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"Estimation of Body Height from Total Facial Height in Living Subjects in Gujarat Region"

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Abstract :

Introduction: Estimation of stature is necessary in forensic anthropology and archaeology. The prime aim of this study is to find the correlation of body height with total facial height in Gujarati population and also to derive regression equation for accurate measurement of body height from total facial height. **Material and methods:** This study was conducted on 510 individuals (243 males and 267 females) aged between 18 to 30 years in Gujarat region. Total facial height and body height of the subject were measured by sliding caliper and standard height measuring instrument respectively. The data was analysed statistically for significance, correlation and regression analysis to derive regression equations for body height from total facial height. **Result:** We calculated Mean and Standard deviation of total facial height and body height. We found Pearson's correlation coefficient (r) = 0.46 for all subjects; r = 0.06 for males and r = 0.30 for females. We also found regression equations in order to estimate body height from total facial height. **Conclusion:** It was determined that total facial height has strongly positive correlation with body height. The regression equations derived from the data can accurately estimate the body height from total facial height in Gujarati population when facial remains are brought for anthropometric examination.

Key words: Total facial height, body height, correlation, Gujarat region.

Introduction:

Estimation of stature is necessary in forensic anthropology and archaeology. Body height is a very important parameter for identification of any person. Height estimation is important for calculating lung volume, metabolic rate and glomerular filtration rate. (Methepatil SS et al., 2022). Stature is the combination of length of certain bones and appendages of the body which is affected by many factors such as genetics, environment and nutrition. (Nat BS., 1931).

Anthropometry is a systematized measuring technique that expresses quantitatively the dimensions of the human body and skeleton. (Akhter Z., 2013). In certain disasters like earthquakes, floods, bomb blasts, aeroplane crash, animal attacks, where only few body fragments are available, body height measurement would be difficult. In such cases, regression equation can be useful to estimate the body height.

Many studies have been reported for measurement of body height from long bones by many authors. [Allbrook., D (1961), Athawale NC., (1963)]. Many authors also reported studies using different body parameters such as head circumference, (Shah RK et al. 2017) arm span measurements, (Hossain S et al., 2011). as well as hand and foot measurements [Sanli SG et al., (2005), Singh V et al., (2020)] and found them correlated with body height.

Material and methods:

The present study has been carried out in Gujarat region on a total of 510 (243 males & 267 females) living subjects. The subjects taken for study were medical students, students of other faculties, staffs and other persons belonging to different regions of Gujarat.

Inclusion criteria:
Male and female Gujarati people in the age group of 18-30 years were selected.

Exclusion criteria:

1. Individuals having any obvious craniofacial abnormalities like congenital, developmental or acquired through any form of trauma.
2. Individuals having history of plastic or reconstructive surgery.

Ethical consideration:

The prior permission was taken from the concerned authorities and also informed consent from every person was taken for the different measurements pertaining to the study. Strict confidentiality of all the subjects was maintained.

Equipments used in study:

Sliding caliper

Standard height measuring instrument

Methodology:

Before taking measurements, all the subjects were informed about the whole procedure of taking the measurements. Total facial height was taken with the person sitting in a chair, in relaxed condition and head in anatomical position. Total facial height was taken by measuring the distance between root of the nose (nasion) to the lowest median landmark on the lower border of the mandible (gnathion) with the help of sliding caliper (Plate-1). [Alam MT et al., (2017), Farkas LG et al., (2005)]. Height of the individual was measured in standing erect anatomical position with bare foot from vertex to heel with standard height measuring instrument (Plate-2). (Yadav N et al., 2019). All above mentioned measurements were measured in centimeters and during fix time of the day to avoid diurnal variation. They were taken by the same person to avoid subjective error in methodology.
Obtained data were statistically analyzed for mean, standard deviation, Pearson's correlation coefficient and linear regression analysis.

Plate-1:Photograph Showing Measurement of Total Face Height

Plate – 2:Photograph Showing Measurement Of Stature (Height) From Vertex To Heel With Bare Foot In Standing Position Using Standard Height Measuring Instrument

Result:

All the readings were compiled and calculated in MS Excel Windows 10.

