The Academic
International Journal of Multidisciplinary Research

An Online Peer Reviewed / Refereed Journal
Volume 2 | Issue 5 | May 2024
ISSN: 2583-973X (Online)
Website: www.theacademic.in

Stature Estimation from Cephalo-Facial Measurements in Parsi Population of Gujarat Region

Grishma Pithiya
Research Scholar, Department of Biochemistry and Forensic Science,
Gujarat University, Ahmedabad, Gujarat, India

Ankita Patel*
Assistant Professor, Department of Biochemistry and Forensic Science,
Gujarat University, Ahmedabad, Gujarat, India
anki.patel122@gmail.com

Nidhi Gondaliya
Assistant Professor, Department of Life Science,
Gujarat University, Ahmedabad, Gujarat, India

ARTICLE DETAILS

Research Paper

Keywords:

Forensic Science, Forensic anthropology, Cephalo-facial measurements, Stature, Parsi Population

ABSTRACT

In the forensic examination of unidentified, extremely decayed, lacerated, and fragmented human remains stature estimation is an important task. Stature assessment is crucial in circumstances where cranial remains are submitted for medico-legal analysis. This research aims to derive regression formulas that may be used to estimate the stature of individuals in the Parsi community of Gujarat based on craniofacial measurements. A total number of 105 Parsi adults (46 females and 59 males) aged between 20-70 years were preferred for this study. Standard anthropometric instruments (measuring tape and spreading caliper) were used for the cephalon-facial measurements such as head breadth, stature, and head length. The dependent variable in this study was stature, whereas the cephalo-facial measures were the independent variables. The data was then statistically analyzed and all the probable models of linear regression for females and males were demonstrated for the perfect mode. The comparison of the real and anticipated statures confirmed the accuracy of the regression equation.

Compared to the Head Breadth and the Stature, the Head Length and the Stature had a stronger positive and significant coefficient of connection.

1. Introduction:

Stature is composed of the height and length of five skeletal structures i.e., pelvis, vertebral column, skull, ankles, and lower limbs. (Byers S.N., 2016) At times in forensic examination, there is the involvement of undiscovered, disintegrated, mismatched human remains. In such medico-legal cases, stature estimation plays an important role along with the determination of sex, age, and ancestry to establish the identity of a deceased. (Wankhede et al., 2015)There are two main methods for the estimation of living stature i.e., the Anatomical method and the Mathematical method. The anatomical approach involves measuring all the skeletal components from the head to the foot and then applying a correction factor to account for the presence of soft tissues. The mathematical technique focuses on the ratio between different bones and live stature, as this ratio remains constant regardless of age after skeletal maturity has been reached. (Pelin et al., 2010) For stature estimation, regression analysis is the best mathematical method to the extent that the accuracy of the estimate is concerned. (Krishan & Kumar, 2007)Several studies have been done on an estimation of ethnicity and sex from craniofacial analysis but there is limited research on the determination of stature from craniofacial measurements. (Khodke et al., 2015)It becomes more important in such medico-legal cases, where only the skull or head is available for examination. (Krishan & Kumar, 2007) Studies show that stature also differs according to race, sex, age, nutrition, etc.(Wankhede et al., 2015) Studies have proved that different populations or races should have separate regression formulae for the estimation of stature due to their varied culture, climates, habits of living, etc.(Khodke et al., 2015; Wankhede et al., 2015) The data regarding stature estimation from cephalon-facial measurements in the Parsi Population is scarce and hence, there is a need for a systematic anthropometric study of the Parsi population. The current study proposes to obtain the regression equations for stature estimation from craniofacial measurements in the Parsi Population of the Gujarat region.

