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A Statistical Evaluation for Predicting the Stature Using the Facial Height by Regression Analysis

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Abstract

Aims: To predict the stature using the facial height by regression analysis. *Methods and Material:* The subject's Stature was measured by a stadiometer and the facial height by a vernier calliper in 150 medical students. *Statistical Analysis used:* The data was analyzed statistically by regression analysis. *Results:* Based on the linear regression analysis, stature would increase by 7.09 cm and 7.07cm for each cm increase in facial height in males and females respectively (P < 0.001). Mean stature was 167.54±9.59 cm and mean facial height was 10.77±0.76 cm. The P value was less than 0.001. This shows a significant positive correlation between stature and facial height. *Conclusions:* Estimation of stature from facial height could be performed where only unknown head and face are brought for anthropometric examinations.

Keywords: Stature; Facial Height; Regression.

Introduction

Stature is one of the primary characteristics of identification. Determination of individuality of a person is Personal identification. Personal identification is of two types i.e. complete (absolute) and incomplete (partial). Absolute fixation of individuality of a person is complete identification. To know only some facts about the identity of the person is partial identification [1]. Facial height is one of the important somatometric body dimensions [2].

Height or stature is an important anthropometric parameter in the personal details of any individual. Many anthropometric studies have been performed to establish relationship between stature and length of the long bones and other body dimensions such as arm length. However, researches that correlate facial height and stature are uncommon [3].

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Anthropometric techniques have been applied to find body size for more than hundred years. With an increase in mass disasters, the identification of the stature of the person became quite difficult task [4].

Earlier, researchers have utilized many bones of human skeleton such as long bones to short bones to find the stature of a person. They concluded that the stature can be estimated even from the smallest bone. Some scientists have used fragments of the long bones for the estimation of stature [5].

Many authors have performed studies for the estimation of stature from various body parts like hands, trunk, intact vertebral column, upper and lower limbs, individual long and short bones, foot and footprints. But only a few researches have been done on cephalofacial dimensions of the facial height with respect to estimate the stature [6-12].

Materials and Methods

Present study was conducted in the department of Anatomy at Hind Institute of Medical Sciences, Sitapur UP (India). A total of 150 medical students (107 males and 43 females) participated in this study as subjects. They were aged between 18 to 25 years. Subjects with the history of abnormal neurological findings affecting the facial dimensions, oculofacial trauma and craniofacial deformities were excluded from the study.

Inclusion Criteria

1. Subjects in age group of the 18-25 years.
2. Healthy adult subjects without any skeletal deformities (dwarfism and gigantism).
3. Subjects being able to stand in an erect posture without any spinal or muscular pathology.

Exclusion Criteria

1. Subjects with spinal deformities like kyphosis, lordosis and scoliosis.
2. Subjects with facial deformities that can affect facial height.
3. Individuals with craniofacial deformities (congenital or acquired)
4. Individuals with abnormal neurological findings (such as facial palsy, ptosis and squint)

Equipments used in the Study

- Stadiometer
- Vernier caliper
- Digital camera

Somatometric Parameters

- Stature
- Facial Height

Stature and Facial Height are measured for all the participants according to the standard anthropometric methods of the International Society for the Advancement of Kin anthropometry [13].

Informed consents were taken from the subjects. The (anthropometric variables) facial height and the stature were measured.

Definition of Stature

It is the distance from the plane where the individual stands to the vertex (the highest point on head when the head is in eye ear plane) .The individual should be in erect posture [14].

Procedure for Measurement of Stature

Stature is measured to the nearest 0.1 centimetres (cm) in bare feet with the subject standing upright against a stadiometer. The subjects head has to be in the Frankfort horizontal plane. This is achieved when the lower edge of the eye socket (the orbitale) is horizontal with the tragion (A point in the depth of notch just above the tragus of the ear). The subjects are said to stand erect with his heel together and his backs straight as possible so that his heels, buttocks, shoulders and the head touches the rod of stadiometer. The arms are hung freely by the sides. Asking the subject to take a deep breath and hold it, a reading is taken from the stadiometer scale at his vertex point. The subject is then told to breathe and to step away from floor of stadiometer [15].

