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Original Research Article

Estimation of Stature based on percutaneous length of Ulna in living subjects

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Abstract: Stature estimation has several important implications like identification of unknown bodies in forensics, medicolegal cases and Anthropological studies. Most commonly used bones for estimation of stature are the long bones of the body including humerus, femur, tibia and ulna. We in the present study tried to evaluate the height of the individuals based on percutaneous measurement of length of ulna in living subjects. This study was conducted at the Department of Anatomy, Nimra Institute of Medical Sciences, Vijayawada, and Andhra Pradesh. Male and female subjects (n=50) each were included in the study randomly. All the individuals were between 21-24 years of age. Standing height was measured by asking the individual to stand bare foot on baseboard of a Standard metric height measuring stand with Frankfurt plane parallel to the ground. The measurements were recorded in nearest to 0.5cms percutaneous length of ulna was measured with help of spreading calipers, from tip of olecranon process to tip of styloid process of ulna with elbow flexed and palm placed on opposite shoulder. The mean height of male subjects was 165.72 ± 3.95 and mean length of right ulna was 29.84 ± 2.03 and the mean length of left ulna was 29.78 ± 2.04. The Mean height in female was 160.58 ± 3.52 and the mean length of right ulna was 26.70 ± 0.73 and left ulna was 26.63 ± 0.73. Regression equations were calculated for estimation of stature in male and female separately with the length of right ulna and left ulna. Stature of individuals varies with Gender, race, region and ethnicity. The ulna being a percutaneous bone it is easy to measure its length and determine regression equations for estimation of stature in this group of population. Such equations can be used by anatomists, anthropologists, and forensic experts as and when required in this group of population.
Keywords: Stature, Estimation, Percutaneous length of ulna

INTRODUCTION

Anthropometric studies are of interest for anatomists, anthropologists and forensic experts. Stature is defines as height of the body in upright position and it is considered as one of the important parameters of personal identity. [1] Estimation of stature from different parts of skeleton of a human body by anthropometric analysis and their correlation can be useful and plays important role in establishing unidentified bodies or any mutilated body part by medicolegal experts [2, 3]. The most detailed description of stature estimation from skeletal remains was compiled by Krogman and Iscan [1]. It was Pearson K *et al.;* [4] first introduced the co-relational calculus into the field of work for the prediction of the stature from the measurement of the long bones. Height is one of the factors in the description of individuality of an individual and it varies with race, age sex, heredity, climate and nutritional status. Stature estimation especially from length of long bones was shown to have important relationship with body part dimensions and thus could prove important in predicting height of the individuals [3, 5].

Several workers have done studies on cadavers or skeletal remains [6, 7] however studying cadavers has several disadvantages like they generally belong to aged individuals who may have suffered several chronic debilitating diseases that may ultimately affect their skeletons therefore the accuracy may be doubtful. Trotter M *et al.;* have shown that there was an increase in height of 2.5cms after death, when the measurements were taken in recumbent posture [5]. 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 is palpable down to the styloid process. The ulna has easily identifiable surface landmarks making the measurements possible even in compromised postures [8].

In several studies it has been used in deriving regression equations of height in living subjects as compared to lower limb bones [9, 10]. Ossification of the ulna starts at 8th fetal week, and the proximal epiphysis fuses with the shaft in the 14th year in females and 16th year in males [11]. The distal epiphysis unites with the shaft in the 17th year in females and 18th year in males [11]. The linear regression equation of the height based on the ulna length has a definitive advantage over that of the tibial length as it can be used when lower extremities are deformed some studies have shown that ulnar length to be superior to arm span measurement and hand length measurement in predicting height. With this background we in the present study tried to estimate the stature of individuals with measurement of length of ulna as to our knowledge no such study has been done so far in this population.

MATERIALS AND METHODS

The present study was carried out in The Department of Anatomy, NIMRA Institute of Medical Sciences, Vijayawada, and Andhra Pradesh. In the study was conducted on 50 Normal healthy Adult male and female subject age range from 21-24 years. Persons with significant medical disorders, including endocrine disorders, history of fracture of hands, injuries, and nutritional deficiencies were excluded from the study. The subjects were from various places in Andhra Pradesh. Institutional Ethical Committee permission was obtained in accordance with Ethical standards laid down in Helsinki declaration of 1964. All persons gave written informed consent for the study.