As shown in Table-1, body height in all subjects varied from 142 cm to 186.8 cm with the mean of 164.689 cm $\pm$ 9.4425 SD, while total facial height in all subjects varied

from 8.64 cm to 13.19 cm with the mean of 10.4967 cm ± 0.7031 SD. Body height in males varied from 143.7 cm to 186.8 cm with the mean of 172.2 cm ± 6.7927 SD, while total facial height in males varied from 9.11 cm to 13.19 cm with the mean of 10.8585 cm ± 0.6794 SD. Body height in females varied from 142 cm to 172.8 cm with the mean of 157.878 cm ± 5.5319 SD, while total facial height in females varied from 8.64 cm to 12.01 cm with the mean of 10.1681 cm ± 0.5460 SD.

Table – 1: Statistical analysis of body height and total facial height (TFH) in all subjects.

	All (Male and Female)		Male		Female	
	Body height (cm)	Total facial height (cm)	Body height (cm)	Total facial height (cm)	Body height (cm)	Total facial height (cm)
Minimum (cm)	142	8.64	143.7	9.11	142	8.64
Maximum (cm)	186.8	13.19	186.8	13.19	172.8	12.01
Mean (cm)	164.689	10.4967	172.2	10.8585	157.878	10.1681
SD (SD)	9.4425	0.7031	6.7927	0.6794	5.5319	0.5460

Pearson's correlation co-efficient was used to find the relationship between the body height and total facial height. Table-2 shows total facial height is correlated with body height. It also shows p value which is statistically highly significant for total facial height in all subjects and in female but it is not significant in males.

Table -2: Statistical analysis of Pearson's correlation co-efficient and linear regression between TFH and body height.

		Correlation (r)	Regression Co-efficient (b)	Constant of Regression equation (a)
Total facial height	Total	r = 0.46, p = 0.0000	6.2405	99.1841
	Males	r = 0.06, p = 0.3414	0.6128	165.5424
	Females	r = 0.30, p = 0.0000	3.0509	126.8557

Linear regression analysis was done from obtained data which provided regression equations for estimation of body height from total facial height.

Regression equations are: Body height (y) = value of constant [a] + regression co-efficient [b] X total facial height [x]. Table – 3 shows regression equations for measuring body height for mean value of total facial height (total, male and female). It also shows comparison of estimated body height calculated from regression equation with actual body height. It shows no significant difference between estimated body height and actual body height.

Table –3: Estimation of body height from linear regression equation for total facial height and comparison of measured body height from actual height.

		Regression equation (for mean value)	Estimated body height (for mean value) (cm)	Actual body height (for mean value) (cm)
Total facial height	Total	y = 99.1841 + 6.2405x = 99.1841 + 6.2405X 10.4967	164.6887	164.6892
	Males	y = 165.5424 + 0.6128x = 165.5424 + 0.6128X 10.8581	172.1962	172.1963
	Females	y = 126.8557 + 3.0509x = 126.8557 + 3.0509X 10.1681	157.8776	157.8775

Plates – 3, 4 and 5 shows scatter diagram and regression lines in all subjects, males and females respectively. The graphs represent linear relation between body height and total facial height.

