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Original article:

Study of stature estimation from facial dimensions

[1]PRITI NEMADE (KHODKE) , [2]AMIT NEMADE

[1]MD, DNB Anatomy, Assistant Professor, IGGMC, Nagpur, India
[2]MS, DNB , Assistant Professor, NKPSIMS, Nagpur, India
Corresponding Author: Dr. Priti Nemade (Khodke)

ABSTRACT

Each and every part of the human body has definite and proportional biological relationship with stature which helps a forensic scientist to calculate the stature from dismembered and mutilated body parts in forensic examinations. Stature estimation is important in medico-legal cases as that of age, sex and race.

Present study comprises of 300 Maharashtrian subjects (150 males and 150 females) in the age group of 18-25 years. Along with stature, two dimensions of face were measured. Measurements were taken with the help of standard instruments.

The mean and standard deviation were obtained. Pearson's correlation coefficient and linear regression equations were derived for males and females separately and for total subjects of the study group.

Both the facial dimensions showed strong correlation with stature. Stature can be estimated by using regression equations derived in the study.

KEYWORDS

Stature, Facial dimensions, Forensic examination

INTRODUCTION

All the human beings occupying this globe belong to the same species i.e. Homo sapiens. No two individuals are exactly alike in all their measurable characters, even genetically identical twins (monozygotic) differ in some respects. These traits tend to undergo change in varying degrees from birth to death, in health and disease, and since skeletal development is influenced by a number of factors producing differences in skeletal proportions between different geographical areas, it is desirable to have some means of giving quantitative expression to variations which such traits exhibit. Anthropometry constitutes that means, as it is the technique of expressing quantitatively the form of the human body.

In other words, Anthropometry means the measurement of human beings, whether living or dead or on skeletal material(1). Cranial, facial and height related anthropometric measurements are considerably affected by sex and ethnicity(2). The importance of facial anthropometry involving facial height is well established for health related fields.(3) Estimation of stature is an important tool in Forensic examination in cases of unknown, highly decomposed, fragmentary and mutilated human remains(4). In order to determine stature separate regression formulae should be developed for each population group. The data regarding stature estimation from facial dimensions in Maharashtra region is scarce. So the present study is conducted to derive regression equations for estimation of stature from facial dimensions in the state of Maharashtra.

AIM: To estimate stature from facial dimensions.

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OBJECTIVES:

1. To study the correlation between stature and different facial measurements.
2. To study gender differences between stature & different facial measurements.
3. To derive regression formulae to predict the height of an individual using different facial dimensions.
4. To compare and correlate the findings of the present study with other studies performed previously.

MATERIAL AND METHODS

The present study lasted for 24 months duration, in which total 300 subjects (150 Females and 150 Males) in the age group of 18-25 years (students of a medical college) were studied.

The subjects were studied for the following parameters.

1. Height
2. Morphological Facial Length (MFL)
3. Bigonial Diameter (BGD)

The instruments used in the study were

1. Anthropometer rod
2. Sliding caliper
3. Spreading caliper

MEASUREMENT

STATURE

Stature is measure of vertical distance from vertex to floor.

Height was measured from vertex to floor by Anthropometer rod with subject standing erect on an even floor, barefoot with heels together and weight evenly distributed between both feet and head in the Frankfurt plane. The distance was measured from the highest point on the subject head to the ground with the help of Anthropometer rod.

Frankfurt plane: The plane passing through the lowest points on the infraorbital margins and the tragion (the notch immediately above the tragus of the ear), which is obtained when the subject is looking straight ahead of him(5).

The facial dimensions were measured as described(6,7).

MORPHOLOGICAL FACIAL LENGTH (MFL)

It is the straight distance from the nasion to the gnathion.

NASION: It is a median point at the root of the nose where the internasal suture meets with the frontonasal suture.

GNATHION: lowest point on the lower border of mandible in the mid sagittal plane.

It was measured with the help of Sliding caliper.

BIGONIAL DIAMETER (BGD)

It is the maximum breadth of the lower jaw between two gonion points on the angles of mandibles.

GONION: It is the most posterior, inferior and laterally situated point on the

external angles of the mandible.

It was measured with the help of Spreading caliper.

The measurements mentioned above were tabulated and statistically analyzed.

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OBSERVATIONS AND RESULTS

Table no. 1, 2 & 3 show minimum & maximum values, mean and standard deviation of all the parameters in males, females and total subjects.

Table No. 4 shows that the mean and median values of MFL, BD are higher for males than those for females, and the difference is found to be statistically significant ($p<0.05$).

Table No. 5 shows that the facial dimensions have significant correlation with stature ($p < 0.001$). These correlations are positive and statistically significant ($p < 0.001$) i.e. if any of the above parameter increases or decreases the height of the subject also increases or decreases.

Table No. 6 shows Regression formulae:

Regression analyses enable us to predict the values of one variable on the basis of other variable.Regression formula: calculated on SPSS Ver 15 and Sigma Plot Ver 10.

$$Y = a + bX$$

Where Y = Height (dependent variable)

X = independent variable.

a = intercept (constant)

b = regression coefficient

Table No 1: Descriptive statistics in total subjects: (n = 300)

Variables (cm)	Mean	Std. Dev	Minimum	Maximum
Height	163.23	8.00	147.00	182.00
MFL	10.71	0.75	9.00	13.00
BGD	9.24	0.61	7.80	10.80

(Std. Dev= Standard deviation)

Morphological Facial Length (MFL), Bigonial Diameter (BGD)

Table No 2: Descriptive statistics in Male study group: (n = 150)

Variables (cm)	Mean	Std. Dev	Minimum	Maximum
Height	169.10	6.15	153.00	182.00
MFL	11.04	0.77	9.80	13.00
BGD	9.53	0.53	8.00	10.80

Table No 3: Descriptive statistics in Female study group: (n = 150)

Variables (cm)	Mean	Std. Dev	Minimum	Maximum
Height	157.36	4.63	147.00	171.00
MFL	10.38	0.58	9.00	12.00
BGD	8.94	0.53	7.80	10.30

(Std. Dev= Standard deviation)

Table No. 4: Comparison of study parameters between males and females.