2. Material and Method:

2.1 Sample size and Study location

The current research was conducted on randomly selected 105 Parsi adults, including 46 females and 59 males aged 20 to 70. The samples were collected from subjects of the adult age group to avoid age-

specific changes. The data were collected in December 2021e from Parsi community residences located in Udvada, Surat, and Ahmedabad district of Gujarat, India. Early in the 20th century, Parsis immigrated to India, settled first in Gujarat state, and remained for almost 800 years. (The editors of Encyclopedia Britannica, 2022)The population of the Parsi community is continuously declining.(Manoj Nair, 2019)

2.2 Sample selection criteria and Anthropometric methodology

Every participant came from a distinct socioeconomic background and had no craniofacial injury or undergone any major head surgery. Prior to data collection, each participant gave their informed permission. The subsequent to avoid diurnal variation, anthropometric measures were acquired from each individual between the hours of 12 and 5 pm. Standard anthropometric instruments were used to collect measurements in centimeters.

Stature: "Stature was measured with a standard anthropometer as the vertical distance from the vertex to the floor when the person is standing erect on a horizontal resting plane barefooted having the palms of the hands turned inwards and the fingers pointing downwards and the head in the Frankfort plane."(Byers S.N., 2016)

Head Length (HL): "The distance between the Glabella and the Opisthocranion was measured with Spreading Caliper (g-op)."(Byers S.N., 2016)

Head Breath (HB): "The distance between two Euryon was measured with Spreading Caliper(eu-eu)."(Byers S.N., 2016)

2.3 Statistical Analysis

The data taken were appropriately recorded and statistically analyzed. All of the measures yielded descriptive statistics, such as mean, standard error, and standard deviation. Linear régression equations for females and males individually as well as for total subjects were calculated. Pearson's Correlation coefficients were also derived. IBM Statistical Package for Social Sciences (SPSS) Version 26.0.0 was used for all statistical analysis.

3. Result:

Table 1 represents the descriptive statistics for each subject, including the average, minimum, maximum, and standard deviation of their stature, head breadth, and head length. This data shows statistics for all subjects including both male and female subjects.

Table 1-Descriptive Statistics of all the Parsi Subjects

	N	Min	Max	Mean		Std. Deviation
				Statistic	Std. Error	
Stature (Measured Height) cm	105	134.62	203.20	169.66	1.33	13.64
Head Breadth (eu-eu) cm	105	10.5	19.2	14.37	.1542	1.57
Head Length (g-op) cm	105	14.5	21.4	18.34	.1316	1.34

***Min-Minimum, † Max-Maximum**

	N	Min	Max	Mean	Std. Deviation

For the male

				Statistic	Std. Error	
Stature (Measured Height) cm	59	154.94	203.20	175.72	1.6515	12.68
Head Length(g-op) cm	59	15.5	21.4	19.00	.1510	1.16
Head Breadth(eu-eu) cm	59	12.5	19.2	15.33	.1416	1.08

Parsi subjects exclusively, Table 2 represents the descriptive statistics, including the Mean, Minimum, Maximum, and Standard Deviation of Stature, Head Breadth, and Head Length.

Table 2- Descriptive Statistics of Male Parsi Subjects

***Min-Minimum, † Max-Maximum**

Table 3 presents the descriptive statistics for the female Parsi subjects exclusively, including the Mean, Minimum, Maximum, and Standard Deviation of Stature, Head Breadth, and Head Length.

Table 3- Descriptive Statistics of the Female Parsi Subject

	N	Min	Max			Std. Deviation
				Statistic	Std. Error	
Stature (Measured Height) cm	46	134.62	195.58	161.89	1.56802	10.63

	Head Breadth(eu-eu) cm	46	10.5	16.2	13.14	.1808	1.22
	Head Length(g-op) cm	46	14.5	21.2	17.51	.1611	1.09

***Min-** **Minimum, †**

Max- **Maximum**

For each Parsi subject, Table 4 shows the correlation between stature and head length and stature and head breadth, respectively.

Table 4- 2-tailed Pearson's Correlation Co-efficient between Stature, Head Breadth, and Head Length for all the Parsi Subjects.

