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Estimation Of Stature From Facial Anthropometric Measurements In Managundi Population, Dharwad

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ABSTRACT

Forensic anthropology deals with the identification of unrecognizable human remains usually in skeletal form by determination of age, sex, race and stature. Personal identification means a determination of individuality of a person. It may be complete (absolute) or incomplete (partial). Complete identification means the absolute fixation of the individuality of a person. Partial identification implies ascertainment of only some facts about the identity of the person while others remain unknown. Age, gender, stature and race are often referred to as the four pillars of the identity of an individual with stature and gender being the two most important. 'Stature' is one of the most important and primary elements in the formulation of the biological profile in the process of personal identification of an individual. The present study was conducted among 205 subjects (108 males and 97 females) that include a population of Managundi village. The study aims to establish database on facial anthropometry and to find out any correlation between stature and facial measurements. The highest correlation coefficient was exhibited by morphological facial height in males ($p = 0.01$) and females ($p = 0.05$). Morphological facial height also had least standard error of estimate i.e 5.81 for males and 5.36 for females. So the facial measurement (Morphological facial height) is the most reliable measurement for estimation of stature in males and females. All the measurements were found to be more in males as compared to females. There is significant positive correlation between stature and facial measurements (Morphological Facial Height and Physiognomic Facial Height) in both sexes. Estimation of stature from facial measurements is a supplementary approach when useful samples like extremities and other body parts are not available for examination. This study, therefore, provides anthropometric data and regression equations for the population of

managundi village of Dharwad district. These equations are both population and sex-specific, hence, the present study has been undertaken to investigate the usefulness of facial measurements in estimation of stature and to compare the reliability of stature estimation by regression analysis.

1. Introduction

Anthropometry is the systematized art of measuring and recording human body parts, like skeleton, cranium, face etc, by the most reliable means and methods for scientific purpose.[1] Forensic anthropology deals with the identification of unrecognizable human remains usually in skeletal form by determination of age, sex, race and stature. Stature or body height is one of the primary and useful tools used in personal identification. The ultimate use of anthropometry in medical science is to help the forensic experts in achieving 'personal identity' in case of unknown human remains. Stature is one of the various parameters of identification for establishing individuality of the person. It is well known that there is a definite relationship between the height of the person and various parts of the body like the head, the trunk and lengths of the upper and lower limbs. Personal identification means a determination of individuality of a person. It may be complete (absolute) or incomplete (partial). Complete identification means the absolute fixation of the individuality of a person. Partial identification implies ascertainment of only some facts about the identity of the person while others remain unknown.[2] Stature is the height of the person in the upright posture. It is an important measure of physical identity. Establishing the identity of an individual from mutilated, decomposed and amputated body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes, etc. It is important both for legal and humanitarian reasons. Age, gender, stature and race are often referred to as the four pillars of the identity of an individual with stature and gender being the two most important.[3] 'Stature' is one of the most important and primary elements in the formulation of the biological profile in the process of personal identification of an individual.[4] Similarly, it is the central dogma in the anthropo-forensic examination.[4,5] Human stature is, therefore, an anatomical complex of linear dimensions.[6-8] Anthropometric data are believed to be objective, and they allow the forensic examiner to go beyond subjective assessments such as 'similar' or 'different'. With measurement data, the examiner can quantify the degree of difference or similarity and state how much confidence can be placed in this interpretation.[9] Various researchers have worked on stature estimation from different body parts of diverse ethnic groups. Bhatnagar et al[10] studied left and right hands separately on Punjabi males. Abdel-Malek et al[11] took two somatometric measurements of the hands on Egyptian subjects. Jason et al[12] estimated stature from the length of cervical, thoracic, lumbar, thoraco-lumbar and cervico-thoracolumbar segments of the spine. Krishan and Sharma[13] conducted a study on the bilateral asymmetry and estimation of stature from arm length and its segments on a Punjabi population. Duyar and Pelin[14] established relationship

between tibial length and stature. Ozaslan et al[15] conducted study on the estimation of stature from seven somatometric measurements of the lower. This study, therefore, provides anthropometric data and regression equations for the population of managundi village of Dharwad district. These equations are both population and sex-specific, hence the study has been undertaken to investigate the usefulness of facial measurements in estimation of stature and to compare the reliability of stature estimation by regression analysis.

