Original Article

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Estimation of Stature by using the Length of Ulna in Tribal Male Population of Udaipur District: A Cross-sectional Study

Anatomy Section

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ABSTRACT

Introduction: Anthropometry is one of the traditional and conceivably the basic tool of biological anthropology. Height is an important identifying feature of an individual. Estimation of height can be done by measurement of ulna and various regression formulae have been derived by different authors for different regions.

Aim: To define correlation and to derive the linear regression equation from the length of ulna in male tribal population of Udaipur region, Rajasthan, India.

Materials and Methods: The present cross-sectional study was conducted at Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India, from February 2019 to January 2020. Male tribal population between the age of 20-40 years, in and around Udaipur district of Rajasthan, were included in this study. Measurement of ulnar length of both right and left sides were recorded along with their height. ANOVA test was done to find out the correlation between height and ulnar length. Regression equation was formulated for the study population.

Results: Total 245 males, belonging to Bhil and Meena tribes of Rajasthan, of mean age 31.87 years, were included in this study. The mean length of right ulna was 25.52 cm, of left ulna was 25.82 cm, and mean height was 159.34 cm. The study showed a positive correlation between the length of ulna and total height of male population of Udaipur region, in which the correlation coefficient of right ulna with height was 0.61, and that of left ulna with height was 0.64.

Conclusion: A positive correlation exists between the length of ulna and height of an individual.

Keywords: Anthropometry, Arm bones, Body height

INTRODUCTION

Anthropometry has an interesting history of application in forensic sciences. Its findings are of paramount importance in medical sciences especially in the fields of human anatomy and forensic. Assessment of stature from separate parts of skeleton of a human body can be useful and plays notable role in establishing unidentified bodies or any mutilated body part by medicolegal authorities [1]. Height is one of the factors in the explanation of uniqueness of an entity and it changes with age, sex, race, genes, environment and nutritional standing. Stature assessment especially from length of long bones was shown to have significant relationship with body part magnitudes and thus could prove important in guessing height of the individuals [2-5]. There are quite a few researches of stature estimation using cadavers and skeletal remains [6,7], but it is worthwhile to understand that the stature of a person changes with age and most of the times the age of cadavers or skeletal remains can only be a calculation based on existing data. According to Trotter M et al., the height of an individual increases by 2.5 cm after death, when measured in recumbent position [3].

The ulna is a long bone on the medial side of the forearm. Proximally, the ulna has a bony process called the olecranon process which articulates with the humerus. Distally, the ulna bears a styloid process. The olecranon is subcutaneous and easily palpable. The whole length of the subcutaneous border of the ulna can be palpated down to the styloid process. The ulna has easily recognisable surface landmarks making the measurements likely even in compromised positions [8]. The problem of correlating the length of the long limb bones with the height of the individual has challenged scientists for a long time. Various long bones like tibia, fibula, humerus, radius and ulna have been engaged for stature assessment using an assortment of methodologies [3-12]. A study proved a positive correlation between stature and percutaneous measurement of ulna [6]. Another study concluded that the stature of a dead person can be calculated with the help of regression formula of ulnar length derived in their study [5]. No literature is available for stature estimation of tribals of Udaipur region, and therefore this study was taken up. Only male population was taken for the study because the females were not permitted by their male counterparts to participate.

Therefore, the purpose of this study was to examine the anthropometric relationship between ulnar length and stature and to derive the linear regression equation to estimate the stature.

MATERIALS AND METHODS

The present cross-sectional study was conducted at Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India, from February 2019 to January 2020. The data collection was done with the assistance of workers of Primary Health Centres (PHC), and Community Health Centres (CHC) of Udaipur. Ethical clearance was obtained from the Institutional Ethical Committee (letter number GU/HREC/EC/2019/670), and written consents were taken from the subjects.

Inclusion criteria: Tribal (Bhil and Meena) males of age group 20-40 years born and brought up in the tribal community of Udaipur region were included in the study. Jhadol, Kotra, Gogunda, and Sarada regions (the tribes are ethnic to these regions) were considered for data collection.