Definition of Facial Height

The distance from the nasion (the nasal root) to the gnathion (the lowest point on the lower border of the mandible in the mid sagittal plane) [14].

Procedure for Measurement of Facial Height

The subject was asked to sit on a chair with the head facing forward. From nasion to gnathion, the two sliding ends of the vernier caliper were placed. The vernier caliper was then removed from the face and the facial height was recorded in nearest mm, which is the straight distance from the nasion to the gnathion [16].

Statistical Analysis

The data thus collected was subjected to statistics like mean, standard deviation, Karl Pearson's correlation coefficient, regression analysis, standard error of estimate etc. and were analyzed using SPSS (Statistical Package for Social Sciences) on windows XP professional.

Results

The study was conducted on 107 Male and 43 Female students, age range (18-25 yrs). The Sample size with mean age is shown in Table 1.

Table 2 showing mean stature and mean facial height are (167.54±9.59) cm and (10.77±0.76) cm respectively ($p<0.001$ and Pearson's coefficient 'r'=0.34). Therefore, there is a significant positive correlation between body height and facial height.

Table 3 shows regression equation to calculate stature from facial height (FH) in males. A hypothetical regression equation is depicted as follows: Stature = a + bx where 'a' is the regression coefficient of dependent variable i.e. stature and 'b' is the regression coefficient of independent variable (facial height), 'x' is facial height.

The Table 3 also presents the standard error of estimate (SEE) calculated regression formula for estimation of stature. The SEE tends to predict the deviation of estimated stature from the actual stature. A low value is indicative of the greater reliability of prediction and the higher value of SEE denotes less reliability of prediction [17]. SEE is 5.39 in cases of males.

Table 4 shows regression equation to calculate stature from facial height (FH) in females. A hypothetical regression equation is depicted as follows: Stature = a + bx where 'a' is the regression coefficient of dependent variable i.e. stature and 'b' is the regression coefficient of independent variable (facial height), 'x' is facial height.

The Table 4 also presents the standard error of estimate (SEE) calculated regression formula for estimation of stature. The SEE tends to predict the deviation of estimated stature from the actual stature. A low value is indicative of the greater reliability of prediction and the higher value of SEE denotes less reliability of prediction. (17). SEE is 4.34 in cases of females.

In the Table 5, the minimum, maximum and mean values of the measurements were substituted in regression equation and estimated stature was calculated. It is evident from the table that minimum estimated stature is greater than the actual minimum stature whereas maximum estimated stature is less than the actual maximum stature. Mean estimated values are closest to the actual stature.

In the Table 6, minimum, maximum and mean values of the measurements were substituted in regression equation and estimated stature was calculated. It is evident from the table that minimum estimated stature is greater than the actual minimum stature whereas maximum estimated stature is less than the actual stature. Mean estimated values are closest to the actual stature.

Table 7 shows the difference between the mean actual stature and mean estimated is 0.48 which is statistically insignificant

Table 8 showing the difference between the mean actual stature and mean estimated stature as 0.07 which is considered as negligible and statistically insignificant.

In Table 9, a simple linear regression was calculated to predict stature (as dependent variable) based on facial height (independent variables) separately in males. Based on the linear regression analysis, stature would increase by 7.09 cm for each cm increase in facial height ($P < 0.001$) in males.

In Table 10, a simple linear regression was calculated to predict stature (as dependent variable) based on facial height (independent variables) separately in females. Based on the linear regression analysis, stature would increase by 7.07 cm for each cm increase in facial height ($P < 0.001$) in females.

