Journal of Cardiovascular Disease Research
ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 7, 2024

Type of article: Original article

ESTIMATION OF HEIGHT FROM FACIAL PARAMETERS WITH REPSECT TO GENDER IN ADULTS FROM INDORE, INDIA

Dr.Rajesh R Vijay Kumar[1], Dr.Vimal Modi[2], Dr.Palla Lydia Stotramani[3], Dr. Gudla Anil babu[4], Dr.Doddoju Veera Bhadreshwara Anusha[5*]

[1]Assistant Professor, Research Scholar,Department of Anatomy, Malwanchal University, Indore, Madhya Pradesh, India.

[2]Professor, Department of Anatomy,Index Medical College, Malwanchal University,Indore, Madhya Pradesh, India.

[3]Junior resident, Department of obstetrics and gynaecology, konaseema institute of medical sciences,amalapuram, Andhra Pradesh.

[4]Junior Resident, Department of orthopaedics, NRI medical College,chinakakani, Andhra Pradesh.

[5*]Associate Professor, Department of Community Medicine, RVM institute of medical sciences and research centre.

Corresponding Author: Dr.Doddoju Veera Bhadreshwara Anusha, Associate Professor, Department of Community Medicine, RVM institute of medical sciences and research centre.

Abstract:

Introduction: Human identification is the process of recognizing a specific person based on their distinctive physical traits. In crime investigations, one of the most useful anthropometric parameters for identifying people is their height. Forensic anthropologists' analyses and identify human remains like dry bones and skull using metric techniques. These aid in assessing age, sex, stature, ancestry, and distinctive characteristics of the skeleton. Determining a person's height and gender is crucial in forensic science when establishing their identification.

Methodology:A cross sectional study was done in adults belonging to Indore. Both the institute's ethical approval and the patients' informed permission were obtained. The participants' demographic information, Measurements of face characteristics were taken, along with height. The cephalon-facial measurements used were maximum head length (MHL), maximum head breadth (MHB), horizontal head circumference (HC), Bigonial diameter (BD), physiognomic facial length (PFL), ear length (EL), ear breadth (EB), and cephalic index (CI). All face parameter data was transformed from millimeters to centimeters and aanalysed with respect to gender. Data was analysed on Windows XP Professional using SPSS (Statistical Package for the Social Sciences). The collected data were analysed using

regression analysis, standard error of estimate, mean, standard deviation, and Karl Pearson's correlation coefficient. The estimation of height was done using regression models. Using them on a different sample of 25 males and 25 females from Indore allowed us to assess their dependability as well.

Results: There were 494 women and 506 men, with an age distribution of within the 18–50 age bracket. The best factors for male identification in the Indore population were found to be height > 172.2 cm, Bigonial width > 12.91 cm, lower facial height > 6.62 cm, and upper facial height > 6.6 cm.The ideal characteristics it was decided that the following measurements were used to identify females in the Indore population: LFH < 3.58 cm, UFH < 4.38 cm, and Height < 146.87 cm.

Conclusion: Results for the Indore, populations may be found in the regression equations supplied by this research, which assesses stature from face parameters. When forensic examinations include solely face remains, these methods have been shown accurate and reliable.

Keywords: Estimating height, Indore, Facial parameters, male, female, correlation.

INTRODUCTION

Forensic assessment of height is an important step. Bones may also be used to provide an approximation of height. An individual's estimated height may be derived from even the smallest of bodily measurements, like that of a finger.

This method of forensic anthropology is based on the notice that different body component sizes seem to cluster around a person's height for a certain mix of gender, age, and ethnicity.Forensic examination relies heavily on the proportionate biological connection of the same height as the rest of the human body—face, trunk, limbs, etc., in order to determine stature from severed or otherwise deformed body parts. Craniofacial structures are less likely to deteriorate than other types of facial bones because their anatomical features are uniform, clear, and simple to see. Even in cases when favoured predictors, such as the pelvis and long bones, are damaged or missing, accurate measurement of the person's height may be accomplished by meticulous examination of these components. Estimating height is very important.