		Stature (Measured Height) cm	Head Breadth (eu-eu) cm	Head Length (g-op) cm
Stature (Measured Height) cm	Pearson Correlation	1	.319**	.473**
	Sig. (2-tailed)		.001	.000
	N	105	105	105
Head Breadth (eu-eu) cm	Pearson Correlation	.319**	1	.491**
	Sig. (2-tailed)	.001		.000
	N	105	105	105
Head Length (g-op) cm	Pearson Correlation	.473**	.491**	1
	Sig. (2-tailed)	.000	.000	
	N	105	105	105

**. Correlation is significant at the 0.01 level (2-tailed).

According to Table 5, there is a correlation between the male Parsi subjects' stature and head length and stature and head width.

Table 5- 2-tailed Pearson's Correlation Coefficient between Stature, Head Length, and Head Breadth

		Stature (Measured Height) cm	Head Length (g-op) cm	Head Breadth (eu-eu) cm
Stature (Measured Height) cm	Pearson Correlation	1	.375**	-.073
	Sig. (2-tailed)		.003	.584
	N	59	59	59
Head Length(g-op) cm	Pearson Correlation	.375**	1	.000
	Sig. (2-tailed)	.003		.998
	N	59	59	59
Head Breadth(eu-eu) cm	Pearson Correlation	-.073	.000	1
	Sig. (2-tailed)	.584	.998	
	N	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

for the Male Parsi Subjects.

Table 6 shows the correlation between the stature of female Parsi subjects and their head length and head breadth, respectively.

Table 6- 2-tailed Pearson's Correlation Coefficient between Stature, Head Breadth, and Head Length for the Female Parsi Subjects.

		Stature (Measured Height) cm	Head Breadth (eu-eu) cm	Head Length (g-op) cm
Stature (Measured Height) cm	Pearson Correlation	1	-.013	.103
	Sig. (2-tailed)		.931	.497
	N	46	46	46
Head Breadth(eu-eu) cm	Pearson Correlation	-.013	1	.410**
	Sig. (2-tailed)	.931		.005
	N	46	46	46
Head Length(g-op) cm	Pearson Correlation	.103	.410**	1
	Sig. (2-tailed)	.497	.005	
	N	46	46	46

**. Correlation is significant at the 0.01 level (2-tailed).

The linear regression models for calculating each Parsi subject's stature (in centimeters) based on cephalo-facial data are shown in Table 7.

Table 7: Regression Formulae for estimation of stature from the head length and head breadth for all the Parsi subjects

	Regression Formulae

HL	4.78*HL+81.80
HB	2.75*HB+130.08

***HL- Head Length, † HB-Head Breadth**

For just the male Parsi subjects, Table 8 presents the linear regression equations for determining stature (in centimeters) using cephalo-facial measures.

Table 8: Regression Formulae for estimation of stature from the head length and head breadth for Male Parsi subjects

	Regression Formulae
HL	4.09*HL+97.90
HB	-0.84*HB+188.73

***HL- Head Length, † HB-Head Breadth**

Only for the female Parsi subjects, Table No. 9 presents the linear regression equations for the calculation of stature (cm) using cephalo-facial measures.

Table 9: Regression Formulae for estimation of stature from the head length and head breadth for Female Parsi subjects

	Regression Formulae
HL	0.99*HL+144.40
HB	-0.11*HB+163.40

***HL- Head Length, † HB-Head Breadth**

4. Discussion:

For Stature estimation, Regression analysis is the best mathematical method to the extent that the accuracy of the estimate is concerned. (Krishan & Kumar, 2007) Ultimate care was taken while taking measurements of the subjects. (Krishan, 2012) This study has been carried out on the Parsi Population of