Table 1: Sample size

Sample	No. of Subjects	Mean Age (Years)
Medical Male Students	107	22.36 ± 1.21
Medical Female Students	43	20.36 ± 1.29

Table 2: Descriptive Statistics of Stature and Facial Height

S.N.	Variable	Mean	Median	Mode	Standard Deviation	Pearson's Coefficient 'r'	P-value
1.	Stature (cm)	167.54	168	173	9.59		
2.	Facial Height (cm)	10.77	10.8	10.8	0.76	0.34	<0.001

Table 3: Regression equation for estimation of stature (cms) from facial height in males

Regression Equation	**SEE
Stature = 154.32+ 1.391(FH)	5.39

*FH= Facial Height
**SEE = Stand Error of Estimate

Table 4: Regression equation for estimation of stature (cms) from facial measurements in females

Regression Equation	**SEE
Stature = 148.63+ 0.742(*FH)	4.34

*FH= Facial Height
**SEE = stand error of estimate

Table 5: Comparison of actual stature and estimated stature from facial height in males using regression analysis

Estimated stature using regression equation	Minimum estimated stature	Maximum estimated stature	Mean estimated stature
Facial height	165.12	171.51	168.32
Actual stature	152	189	168.70

Table 6: Comparison of actual stature and estimated stature from facial measurements in females using regression analysis

Estimated stature using regression equations	Minimum estimated stature	Maximum estimated stature	Mean estimated stature
Facial height	153.91	156.94	155.43
Actual stature	129	182	155.50

Table 7: Comparison of mean actual stature (168.70 cm) and mean estimated stature in males

Estimated stature using regression equations for (in cm)	Mean estimated stature	Difference between means=mean actual stature – mean estimated stature
facial height	168.32	0.48

Table 8: Comparison of mean actual stature (155.50 cm) and mean estimated stature in females

Estimated stature using regression equations for (in cm)	Mean estimated stature	Difference between means=mean actual stature – mean estimated stature
facial height	155.43	0.07

Table 9: Linear regression analysis with stature (dependent variable) and facial height (independent variables) in males Dependent variable: Stature (cm)

Independent variables	Unstandardized coefficient (β)	95% CI	R-squared	P-value
Facial height (cm)	7.09	5.54 – 8.61	0.376	<0.001

CI= class interval

Table 10: Linear regression analysis with stature (dependent variable) and facial height (independent variables) in females Dependent variable: Stature (cm)

Independent variables	Unstandardized coefficient (β)	95% *CI	R-squared	P-value
Facial height (cm)	7.07	5.52 – 8.56	0.366	<0.001

*CI= Class Interval

Table 11: Showing Comparison between Various Studies done by Different Authors with Our Study

Authors/year	Mean body height (cm)	Mean Facial height (cm)	P value	Pearson's coefficient 'r'value
Jadav HR and Shah GV (2004)	168.10	-	-	-
Jibonkumar and Lilinchandra (2006)	162.29±0.38	11.25±0.437	<0.001	0.213
Swami S, Kumar M and Patnaik VVG (2015)	-	-	<0.001	-
Yadav SK et al (2015)	162.70 ± 8.45	10.70 ± 0.73	<0.001	0.61
Kumar M and Patnaik VVG(2013)	-	-	<0.001	-
Our study	167.54±9.59	10.77±0.76	<0.001	0.34

Discussion

All the measurements were found to be more in males as compared to females. These observations were in concordance with the earlier studies. Such standards based on ethnic or racial data are desirable because these standards reflect the potentially different patterns of craniofacial growth resulting from racial, ethnic and sexual difference. The study provides correlation between the facial measurements with stature and also devises regression equations to calculate stature from these measurements as it is the best method as far the accuracy or reliability of the estimate is concerned [18].

The dimensions of anthropometry are different for age, sex, body size, race, ethnic groups, geographical location, dietary variation and even religion. Despite of this variation, height has been measured from many other parameters of the human body by refining formulae. The obtained data have become very much important in identifying the persons. The body height of a person is genetically predetermined and is an inherent characteristic. Estimation of height is taken an important parameter in the identifying unknown remains of human beings [19,20,21].

