



## Prediction Of Stature Estimation From Facial Parameters

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### Abstract

Anthropometry is concerned with measurement of physical sizes and shapes of human body. Anthropometry is derived from the Greek word anthropos means man, metry means to measure, thus anthropometry is a science that correlated with the measurement of size, weight and proportions of human body. Aim of this study is to derive regression equation for each facial parameter to determine the stature. This is a cross sectional study. After IEC approval and written informed consent was taken from participants included in the study. A total of 1000 subjects belonged to study group, 506 males and 494 females for Sangli District participated in the study. Religion wise 542 Hindu, 458 Muslim. The procedures was explained to the subjects and measurements was taken. For statistical analysis SPSS software is used. Statistical analysis was presented in tabular form as mean, standard deviations, minimum and maximum value of stature and facial parameters. A statistically significant difference is seen in all the parameters. The regression formulae were derived separately by using regression analysis of the facial parameters with stature. For identification of males of Sangli district population, amongst all stature and facial parameters studied, height, Lower Facial Height (LFH) and Upper Facial Height (UFH) observed to be the best parameters. For identification of females of Sangli district population, LFH, UFH and Height found to be the best parameters. TFH is the best facial parameter to correlate with stature in both sexes for Sangli district population.

**Keywords:** Stature, Upper Facial Height, Lower Facial Height, Total Facial Height

### Introduction

Anthropologists distinguish groups of people on the basis of common origin, living, or having lived, in certain defined regions and possessing different characteristic features in their appearance. All these groups blend imperceptibly into one another with intermediate types possessing various combinations of physical characteristics. Modern man is biologically uniform in basic features (for example upright posture, well-developed hand and feet, prominent chin, absence of bony eye brow, an intricately structured brain encased in a big skull with a straight high forehead and 46 number of

chromosomes) and polymorphous as regards many secondary features. Scientists consider all human beings as belonging to a single species, Homo sapiens. The variations found in groups living in different geographical areas reflect only a differentiation within the single species due to host of biological, social and other factors. In anthropology there are two schools of thought on the origins of man and the major races—the polycentric and the monocentric schools. But one should remember that there are no strict lines of demarcation between races.

Anthropometry is concerned with measurement of physical sizes and shapes of human body.<sup>1</sup>

Anthropometry is derived from the Greek word anthropos means man, metry means to measure, thus anthropometry is a science that correlated with the measurement of size, weight and proportions of human body. It was developed by a German Anatomist, Johanne Sigismund Elsho for his doctoral thesis at the University of Padua in 1654.<sup>2</sup>

Anthropometry is the systemic technique for measuring and taking observations on man, his skeleton, the skull, the limbs, trunk etc.<sup>4</sup>

Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other and are manifestation of the internal structure and tissue components which in turn, are influenced by environmental and genetic factors. It is a technique used in both physical & systemic measurements of the bones of the human skull.<sup>3-6</sup>

There are inter-racial and inter-geographical differences in measurements & their correlations with stature. What may be true for one race or one region may not be true for other.<sup>7</sup> There are very few studies and references available on facial parameters in India.

Anthropometric studies play an important role in distinguishing a pure race from the local mingling of races.<sup>8</sup> Facial anthropometric studies involving facial height have far-reaching implications in health-related fields.<sup>9-10</sup> The science of comparative racial anthropometry has shown that there are consistent differences in the body proportions of various human races.<sup>11</sup> Each race has different gene pools and even genetically different subgroups that exhibit different behaviours, characteristics and peculiarities.<sup>12</sup>

In the past, facial anthropometry has been successfully utilized for forensic purposes by some scientists.<sup>13,14</sup> However, only a few studies have been conducted on facial height proportions in different communities.<sup>15,16</sup> The external physical appearance is very important in the personal identification of any individual or race.

