

# Facial indices of North and South Indian Adults: Reliability in Stature Estimation and Sexual Dimorphism

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## ABSTRACT

**Introduction:** Anthropological studies have document differences in craniofacial features as well as in body characteristics among different populations. The variations in the facial morphology arise through a differential growth and they help us in distinguishing one person from another. These are controlled by a number of factors which include genetic heritage, climate and environment in which we live. Very few researchers from India have worked on these facial features with respect to population and environment. The present work was undertaken to determine whether facial variations were subjected to sexual dimorphism. In addition, comparison of facial indices was made, in order to determine possible variations between south and north Indian populations.

**Methods:** The sample consisted of 200 individuals, 100 each

from north and south Indian regions. Various facial parameters were determined on the basis of international anatomical description and facial indices were calculated.

**Results:** North Indian males and females had highest facial height and upper facial height. Facial width of south Indians was more as compared to that of north Indians in both sexes. Regression equation was calculated to compare the probable height with actual height.

**Conclusion:** All the facial parameters and facial indices were found to be statistically highly significant and they showed inter-regional and gender variations. These indices will be beneficial in facial reconstruction surgeries, maxillofacial surgeries, and in forensic medicine, for estimating the stature and sex of an individual.

**Key words:** Facial indices, Forensic anthropometry, Population, Facial height

## INTRODUCTION

The four parameters i.e., stature evaluation, age estimation, sex determination and population affiliation have been considered as the "Big Fours" of forensic anthropology. Various studies have been conducted and some are in progress in many parts of the world in this regards. Although a number of studies have been conducted in the last century or so, with regards to sexual dimorphism and stature estimation, a majority of them have focused their attention on them by using different bony components of the body. Very few researchers like Umar et al., [1] Heideri et al., [2], Ghosh and Malik [3], Jahanshahi et al., [4] Ngeow and Aljunid [5,6] and Raji et al., [7] have worked on the craniofacial anthropometrics.

India has been peopled by human groups which carry a diversity of genes and cultural traits. It has been said that India is a land of two populations. The lighter skinned Aryans and the darker skinned Dravidians. Dravidians were the original inhabitants of India, whom the invading Aryans conquered and dominated [8].

To study the Indian population, we can consider the Tropic of Cancer which passes through the middle part of India and divides it into two regions; north and south India. People who stay in north India are tall, fair and thin, while south Indians are short in stature, stout and broad. The climates of these two regions are different and hence, according to the environment, there are changes in facial features. The present work was undertaken to compare variations in north and south Indian populations, and to correlate their facial indices with the stature and sex of an individual. This correlation could be beneficial in facial reconstruction surgeries, maxillofacial surgeries, estimation of a person's stature, and even in forensic applications.

## MATERIAL AND METHODS

The sample consisted of 200 individuals with normal craniofacial configurations; 100 males and 100 females of northern and southern

India, who were older than 18 years of age. Data was collected by considering following parameters: total facial height (nasion to gnathion); upper facial height (nasion to prosthion); bizygomatic width (distance between two zygions); and height of the individual. Total and upper facial indices were calculated. The above index was determined on the basis of international anatomical descriptions. Based on this index, the types of facial shapes were categorised according to Bannister's classification [9].

In order to determine the morphological indices in each ethnic group and sex, we used the Chi-square test, and for comparison of the means of the anthropometric measurements, the Student's t-test was used. The ratio of the total height to the total body height was calculated by using the means of those heights. The correlation between total body height, total facial index and upper facial index was determined by using the regression formula. Body height and spinal stability are subjected to marked diurnal variations. Height loss occurs within 3 hours of rising in the morning, with an overall loss of about 15 mm and for avoiding possible errors, the height of each individual was measured in between 11 am and 1 pm.

## RESULTS

The findings of this study have been depicted in [Tables/Fig-1 & 2]. Statistically significant differences ( $p= 0.001$ ) were noticed on comparing the parameters of total facial index between north and south Indian females ( $107.7 \pm 7.69$  and  $85.39 \pm 6.33$  respectively), north Indian males ( $101.4 \pm 1.95$ ) and females ( $107.7 \pm 7.69$ ) and south Indian males ( $100.28 \pm 1.77$ ) and females ( $85.39 \pm 6.33$ ), and a significant difference was obtained between facial indices of total Indian males and females ( $p= 0.003$ ).

Standard comparison parameters of upper facial index between north Indian males ( $58.99 \pm 2.11$ ) and south Indian males ( $58.46 \pm 2.05$ ) and between north Indian males ( $58.99 \pm 2.11$ ) and north Indian females ( $60.4 \pm 3.59$ ) showed statistically significant differences. Upper facial index showed highly significant results

between north Indian females (60.4 ± 3.89) and south Indian females (52.3 ± 3.43), south Indian males and females (58.46 ± 2.05 and 52.3 ± 3.43 respectively), and between total Indian males and females (p= 0.001), as has been shown in [Tables/Fig-1 & 2].