Aim and Objectives

- To establish data on facial anthropometry of 205 Managundi villagers.
- To find out the correlation of facial dimensions with stature.
- To observe the sex differences in facial parameters.
- To find the correlations among different measurements.
- To find out which is the best measurement to estimate the stature of an individual.
- To establish the significance of the present study for use in forensic and other allied sciences.

2. Materials And Methods

The study was conducted among 205 subjects i.e one hundred and eight (108) males and ninety seven (97) females with the age group of 20-60 years that include a population of Managundi village of Dharwad district, Karnataka. Simple random sampling technique was used to select the subjects for the study and the sample size was determined using the Cochran method.[16] The anthropometric landmarks like Trichion, Nasion, Gnathion, Gonion, and Bizygomatic arch were marked by the demographic pen. All the measurements were taken using standardized anthropometric measuring equipment. With the help of sliding, spreading calipers, Anthropometric rod, the measurements were taken in centimetres. These measurements were carried out by only one of the authors at a fixed time daily from 12 pm to 5 pm to avoid any diurnal variation. Height was taken from the vertex to the floor following the anatomic position and Frankfort plane. Measurement of the stature was done by asking this subject to stand on a horizontal platform with his heels together stretching upward to a full extent, aided by gentle traction by the measure on the mastoid process. The subject's back was as straight as possible. The subject was advised not to change his position while measurements being taken. All the measurements were taken thrice to ensure accuracy and the mean of the three readings was taken as the final reading. All the measurements were recorded, tabulated and statistically analyzed. Precision and reliability of these measurements were ensured since only one of the authors was involved. This is necessary because precision and reliability are very important in forensic studies.

Inclusion Criteria

- The subjects were apparently healthy.
- Subjects between the ages of 20-60 years of Indian Origin.

Exclusion Criteria

- The subjects under 20 years of age were excluded from the study.
- Cases having any significant diseases, metabolic disorders were excluded.
- Subjects with hands or feet deformities were excluded from the study

Furthermore, the purpose of the study was explained to the participants and written informed consent was obtained before the commencement of the study. Five facial measurements along with the stature of the subjects were taken according to standard anthropometric procedures.[17] The measurements taken are defined as follows:

- Stature/height vertex: It measures the vertical distance from the vertex (v) to the floor.
- Physiognomic Facial Height (tr-gn): It measures the straight distance between the trichion and gnathion.
- Morphological Facial Height or Total Facial Height (n-gn): It measures the straight distance between nasion and gnathion.
- Bizygomatic Breadth (zy-zy): It is the maximum face breadth taken on the zygomatic arches between the two zygion points.
- Height Of Forehead (tr-n): It measures the projective distance between trichion and nasion.
- Bigonial breadth (go–go): It measures the straight distance between the two gonia.

3. Results And Discussion

Facial assessment by metrical methods is currently performed in different fields such as plastic and orthodontic surgery and diagnosis for cephalo-facial anomalies, medico-legal aspects and in Forensic science. However, very few studies have proposed facial analysis for forensic purpose. In cases where only fragmentary body parts are recovered, it becomes difficult to establish identity. In such cases, identification of stature and ethnic group becomes important to establish identity. All the data was recorded, tabulated and statistically analyzed. The data were subjected to statistical analysis like mean, standard deviation, Karl Pearson's correlation coefficient (r), linear regression analysis using statistical package for social sciences (SPSS).