Gujarat where no previous study has been carried out. The average stature for male is recorded as greater than that of female (Agnihotri et al., 2011; Celbis & Agritmis, 2006; Edet et al., 2021; Habib & Kamal, 2010; Kalia et al., n.d.; Patil & Mody, 2005; Reddy et al., 2018; Sahni et al., 2010; Sen et al., 2014; Sen & Ghosh, 2008; Shah et al., 2020; Shrestha et al., 2015; Wankhede et al., 2015) Bardole and Dixit, found the correlation of Stature and Head Length as 0.39 for male subjects and 0.32 for female subjects, whereas the correlation for Stature and Head Breadth was recorded as 0.26 for male subjects and 0.23 for female subjects. (Bardale et al., 2006) Another study conducted by Arun Kumar Agnihotri et al. for the Indo-Mauritian population shows the correlation for Stature and Head Length as 0.331 for male subjects and 0.159 for female subjects. However, the correlation for Stature and Head Breadth was recorded as 0.193 and 0.015 respectively for female subjects and male subjects. (Agnihotri et al., 2011) A study conducted on the Nepalese population shows a correlation between Stature and Cranium Length as 0.494 for male craniums and 0.243 for the female cranium, whereas the correlation for Stature and Cranium Breadth was recorded as 0.383 and 0.271 respectively for male craniums and female craniums. (Shrestha et al., 2015)Another study conducted by Priti Nemade et al. in Maharashtra shows a very significant correlation for Stature and Head Length and Stature and Head Breadth as 0.718 and 0.598 respectively for all the subjects. Female subjects show a correlation for Stature and Head Length and Stature and Head Breadth as 0.677 and 0.578 respectively. For Male subjects show a correlation for stature and Head Length and Stature and Head Breadth as 0.745 and 0.536 respectively. (Khodke et al., 2015) A study conducted on the Sudanese population shows a correlation for Stature and Head Length as 0.218 for male subjects and 0.289 for female subjects. However, the Correlation for Stature and Head Breadth was recorded as -0.079 in males which indicates that the Head Breadth has shown less significantly correlate with stature in males. For Female subjects, a correlation for Stature with Head Breadth was recorded as 0.195, which indicates a positive correlation of stature with head breadth in female subjects than the male subjects. (Ahmed & Taha, 2016) Another study conducted in Japan Shows Correlation for Stature with Cranium Length is 0.608 and the correlation for Stature with Cranium Breadth is 0.551 in all the samples of Computed Tomographic Images. (Torimitsu et al., 2016) A study conducted by Kewal Krishan on adult male Gujjars shows Correlation for Stature and Head Breadth is 0.682 and the correlation for Stature and Head Length is 0.775, which is highly significant for stature estimation. (Krishan, 2008) Another study conducted by Renu Kamal et al. shows the correlation for Stature and Head Breadth as 0.085 for male subjects and 0.162 for female subjects. However, the correlation for Stature and Head Length was recorded as 0.182 for male subjects and 0.355 for female subjects. (Kamal & Yadav, 2016) A study conducted by Chiba and Terezawa on Japanese cadavers,

found the correlation between Stature and Cranium Length as 0.39 for male subjects and 0.003 for female subjects. (Chiba & Terazawa, 1998) Another Study conducted by Kanchankumar P. Wankhede et al. for Central Indian Population shows a correlation for Stature and Head Breadth as 0.262 for female subjects and 0.53 for male subjects, whereas the correlation for Stature and Head Length was recorded as 0.206 for female subjects and 0.279 for male subjects. (Wankhede et al., 2015)

In the present study, the correlation for Stature and Head Length was recorded as 0.473 whereas the correlation for Stature and Head Breadth was recorded as 0.319 for all Parsi Subjects. As the 2-tailed Pearson correlation coefficient was also considered, the correlation coefficient for Head Length and Head Breadth was recorded as 0.491 for all Parsi subjects. we discuss separate findings of Male Parsi Subjects and Female Parsi Subjects, Male Parsi Subjects show the correlation for Stature and Head Length recorded as 0.374 and the correlation for Stature and Head Breadth recorded as -0.072, whereas Female Parsi Subjects show the correlation for Stature and Head Length recorded as 0.102 and the correlation for Stature and Head Breadth recorded as -0.013. The correlation for Head length and Head Breadth was recorded as 0.998 for the Male Parsi subjects, whereas the Female Parsi subjects show a correlation of 0.410 for Head Length and Head Breadth. The present study's findings point out that Head Length is more significantly correlated with Stature than that head Breadth in Male subjects and female subjects. If we discuss all subjects from Parsi Population, Head Length and Head Breadth both Significantly correlate with Stature though the Head Length is more significantly correlated with Stature than Head Breadth Head Breadth also shows a very positive correlation with Stature. Hence Head length is a better criterion for male and female both for estimation of Stature when Fragmentary remains of the skull are brought for analysis in the Forensic.

