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Department of Forensic Medicine & Toxicology, Third Floor, Library Building, Seth G S Medical College & KEM Hospital, Parel, Mumbai, Maharashtra, India. Pin-400 012. Email id: mlameditor@gmail.com Phone: 022-24107620 Mobile No. +91-9423016325.



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Original Research Article

Estimation of Stature from Bigonial Breadth in Population of Western Maharashtra

Atharva Ghangrekar^a, Mallikarjun Ballur^{b*}, Priyanka Murgod^c, Rekharani Kumbar^d, Ruchira Chavan^e
^aMBBS UG student; ^eIntern, MIMER Medical college, Pune, Maharashtra, India. ^bProfessor and Head; ^dAssociate Professor, Forensic Medicine; ^cAssociate Professor, Pathology; KLE JGMM Medical college, Hubballi, KLE Academy of Higher Education and Research. Karnataka, India.

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Key words

Stature estimation,
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Abstract

Introduction: Establishing personal identity is the top priority in crime scene investigation mainly when body is mutilated, decomposed and in persons who are found missing. When it comes to the accuracy and dependability of the estimate, regression analysis is the most reliable way. It is increasingly acknowledged that there is a direct correlation between a person's height and other body parts such as the head, trunk, and upper and lower limb lengths; bigonial breadth also like other areas of the body has a clear biological relationship with stature. **Material & Methods:** The present study is a cross sectional study conducted in Forensic Medicine department with 278 medical students included as the study population. Bigonial diameter and stature were measured. **Results:** In our study it was observed that mean height, bigonial diameter were higher in males than in females. Correlation between bigonial width of the mandible and height among men was shown to be statistically significant ($p < 0.05$). Among women, bigonial width presented a weak statistically significant correlation with height. We also established regression equation for both sexes. **Conclusion:** Bigonial diameter can be used for estimation of stature with less accuracy rate when cephalo-facial remains are brought for forensic examination.

1. Introduction

Establishing identity is essential in civil and criminal cases for the living, recently deceased persons, decomposed bodies, mutilated remains, and persons who are found missing.¹

When intact bodies are being inspected, estimating stature is not difficult. When forensic pathologists are working with dismembered human body parts as in natural or man-made mass casualties like earthquakes, tsunamis, cyclones,

floods, aviation accidents, terrorist activities, fire accidents, homicide, however, the task becomes considerably more difficult.²

When it comes to the accuracy and dependability of the estimate, regression analysis is the most reliable way. It is increasingly acknowledged that there is a direct correlation between a person's height and other body parts such as the head, trunk, and upper and lower limb

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*Corresponding author: Dr Mallikarjun Ballur, Professor and Head, Department of Forensic Medicine, KLE JGMM Medical college, Hubballi, KLE Academy of Higher Education and Research. Karnataka, India. (M): +91-9922577571. Email: drmallikarjunballur@gmail.com

lengths, bigonial breadth, like other areas of the body, has a clear biological relationship with stature.^{3,4}

Anatomists, anthropologists, and forensic medicine professionals have always been fascinated by determining a person's height from measurements of various body parts. It has been presumed that each race requires its own finding for stature estimation because of climatic, ethnic, and dietary variations.⁵ Hence, results of studies done in one population cannot be applicable to other populations entirely. Considering this fact, the present study was undertaken and the aim of the study is to derive regression formulae to predict the height of an individual using bigonial breadth and to study gender differences between stature and bigonial breadth.

2. Material and Methods

This cross-sectional study was conducted after obtaining permission from the institutional ethics committee. Written informed consent was obtained before collecting the measurements. The study was done among a total of 278 MBBS undergraduates (144 males and 134 females) between the age 20-25 years. All adults who are healthy and without any pathological fractures, developmental disturbances of the mandible, inflammation of the face, traumatic injuries, and surgery were included in the study and those with previous history or clinical signs of orthodontic or orthognathic therapy, head trauma or surgery and Individuals suffering from chronic illness, endocrine disorders, deformities of foot, lower limbs (Knock-Knee), and vertebra column (Scoliosis, Kyphosis) were excluded from this study. The instrument used for the study was digital vernier calliper for measurements of bigonial diameter and stadiometer for measurement of stature. After suitably explaining the subjects about the study, its procedure and after obtaining informed written consent, the subjects were asked to stand straight on a stadiometer and then their stature was measured from vertex to floor with the head in the Frankfurt horizontal plane.