Variables (cm)	Male				Female				Mann-Whitney U	
	Mean	SD	Median	IQR	Mean	SD	Median	IQR	Z value	P value
Height	169.1	6.15	169.00	9.15	157.36	4.63	157.40	6.07	12.957	0.000
MFL	11.04	0.77	11.00	1.10	10.38	0.58	10.35	0.83	7.394	0.000
BGD	9.53	0.53	9.50	1.00	8.94	0.53	9.00	0.60	8.292	0.000

Note: Normality Test (Shapiro-Wilk) failed ($P<0.05$), thus Mann-Whitney Rank Sum Test applied.
(SD = Standard deviation, IQR=Inter quartile range)

Table no. 5: Correlation coefficients of Facial dimensions with Height:

Correlation is significant at the 0.01 level (2-tailed).

P value for all the parameters, **$p < 0.001$**

Parameters	Correlation Coefficients (r)		
	Total	Male	Female
MFL	0.687	0.560	0.661
BGD	0.696	0.631	0.503

Table no. 6: Regression equations for height with Facial dimensions:

Parameters	Regression Equations		
	Total	**Male**	**Female**
MFL	y = 7.2865x + 85.191	y = 4.5001x+119.41	y = 5.2863x + 102.5
BGD	y = 9.1652x + 78.582	y = 7.3336x+99.191	y = 4.3624x + 118.37

Table 7: Comparison of MFL among different studies:

Study done by	Gender	Mean MFL (cm)	SD	Range	Correlation Coefficient	Regression equation
Krishan K 2008 (4)	M	10.81	0.735	8.7-12.4	0.455	S=121.869+4.618X
Krishan K & Kumar R 2007 (6)	M	10.24	0.823	9.0-12.1	0.345	S=122.461+2.983X
Wankhede KP et al 2012 (8)	M	11.43	1.04	9.60-18.80	0.197	S=156.34+1.28X
	F	10.66	0.75	7.5-14.4	0.144	S=144.96+1.12X
Jibonkumar & Lilinchandra 2006 (9)	M	11.25	0.61	9.9-12.7	0.213	S= 141.261 +1.869X
Present study 2012	Total	10.71	0.75	9.0-13.0	0.687	S= 7.2865X + 85.191
	M	11.04	0.77	9.8-13.0	0.560	S=4.5001X + 119.41
	F	10.38	0.58	9.0-12.0	0.661	S= 5.2863X + 102.5

(Where SD= Standard deviation, S=Stature, X=MFL)

Table 8: Comparison of BGD among different studies:

(Where SD= Standard deviation, S=Stature, X=BGD)

Study done by	Gender	Mean BGD (cm)	SD	Range	Correlation coefficient	Regression equation
Krishan K 2008 (4)	M	9.783	0.377	6.6-10.8	0.462	S=109.991 + 6.483X
Krishan K & Kumar R 2007 (6)	M	8.347	0.381	6.7- 10.6	0.449	S=122.200 + 8.371X
Jibonkumar & Lilinchandra 2006 (9)	M	14.12	0.50	12.8-15.4	0.365	S = 107.004+3.913X
Present study 2012	Total	9.24	0.61	7.8-10.80	0.696	S= 9.1652X + 78.582
	M	9.53	0.53	8.0-10.80	0.631	S=7.3336X + 99.191
	F	8.94	0.53	7.8-10.30	0.503	S= 4.3624X + 118.37

DISCUSSION

Table No. 7shows that, in the present study, the correlation coefficient of Morphological Facial length with height was 0.560 in males, 0.661 in females and 0.687 in total subjects. The mean MFL in males was 11.04 ± 0.77 cm and in females, it was 10.38 ± 0.58 cm. Gender difference in mean MFL in our study was statistically significant (P< 0.05). It complies with the findings of Wankhede KP et al(8)

Table No. 8 shows, in females, BGD showed the least correlation with height (r=0.503) as compared to other parameters. The mean Bigonial diameter in our study was 9.53 ± 0.53 cm in males and 8.94 ± 0.53 cm in females. Gender difference in mean BGD in our study was statistically significant ($p < 0.05$). It was larger in males as compared to females. The correlation coefficients derived in the present study were higher than those of previous studies (4,6,9)

CONCLUSIONS

1. The mean height of male subjects is higher than that of female subjects in the study group and gender difference is statistically significant (P< 0.05).
2. The mean of facial measurements is higher in male than in female subjects in the study group and the gender differences in mean is statistically significant (P< 0.05).
3. BGD showed maximum Correlation with stature than MFL in total subjects and in males whereas in females MFL is more correlated with stature than BGD
4. Stature can be estimated by using linear regression equation derived in our study.
5. The regression formulae derived in the present study will be of potential use in medico-legal, anthropological and archaeological studies.
6. The only precaution which must be taken into consideration is that these formulae are applicable to the population from which the data have been collected due to inherent population variations in these dimensions, which may be attributed to genetic and environmental factors like climate and nutrition.

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