Original Article

DOI: 10.7860/JCDR/2016/18406.7386

Dentistry Section

An Odontometric Approach for Estimation of Stature in Indians: Cross- Sectional Analysis

ACHLA BHARTI YADAV[1], SUMIT KUMAR YADAV[2], NEAL BHARAT KEDIA[3], ABHINAV KUMAR SINGH[4]

ABSTRACT

Introduction: Height/stature is one of the useful anthropometric parameter for individual identification. Correlation of stature to long bones, even fragmentary bones is frequently reported among various populations. As teeth have the advantage of being composed largely of hard tissue which is relatively indestructible, the careful study of these can enable reliable determination of stature of the person in life.

Aim: The present study was designed to elucidate the anthropometric correlation of tooth dimensions with stature and also devises regression formulae.

Materials and Methods: This study was carried out on 361 Indian students (151 males and 210 females) in the age range of 21- 45 years to estimate stature using odontometry. Stature and tooth measurements were taken on each partcipant following standard methods and techniques. Karl Pearson's correlation co-efficient and linear regression was used to estimate stature.

Results: Regression analysis showed that the canine width can aid in estimation of stature as an adjunct when only teeth are available for identification.

Conclusion: Tooth dimensions can be used only as a supplementary approach for the estimation of stature but with caution.

Keywords: Anthropometric, Height, Tooth dimensions, Regression analysis

INTRODUCTION

Establishment of identity of unknown is the main aim of anthropometry, to supplement the law enforcement agencies. Routine methods have some limitations, especially, in highly mutilated bodies which makes identification difficult. In forensic investigations of such cases, estimation of stature becomes equally important along with other identification parameters like age, sex, race, etc., [1-3].

Stature or body height is an important anthropometric parameter that can be used to determine physical identity as it is one of the distinct visible factors of an individual [4, 5]. In the events of murders, accidents or natural disasters, which results in highly decomposed, fragmentary and mutilated human remains, stature estimation provides relevant data for personal identification [6]. A proportional biological relationship of stature exists with every part of human body including head, face, trunk, extremities etc., which plays a vital role in forensic examination to calculate the stature from dismembered and mutilated body parts [3]. Scientists have worked on various bones of the human skeleton for reconstruction of stature with varying degree of accuracy [7-16]. Even foot and shoe print length are not exempt from scrutiny [17-22]. In extreme situations where the evidences are incomplete and fragmented, sections of long bones have also been used for the estimation of stature by forensic anthropologists with great accuracy [23]. It is frequently observed that during forensic and archeological excavations, all the bones of the individual are usually not retrieved and it is common to have the head amputated from the trunk in mutilated body [24]. Consequently, teeth being relatively resistant to decay [24-26], therefore, careful study of teeth can enable reliable determination of stature of the person in life particularly when other predictors are destroyed or fragmented.

AIM

Looking at the paucity of studies pertaining to estimation of stature from odontometry in India and usefulness of these studies in forensic and legal medicine, the present study was designed to elucidate the anthropometric correlation of tooth dimensions with stature and also devises regression formulae.

MATERIALS AND METHODS

Sample: After obtaining the institutional ethical clearance from KLE VK Institute of Dental Sciences, Belgaum and informed consent from all the participants, a cross- sectional study was done on 361 healthy Indian students (151 males and 210 females) in the age range of 21-45 years from our dental college. Subjects with history of orthodontic and orthognathic treatment were excluded from the study as after such kind of treatments minor changes in facial profile can be seen.

Anthropometric measurements and techniques: Stature was measured as the vertical distance from the plane where the subject stands barefooted to the vertex on the head with their back to a standard anthropometer scale. All measurements were taken from 9am-12pm to avoid any diurnal variation in stature [27]. The parameters concerned to odontometry were greatest mesio-distal crown width of six maxillary anterior permanent teeth including central incisor, lateral incisor, and canine of right and left quadrant (RCI, RLI, RC, LCI, LLI, LC) measured directly on the subjects between anatomic contact points of each tooth on either side of the maxilla with the help of digital Vernier's Caliper (Mituyoto, Japan, precision value +/- 0.01 mm) [Table/Fig-1] and these were checked regularly before usage for precision and accuracy; Combined Mesio-Distal Width (CMDW) of maxillary anterior teeth was calculated by adding these measurements.

[Table/Fig-1]: Mesio-distal crown width.