Stature is an important biological parameter in medico-legal forensic examination. It occurs many a times when highly decomposed or mutilated bodies or fragmentary remains of skull are brought for medico-legal examination. Sometime only skull is brought for examination. There is definitive biological correlation of stature with all the body

parts such as extremities, head, trunk, vertebral column etc.<sup>17</sup>

Since all these parts of the body and bones are not always available for forensic examination, it becomes necessary to make use of other parts of the body like head and face region. But only a few studies have been conducted on cephalo-facial region with respect to estimation of stature. There are plenty of studies which focus on other aspects of the cephalo-facial identification. Determination of sex and race from cephalic region, various methods of reconstructing the face appearance in an individual from the bones of the skull, new facial soft tissue depth data, ultrasound, computerized tomography-scans and 3D reconstruction computer programs are in full development throughout the world.<sup>18,19</sup>

In many cases, brought for medico legal and forensic examinations, where only the cephalo-facial region is available, it becomes difficult for the forensic scientist to identify the deceased in the absence of any detailed and in depth study on this region.<sup>20,21</sup>

### **Aim And Objectives**

1. To measure the stature of an individual.
2. To measure the facial parameters (total facial height, upper facial height, lower facial height) of the same individual.
3. To derive regression equation for each facial parameter to determine the stature.

### **Materials And Method**

This is a cross sectional study

1. After IEC approval and written informed consent was taken from participants included in the study.
2. A total of 1000 subjects belonged to study group. 506 males and 494 females for Sangli District participated in the study. Religion wise 542 Hindu, 458 Muslim.

The procedure was explained to the subjects before taking measurements.

Following anthropometric measurements were taken with reference to following anthropometric landmarks.

1. Stature/Body height- Stature/Height-in standing position, from heel to highest point of scalp

2. Total Facial Height –TFH- from nasion to gnathion
3. Upper Facial Height-UFH- from nasion to prosthion
4. Lower Facial Height-LFH- from prosthion to gnathion

**Inclusion Criteria:**

Adult individuals both male and female belonging to the age group above 18 years in Sangli district from Hindu, Muslim religions , native of Sangli district.

**Exclusion Criteria:**

Individuals having congenital facial deformity/stature anomaly/undergone any facial surgery, deformed face.

**Fig no.1-Stature/body height- Stature/Height-in standing position, heel to highest point of scalp**



**Fig no.2-Total Facial Height- Total Facial Height-from nasion to gnathion**



**Fig no.3-Upper Facial Height- Upper Facial Height-from nasion to prosthion**



**Fig no.4-Lower facial height- Lower facial height-from prosthion to gnathion**



**Observation-** The study was conducted after taking ethics clearance from the institute and informed written consent from the individuals. The data was collected from individuals regarding demographic profile, height and three facial parameters.

Statistical analyses of the results were performed separately for males and females for gender variations. Even religion wise differences were studied. Regression equations were derived.

For statistical analysis SPSS software is used. Statistical analysis was presented in tabular form as mean, standard deviations, minimum and maximum value of stature and facial parameters.

**Table 1: Descriptive statistics of Height and Facial parameters amongst Sangli District population: (n=1000, M=506, F=494)**

F P	Sex	Mean	SD	SEE	Min	Max	P value	IP	% of IP	CR	DP	% D.P.
T F H	M	11.05	0.71	0.031	8.95	12.96	<0.001	>13.13	0	8.92 - 13.18	> 12.13	1.1
	F	10.03	0.70	0.031	7.67	13.13		<8.95	1.3	7.93 - < 8.92	1.3	

										12.13			
U F H	M	5.70	0.44	0.020	4.16	7.12	<0.001	> 6.73	1.5	4.38 7.02	-	> 6.6	2.1
	F	5.22	0.46	0.021	3.63	6.73		< 4.16	1.1	3.84 6.6	-	< 4.38	3.1
L F H	M	5.35	0.59	0.026	3.48	7.37	<0.001	> 7.97	0	3.58 7.12	-	> 6.62	2.1
	F	4.79	0.61	0.027	2.20	7.97		< 3.48	1.2	2.96 6.62	-	< 3.58	3.3
H t	M	167.54	6.89	0.305	144	185	<0.001	> 173	2.2	146.87- 188.21	-	> 172.24	3.1
	F	153.01	6.41	0.289	133	173		< 144	3.2	133.78 - 172.24	-	<146.87	2.3

(\*P<0.001; highly statistically significant)

Table 1 outlines that height and all facial parameters are greater in males than in females of Sangli district population.

A statistically significant difference is seen in all the parameters. For sexual dimorphism, identification point for each parameter was calculated from the range of each measurement. From this percentage of identified persons was calculated. The calculated range is obtained by (mean±3S.D) to check the accuracy of data collected. Demarking points were worked out from calculated range. By applying demarking point for each parameter, percentage of identified males and females was recorded.