Table 1 shows the data of mean ± standard deviation. The mean ± standard deviation in stature of the males was 171.84±6.49 cm and that of females was 157.57±5.74 cm. The mean ± standard deviation in Height of Forehead in

males was 6.75±0.61 cm and 6.24±0.62 cm in females. The mean ± standard deviation in Morphological Facial Height in males was 10.35±0.54 cm and 9.66±0.59 cm in females. The mean ± standard deviation in Physiognomic Facial Height in males was 16.98±0.76 cm and 15.80±0.77 cm in females. The mean ± standard deviation in bizygomatic breadth in males was 11.60±1.25 cm and 10.56±1.44 cm in females. The mean ± standard deviation in bigonial breadth in males was 11.77±1.15 cm and 11.13±1.25 cm in females. All the measurements were found to be more in males as compared to females.

Table 2 shows the pearson correlation coefficient between stature and facial measurements. There is significant correlation coefficient between stature and Morphological facial height (r = 0.45, p = 0.01 for males and r = 0.369, p = 0.05 for females), stature and Physiognomic facial height (r = 0.33, p = 0.004 for males and r = 0.20, p = 0.02 for females).

Table 3 shows the Linear regression equations which were derived for each facial measurement in the two sexes. The hypothetical regression equation is represented as stature (S) = a + bX, where 'a' is the regression coefficient of the dependant variable i.e. stature, 'b' is the regression coefficient of the independent variable i.e. any facial measurement and 'X' is the mean of that particular measurement. The standard error of estimation (SEE) for all variables was low ranging 5.81-6.54 for males and 5.36-5.74 for females. The regression equation for stature and Height of forehead (HOF) was found to be y= 168.97 + 0.42 (HOF) for male, y = 166.53-1.43 (HOF) for females. The regression equation for stature and Morphological facial height (MFH) was found to be y= 115.58 + 5.43 (MFH) for male, y= 123.34 + 3.54 (MFH) for females. The regression equation for stature and Physiognomic facial height (PFH) was found to be y= 123.98 + 2.81 (PFH) for male, y= 133.69 + 1.51 (PFH) for females. The regression equation for stature and Bizygomatic Breadth (BZ) was found to be y= 175.85 – 0.33 (BZ) for male, y= 161.76 – 0.39 (BZ) for females. The regression equation for stature and Bigonial Breadth (BG) was found to be y= 170.95 + 0.07 (BG) for male, y= 151.79 + 0.52 (BG) for females.

Generally the most common method of stature estimation is from anthropometric measurements of extremities, head, trunk, vertebral column etc.[18-21] Many studies have been conducted on stature estimation from isolated bones, or different body parts like arms, hands, feet etc for different ethnic groups.[22-25] A. K. Agnihotri et al[26], studied 150 Indo Mauritian students for stature estimation by using facial measurements. Pearson correlation coefficient (r) for horizontal head circumference (r=0.494), nasal breadth (r=0.380) and morphological facial length (r=0.328) showed better correlation with stature among males and among females physiognomic Facial length (r=0.382), Bizygomatic breadth (r=0.276) and horizontal head circumference (r=0.375) showed better correlation with stature. Jibonkumar et al[27] conducted a study to estimate stature of Kabui Naga of Imphal Valley, Manipur, using measurements of six different facial dimensions of 199 male Kabuis of the

Imphal valley in the age group of 18 to 45 years. Six facial dimensions and stature of each subject had been measured. All the facial parameters show significant positive co-relation with stature ($p < 0.001$). The highest co-relation of stature was with Bigonial Breadth with 'r' value of 0.365 followed by External Bi-ocular Breadth (0.326)and the lowest correlation of stature was (0.185) with Breadth of Bizygomatic Arch. From the various studies on stature estimation from facial parameters it is seen that Pearson correlation coeff is <0.5 which means that morphological facial length and bizygomatic facial breadth have a weak correlation with stature. The Pearson correlation coefficient is of the order 0f ~0.4 for north Indians as seen in studies by K Krishan, K Krishan and Kumar, Kharyal et al, other studies show a much lower Pearson correlation coefficient of ~0.2.