5. Conclusion:

The present study concludes that maxillofacial plays a vital role in stature estimation as any other if part of the body is brought for medico-legal examination. It was seen that the maxillofacial region measurements gave a reliable result for stature estimation. Furthermore, it is determined that the computed regression equations exhibit improved estimation consistency and accuracy in both the research sample and a random sample drawn from a mixed community of Gujarati Parsis. These formulas are population-specific and won't work on populations from other parts of the world since they won't provide relevant results.

Acknowledgment:

The subjects willingly agreed to participate in the study and provided the information and data needed for the research, for which the authors are grateful.

Source of Funding:

No funding agency specifically awarded a grant for this research.

Conflict of Interest:

There is no conflict of interest, according to the authors.

References:

Agnihotri, Arun Kumar, et al. 'Estimation of Stature from Cephalo-Facial Dimensions by Regression Analysis in Indo-Mauritian Population'. *Journal of Forensic and Legal Medicine*, vol. 18, no. 4, May 2011, pp. 167–172, doi: 10.1016/j.jflm.2011.02.006.

Ahmed, Altayeb Abdalla, and Samah Taha. 'Cephalo-Facial Analysis to Estimate Stature in a Sudanese Population'. *Legal Medicine*, vol. 20, Elsevier B.V., May 2016, pp. 80–86, doi: 10.1016/j.legalmed.2016.04.008.

Bardale, R., et al. 'Estimation of Stature from Somatometry of Skull'. *Journal of Medico Legal Association of Maharashtra2006*, vol. 18, 2006, pp. 22–26.

Byers S.N. *INTRODUCTION TO FORENSIC ANTHROPOLOGY*. Fifth Edition, 2016.

Celbis, Osman, and Hasan Agritmis. 'Estimation of Stature and Determination of Sex from Radial and Ulnar Bone Lengths in a Turkish Corpse Sample'. *Forensic Science International*, vol. 158, no. 2–3, May 2006, pp. 135–139, doi: 10.1016/j.forsciint.2005.05.016.

Chiba, Misako, and Koichi Terazawa. 'Estimation of Stature from Somatometry of Skull'. *Forensic Science International*, 1998, pp. 87–92.

Edet, Iboro E., et al. 'Stature Reconstruction from Measurements of Craniofacial Parameters: A Study of the Oro People of Akwa Ibom State'. *International Journal of Research and Innovation in Applied Science*, vol. 06, no. 04, 2021, pp. 90–94, doi:10.51584/IJRIAS.2021.6405.

Habib, Sahar Refaat, and Nashwa Nabil Kamal. 'Stature Estimation from Hand and Phalanges Lengths of Egyptians'. *Journal of Forensic and Legal Medicine*, vol. 17, no. 3, Apr. 2010, pp. 156–160, doi: 10.1016/j.jflm.2009.12.004.

Kalia, Shalini, et al. *Stature Estimation Using Odontometry and Skull Anthropometry*. https://www.ijdr.in/text.asp?2008/19/2/150/40471.

Kamal, Renu, and Praveen Kumar Yadav. 'Estimation of Stature from Different Anthropometric Measurements in Kori Population of North India'. *Egyptian Journal of Forensic Sciences*, vol. 6, no. 4, Egyptian Forensic Medicine Authority, Dec. 2016, pp. 468–477, doi: 10.1016/j.ejfs.2016.12.001.

Khodke, Priti Nemade, et al. 'Regression Analysis on Stature Estimation from Cephalic Dimensions'. *Indian Journal of Basic and Applied Medical Research*, vol. 4, no. 3, 2015, pp. 298–312.

Krishan, K. 'Anthropometry in Forensic Medicine and Forensic Science-'Forensic Anthropometry''. *The Internet Journal of Forensic Science*, vol. 2, no. 1, 2012, pp. 1–8, doi:10.5580/1dce.