Exclusion criteria: Males with physical deformity, injury, skeletal abnormalities- like polio, previously fractured forearm, amputated upper limb, record of any surgical procedure effecting the stature and hand were excluded from this study.

Sample size calculation: Sample size of 245 males was determined by measuring all tribal males belonging to the specified communities living in the areas mentioned earlier, fulfilling the inclusion criteria and present during the study period. The subjects were primed and

informed of the date of visit by the workers of PHC and CHC and gathered together by these workers.

Spreading caliper was used for the measurement of right and left ulnar length by measuring the distance between the tip of olecranon process to the tip of styloid process with elbow flexed and palm placed over the opposite shoulder. Standing metric height measuring stand was used for vertical height measurements from crown to the heel in erect anatomical position with bare foot on the baseboard of stand and Frankfurt's plane parallel to the ground.

STATISTICAL ANALYSIS

Data entry and analysis was done using Statistical Package for Social Sciences (SPSS) version 16.0. ANOVA test was done to find out the correlation. The regression equation was derived at and a p-value of <0.05 was considered significant. By using the correlation coefficient and regression coefficient the result was generated.

RESULTS

The mean age of the population was 31.87±6.23 years, height was 159.34±9.15 cm, and length of right and left ulna was 25.52±1.66 cm and 25.82±1.63 cm, respectively [Table/Fig-1].

Variable	(Mean±SD)
Age (years)	31.87±6.23
Height (cm)	159.34±9.15
Length of right ulna (cm)	25.52±1.66
Length of left ulna (cm)	25.82±1.63

[Table/Fig-1]: Mean values of different variables.

The correlation coefficient (r) of right and left ulna showed positive correlation between the height of the person and his ulnar length [Table/Fig-2]. The regression equation for right ulnar length and height:

y=3.3875x+72.898 and,

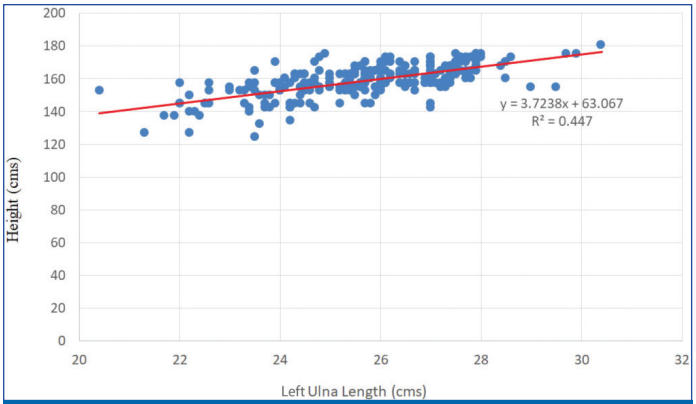
for left ulnar length and height:

y=3.7238x+63.067 {where y=height and x=ulnar length}.

Independent variable	Length of right ulna (cm)	Length of left ulna (cm)
Intercept	72.898	63.067
Regression coefficient	3.3875	3.7238
Correlation coefficient (r)	0.61	0.64
Coefficient of determination (r^2)	0.377	0.447

[Table/Fig-2]: Intercept, Regression coefficient, Correlation coefficient (r) and Coefficient of determination (r^2).

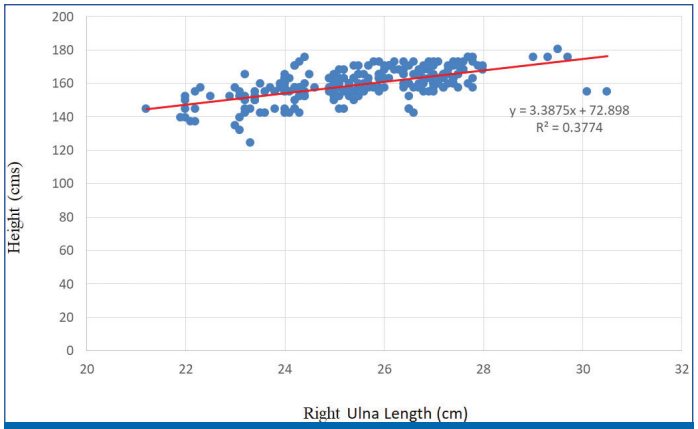
Linear regression coefficient between the right and left ulna length and height in males showed a positive correlation [Table/Fig-3,4].