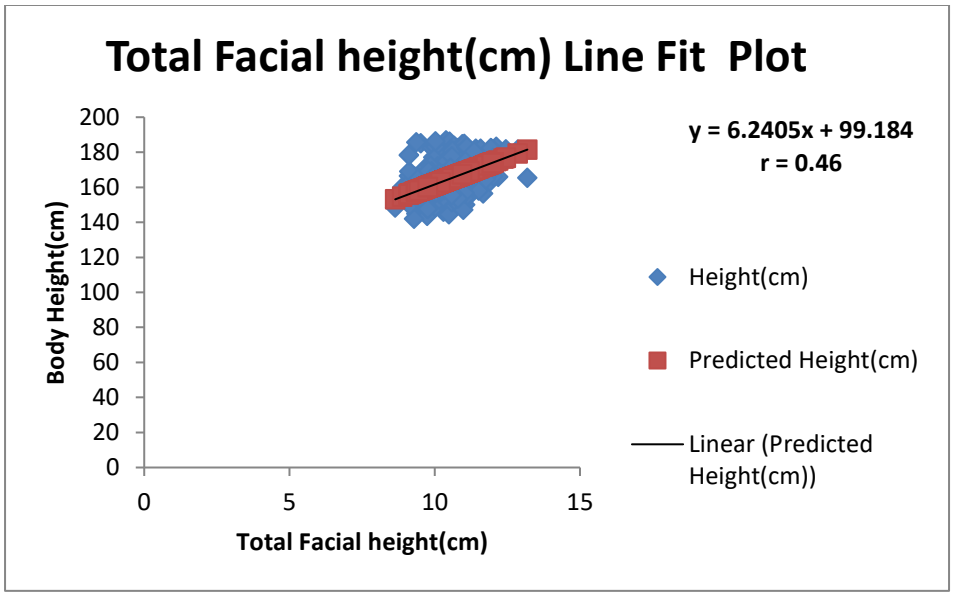

Plate – 3: Scatter diagram showing correlation between body height and total facial height in all subjects

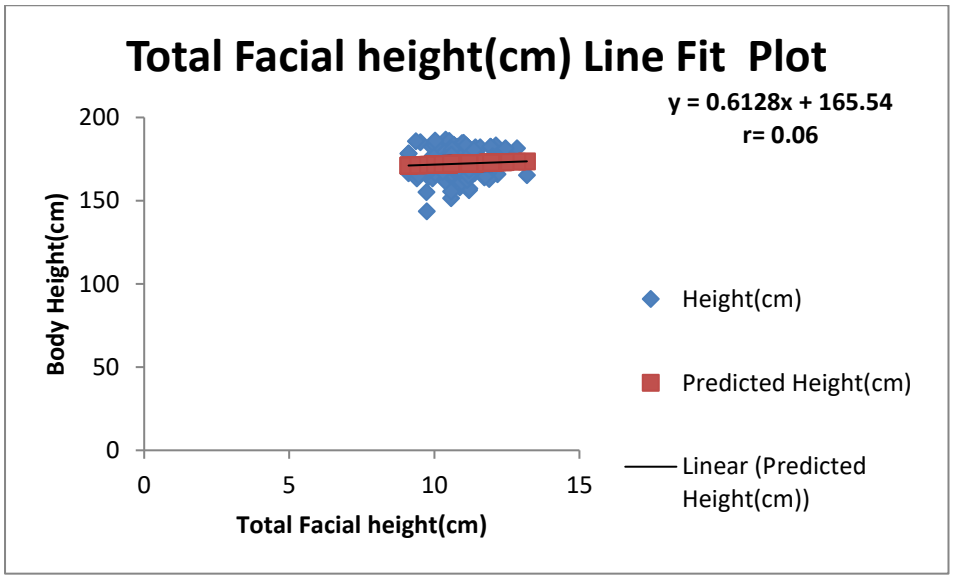

Plate – 4: Scatter diagram showing correlation between body height and total facial height in males