Amongst all above parameters studied, height > 172.2cm, Lower Facial Height (LFH) > 6.62 cm and Upper Facial Height (UFH) > 6.6 cm observed to be the best parameters for identification of males of Sangli district population.

For identification of females of Sangli district population, LFH < 3.58 cm, UFH < 4.38 cm and Height < 146.87 cm found to be the best parameters.

**Table 2: Descriptive statistics of height and facial parameters amongst Hindu Population of Sangli District .**

FP	Sex	Mean	SD	SEE	Min	Max	P value
TFH	M	11.01	0.71	0.041	9.30	12.97	<0.001
	F	10.10	0.64	0.039	8.53	11.96	
UFH	M	5.62	0.42	0.025	4.16	6.84	<0.001
	F	5.21	0.43	0.026	3.91	6.67	
LFH	M	5.38	0.58	0.033	3.70	7.37	<0.001
	F	4.89	0.49	0.031	3.73	7.59	

<b>Ht</b>	M	167.68	7.79	0.39	144	185	<0.001
	F	152.99	6.69	0.41	133	173	

Table 2 compares the data about height and various facial parameters in males and females of Hindu religion of Sangli district. It shows that height and all facial parameters are greater in Hindu males than in Hindu females. A statistically significant difference is seen in all the parameters.

**Table 3: Descriptive statistics of Height and facial parameters amongst Muslim Population of Sangli District.**

<b>FP</b>	<b>Sex</b>	<b>Mean</b>	<b>SD</b>	<b>SEE</b>	<b>Min</b>	<b>Max</b>	<b>P value</b>
<b>TFH</b>	M	11.12	0.73	0.064	8.95	12.75	<0.001
	F	10.07	0.72	0.064	8.39	13.13	
<b>UFH</b>	M	5.87	0.44	0.038	4.60	7.12	<0.001
	F	5.36	0.45	0.041	4.35	6.73	
<b>LFH</b>	M	5.27	0.59	0.052	3.48	6.84	<0.001
	F	4.67	0.84	0.076	2.20	7.97	
<b>Ht</b>	M	167.90	6.94	0.61	146	185	<0.001
	F	152.64	6.01	0.54	136	166	

(\*P<0.001; highly statistically significant)

Table 3 compares the data about height and various facial parameters in males and females of Muslim religion of Sangli district. It shows that height and all facial parameters are greater in Muslim males than in Muslim females. A statistically significant difference is seen in all the parameters. The regression formulae were derived separately by using regression analysis of the facial parameters with stature.

Regression equation ( $y=a+bx$ )

Y=stature,

x=independent variable,

a=regression coefficient of dependent variable,

b=regression coefficient of independent variable.

Standard error of estimate (SEE) was calculated for each regression equation.

**Table 4: Correlation Coefficient (r) and regression analysis of height with facial parameters for Sangli District population.**

<b>FP</b>	<b>Sex</b>	<b>r value</b>	<b>Regression equation</b> $y=a+bx$	<b>SEE</b>	<b>P value</b>
<b>TFH</b>	M	<b>0.462</b>	<b>Y=117.43 + 4.5TFH</b>	<b>6.11</b>	<b>&lt;0.001</b>
	F	<b>0.411</b>	<b>Y=115.72 + 3.7TFH</b>	<b>5.87</b>	<b>&lt;0.001</b>
<b>UFH</b>	M	<b>0.224</b>	<b>Y=147.78 + 3.4UFH</b>	<b>6.73</b>	<b>&lt;0.001</b>
	F	<b>0.267</b>	<b>Y=133.69 + 3.7UFH</b>	<b>6.19</b>	<b>&lt;0.001</b>
<b>LFH</b>	M	<b>0.381</b>	<b>Y=143.29 + 4.5LFH</b>	<b>6.36</b>	<b>&lt;0.001</b>

	F	<b>0.228</b>	<b>Y=142.13 + 2.3LFH</b>	<b>6.27</b>	<b>&lt;0.001</b>
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Table 4 summarizes that all facial parameters showed positive correlation with stature significantly (P <0.001) in males of Sangli district population. SEE for males is ranging between 6.11 to 6.73. Total Facial Height (TFH) with higher “r” value of 0.462 and lesser SEE –6.11 and Lower Facial Height (LFH) with “r” value of 0.381 and SEE – 6.36 showed better correlation with height than remaining parameters. TFH is the best facial parameter to correlate with height for males of Sangli district population.