North Indian females have longer upper facial heights than facial widths and therefore, their faces become longer. In contrast, the facial widths of south Indian females are larger than their upper facial heights, which cause their faces to be presented as broad to round [Tables/Fig-3 & 4].

[Tables/Fig-5] shows the correlation between height and facial height of Indian males and females per region. The average face

Parameter	Facial Index		Upper Facial Index	
	Males	Females	Males	Females
Number	100	100	100	100
Mean	100.68	96.54	58.72	56.36
Standard deviation	1.90	13.22	2.09	5.36
Maximum	109.40	118.82	64.32	66.89
Minimum	95.55	78.98	51.73	44.87
Standard error of mean	0.19	1.32	0.21	0.54
median	100.70	93.40	58.54	56.03
Degree of freedom	103		128	
t value	3.10		4.13	
Test significant	Significant		Highly Significant	
Two-tailed probability p value	0.003		<0.001	

**[Table/Fig-1]:** Comparison of facial index between Indian males and females

parameter	North Indian		South Indian		p values at 95% confidence limit	
	Males	Females	Males	Females	Males	Females
Facial length	123.6 ±4.0	117.0 ±7.4	119.7 ±5.9	101.0 ±6.2	t = 3.85 p = <0.001, HS	t = 11.99 p = <0.001, HS
Facial width	122.2 ±3.1	108.8 ±4.1	119.3 ±4.7	118.5 ±4.9	t = 3.66 p = <0.001, HS	t = 10.69 p = <0.001, HS
Upper facial length	72.1 ±3.7	65.6 ±3.5	69.7 ±2.6	61.9 ±4.5	t = 3.81 p = <0.001, HS	t = 4.56 p = <0.001, HS
Stature	1732.5 ±70.0	1560.1 ±45.5	1706.0 ±58.6	1570 ±53.8	t = 2.05 p = 0.04, S	t = 0.99 p = 0.32, NS
Facial index	101.04 ±1.95	107.7 ±7.69	100.28 ±1.77	85.39 ±6.33	t = 2.16 p = 0.03, S	t = 15.84 p = <0.001, HS
Upper facial index	58.99 ±2.11	60.40 ±3.59	58.46 ±2.05	52.30 ±3.43	t = 1.28 p = 0.21, NS	t = 11.53 p = <0.001, HS

**[Table/Fig-2]:** Comparison of facial parameters between South and North region population of India (HS- highly significant; S-significant; NS-not significant)

height was 1:13.69 and it was 1:14.93 that of the total body height for north and south Indians respectively.

Heights of the individuals were compared with their facial indices and a correlation was found between them by using, linear and multiple regression equations by using standard formulae. The height or stature can be obtained from total facial index as follows; for north Indian males: -201 ± 19.1 (Total Facial Index), SE ±4.38; South Indian males: -224 ± 19.2 (Total Facial Index), SE ±3.88; North Indian females: 1413 ± 1.37 (Total Facial Index), SE ±0.83; and South Indian females: 1463 + 1.27 (Total Facial Index), SE ±1.21. From upper facial index, the stature of an individual can be calculated as follows; for North Indian males: 754 + 16.6 (Upper Facial Index), SE ±4.15; South Indian males: 2141 - 7.43 (Upper Facial Index), SE ±3.98; North Indian females: 1381 + 2.97 (Upper Facial Index), SE ±1.78; and South Indian females: 1400 + 3.28 (Upper Facial Index), SE ±2.21.

Facial type	Facial index range	No. of North Indian males	No. of South Indian males	No. of North Indian females	No. of South Indian females
Hypereuryprosopic (very broad face)	< 79.9	0	0	0	15
Euryprosopic (Broad face)	80-84.9	0	0	2	12
Mesoprosopic (Round face)	85-89.9	0	0	1	10
Leptoprosopic(long face)	90-94.9	0	0	2	9
Hyperleptoprosopic(very long face)	>95	50	50	45	4

**[Table/Fig-3]:** Banister's classification of facial index of facial types (Chi Square test = 158.9 p = <0.001)

Facial type	Facial index range	No. of North Indian males	No. of South Indian males	No. of North Indian females	No. of South Indian females
Hypereuryene (very broad face)	< 44.9	0	0	0	1
Euryene (Broad face)	45-49.9	0	0	2	8
Mesene (Round face)	50-54.9	2	1	0	34
Leptene (long face)	55-59.9	33	41	10	6
Hyperleptene (very long face)	>60	15	8	38	1

**[Table/Fig-4]:** Banister's classification of upper facial index of facial types (Chi Square test = 197.9, p = <0.00)

parameter	North Indian male	South Indian male	North Indian female	South Indian female
Height mean (mm)	1735.2 ±70.0	1706.0 ±58.6	1560.1 ±45.5	1570.0 ±53.8
Facial length mean (mm)	123 ±4.0	119.7 ±5.9	117.0 ±7.4	101.0 ±6.2
Mean	14 ±0.45	14.27 ±0.31	13.38 ±0.83	15.59 ±0.80