[Table/Fig-3]: Linear regression coefficient between left ulna length and height in males.

DISCUSSION

Morphometric analysis of forearm helps in estimation of stature by utilising the regression formulae derived by various studies for general or local population. Yet the formulae for different geographical studies are not the same. Hence, for stature estimation of male tribals of Udaipur, the study was carried out to investigate the relationship between the stature and length of ulna in and around Udaipur district. Ulna was used to estimate stature by other authors also in the recent past [Table/Fig-5] [5,6,13]. All these studies had been carried out in different populations of India, and found a positive correlation of the length of ulna with stature of the individual. Yet the regression formulae differed for each population. The current study was carried out on the male tribal population of Udaipur, whereas the above three studies were done on both male and female population of different regions of India; but none of them studied any tribal population. Mehta AA et al., studied only 50 males, Algotar GN et al., studied 400 males and Prasad KA et al., studied 200 males with the same number of females also but the current study was conducted on male population only because of patriarchy and male dominance among those tribal population; as such most of the females were hesitant and not allowed to participate in the study (as informed by the workers of PHC and CHC who helped in assembling the participants) [5,6,13]. In the present study, all measurements were taken between 10:00-12:00 hours to avoid differences due to diurnal variations [6].



[Table/Fig-4]: Linear regression coefficient for ulna length and height.

Researchers of other countries also studied long bones for stature estimation and concluded that they required region specific regression formulae. In a study by Duyar I and Pelin C the researchers found that the widely used formula for whites was not accurate for the Turkish population [11]. In the Allbrook D study, they derived regression formulae for estimation of stature from length of ulna as 'stature= 88.94+3.06 (ulna length)±4.4 (SE)' [12]. Athwale MC studied 100 Maharashtrian males of age ranging from 25 to 30 years, and derived a regression formula for estimation of stature [9]. Devi S et al., found coefficient 0.619 for male and 0.584 for female for estimation of stature, by using upper arm length among Maring tribes in Chandel, Manipur [14]. All these studies stress on the need for locally derived regression formulae for their population, although positive correlation was found to exist between the studied long bone and the stature of the individuals.

This study found that all the previous studies on estimation of stature by long bones are of the opinion that a separate regression equation is required for the local population to estimate the height/stature by measurement of long bones. The current study is of value for the anatomists, anthropologists and forensic experts in determining the stature of male tribals of Udaipur by measurements of ulna, as and when required. This knowledge can also be of use in identification of an unknown individual in case a dismembered part is found. In an event of any natural or unnatural disaster, human body remains, or skeletal remains, may need to be identified by experts. This data can be of vital importance for such identifications. Stature methodology is a cause of concern for bioarcheologists and investigation of this study can help add literature for the local population. The clinical application of this study can be in making of prosthesis for the

Parameters	Current study	Mehta AA et al., [5]	Algotar GN et al., [6]	Prasad KA et al., [13]
Age (years)	20-40	18-30	18-25	18-28
Gender	Male (N=245)	Male (n=165) and Female (n=165)	Male (n=400) and Female (n=400)	Male (n=100) and Female (n=100)
Population studied	Tribal population (Bhil and Meena) of Udaipur (Rajasthan) region	Population of central India (Bhopal)	Native students of Gujarat	Students of medical college of rural Maharashtra
Height (cm)	159.34 in males	165 of both males and females	169.930 in males	172.93 in males
Measurements of ulna (Right and left) (cm)	Right ulna 25.52 Left ulna 25.82	Right ulna: 26.67 Left ulna: 26.1	Right male ulna: 26.526 Left male ulna: 26.380	Right male ulna: 27.52 Left male ulna: 27.26
Formula	Right side: y=3.3875x+72.898 Left side: y=3.7238x+63.067 Where, y=height and x=ulnar length.	Right side: Y1=70.004+3.562X1 Left side: Y2=79.24+3.285X2 Where, Y1 and Y2 are estimated heights from length of right and left ulna X1 and X2 are length of right and left ulna	Right side: Male stature in cm=108.93+2.30×(Percutaneous right ulna length)±3.11 Left side: Male stature in cm=109.93+2.29×(Percutaneous left ulna length)±3.12	For male: Y=93.45+2.92X Where Y=Height/Stature (cm) X=Length of ulna (cm)