Krishan, Kewal. 'Estimation of Stature from Cephalo-Facial Anthropometry in North Indian Population'. *Forensic Science International*, vol. 181, no. 1–3, Elsevier Ireland Ltd, Oct. 2008, pp. 52.e1-52. e6, doi: 10.1016/j.forsciint.2008.08.001.

Krishan, Kewal, and Raj Kumar. 'Determination of Stature from Cephalo-Facial Dimensions in a North Indian Population'. *Legal Medicine*, vol. 9, no. 3, May 2007, pp. 128–133, doi: 10.1016/j.legalmed.2006.12.001.

Manoj Nair. 'As Their Population Declines, Parsi-Zoroastrians Struggle to Manage Religious Properties'. *Hindustan Times*, Mumbai: 20 Jan. 2019.

Patil, Kanchan R., and Rajendra N. Mody. 'Determination of Sex by Discriminant Function Analysis and Stature by Regression Analysis: A Lateral Cephalometric Study'. *Forensic Science International*, vol. 147, no. 2-3 SPEC.ISS., Jan. 2005, pp. 175–180, doi: 10.1016/j.forsciint.2004.09.071.

Pelin, Can, et al. 'Body Height Estimation from Head and Face Dimensions: A Different Method'. *Journal of Forensic Sciences*, vol. 55, no. 5, 2010, pp. 1326–1330, doi:10.1111/j.1556-4029.2010.01429. x.

Reddy, Munish, et al. 'Correlation and Estimation of Stature from Cephalofacial Measurements: A Study on Western Uttar Pradesh Population'. *Journal of Forensic Dental Sciences*, vol. 10, no. 2, Informatics Publishing Limited, 2018, p. 101, doi: 10.4103/jfo.jfds_30_16.

Sahni, Daisy, et al. 'Estimation of Stature from Facial Measurements in Northwest Indians'. *Legal Medicine*, vol. 12, no. 1, Jan. 2010, pp. 23–27, doi: 10.1016/j.legalmed.2009.10.002.

Sen, Jaydip, et al. 'Estimation of Stature from Lengths of Index and Ring Fingers in a North-Eastern Indian Population'. *Journal of Forensic and Legal Medicine*, vol. 22, Churchill Livingstone, 2014, pp. 10–15, doi: 10.1016/j.jflm.2013.11.010.

Sen, Jaydip, and Shila Ghosh. 'Estimation of Stature from Foot Length and Foot Breadth among the Rajbanshi: An Indigenous Population of North Bengal'. *Forensic Science International*, vol. 181, no. 1–3, Elsevier Ireland Ltd, Oct. 2008, pp. 55.e1-55. e6, doi: 10.1016/j.forsciint.2008.08.009.

Shah, Ritesh K., et al. 'Estimation of Stature from Head Length in Western Indian Gujarati Adolescent Population'. *Indian Journal of Clinical Anatomy and Physiology*, vol. 5, no. 1, IP Innovative Publication Pvt Ltd, Dec. 2020, pp. 42–46, doi:10.18231/2394-2126.2018.0011.

Shrestha, Rijen, et al. 'Craniometric Analysis for Estimation of Stature in Nepalese Population-A Study on an Autopsy Sample'. *Forensic Science International*, vol. 248, Elsevier Ireland Ltd, Mar. 2015, pp. 187.e1-187.e6, doi: 10.1016/j.forsciint.2014.12.014.

The editors of Encyclopedia Britannica. 'Parsi'. *Britannica*, 24 Aug. 2022.

Torimitsu, Suguru, et al. 'Stature Estimation from Skull Measurements Using Multidetector Computed Tomographic Images: A Japanese Forensic Sample'. *Legal Medicine*, vol. 18, Elsevier B.V., Jan. 2016, pp. 75–80, doi: 10.1016/j.legalmed.2015.12.010.

Wankhede, Kanchankumar P., et al. 'Estimation of Stature from Head Length & Head Breadth in Central Indian Population: An Anthropometric Study'. *International Journal of Anatomy and Research*, vol. 3, no. 1, 2015, pp. 954–957, doi:10.16965/ijar.2015.125.