sex and age of an individual.[6]

Thus population specific correlational studies for stature estimation from cranial parameters in different population are needed. Thus this study was planned to established a correlation between Height and Head length, and to find out formulae for estimation of stature for the population of Malwa region of Central India.

MATERIAL AND METHODS

This study was conducted on 200 medical students (100 males and 100 females) at Indore in MGM Medical College, Indore, MP, India. The subjects were apparently healthy and without any craniofacial deformity. The age of the subjects ranged from 18 to 22 years.

The height of the individual was measured between vertex and the floor with the subject standing erect and in anatomical position using standing height measuring instrument. Height was measured to the accuracy of 0.1 cm. The head was kept in Frankfurt Plane during measuring height.

Maximum head length which is distance between the most prominent point on the frontal bone above the root of the nose (glabella) and the most prominent portion of the occipital bone (inion) was measured by placing the anterior caliper tip on glabella while allowing the posterior caliper tip to slide inferiorly along the median plane of the occipital bone until the maximum length was reached (Figure 1). Head length was measured using spreading caliper capable of measuring to the nearest 0.01 mm.

All the measurements were taken at same time in day between 02:00-04:30 PM to eliminate variations due to diurnal variation. All the measurements were taken by the same person and repeated thrice and the mean was taken.

The age, height and head length was calculated as range, mean, standard deviation and regression analysis was done for height and head length. The correlation coefficient and Standard estimated error was calculated and regression equation was obtained. Difference between male and female for age, height and head length was analysed using unpaired student-t test.

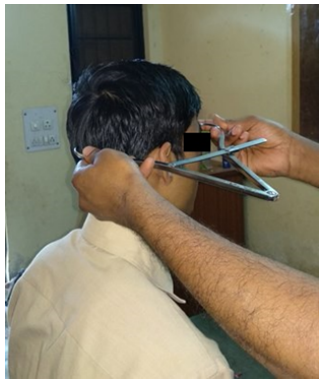

Figure 1: Method of measuring head length

RESULTS

Among all 200 subjects mean height for males (n=100) was 172±0.54 cm (mean±SEM) while 157±0.49 cm (mean±SEM) for females (n=100). As far as mean head length (HL) is concern, mean HL for males was 18.4±0.07 cm and was 17.1±0.07 cm for females. The mean age for males were 19.9±1.14 years while for females were 20.2±0.96 years. There was no statistical difference between the age distribution among males and females. Although height and head length both were statistically different between males and females (height = p<0.0001, HL = p<0.0001).

Table 1: Student t- test between Male and Female

Student t test	***Age***	***Height***	***Head Length***
t – value	t=1.814	t=19.41	t= 13.46
p – value	0.0711	<0.0001	P<0.0001
P value summary	Not Significant	*** Significant	*** Significant
Difference between means	0.27 ± 0.1488	-14.12 ± 0.7272	-1.355 ± 0.1007
Are means signif. different? (P < 0.05)	No	Yes	Yes
95% confidence interval	-0.02346 to 0.5635	-15.55 to -12.68	-1.554 to -1.156
R squared	0.01635	0.6555	0.4777

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

Regression Statistics of HL	***Male*** (observed ht=***171.59***cm)	***Female*** (observed ht=***157.48***cm)
Independent variable(x) = HL	***18.42***	***17.06***
Intercept (a)	***149.65***	***96.31***
Regression coefficient (b)	***1.19***	***3.59***
Correlation coefficient(r)	***0.159***	***0.516***
Coefficient of determination (R^2)	***0.0254***	***0.266***
Std. error of estimate (SEE)	***5.32***	***4.23***
Significance (p)	***	***
Regression formula (y = a+bx)	***y= 149.65+1.19(x)***	***y= 96.31+3.59(x)***
Predicted ht (y)	***171.595cm***	***157.47cm***

*** *Significant at p<0.0001*

Linear regression analysis of height being dependant variable on head length which is an independent variable in this case, shown that correlation coefficient for males was r=0.159 while r=0.516. Females shown to have better correlation of height with head length than males but p values for both of correlation here are highly significant (p<0.0001). The regression equation for height for HL in males and females were as follows:

MaleHeight=149.65+1.19(HL)
FemaleHeight=96.31+3.59(HL)

DISCUSSION

The 200 students that were enrolled from the Malwa region of Madhya Pradesh with equal distribution between either sex, were between age groups of 18 to 22 years. The age group of the subjects in different similar studies conducted in other Indian regions were between 18-25[8], 18-24[9] and 18-22[10] years which was almost similar to the age groups of participants in our study.

The regression analysis is most useful measure for height estimation from different body remains.[11] In our present study where we have studied head length for height estimation, we found that HL is better indicator of height in females (r=0.159) than in males (r=0.516) for estimation of height. In a study on Japanese cadavers by Glaister *et al*., head length was found to be 1/8th of total height of the person which was around 1/9th in our study.[12] In a study Chiba *et al.* derived regression equation for height from head length. The correlation coefficient of head length with height was 0.39 with standard error of estimate of 7.09 in males while correlation coefficient of head length with height was 0.003 with standard error of estimate of 6.97 in females.[13] In our study correlation coefficient of head length with height was 0.159 with standard error of estimate being 5.32, for males and for female standard error of estimate was 4.23 and correlation coefficient of head length with height was 0.516 with a significant correlation between height and head length (p<0.0001). We had reversed results in male females when compared to study of Chiba *et al.* A Study conducted by Bardale *et al.* correlation coefficient was 0.39 with standard error of estimate as 6.08 in males while f 0.32 with standard error of estimate of 5.67 in females which was better in males while less in females than our study.[14] Study by Kalia *et al* shown a coefficient of 0.13 for males which was comparable to our study (r=0.159) and 0.000 for females which was very less than present study (r=0.516).[15] But as Kalia *et al* studied radiographs, the difference in results might be of reason that our study was carried out on living subjects. There was a study by Sarangi *et al* which reported that there was no significant correlation between height and skull parameters. The correlation coefficient of height for skull parameters (HL, HB, and HC) in their study was found to be non-significant.[16] For highly correlated parameters, regression equation can be very useful for prediction[17] and they are widely used for estimation of height, from the measurements of certain long bones.[17-19] Thus we can say that regression equations, Std. error of estimate (SEE) and correlation coefficients are different for different geographical locations, as height is influenced by number of factors like race, regional and environmental factors etc.

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