Craniofacial anthropometry has become an important tool for genetic counsellors and reconstructive surgeons. It is necessary in genetic counselling, to recognize dysmorphic syndromes as accurately as possible. Many dysmorphic syndromes are diagnosed on the basis of advanced cytogenetic and molecular techniques, but also on identification of various morphological anomalies in craniofacial region. The values obtained in the normal population can be compared with the measurements taken from the patients. Thus, deviations from the normal values can be calculated. Therefore, anthropometric data can be used in early diagnosis of common syndromes. It was observed that children with partial foetal alcohol syndrome and foetal alcohol syndrome had a special facial phenotype that could be defined anthropometrically [22].

In our study mean body height and mean facial height is found to be (167.54±9.59) cm and (10.77±0.76) cm respectively ($p<0.001$ and Pearson's coefficient 'r'=0.34). Thus, there is a significant positive correlation between body height and facial height.

In Gujarat Region, Jadav HR and Shah GV derived the body height from the length of head. They observed that the mean body height was 168.10 cm in Gujarati male medical students with their last age range 22 years [20].

Jibonkumar and Lilinchandra conducted study among the Kabuis Naga of Imphal Valley, Manipur. They observed mean body height was (162.29±0.38) cm and facial height was (11.25±0.437) cm. P value was less than 0.001 and Pearson's coefficient was 0.213.Therefore, there was a significant correlation between the two parameters [14].

Swami S, Kumar M and Patnaik VVG conducted anthropometric study in adult Haryanvi Baniyas. There was also observed a significant positive correlation in both sexes [18].

Yadav SK et al. also found statistically significant positive correlation between the body height and the other cephalometric variables in Nepalese population. The observed parameters were; Mean Height (cm) =162.70±8.45, Facial Height (cm) =10.70±0.73, ($p<0.001$ and Pearson's coefficient 'r'=0.61) [3].

Kumar M and Patnaik VVG estimated the body height from Cephalo-Facial Anthropometry in 800 Haryanvi Adults. Their results showed a significant positive correlation between stature and all cephalo-facial measurements except for maximum head breadth which showed an insignificant correlation with stature in both sexes [23].

The regression formulae obtained for estimation of stature from facial height were checked for their accuracy. Table 5 and Table 6 show a comparison of actual stature and stature estimated from facial height using regression analysis. The mean estimated stature values were close to the actual stature in both males and females. While applying these formulae one should keep in mind that these are population specific.

Since regression equations are known to be population and sex specific, there is a need for similar equations to be derived for other endogamous groups [23].

Krishan and Kumar reported 4.41–7.21 cm SEE in estimating stature from sixteen cephalo-facial measurements in their sample on Koli male adolescents of north India [24].

Ryan and Bidmos presented SEE from 4.37 to 6.24 cm in their study on estimation of stature from skulls of indigenous South Africans from Raymond Dart's collection [25].

In the present study, the value SEE is comparatively lower than these studies, i.e. from 4.34 to 5.39 cm in females and males respectively. In other words, in the present study, the stature estimation from cephalo-facial dimensions has greater reliability of estimate when compared with other similar studies.

Conclusions

Estimation of stature from facial height could be performed where only unknown head and face are brought for anthropometric examinations.

It is further concluded that the calculated regression formulae show good reliability and applicability of estimate not only in the sample which was used by earlier researchers (genetically homogeneous population) in the calculation of the regression formulae but also in samples taken from mixed population (genetically heterogeneous population) as in present study.

While applying these formulae, one should keep in mind that these are population specific; these cannot be used on other populations of the world.

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Key Message

Estimation of stature from facial height could be performed where only unknown head and face are brought for anthropometric examinations. Regression formulae show good reliability and applicability of estimate. While applying these formulae, one should keep in mind that these are population specific; these cannot be used on other populations of the world.

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