STATISTICAL ANALYSIS

All measurements were entered into SPSS software package (version 10). Karl Pearson's correlation co-efficient of odontometric parameters with stature was obtained. Simple linear regression analysis was done and regression equations were derived for each parameter.

RESULTS

The mean age of male participants was 22.4 years (range= 21-30 years) while for female participants mean age was 22.2 years. Karl Pearson's correlation coefficient (r) of stature with seven odontometric parameters was obtained for all participants without gender specification. Regression equations have been calculated by regression analysis of the data with stature (y) = a+bx and the values of constants 'a' and 'b' are calculated; where 'a' is the regression coefficient of the dependent variable, i.e. stature and 'b' is the regression coefficient of the independent variable, i.e. any odontometric measurements considered in the study. The Standard Error of Estimate (SEE) was calculated for each formula, which depicts the deviation of estimated stature from the actual stature. A low value is indicative of the greater reliability of prediction from a particular measurement and the higher value of SEE denotes less reliability of prediction. The regression equation with the least Standard Error (SE) was considered to be the best regressor for the estimation of stature.

The findings of the present study revealed that all odontometric parameters showed positive correlation with stature independent of gender with correlation coefficient (r) value ranges from 0.104 to 0.297. Among them maxillary canine width showed highest correlation [Table/Fig-2].

Variable	r	Regression equation (y= a+ bx) [y→stature, x→variables, b→regression coefficient]	SEE	p-value
Combined group (n=251)				
R 11	0.174	y= 139.33 + 2.97 R11	8.907	0.001*
R 12	0.104	y= 153.32 + 1.67 R12	8.997	0.048*
R 13	0.278	y= 126.22 + 5.06 R13	8.690	0.000*
L 21	0.174	y= 138.28 + 3.09 L21	8.908	0.001*
L 22	0.116	y= 151.43 + 1.93 L22	8.984	0.027*
L 23	0.297	y= 120.73 + 5.77 L23	8.639	0.000*
MDW	0.237	y= 124.69 + 0.87 MDW	8.789	0.000*

[Table/Fig-2]: Correlation co-efficient of stature with odontometry and linear regression analysis.
R11: right central incisor, R12: right lateral incisor, R13: right canine, L11: left central incisor, L12: left lateral incisor, L13 left canine, MDW: mesio-distal width SEE: Standard estimate of error; r: correlation with observed stature, *: Statistically significant (p<0.05)

DISCUSSION

Stature is an inherent characteristic, which constitutes an essential element in the description of an individual, for physical anthropological and medico legal investigations [28]. Scientists from all over the world substantially used all the bones of human skeleton right from femur to metacarpals for stature estimation [2, 6-23]. However, when these bones are not available, measurements from other body parts should be used to predict body height. Similar to other bones of the body, dimensions of tooth and skull are also genetically determined [29]; but they also depend on environmental and dietary factors, so their measurements are unique for each race and geographical region [30]. Studies concerning the estimation of stature from odontometric parameters are limited in Indian population. Therefore, the present research aimed to provide the valuable data pertaining to the correlation of stature with tooth for Indians. The idea of deriving combined regression formulae by considering males and females as a whole group is in the situations where gender identification of teeth is questionable.

The findings of the present study revealed that all odontometric parameters were positively and significantly correlated with stature independent of gender, where maxillary canine width showed highest correlation with least error. In contrast, individual tooth measurement had no correlation with stature in Mysorean population [24]. Filipson and Goldson in early 1963 demonstrated no correlation between tooth width and stature in 110 subjects of Sweden, this low correlation could be attributed to smaller sample size or difference in ethnicity [31]. Another research among Caucasians also found no association between tooth width and stature [32]. Nevertheless Garn et al., found a significant correlation between stature and mesio-distal and bucco-lingual dimensions of permanent maxillary lateral incisor, while no such correlation was found with maxillary central incisor [33]. Contradicting to this, another research in African Americans found correlation of stature with maxillary central incisor tooth width in males, while lateral incisor did not show any such correlation [34]. Similar recent studies regarding stature estimation from odontometric parameters are formulated in [Table/Fig-3].