Every part of a human body—face, head, trunk, limbs, etc.—is proportionately related to

every other part of the body. Anthropometric analysis using skeletal material yields quite quick and precise results for sex and tall determination.This study was done to know whether the models can be applied to other populations in India or throughout the world, researchers will compare the study population with others. Aiming to understand how many people's height is correlated with their facial characteristics and how it varies according to genetic, cultural, and environmental variables. To improve identification capabilities, current forensic anthropological techniques and databases may be integrated with face parameter-based height estimates. Forensic anthropology, healthcare, and multidisciplinary research may all benefit from researchers broadening the study's focus to include the Indore population and improving its influence on height estimate using face features

AIMS & OBJECTIVES OF THE STUDY

- To learn how certain anthropometric measures of the face relate to one's height
- To learn if there are any variations in height and facial features between the sexes.
- To find the regression formula for height prediction utilizing various face parameters

METHODOLOGY

A cross sectional study was done in 1000 adults belonging to Indore, India during May 2021 to November 2023 after obtaining institutional ethical committee clearance. The study's purpose was explained to subjects in both English and vernacular, and signed consent was obtained from them.

Inclusion criteria:

Individuals aged 18-60 years lived in Indore for at least five years.

Exclusion criteria

People who suffer from facial abnormalities, have had facial surgery in the past, or have any other ailment that impacts the structure of their face.

The following measures were taken:

1. Height (or stature)

2. TFH (Total Facial Height)

3. Upper facial height (UFH)
4. Lower facial height LFH
5. Nasal Height (NH)
6. Nasal Width (NW)
7. Bizygomatic width (BZW)
8. Bigonial width (BGW)
9. Biorbital width (BOW)
10. IOW, or inter-orbital width

3.3 VARIOUS ANTHROPOMETRIC LANDMARKS:

1. The zygomatic arch's most anterior side is called the zygion.

2. Gonion (go): at the angle of the mandible's most lateral aspect

3. Nasion (n): the nasofrontal suture meets the nasal root.

4. Subnasale (sn): about where the upper lip's philtrum meets the columella.

5. Gnathion (gn): midway along the protuberance of the mandible.

6. Prosthion: Located on the upper alveolar arch, halfway between the upper incisors and median incisors.

ANTHROPOMETRIC MEASUREMENTS

1. Height: The subjects were asked to stand up and have their height measured using a standard flexible steel tape measuring in centimeters from the heel to the top of their skull.

Participants were instructed to sit up straight and relax while staring at a faraway object in order to take their faces measurements. The following facial characteristics were measured using the digital vernier calliper:

2. Total facial height: Measure the distance between Nasion and Gnathion in millimetres to get the total face height.

3. Upper facial height- The height of the upper face may vary from nasion to prosthion on a mathematical scale.

4. Lower facial height — ranging from prosthion to gnathion, measured in metres.

5. Nasal aperture height- Measured in millimeters, it extends from the nose to the tip of the nose.

6. Nasal aperture width- The greatest transverse distance in millimeters between the nasal aperture's right and left edges.

7. Bizygomatic width- It is the measurement of the whole breadth of the face, sometimes called bizygomatic width. It is the distance between the two zygomatic arches.

8. Bigonial width- Measured in millimeter's, it is the widest possible space between the right and left mandibular angles.

9. Bi-orbital width- It is the measurement in millimeters that separates the periphery of the left and right orbits.

10. Inter-orbital width- It is the measurement in millimeters that divides the space between the inside of the two orbits.

3.5 PHOTOGRAPHIC ILLUSTATION

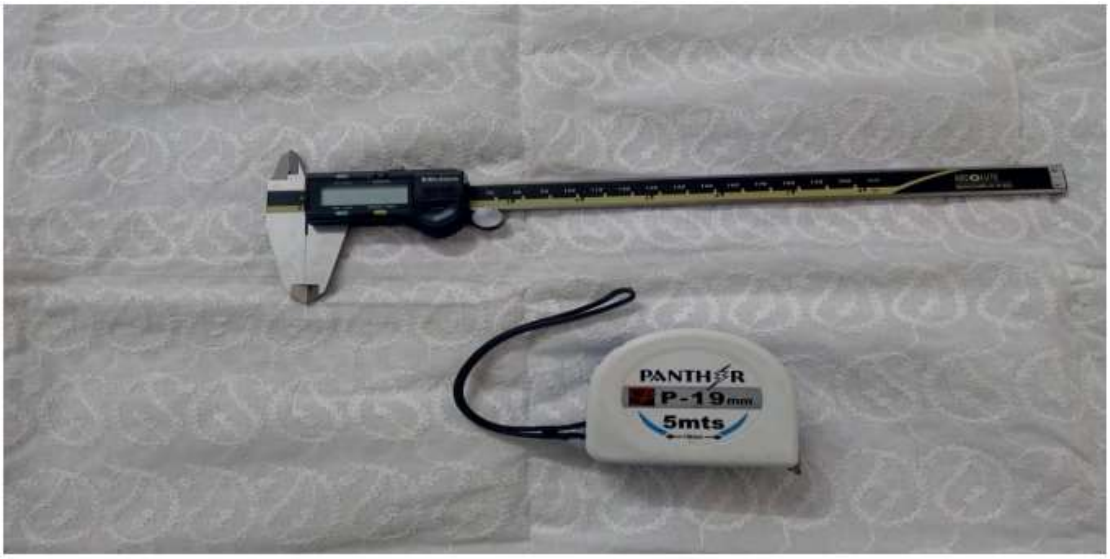

Fig 3.1 Measurement tape with digital vernier calliper

Towering height

Fig 1 Measurement taken when standing, from the ball of the foot to the crown of the head