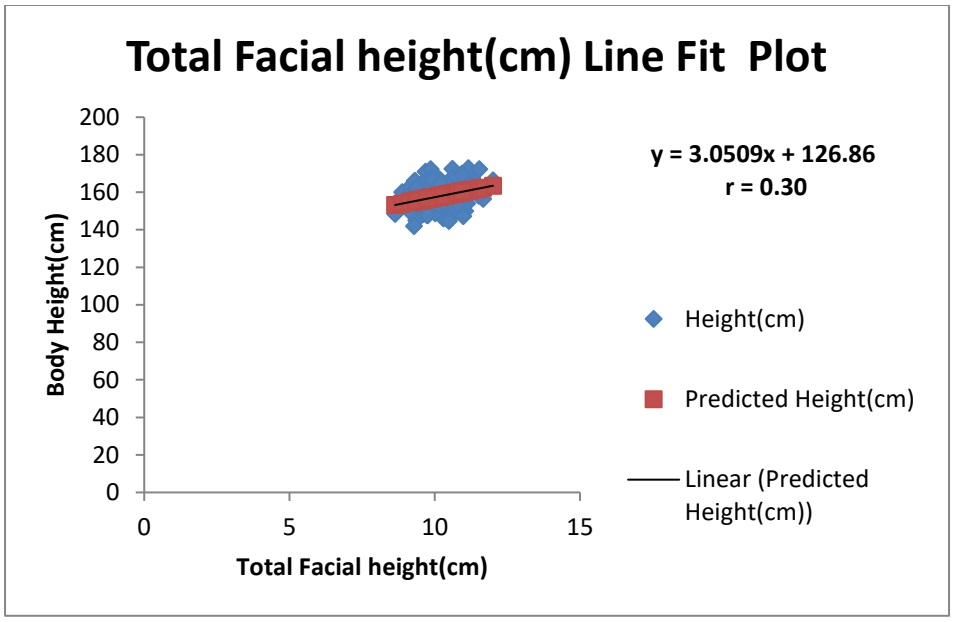

Plate – 5: Scatter diagram showing correlation between body height and total facial height in females

Discussion:

Table –4: Comparison of studies done by various authors.

Author		Mean body height (cm)	Mean total facial height (cm)	Correlation of TFH with Body height
Alam MT et al., (2017)	T	167.54	10.77	r = 0.34, p< 0.001
Yadav Net al., (2019)	T	165.16	11.21	-
	M	170.7	11.48	-
	F	160.37	10.95	-
Reddy M et al., (2018)	M	169.9	11.96	r = 0.498
	F	158.17	11.25	r = 0.474
Nair SC et al., (2022)	Indians (T)	165.2	10.77	r = 0.57, p=0.001
	Africans (T)	169.49	11.3	r = 0.41, p=0.001
Gupta S et al.,(2019)	M	-	12.14	-
	F	-	11.57	-
Hua Zhong MD et al., (2024)	M	171	10.77	r = 0.329, p=0.000

	F	165	11.19	r = 0.137, p=0.035
Jibonkumar et al., (2006)	M	162.29	11.25	r = 0.213, p<0.001
Dinakaran J et al., (2021)	M	168.76	11.06	r = 0.240, p=0.093
	F	155.10	10.57	r = 0.254, p=0.075
Present study	T	164.689	10.4967	r = 0.46, p =0.0000
	M	172.2	10.8585	r = 0.06, p=0.3414
	F	157.878	10.1681	r = 0.30, p=0.0000

(TFH-Total facial height, T- Total, M-Male, F- Female)

Table – 4 shows the comparison of studies done on different population by different authors. Previous studies showed significant correlation between facial height and body height. Mean values for total facial height in other studies are varying with the results of present study, which can be due to racial differences.

The estimation of body height from measurements of long bones, head circumference, foot and hand length is done by many workers. So growth of an individual is affected by many factors. But when only few body parts are available, then estimation of stature must be done by known relationship between body parts and body height. [Sudhir PE et al., (2010), Kumar S et al., (2013)].

Many authors also derived regression equations for measuring body height using total facial height. Yadav Net al., (2019) derived regression equation as Y = 128.73 + 3.24 X TFH for both sexes in North Indian population. Reddy M et al., (2018) derived regression equation as S = 128.712 + 4.122 X TFH for male and S = 121.064 + 3.981 X TFH for females in western Uttar Pradesh population. Nair SC et al., (2022) derived regression equation as Y = 72.22 + 8.62 X TFH for Indians and Y = 113.22 + 4.97 X TFH for Africans. These all equations may vary but they all got non- significant difference between estimated stature and actual stature.

Comparing with previous studies, it is seen that total facial height is a good parameter to be having significant correlation with body height of an individual. Regression equations from our study, show good reliability and applicability but there might be always estimation error of few centimetres. Regression equations

found in other studies for one population, may not be applied to other population. Present study also found that data derived here may vary with other studies.

Conclusion:

It was concluded that total facial height shows strong correlation with body height for males, females and in all subjects by measuring Pearson's correlation coefficient. All the findings also showed highly significant relation ($p < 0.05$) with body height except total facial height for males. Hence, body height of an individual in Gujarati population can be easily estimated by using regression equations when only facial remains are available. These data can be greatly useful in forensic, anthropological and medico-legal scenarios. As these formulas are population and area specific, more studies among different regions and races would be required in future to make stature estimation more reliable.

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