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Estimation of stature from facial measurements in northwest Indians

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ABSTRACT

Estimation of stature is one of the important component in identification of human remains in forensic anthropology. The present investigation attempts to estimate stature from seven facial measurements of 300 (173 males and 127 females) healthy subjects between the ages of 18–70 years from Northwest India. Height of all the subjects was measured and facial measurements were taken. Data was subjected to statistical analysis like mean, standard deviation, multiplication factors, Karl Pearson's correlation coefficient (r), linear and multiple regression analyses using statistical package for social sciences (SPSS). The average height of the subjects was in the range of 154.3–178.3 cm in males and 155.1–168.4 cm in females. Estimated stature calculated by regression analysis of seven facial measurements was almost similar to mean actual stature in both males and females and the difference by using multiplication factors was found to be greater. Standard error of estimation (SEE) computed both by linear and multiple regression analyses was found to be low for the two sexes. Thus we can conclude that regression equations generated from facial measurements can be a supplementary approach for the estimation of stature when extremities are not available.

1. Introduction

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 tool used in personal identification. Estimation of stature from various body parts like extremities is well documented in other countries [1–3] as well as in India [4–7].

However, it becomes difficult when only a bare skull is available for identification purposes and one has to estimate the stature of the deceased. Search of the available literature shows that some authors have given mathematical formulae to determine stature from cranial diameters [8] while others have formulated regression equations from somatometry of the skulls [9,10]. More recently, applicability of regression equations generated from the cephalofacial measurements for stature estimation has been greatly emphasized [11–15].

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 adult stature and to compare the reliability of stature estimation by multiplication factor, and regression analysis.

2. Materials and methods

Data for the present study consisted of 300 adults (173 males, 127 females) belonging to Chandigarh zone of Northwest India (NWI) in the age group of 18–70 years (mean age 36.30 years). Seven facial measurements along with the stature of the subjects were taken according to standard anthropometric procedures [16]. The measurements taken are defined as follows:

1. *Stature/height vertex:* It measures the vertical distance from *vertex* (v) to floor.
2. *Total face height (n–gn):* It measures the straight distance between *nasion* and *gnathion*.
3. *Upper face height (n–pr):* It measures the straight distance between *nasion* and *prosthion*.
4. *Height of lower face (sto–gn):* It measures the straight projective distance between the chin and the opening of the mouth i.e. between *stomion* and *gnathion*.
5. *Minimum frontal breadth (ft–ft):* It measures the straight distance between the two *frontotemporalia*.
6. *Bigonial breadth (go–go):* It measures the straight distance between the two *gonia*.
7. *Biocular breadth (ec–ec):* It measures the straight distance between external *canthi* (*ectocanthia*) i.e. outer corners of the eyes.

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8. *Interocular breadth (en–en):* It measures the straight distance between the internal canthus of the eye i.e. *endocanthion* to *endocanthion*, with the eyelids open.

Collected data was subjected to statistical analysis like mean, standard deviation, multiplication factors, Karl Pearson's correlation coefficient (r), linear and multiple regression analysis using statistical package for social sciences (SPSS).

3. Results

The subjects were classified into six height categories (Table 1) according to Martin's stature classification [16]. It is seen from this table that the maximum number of males (47.1%) falls in the category of medium (164.0–166.9 cm) and minimum (4.1%) in the category of short stature (150.0–159.9 cm). Similarly, in females, the maximum frequency (81.7%) was observed in the category of tall (159.0–167.9 cm) and minimum (0.8%) in the medium category (153.0–155.9 cm). No male was found in the category of very tall and no female was found in the category of short or lower medium stature.

Means and standard deviations (SD) of seven facial measurements along with stature were found to be greater in males than the females ($p < 0.001$; $p < 0.01$) except for interocular breadth (Table 2). The correlation coefficients were found to be low and thus the correlations of facial measurements with stature were very poor (Table 3). However, significant positive correlation of stature with upper facial height ($p < 0.001$) and with total facial height ($p < 0.01$) was observed in both males and females and with height of lower face ($p < 0.05$) only in females.