S. No	Authors	Year	Odontometric parameters	Results	Conclusion
1.	Shalini Kalia et al., [24]	2006	combined mesiodistal width of maxillary anterior teeth	Statistically significant	Provide reliable method of estimation of height.
2.	Amit Gupta et al., [35]	2014	combined mesiodistal width of maxillary anterior teeth	Statistically insignificant	Combined mesiodistal width is unreliable for stature estimation.
3.	Rajbir Khangura et al., [36]	2015	a. combined mesiodistal width of maxillary anterior teeth	Statistically insignificant	Intercanine and interpremolar width can be used to calculate the stature.
			b. intercanine width and interpremolar width	Statistically significant	
4.	Present study	2016	Individual tooth dimension of maxillary anterior teeth and their combined mesiodistal width	Statistically significant	Amongst all parameters canine width is the best predictor for stature estimation.

[Table/Fig-3]: Recent studies of stature estimation from odontometric parameters.

Our results hypothesize that odontometry is as such unreliable for stature estimation but in situations when only teeth are available for identification, the maxillary canine width can be used as an adjunct in the estimation of stature for Indian population irrespective of gender.

LIMITATION

There are few limitations of the present study like ethnic or regional specific regression formulae are not obtained and only anterior teeth have been included in the study. Future implications are further investigations on large sample size and gender specific formulas should also be generated.

CONCLUSION

From the present study, it can be concluded that regression equations generated from odontometric parameters can be used as a supplementary approach for the estimation of stature when extremities are not available but with caution as these are population specific and cannot be used on other populations of the world. However, canine width can aid in estimation of stature

as an adjunct when only teeth are available for identification; further investigations should be carried out on large sample by considering ethnic and community background.