Bigonial diameter - The maximum breadth of the lower jaw, between two gonion points (gonion is the most posterior, inferior and laterally situated point on the angles of the mandible) on the angle of mandible was taken with the help of digital vernier caliper.

All measurements were taken in centimeters. To minimize subjective errors all measurements were taken three times and then the mean was taken. After

collection of data these were evaluated and analyzed with SPSS software 20. Data was subjected to descriptive statistics (mean, standard deviation) and then Karl Pearson correlation test was used for finding the significance of correlation between the stature and bigonial diameter in both males and females. A linear regression equation was developed for calculation of stature using bigonial diameter for males and females.

3. Results

278 subjects participated in this study, out of which 144 were males and 134 were females. The age of the study participants ranged from 18-23 years. The mean age for males was 19.82 years whereas for females it was 19.21 years. The mean stature for males and females was found to be 170.90 ± 6.97 cm and 157.28 ± 6.00 cm respectively. The mean values of bigonial diameter for males and females was found to be $11.3 \text{ cm} \pm 0.84 \text{ cm}$ and $10.90 \pm 0.96 \text{ cm}$ respectively. It was observed that the mean height, bigonial diameter were higher in males than in females (**Table 1**). Correlation between height and the bigonial diameter was found out by calculating correlation coefficient.

Table 1: Descriptive statistics in total subjects

Parameter	Sex	Mean	SD	Range
				Minimum-Maximum
Bigonial diameter	Males	113.71	8.47	138.13 - 168.89
	Females	109.06	9.66	142.2 - 165.62

The Pearson correlation test showed that there is a significant correlation between male bigonial diameter (p value 0.02) and stature, however in females there is no significant statistical correlation between female bigonial diameter and stature (p value >0.05) (**Table 2**).

Table 2: Pearson Correlation Coefficients Between Stature and Bigonial diameter in Males and Females

Measurements	Sex	r*	p- value
Bigonial diameter	Males	0.191279	0.02
	Females	0.049744	0.57

*r: Pearson correlation coefficient

After finding a positive correlation between the bigonial diameter and stature, regression analysis was done for the estimation of stature in both males & females. To calculate regression equations the values of constants "a" and "b" (regression coefficient of the dependent variable and independent variable respectively) were calculated. Then, the stature was calculated. **Table 3** shows standard error of estimate.

Table 3: Regression Equations for Estimation of Stature from Bigonial diameter in Males and Females

Regression Equation		Standard Error of Estimate (SEE)	
Males	Females	Males	Females
Height= 153.50+0.15(BD)	Height = 153.90+0.03(BD)	7.78	5.92

Table 4: Studies showing comparison of mean values and p values of Bigonial diameter of present study with the mean and p values of previous studies

Sr. No.	Authors	Study population	Mean Bigonial diameter		P value	
			Male	Female	Male	Female
1	Present study	Maharashtra	11.37	10.90	0.02	0.57
2	Shah et al ⁶	Gujarati Population	10.38	8.79	< 0.05	< 0.05
3	Sahni et al ¹²	Northwest Indian Population	10.64	10.26	0.20	0.29
4	Agnihotri et al ¹³	Indian-Mauritian	10.55	9.90	0.85	0.17
5	Kumar & Gopichand ¹⁴	Haryanvi Bania Population	11.45	10.33	0.0009	0.016
6	Krishan and Kumar ¹⁵	North Indian Kolis	8.34	-	<0.001	-
7	Krishan ¹⁰	North Indian gujjars	9.73	-	<0.001	-
8	Yadav et al ¹⁶	Uttar Pradesh	9.91	9.04	< 0.05	-
9	Varghese et al ¹⁷	South India	11.62	9.89	<0.0001	<0.0001