Linear regression equations were derived for each facial measurement in the two sexes (Table 4). 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. Standard error of estimation (SEE) for all variables was low ranging 3.56–3.70 for males and 2.90–2.95 for females.

Table 3
Correlation coefficient between stature and various facial measurements in males and females.

Measurements (cm)	Male (N = 173)		Female (N = 127)	
	r-Value	p-Value	r-Value	p-Value
Total facial height (n–gn)	0.219**	0.002	0.181*	0.021
Upper facial height (n–pr)	0.270***	0.000	0.167*	0.030
Height of lower face (sto–gn)	0.028	0.358	0.195*	0.014
Minimum frontal breadth (ft–ft)	0.088	0.124	0.060	0.253
Bigonial breadth (go–go)	0.064	0.201	0.047	0.299
Biocular breadth (ec–ec)	0.071	0.178	0.121	0.088
Interocular breadth (en–en)	−0.030	0.347	−0.061	0.246

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Means and SD of the multiplication factors of facial measurements with regard to stature are given in Table 5. In both sexes, the multiplication factor was found to be higher for all the facial measurements. Table 6 gives a comparison of mean actual stature (MAS) and mean estimated stature (MES) calculated by using regression analysis and multiplication factors. Mean values of various facial measurements were substituted in their respective regression equations and multiplication factors to calculate MES. Using regression analysis MES was equal or slightly less (0.01 cm) than MAS in both males and females except in case of upper facial height in females, where MES was more than MAS with the difference of 4.93 cm. On the other hand using multiplication factors the MES was found to be greater than MAS in both the sexes and the difference varied from 0.57 to 8.93 cm in males and from 0.35 to 1.91 cm in females. Thus indicating that in the estimation of stature, linear regression equations are more reliable than multiplication factors.

Tables 7 and 8 represent multiple regression coefficients, constant, SEE and correlation coefficients for all the seven combinations (i.e. when seven variables were considered and so on). SEE ranged from 3.569 to 3.610 in males and 2.880 to 2.914 in females. In the males, significant correlation coefficients were found for all

Table 1
Frequency of distribution of stature in males and females according to Martin's classification [16].

Stature classification (cm)	Male (N = 173)			Female (N = 127)		
	Range	N	%	Range	N	%
Short	150.0–159.9	7	4.1	140.0–148.9	0	0
Lower medium	160.0–163.9	21	12.2	149.0–152.9	0	0
Medium	164.0–166.9	81	47.1	153.0–155.9	1	0.8
Upper medium	167.0–169.9	39	22.1	156.0–158.9	15	11.9
Tall	170.0–179.9	25	14.5	159.0–167.9	104	81.7
Very tall	180.0–199.9	0	0	168.0–186.9	7	5.6

Table 2
Means and standard deviations of facial measurements along with stature in the two sexes.

Measurements (cm)	Male (N = 173)		Female (N = 127)		t-Test
	Range	Mean ± SD	Range	Mean ± SD	
Stature (height vertex)	154.3–178.3	165.90 ± 3.69	155.1–168.4	163.24 ± 2.94	6.704***
Total facial height (n–gn)	9.70–13.0	11.25 ± 0.67	9.5–12.4	10.80 ± 0.54	6.233***
Upper facial height (n–pr)	5.5–7.8	6.85 ± 0.48	5.5–7.4	6.53 ± 0.42	5.799***
Height of lower face (sto–gn)	2.5–4.5	3.67 ± 0.37	2.9–4.3	3.53 ± 0.30	3.506**
Minimum frontal breadth (ft–ft)	8.8–12.2	10.59 ± 0.62	8.0–11.5	9.90 ± 0.59	9.678***
Bigonial breadth (go–go)	9.0–12.4	10.64 ± 0.63	8.2–11.3	10.26 ± 0.68	4.974***
Biocular breadth (ec–ec)	5.0–10.9	9.86 ± 0.60	8.5–10.9	9.68 ± 0.47	2.802**
Interocular breadth (en–en)	1.7–4.7	2.27 ± 0.33	1.7–2.7	2.21 ± 0.23	1.845

** $p < 0.01$.
*** $p < 0.001$.