(Table-1) Descriptive Statistics in Total Subjects N=205

PARAMETRES	SEX	MEAN (in cm)	S.D.	MAXIMUM (in cm)	MINIMUM (in cm)
Height Of Forehead	MALE	6.7507	0.6139	8.2	5.7
	FEMALE	6.2429	0.62372	7.4	4.6
Morphological Facial Height	MALE	10.3577	0.5466	11.6	9.4
	FEMALE	9.661	0.5987	10.6	7.5
Physiognomic Facial Height	MALE	16.9816	0.765	18.5	15.8
	FEMALE	15.804	0.77965	17.4	14.1
Bizygomatic Breadth	MALE	11.6004	1.2552	14.3	8.8
	FEMALE	10.5620	1.4457	13	7.2
Bigonial Breadth	MALE	11.7781	1.15708	13.7	9.3
	FEMALE	11.131	1.2572	13.6	8.7
Stature	MALE	171.84	6.49483	188	159
	FEMALE	157.57	5.74336	174	146

Table-2) Pearson Correlation Coefficients Between Stature and Facial Measurements In Males And Females.

PARAMETRES	SEX	PEARSON CORRELATION COEFFICIENTS (r)	p-Value
Height Of Forehead	MALE	0.04	0.7395
	FEMALE	-0.155	0.097
Morphological Facial Height	MALE	0.45	0.01
	FEMALE	0.369	0.05
Physiognomic Facial Height	MALE	0.33	0.004
	FEMALE	0.2050	0.0286
Bizygomatic Breadth	MALE	-0.06	0.579
	FEMALE	-0.100	0.2896
Bigonial Breadth	MALE	0.013	0.9109
	FEMALE	0.1152	0.222

(Table-3) Regression Equations For Estimation of Stature (in cm) from Facial Measurements(in cm) in Males and Females.

PARAMETRES	SEX	REGRESSION EQUATIONS	STANDARD ERROR
Height Of Forehead	MALE	HEIGHT=168.9767+0.424899(HOF)	6.53
	FEMALE	HEIGHT= 166.5377-1.43641(HOF)	5.69
Morphological Facial Height	MALE	HEIGHT=115.5895+5.431259(MFL)	5.81
	FEMALE	HEIGHT=123.3443+3.542536(MFH)	5.36
Physiognomic Facial Height	MALE	HEIGHT=123.9882+2.818143(PFH)	6.17
	FEMALE	HEIGHT=133.6949+1.510674(PFH)	5.64
Bizygomatic Breadth	MALE	HEIGHT=175.8574-0.33588(BZ)	6.52
	FEMALE	HEIGHT=161.7675-0.3974(BZB)	5.74
Bigonial Breadth	MALE	HEIGHT=170.9515+0.075864(BG)	6.54
	FEMALE	HEIGHT=151.7091+0.526545(BGB)	5.73

4. Conclusion

The present study was conducted among 205 subjects (108 males and 97 females) to establish a database on facial anthropometry and to find out any correlation between stature and facial measurements. Three measurements were taken. All the data was recorded, tabulated and statistically analyzed. All the measurements were found to be more in males as compared to females. The study provides a 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. The stature estimation in these cases can supplement the other personal identification data like an estimation of age, sex, race etc where only head and face are available for examination. In the present study highest correlation coefficient was exhibited by morphological facial height in males ($p = 0.01$) and females($p = 0.05$). Morphological facial height also had the least standard error of estimate i.e 5.81 for males and 5.36 for females. So the facial measurement (Morphological facial height) is the most reliable measurement for estimation of stature in males and females. But while applying the regression formulae, one should keep in mind that these are population-specific (Managundi village Population); these cannot be used on other populations of the world. The regression formulae so obtained were checked for their accuracy by substituting the mean value of the facial measurements in their respective equations and estimated stature was calculated. The mean estimated values were close to the actual stature.

Thus the following conclusions can be drawn from the present study:

i. All the measurements were found to be more in males as compared to females.
ii. There is a significant positive correlation between stature and facial measurements (Morphological Facial Height and Physiognomic Facial Height) in both sexes.
iii. There is a negative correlation between stature and Bizygomatic Breadth in both sexes.

iv. The most reliable facial measurement to estimate stature using regression analysis in both sexes is morphological facial height.

v. Estimation of stature from facial measurements is a supplementary approach when useful samples like extremities and other body parts are not available for examination.

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