Total Facial Height (TFH) with “r” value of 0.411 and least SEE – 5.87 found to be the best facial parameter to correlate height for females.

**Table 5: Correlation Coefficient(r) and linear Regression Analysis of height with facial parameters in Hindu population.**

FP	Sex	r value	Regression equation y=a+bx	SEE	P value
TFH	M	<b>0.470</b>	<b>Y=118.16 + 4.5TFH</b>	<b>6.01</b>	<b>&lt;0.001</b>
	F	<b>0.448</b>	<b>Y=105.39 + 4.7TFH</b>	<b>5.99</b>	<b>&lt;0.001</b>
UFH	M	<b>0.237</b>	<b>Y=146.34 + 3.8UFH</b>	<b>6.61</b>	<b>&lt;0.001</b>
	F	<b>0.251</b>	<b>Y=132.46 + 3.9UFH</b>	<b>6.48</b>	<b>&lt;0.001</b>
LFH	M	<b>0.412</b>	<b>Y=141.88 + 4.8LFH</b>	<b>5.33</b>	<b>&lt;0.001</b>
	F	<b>0.324</b>	<b>Y=131.49 + 4.4LFH</b>	<b>6.34</b>	<b>&lt;0.001</b>

Table 5 summarizes that all facial parameters showed positive correlation with stature significantly (P < 0.001) in Hindu males of Sangli district population. Total Facial Height (TFH) with higher “r” value of 0.470 and lesser SEE –6.01 and Lower Facial Height (LFH) with “r” value of 0.412 and SEE – 5.33 showed better correlation with height than remaining facial parameters. TFH is the best facial parameter to correlate with height for Hindu males of Sangli district population.

Comparing “r” value of TFH in Hindu males and females, it is seen that “r” value is more in males (0.470) as compared to females (0.448). Hence, we can say that TFH is the best facial parameter to correlate with stature for Hindu population of Sangli district

**Table 6: Correlation Coefficient(r) and linear Regression Analysis of height with facial parameters in Muslim population.**

FP	Sex	r value	Regression equation y=a+bx	SEE	P value
TFH	M	<b>0.421</b>	<b>Y=123.31 + 4.0TFH</b>	<b>6.31</b>	<b>&lt;0.001</b>
	F	0.211	Y=135.01 + 1.8TFH	5.89	0.01
UFH	M	0.185	Y=150.72 + 2.9UFH	6.84	0.03
	F	0.204	Y=138.06 + 2.7UFH	5.91	0.02
LFH	M	<b>0.367</b>	<b>Y=145.50 + 4.3LFH</b>	<b>6.47</b>	<b>&lt;0.001</b>
	F	0.034	Y=151.49 + 0.2LFH	6.03	0.70

(\*P<0.05; statistically significant by linear regression)

Table 6 summarizes that only TFH, LFH showed positive correlation with stature significantly ( $P < 0.001$ ) in Muslim males of Sangli district population. Total Facial Height (TFH) with higher “r” value of 0.421 and lesser SEE -6.31 showed better correlation with height than remaining facial parameters.

For Muslim females in Sangli district population no single facial parameter found to correlate with stature.

**Discussion-**

**Stature/Height**

**Table 7.1: Comparison of mean value of Stature with previous studies .**

Author	Population	Stature cm	
		Males	Females
Sahni (2010)	Northwest	165.90	163.24
Ilayperuma (2010)	Srilankan	162.95	152.48
Agnihotri., (2011)	Indo-Mauritius	173.40	157.36
Asha and Prabha (2011)	South India	169.62	156.82
Wankhede (2012)	Nagpur	170.97	156.89
Sheetal sagar (2014)	Jat	152.53	152.44
Ajeet Jaiswal (2014)	Kattunayakan	165.66	151.04
Twisha (2015)	Gujarati	164.3	150.56
Swami (2015)	Haryanvi	168.71	155.18
Pokharel (2018)	Nepali	167.42	155.99
<b>Present study</b>	<b>Sangli district population</b>	<b>167.54</b>	<b>153.01</b>
	<b>Hindu population</b>	<b>167.68</b>	<b>152.99</b>
	<b>Muslim population</b>	<b>167.90</b>	<b>152.64</b>

Table 7.1 shows that mean value of stature of males is more than mean stature of females in all previous studies done by various researchers. Our study also confirms the same. The mean stature of males of the present study Sangli district population (167.54cm), Hindu population and Muslim population is comparable with studies done by Pokharel<sup>22</sup> on Nepalese population. Mean stature of males in the present study is lower than the Indo-Mauritian population<sup>23</sup> and higher than Srilankan population.<sup>24</sup>



The mean stature of females of Hindu & Muslim population confirms Srilankan population, Jat population. The difference may be due to geographic, ethnic, genetic or environmental variations.