REFERENCES

[1] Krishan K. Anthropometry in forensic medicine and forensic science-'Forensic Anthropometry'. *The Internet Journal of Forensic Science*. 2007. DOI: 10.5580/1dce [cited 2014 Nov 05].
[2] Sheta A, Hassan M, Elserafy M. Stature estimation from radiological determination of humerus and femur lengths among a sample of Egyptian adults. *Bull Alex Fac Med.* 2009; 45:479-86.
[3] Krishan K. Estimation of stature from cephalo-facial anthropometry in North Indian population. *Forensic Sci Int*. 2008; 181:52.e1-6.
[4] Kumar J, Lilinchandra. Estimation of stature using different facial measurements among the Kabui Naga of Imphal Valley, Manipur. *Anthropologist.* 2006; 8:1-3.
[5] Jadav HR, Shah GV. Determination of personal height from the length of head in Gujarat region. *J Anat Soc India*. 2004; 53:20-21.
[6] Jasuja OP, Singh G. Estimation of stature from hand and phalange length. *Journal of Indian Academy of Forensic Medicine*. 2004; 26:100-06.
[7] Holland TD. Estimation of adult stature from fragmentary tibias. *J Forensic Sci*. 1992:37:1223-29.
[8] Jason DR, Taylor K. Estimation of stature from the length of the cervical, thoracic and lumbar segments of the spine in American Whites and Blacks. *J Forensic Sci.* 1995;40: 59-62.
[9] Mohanty NK. Prediction of height from percutaneous tibial length amongst Oriya population. *Forensic Sci Int*. 1998; 98:137-41.
[10] Ozaslan A, Iscan MY, Ozaslan I, Tugcu H, Koc S. Estimation of stature from body parts. *Forensic Sci Int.* 2003; 132:40–45.
[11] Hauser R, Smolinski J, Gos T. The estimation of stature on the basis of measurements of the femur. *Forensic Sci Int*. 2005; 147:185-90.
[12] Duyar I, Pelin C, Zagyapan R. A new method of stature estimation for forensic anthropological application. *Anthropological Science*. 2006; 114:23–27.
[13] Bhavna, Nath S. Estimation of stature on the basis of measurements of the lower limb. *Anthropologist Spec*. 2007; 3:219-22.
[14] Didia BC, Nduka EC, Adele O. Stature estimation formulae for Nigerians. *J Forensic Sci*. 2009; 54:20-21.
[15] Bidmos MA, Asala S. Calacaneal measurement in estimation of stature of South African Blacks. *Am J Phys Anthropol*. 2005; 126:335-42.
[16] Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in a North Indian population. *J Forensic Leg Med*. 2007;14:327-32.
[17] Jasuja OP, Singh J, Jain M. Estimation of stature from foot and shoe measurements by multiplication factors: a revised attempt. *Forensic Sci Int*. 1991; 50:203-15.
[18] Jasuja OP, Manjula. Estimation of stature from footstep length. *Forensic Sci Int.* 1993;61:1-5.
[19] Ozdena H, Balcib Y, Demirustu C, Turgutd A, Ertugrul M. Stature and sex estimate using foot and shoe dimensions. *Forensic Sci Int*. 2005;147:181–84.
[20] Patel SM, Shah GV, Patel SV. Estimation of height from measurements of foot length in Gujarat region. *J Anat Soc India*. 2007;56:25-27.
[21] Zeybek G, Ergur I, Demiroglu Z. Stature and gender estimation using foot measurements. *Forensic Sci Int*. 2008;181:54.e1–5.
[22] Sen J, Ghosh S. Estimation of stature from foot length and foot breadth among the Rajbanshi: an indigenous population of North Bengal. *Forensic Sci Int*. 2008; 18:55.e1–6.
[23] Udhaya K, Sarala Devi KV, Sridhar J. Regression equation for estimation of length of humerus from its segments: a South Indian population study. *Journal of Clinical Diagnostic Research*. 2011; 5:783-86.
[24] Kalia S, Shetty SK, Patil K, Mahima VG. Stature estimation using odontometry & skull anthropometry. *Indian J Dent Res.* 2008; 19(2): 150-54.
[25] Verze L. History of facial reconstruction. *Acta Biomed*. 2009; 80: 5-12.
[26] Patil KR, Mody RN. Determination of sex by discriminant function analysis & stature by regression analysis: a lateral cephalometric study. *Forensic Sci Int*. 2005; 147(2-3): 175-80.
[27] Krishan K, Krishan Vij. Diurnal variation of stature in three adults and one child. *Anthropologist.* 2007; 9(2): 113-17.
[28] Krogman WM, Iscan MY. The human skeleton in forensic medicine. 2nd ed. Springfield, Illinois, U.S.A: Charles C. Thomas Pub Ltd.; 1986. p. 302-348.
[29] William PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussk JE, et al. Gray's Anatomy. 38th ed. ELBS/ Churchill Livistone; 1995. p. 607-10.
[30] Bermudez De Castro JM, Nicolas ME. Posterior dental size reduction in hominids: the Atapuerca evidence. *Am J Phys Anthropology*. 1995; 96: 335-56.
[31] Filipsson R, Goldson L. Correlation between tooth width, width of the head, length of the head, and stature. *Acta Odontol Scand*. 1963; 21: 359-65.
[32] Sterrett JD, Oliver T, Robinson F, Fortson W, Knaak B, Russel CM. Width/length ratios of normal clinical crowns of the maxillary anterior dentition in man. *J Clin Periodontol*. 1999;26:153-57.
[33] Garn SM, Lewis AB, Kerewsky RS. The magnitude and implications of the relationship between tooth size and body size. *Arch Oral Biol*. 1968; 13:129-31.
[34] Henderson AM, Corruccini RS. Relationship between tooth size and body size in American Blacks. *J Dent Res*. 1976; 55:94-96.
[35] Gupta A, Kumar K, Shetty DC, Wadhwan V, Jain A, Khanna KS. Stature and gender determination and their correlation using odontometry and skull anthropometry. *J Forensic Dent Sci.* 2014; 6(2): 101–06.
[36] Khangura RK, Sircar K, Grewal DS. Four odontometric parameters as a forensic tool in stature estimation. *J Forensic Dent Sci*. 2015;7:132-36.

PARTICULARS OF CONTRIBUTORS:
1. Demonstrator, Department of Oral Pathology, Post Graduate Institute of Dental Sciences, Rohtak, Haryana, India.
2. Reader, Department of Orthodontics & Dentofacial Orthopedics, Mithila Minority Dental College & Hospital, Darbhanga, Bihar, India.
3. Reader, Department of Orthodontics & Dentofacial Orthopedics, Buddha Institute of Dental Sciences & Research, Patna, Bihar, India.
4. Reader, Department of Endodontics, Buddha Institute of Dental Sciences & Research, Patna, Bihar, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Achla Bharti Yadav,
Demonstrator, Department of Oral Pathology, Post Graduate Institute of Dental Sciences, Rohtak-124001, Haryana, India.
E-mail: drachlabharti@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Dec 18, 2015**
Date of Peer Review: **Jan 29, 2016**
Date of Acceptance: **Feb 04, 2016**
Date of Publishing: **Mar 01, 2016**