ANALYSING DATA STATISTICALLY

Every facial feature was converted to centimetres. Software: SPSS 22.0, developed and maintained by SPSS Inc. and housed at IBM in Delaware, was used to analyses the data after it had been coded and put into an Excel sheet. All of the variables were given descriptive statistics, which include mean, standard deviation, and range. The collected data were analysed using regression analysis, standard error of estimate, mean, standard deviation, and Karl Pearson's correlation coefficient. The estimation of height was done using regression models. Using them on a different sample of 25 males and 25 females from Indore allowed us to assess their dependability as well.Statistical significance set at $p< 0.05$.

Results:

Table 1: Distribution of study population by age and gender.

Age Group	Male	Female	Total
18-30	434	419	853
31-40	57	55	112
41-50	15	20	35
Total	506	494	1000

There were 494 women and 506 men, with an age distribution of within the 18–50 age bracket.

Table 2: Distribution of Face proportion parameter with respect to Gender (n=1000, M=506, F=494)

FP	Sex	Mean	SD	SEE	Min	Max	P value

TFH	M	11.05	0.71	0.031	8.95	12.96	<0.001
	F	10.03	0.70	0.031	7.67	13.13	
UFH	M	5.70	0.44	0.020	4.16	7.12	<0.001
	F	5.22	0.46	0.021	3.63	6.73	
LFH	M	5.35	0.59	0.026	3.48	7.37	<0.001
	F	4.79	0.61	0.027	2.20	7.97	
NH	M	4.76	0.41	0.018	1.58	5.77	<0.001
	F	4.49	0.46	0.021	1.55	4.96	
NW	M	3.63	0.34	0.015	2.38	4.54	<0.001
	F	3.32	0.37	0.016	1.33	4.96	
BOW	M	10.11	0.54	0.024	7.70	11.73	<0.001
	F	9.72	0.53	0.024	7.23	11.34	
IOW	M	3.40	0.35	0.016	2.39	4.88	<0.001
	F	3.25	0.34	0.015	1.90	4.75	
BZW	M	11.84	0.73	0.033	9.59	13.90	<0.001
	F	11.49	0.71	0.032	9.21	13.89	
BGW	M	10.87	0.83	0.037	9.38	13.44	<0.001
	F	10.42	0.83	0.037	8.32	12.89	
Height	M	167.54	6.89	0.305	145	185	<0.001
	F	153.01	6.41	0.289	133	173	

(*P<0.001; highly statistically significant)

Males in the Indore population outnumber females across the board when it comes to height and other face features. All of the metrics show a statistically significant difference. The best factors for male identification in the Indore population were found to be height > 172.2 cm, Bigonial width > 12.91 cm, lower facial height > 6.62 cm, and upper facial height > 6.6 cm.The ideal characteristics it was decided that the following measurements were used to identify females in the Indore population: LFH < 3.58 cm, UFH < 4.38 cm, and Height < 146.87 cm. (Table 2)

Table 3: Analysis of the study population's height in relation to face characteristics using regression and the correlation coefficient (r).

FP	Sex	R value	Regression equation Y = a+bx	SEE	P value
TFH	M	0.462	Y = 117.43+4.5TFH	6.11	<0.001
	F	0.411	Y = 115.72 + 3.7 TFH	5.87	<0.001
UFH	M	0.224	Y = 147.78+3.8 UFH	6.73	<0.001
	F	0.267	Y = 133.69+3.7 UFH	6.19	<0.001
LFH	M	0.381	Y = 143.29+4.5LFH	6.36	<0.001
	F	0.228	Y = 142.13+ 2.3 LFH	6.27	<0.001
NH	M	0.224	Y = 149.71+3.7NH	6.73	<0.001
	F	0.239	Y = 138.58+3.2NH	6.25	<0.001
NW	M	0.087	Y = 161.67+1.6NW	6.88	0.07
	F	0.136	Y = 145.30+2.3NW	6.36	0.003
BOW	M	0271	Y = 132.27+3.4BOW	6.64	<0.001
	F	0.283	Y = 119.18+3.4BOW	6.15	<0.001
IOW	M	0.192	Y = 155.07+3.6IOW	6.77	<0.001
	F	0.132	Y = 152.52+3.5IOW	6.65	<0.001
BZW	M	0.295	Y = 129.92+3.6BZW	6.53	<0.001
	F	0.269	Y = 124.71+2.8BZWx	6.45	<0.001
BGW	M	0.078	Y = 161.03+0.8BGW	7.52	<0.001
	F	0.144	Y = 142.64+1.2BGW	6.62	<0.001