**[Table/Fig-5]:** Relation between height and facial height of region wise males and females

## DISCUSSION

Anthropologists distinguish groups of people on the basis of common origin; on whether they were living or had lived in certain defined regions and had possessed different characteristic features in their appearance. Variations are found in groups who live in different geographical areas within the single species, due to individual's biological, social and other factors. During the early part of the last century, the schemes of classification of Indian people like Risley's [10], Guha's [8], and Sarkar's classifications [8] were largely based on morphological and anthropometric characters. Intra- and inter-population variations are affected by ecological, biological, geographical, racial, gender, and age factors [11]. On the basis of above factors, various workers have conducted anthropological studies on age, gender, and racial variations in different geographical areas. As a consequence, human population poses characteristics that stamp them as the residents of particular areas of world. The facial framework is expressed as the facial index, which is the ratio of facial length to facial width [7]. The population has a genetic influence on the morphological features, but expressivity of genes is affected by environmental and other factors. There are several theories that relate to the effects of temperature on head shape and facial form [12]. Buretic-Tomljanovic et al., [13], found that environmental factors such as diet, climate, and weather had a significant effect on body height and craniofacial variability in adults who were aged 18-21 years. Farkas et al., [12] studied the facial morphology of 26 ethnic groups in the world. The study included five Asian ethnic groups, among which one was Indian. The facial width in the present study showed lower values in both genders; while in case of facial height, the mean values coincided with those of Farkas' study. We also undertook the task of comparing our findings with those of Farkas' data on north American White Caucasoid adults, because Farkas had recently found that Indians presented with Caucasoid features.

## South Indians

The facial lengths of Nigerians [7] and Malaysian Indians [5] were similar to our data, but the mean facial length of Indian people from Andaman and Nicobar Island [13] was less than that which was seen in the present study. This difference may have been caused by environmental factors or food habits, which had shown a possible similar origin of Malaysian Indians, Malaysians and Nigerians, as that of south Indians. The mean facial width which was observed by Raji et al., [7] correlated with that which was seen in present study. In Pandey's study [13], it was observed that Malaysian Indians had higher values for mean facial width in both sexes. It showed that environment produced an effect on facial width when a person moved from one geographical area to other. Males had larger facial widths than females, except in cases of Malaysian females, who had more widths than their male counterparts. The upper facial length of Malaysian population was more in both sexes as compared to that in our study, with little or no difference in standard deviations. This difference may have been caused by food habits, which may have led to an increased size of the maxillary alveolar arch. Pandey's study on Indians of Andaman and Nicobar Island indicated that almost 60% males and 77% females were hyperleptoprosopic (had very broad faces) and other males. This may be due to very small population which was taken up for study, as each population contains different face types [13]. Raji and her co-workers reported that Nigerians had very long faces in both genders [7]. In the present study, southern Indian males were found to have very long faces and females had round to broad faces. According to Bannister's classification of upper facial index; south Indian males had long faces (leptene) to round faces (mesene). South Indian females had broad (euryene) to long face types.

## North Indians

The present study was similar to those of Ghosh and Malik [3] and Baruah et al., [14] which were done on Indians from Assam. The mean facial lengths of Indians from the northern region in both genders were larger than those of southern Indians. As they lived in colder weather, the weather had led to an increase in length of nose, and as a result, an increase in facial height. Facial width in present study was lower than that which was seen in Baruah and Ghosh's study which was done on north Indians. Upper facial height which was measured by Baruah et al., in Assam population was higher than that in present study, which may be attributed to geographical variations [14]. Heidari [2] conducted a study in 2009 on Baluchi and Sistani women, who showed close resemblances to northern Indians. This resemblance revealed a common origin of both, which could be explained by assuming common origin of immigrant Aryans of India and Bauchs and Sistanis of Iran.

Ghosh and Malik's [3] study which was done on West Bengal population (India) determined that Indians from this area had broad to very broad faces in both genders. Jahanshahi's study on Fars and Turkmans of Iran revealed that they had round to broad faces

[4]. In the present study, north Indian males were found to have very long faces and females showed very long to round faces. According to Bannister's classification, north Indian males had hyperleptoprosopic faces and females had hyperleptoprosopic to mesene faces.

Statistically significant differences were observed with respect to south and north Indian males and females in all facial parameters, which could be explained on the basis of hormonal influence on facial morphology.

## CONCLUSION

From our study, we can conclude that statistically significant population and sexual differences exist in all facial parameters and indices. Environmental factors are undoubtedly an effective determinant and people of northern and southern regions which indicate that they are from different origin. Sex determination and stature estimation become easy when the standard facial indices for a particular population are available. Also, these results can be used for medico-legal purposes and reconstructive surgeries, with a word of caution, that these results 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.

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