**Total Facial Height:**

**Table 7.2: Comparison of mean value of Total Facial Height with previous studies:**

Author	Population	Mean Total Facial Height (cm)	
		Males	Females
O Ebeye(2009)	Nigerian	12.61	11.91
EseAnibor(2013)	Ijaw ethnic group	11.58	10.86
D.Jeremic(2013)	Central Serbia	12.14	11.08
Ajeet Jaiswal (2014)	Tamilnadu	5.72	5.54
Twisha et al(2015)	Gujarati	9.85	8.54
Swami et al (2015)	Haryanvi	11.07	10.21
Sinchal Datta (2017)	Mumbai (Maharashtra)	11.19	10.34
Pokhrel(2018)	Nepali	12.14	11.53
<b>Present study</b>	<b>Sangli district population</b>	<b>11.05</b>	<b>10.03</b>
	<b>Hindu Population</b>	<b>11.01</b>	<b>10.10</b>
	<b>Muslim Population</b>	<b>11.12</b>	<b>10.07</b>

**Upper Facial Height**

**Table 7.3: Comparison of mean value of Upper Facial Height with previous studies:**

Author	Population	Upper Facial Height (cm)	
		Males	Females
	Brahmin	4.44	4.42

Baral P et al(2010)	Chhetri	4.46	4.44
	Rai	4.32	4.31
	Limbu	4.33	4.32
Prasanna et al(2014)	North Indian	7.21	6.56
	South Indian	6.79	6.19
<b>Present study</b>	<b>Sangli district population</b>	<b>5.70</b>	<b>5.22</b>
	<b>Hindu Population</b>	<b>5.62</b>	<b>5.21</b>
	<b>Muslim Population</b>	<b>5.87</b>	<b>5.36</b>

**Table 7.4: Comparison of correlation coefficient (r) of STATURE with TOTAL FACIAL HEIGHT of previous studies**

Author	Population	Sex	Total Facial Height	
			r	P
Patil&Mody (2005)	Central India	M	0.925	<0.001
Jibon et al (2006)	Imphal Valley	M	0.213	<0.001
K Krishna et al (2008)	North India	M	0.455	<0.001
Kharyal et al (2008)	Himachal Pradesh	M	0.390	<0.001
		F	0.350	<0.001
Sahni et al (2010)	North west India	M	0.219	<0.002
		F	0.181	0.021
Pelin et al (2010)	Turkish	M	0.199	<0.001
Sinchal Dutta (2017)	Maharashtra	M	0.166	<0.01
		F	0.272	<0.001
Agnihotri (2011)	Indo-Mauritian	M	0.320	<0.001
		F	0.190	<0.01

K P Wankhede et al (2012)	Maharashtra	M	0.197	<0.001
		F	0.144	<0.002
Present study	Sangli district population	M	<b>0.460</b>	<b>&lt;0.001</b>
		F	<b>0.410</b>	<b>&lt;0.001</b>
	Hindu Population	M	<b>0.470</b>	<b>&lt;0.001</b>
		F	<b>0.448</b>	<b>&lt;0.001</b>
	Muslim Population	M	<b>0.421</b>	<b>&lt;0.001</b>
		F	<b>0.211</b>	<b>0.01</b>

### Conclusion

For identification of males of Sangli district population, amongst all stature and facial parameters studied, height, Lower Facial Height (LFH) and Upper Facial Height (UFH) observed to be the best parameters.

For identification of females of Sangli district population, LFH, UFH and Height found to be the best parameters.

TFH is the best facial parameter to correlate with stature in both sexes for Sangli district population.

TFH is the best facial parameter to correlate with stature in both sexes for Hindu population of Sangli district.

No single facial parameter found to be correlate with stature for Muslim females and TFH is the best parameter to correlate with height in Muslim males of Sangli district.

The present study has provided regression equations for evaluation of stature from facial parameters for Sangli district population, Hindu population and Muslim population.

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