[Table/Fig-5]: Comparison between current study and other studies on ulna [5,6,13].

limb in case of amputation or loss of limb due to any other cause in population.

Limitation(s)

The main limitation of the current study was that the female tribal population could not be studied because the females were not permitted by their male counterparts to participate.

CONCLUSION(S)

The current study has derived a regression equation for the estimation of stature of living tribal males of Udaipur district of Rajasthan, India, by using their length of ulna and stature measurements and a positive correlation exists between the ulnar length and stature of an individual. Thus, ulnar length in males can be used as a reliable and accurate parameter in estimating the height of an individual.

REFERENCES

[1] Krogman WM, Iscan MY. The human skeleton in forensic medicine. Thomas CC. 2nd Ed. Springfield; 1986:58.
[2] Meitei NJ, Devi HS. Estimation of stature using lower limb dimensions among maring males of Manipur. Anthropologist. 2014;17(2):681-83.
[3] Gaur R, Kaur K, Airi R, Jarodia K. Estimation of stature from percutaneous lengths of tibia and fibula of scheduled castes of Haryana State, India. Ann Forensic Res Anal. 2016;3(1):1025-30.
[4] Mall G, Hubig M, Büttner A, Kuznik J, Penning R, Graw M. Sex determination and estimation of stature from the long bones of the arm. Forensic Science International. 2001;117(1):23-30.
[5] Mehta AA, Mehta AA, Gajbhiye VM, Sarthak V. Estimation of stature from ulna. Int J Anat Res. 2015;3(2):1156-58.
[6] Algotar GN, Chauhan VN, Bhise RS. Ulna: A tool to estimate stature. Int J Forensic Med Toxicol Sci. 2019;4(2):49-51.
[7] Celbis O, Agritmis H. Estimation of stature and determination of sex from radial and ulnar bone lengths in a Turkish corpse sample. Forensic Science International. 2006;158(2):135-39.
[8] Ebite LE, Ozoko TC, Eweka AO, Otuaga PO, Oni AO, Om'Iniabohs FA. Height: Ulna ratio: A method of stature estimation in a rural community in Edo state, Nigeria. The Internet Journal of Forensic Science. 2008;3(1):12-18.
[9] Athwale MC. Estimation of height from length of forearm bones-A study on 100 Maharashtrian male adults of age 25-30. American Journal of Physical Anthropology. 1963;21:105-12.
[10] Patel MP, Joshi NB, Dongre AV. Regression equation of height on tibial length. The Indian Journal of Medical Research. 1964;52:531-34.
[11] Duyar I, Pelin C. Estimating body height from ulna length: Need of a population-specific formula. Eurasion J. Anthropol. 2010;1(1):11-17.
[12] Allbrook D. The estimation of stature in British and East African males based on the tibial and ulnar bone lengths. Journal of forensic Medicine. 1961;8:15-27.
[13] Prasad KA, Shukla SN, Dinesh KA. Estimation of human stature from ulnar length in rural region of Maharashtra. Indian Journal of Clinical Anatomy and Physiology. 2016;3(3):343-47.
[14] Devi S, Das H, Purnabati BK, Singh SD, Devi J. Estimation of stature from upper arm length among the Marings of Manipur. Indian Medical Journal. 2006;100(8):271-73.

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