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

In males, all face indicators except for NW,IOWand BGW demonstrated a strong positive connection with height (P <0.001). Out of all the facial characteristics, Total Facial Height

(TFH) had the best connection with height. When it comes to men in the study population, TFH is the most reliable face metric for height correlation with r value 0.462.

In females there was a substantial positive connection between height and all face measures, with the exception of NW, IOW, and BGW ($p < 0.001$). Total Facial Height (TFH) was shown to be the most effective facial feature for female height correlation, with an R-value of 0.411 and the lowest SEE - 5.87.

The r‖ value of TFH is higher in men (0.462) than in females (0.411) in Indore, when comparing the sexes. In the Indore community, TFH is the most reliable face measure for predicting height for both sexes. (table 3)

Table 4: Methods for Estimating Male Height (cm) from Cephalo-Facial Measurements Using Regression Equations

Regression Equation	Standard Error of Estimate (SEE)
Height= 146.29+1.329(MHL)	6.20
Height= 147.74+1.695(MHB)	6.16
Height= 126.97+0.813(HC)	6.12
Height= 152.36+1.803(BD)	6.18
Height= 152.89+1.647(MFL)	6.12
Height= 148.89+1.268(PFL)	6.15
Height= 175.98+(-0.650)EL	6.27
Height= 166.59+1.493(EB)	6.26
Height= 165.35+0.086(CI)	6.27

Equations for calculating stature from cephalon-facial measurements were shown. The cephalon-facial measurements used were maximum head length (MHL), maximum head breadth (MHB), horizontal head circumference (HC), Bigonial diameter (BD), physiognomic

facial length (PFL), ear length (EL), ear breadth (EB), and cephalic index (CI). Here is an example of a hypothetical regression equation:Get your stature by adding a and bx.

The regression coefficients of the independent variable (any cephalon-facial measurement) and the dependent variable (stature) are denoted by 'a' and 'b,' respectively, and 'x' may be any cephalon-facial measurement. Horizontal head circumference and morphological facial length had the lowest standard error of estimation (SEE).

Table 5: Methods for Estimating Female Height (cm) from Cephalo-Facial Measurements Using Regression Equations

Regression Equation	Standard Error of Estimate (SEE)
Height= 96.30+3.323(MHL)	5.96
Height= 115.07+3.090(MHB)	6.02
Height= 62.88+1.761(HC)	5.74
Height= 115.54+4.144(BD)	5.94
Height= 135.64+2.008(MFL)	6.14
Height= 125.75+1.738(PFL)	6.12
Height= 139.70+2.788(EL)	6.25
Height= 149.63+2.268(EB)	6.33
Height= 150.26+0.083(CI)	6.36

Equations for calculating stature from cephalon-facial measurements for females were shown, with the values of cephalon-facial measurements. The cephalon-facial measurements used were maximum head length (MHL), maximum head breadth (MHB), horizontal head circumference (HC), Bigonial diameter (BD), physiognomic facial length (PFL), ear length (EL), ear breadth (EB), and cephalic index (CI). Get your stature by adding a and bx.

The regression coefficients of the independent variable (any cephalon-facial measurement) and the dependent variable (stature) are denoted by 'a' and 'b,' respectively, and 'x' may be any

cephalon-facial measurement. In terms of horizontal head circumference, the SEE is at its lowest.

DISCUSSION

From May 2021 to November 2023, the research was carried out at the Anatomy department. One thousand adult Participants in the study ranged in age from eighteen to fifty years old. The research did not include individuals who had undergone face surgery, had facial deformities, abnormalities of the height, or facial congenital defects.

With the subjects' informed written agreement and the institute's ethical approval, the research was done. Participants' demographic information, as well as their height and nine face attributes, were gathered

People between the ages of 18 and 30 made up the bulk of the sample in this research. The average age of the males was 23.66 ±7.16 years and the females were 23.72 ±7.12 years. There were 51% males and 49% females.