4. Discussion

Determination of the biological profile of a victim or suspect in forensics and crime scene investigation is a top priority. Estimation of stature from measurements of long bones, foot length, and hand length has been tried by many researchers. Since everyone's growth is influenced by many factors as mentioned above producing differences in skeletal proportions, it is important to know such differences in different regions and races. Further, when only few body parts are available, an estimate of height then must be made based on relationship of body parts with the stature. In this respect, stature is one of the parameters with great importance in creating the biological profile. The estimation of stature from skull bones alone can be a challenging task. Inadequate body height data along with cephalo-facial measurements is one of the hurdles faced in computing the stature estimation formula. Bigonial diameter can be utilized for the approximation of stature when facial remains are brought for medicolegal examination.

In our study, the means for all the variables used were shown to be higher among males than among females. Similar results were obtained by Shah et al⁶ and by Patil and Mody⁷ in a lateral cephalometric study on adults in central India. In our study correlation between the bigonial width of the

mandible and height among men was shown to be statistically significant ($p < 0.05$). Among women, the bigonial width presented a weak statistically significant correlation with height, similar to the values found by Shah et al.⁶ A comparison of mean values and p values of Bigonial diameter of present study with the mean and p values of previous studies is shown in **Table 4**.

In study conducted by Aragao et al⁸ on Brazil population, it was observed that mean bigonial diameter showed statistical significance in males but in females there was no statistical significance as seen in our present study. In a study on Sudanese Arab students, Ahmed and Taha⁹ reported that the highest correlation coefficients between cephalofacial measurements and height was related to the bigonial width and in another study conducted by Krishan¹⁰ on a sample of 996 adults Gujjars in northern India indicate that all the variables used presented positive correlations with height, with correlation coefficients ranging from 0.455 to 0.781, but in our study there was a correlation between height and bigonial diameter in males and in females there was no correlation.

In a Turkish population, Pelin et al¹¹ sought to evaluate the correlation coefficients between cephalofacial anthropometric variables and height, according to different types of head and different

types of face. They found that these variables were not good predictors for estimating height. Sahni et al¹² also found low correlation coefficients between facial variables and height as observed in our study in females. Agnihotri et al.¹³ observed that in the Indo-Mauritian population the cephalo-facial dimensions are not good predictors for estimating stature. Subsequent studies conducted by Kumar and Gopichand¹⁴ on 800 male & female Haryanvi Bania Population, Krishan and Kumar¹⁵ on North Indian Kolis, Yadav et al¹⁶ on North Indian population, Vargehese et al¹⁷, Kulkarni et al¹⁸ and on South Indian population, Ilayperuma¹⁹ on Sri Lankan population, Akther²⁰ and Zakia A et al²¹ on Bangladesh population, Ewunonu and Anibeze²² on South-Eastern Nigerian population, Jibonkumar et al²³ on Manipur population, Mansur D²⁴ on Nepal population indicate that there is positive correlation between stature and bigonial diameter. But Ekezie et al²⁵ mentioned that the Bigonial diameter did not show any positive correlation with stature in Igbos (South Eastern Nigerians). There are even other parameters helpful to calculate stature like palm length²⁶, foot length, etc. Human identification is a crucial task to any investigating authority in a crime investigation.

5. Limitations

This study has been conducted on medical students of western Maharashtra. Hence, the studies in rest of the country and on diverse ethnic group are needed to verify whether the bigonial diameter can be used for estimation of stature elsewhere.

6. Conclusion

Bigonial diameter in our study is significantly associated with height in males however Pearson correlation coefficient (r) of 0.19 shows that only 3% variation in heights can be explained with variation of bigonial diameter. Hence bigonial diameter cannot be independently used for prediction of height. We also established the regression equation for both sexes. Therefore, it can be concluded that, like other parts of the human body, bigonial diameter can also be used for estimation of stature with less accuracy rate when cephalo-facial remains are brought for forensic examination. While applying linear regression formulae, one should keep in mind that these are population specific; these cannot be used on other populations of the world.

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