Among four endogamous groups in Nepal's Sunsari area, Baral P et al. also discovered a slightly higher male population (51% vs. 49%). [1]

Research conducted in central India by Wankhede KP et al. also found similar results; The average age of the participants was 19.42 years, and there were 55.31 percent males and 44.69% girls in the research.[2]

STATURE/HEIGHT

In every prior study conducted by different researchers, males average height was higher than females average height. The results of our investigation corroborate this. Males in this study's Indore population, had a mean height of 167.54 cm, which is similar to research done on the Nepalese population by Pokharel.[3] The average male height in this research is greater than the Sri Lankan population but lower than the Indo-Mauritian population.

TOTAL FACIAL HEIGHT

Males in the Indore population have an average total face height of 11.05 ±0.71 cm, while females have an average of 10.03 ±0.70 cm, a difference that is very significant statistically. ($P<0.000$).

Studies done by Sinchal Datta on Mumbai men and women[4] and the Haryanvi study by Swami et al. on males and females both had similar results, which indicated that men and women in Indore had equal mean total face heights. Although they are more than in Gujarati130 and Tamil Nadu, the levels are lower when compared to males and females from other countries. [5]

UPPER FACIAL HEIGHT

This research lends credence to the idea that Indore residents had lower mean values for Upper Facial Height (men 5.70 cm, women 5.22 cm) in comparison to their Northern and Southern Indian equivalents. Compared to the research conducted by Shetti et al., these values are higher[6].Mean morphological face length, value in males was 11.07cm & 10.21 cm in females. Study by Mahesh Kumar et al the mean values were more in males as compared to females. This is in agreement with the studies done by previous authors.[7] The mean facial lengths of all the previous studies done on various population groups of the world are higher than the present study both in males and females except North Indian Kolis (Krishan & Kumar) and North Indian Gujjars (Krishan) where it was less than the present study in males.[8,9]

LOWER FACIAL HIGHT

Males in Indore had a lower mean face height (5.35 cm), which is lower than the Nigerian population but similar to research conducted by Shetti et al and Otoole AJet al.[6,10]

In study by Kallianpur et al, Facial heights were found to be higher in males in both groups. Unpaired *'t'* test results between UFH, LFH and TFH in males and females did not show significant correlation. No statistically significant difference was found in facial height proportions between the two races.[11] Patil and Mody found the highest correlation (r' value of 0.925) between stature and total face height among males from central India.[12]

BIZYGOMATIC WIDTH

In the study performed by Yesmin et al., the mean and standard deviation value of bizygomatic width was found as 127.3 ± 8.0 mm.[13] Also study by Rumeysan et al shows parallelism with our results.[14]

NASAL HEIGHT;

Across all study groups, males had a noticeably larger nose height than female. [13,14]

NASAL WIDTH;

Across all demographics analysed, men had a wider nasal bridge than women. Also, our research backs this up. Compared to the populations of Western Uttar Pradesh, Jat, and Indore, the nasal width of the Indore population in this research is greater for both sexes. Variations in environment, genetics, ethnicity, or geography could be to blame for the discrepancy.

BI-ORBITAL WIDTH

In this research, men had a wider bi-orbital breadth than women did on average. The current study's male and female participants had wider bi-orbital bones than the populations of M.P, Pune, and Kenya.[8]

INTER-ORBITAL WIDTH

The current research found that men had a greater mean inter-orbital width than women.

BIGONIAL WIDTH

Bigonial breadth was greater in men than in women in this research.In present study, values of mean bigonial diameter of males were found to be higher than the previous studies conducted by Krishan & Kumar (2007), Krishan (2008), Pelin et al., (2010), Sahni et al., (2010) &Aghnotri et al., (2011).[8,9,15,16,17]

A significant R-value of 0.461 indicates a robust positive association between stature and zygomatic breadth in research conducted by K Krishna on men from North India.[9]

CONCLUSION

The investigation included both male and female volunteers, with ages ranging from 18 to 50 population's total sample size of 1000. Total face height, upper face height, lower face height, nasal aperture width, bi-orbital width, inter-orbital width, and total face width/bizygomatic width are the characteristics that are being measured. The examination of stature was done using regression models. Using them on a different sample of 25 boys and 25 females from Indore allowed us to assess their dependability as well. The best stature and face criteria for

male identification in the Indore population were found to be measures of the height, Bigonial width, lower face height, and upper facial height respectively.We discovered that LFH, UFH, and height were the most useful factors for identifying females in the Indore population. Our summary is based on a comparison of the standard error of estimate and every one of the values of the correlation coefficients calculated by Karl Pearson face parameters that were analysed.

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