Measurement of height: Height of the individual subject was measured (in centimeters) in standing erect Anatomical position with bare foot on the baseboard of a Standard metric height measuring stand and Frankfurt's plane parallel to the ground. The measurement of height will be taken in centimeters by bringing the projecting horizontal sliding bar to the vertex. Percutaneous ulna length was measured with elbow flexed and palm placed over opposite shoulder and marking the tip of olecranon process and tip of styloid process of ulna and measuring the distance between the two points using spreading calipers. Ulna length were measured independently on right side as well as left sides. All the measurements were recorded by the same observer and between the same times every day in order to avoid any variations. All the data was recorded in MS excel and statistical analysis was done using SPSS version 17 on windows format.

RESULTS

The values of height and length of ulna right and left were recorded separately for both male (n=50) as well as female (n=50) subjects. The Mean Height of male subjects was 165.72 ± 3.95 cms and the mean values of Length of ulna on right side was 29.84 ± 2.03 and on left side it was 29.78 ± 2.04. For the female The Mean heights was 160.58 ± 3.52 and mean length of ulna on right side was 26.70 ± 0.73 and mean length of ulna on left side was 26.63 ± 0.72 given in table 1 below.

Table 1: Showing the Mean and SD values of Height and percutaneous length of ulna in both sexes

Parameter	MALE	FEMALE
Height (cms)	165.72 ± 3.95	160.58 ± 3.52
Length of Ulna (R) (cms)	29.84 ± 2.03	26.70 ± 0.73
Length of Ulna (L) (cms)	29.78 ± 2.04	26.63 ± 0.72

The correlation coefficient between the heights of the subject with the length of ulna was calculated in male and female subjects. The values were recorded in the table 2. Male subjects have positive correlation values of 0.93 which indicate there is strong positive correlation between the height and length of ulna. As it is a positive correlation it indicates that as the height of individual increases the length of the ulna has also increased. In female subjects there was also positive correlation between the height of the individual and length of ulna its vales were +0.63 for right ulna and +0.61 for left ulna given in table 2.

Table 2: Correlation of Height with length of ulna in male and female

Sex		Correlation coefficient 'r'
Male	Length of ulna [Right]	+0.93
	Length of ulna [Left]	+0.93
Female	Length of ulna [Right]	+0.63
	Length of ulna [Left]	+0.61

Regression equations were calculated for male for estimation of height from the length of ulna of right as well as the left sides were calculated in this group the regression equation obtained were Height = 111.8 + 1.80 X Length of ulna Right and Height = 112.13 + 1.79 X Length of ulna Left. The same parameters were plotted in form of graph and linear regression line was obtained see figure 1.

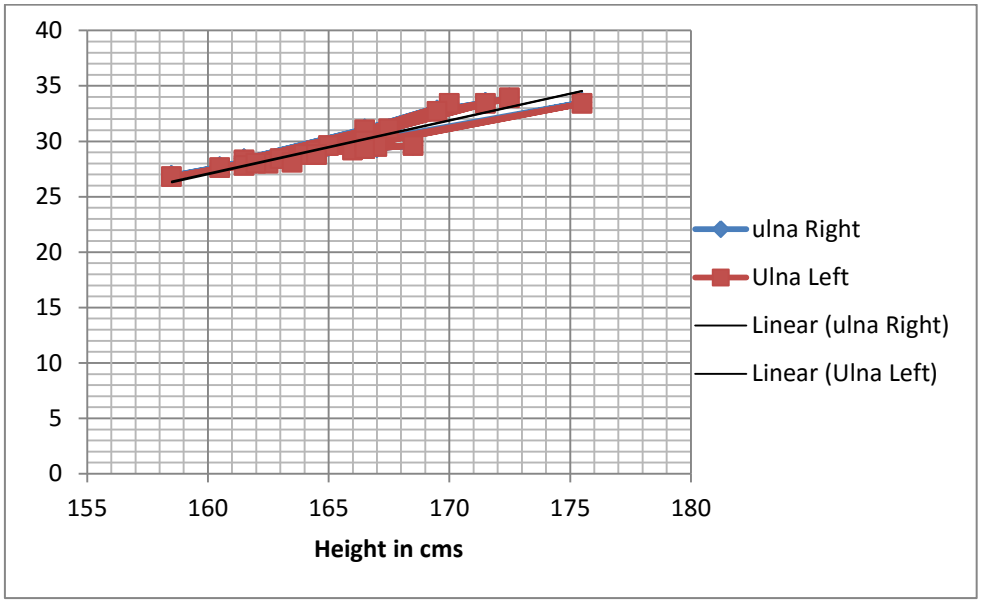

Fig-1: Showing the graph with linear regression line in male subjects

For female subjects Regression equation were calculated for estimation of height from the length of ulna of right and left sides separately. In this group the regression equation obtained were Height = 57.16 + 3.87 X Length of ulna Right and Height = 47.05 + 4.23 X Length of ulna left. The same parameters were plotted in form of graph and linear regression line was obtained see figure 2.

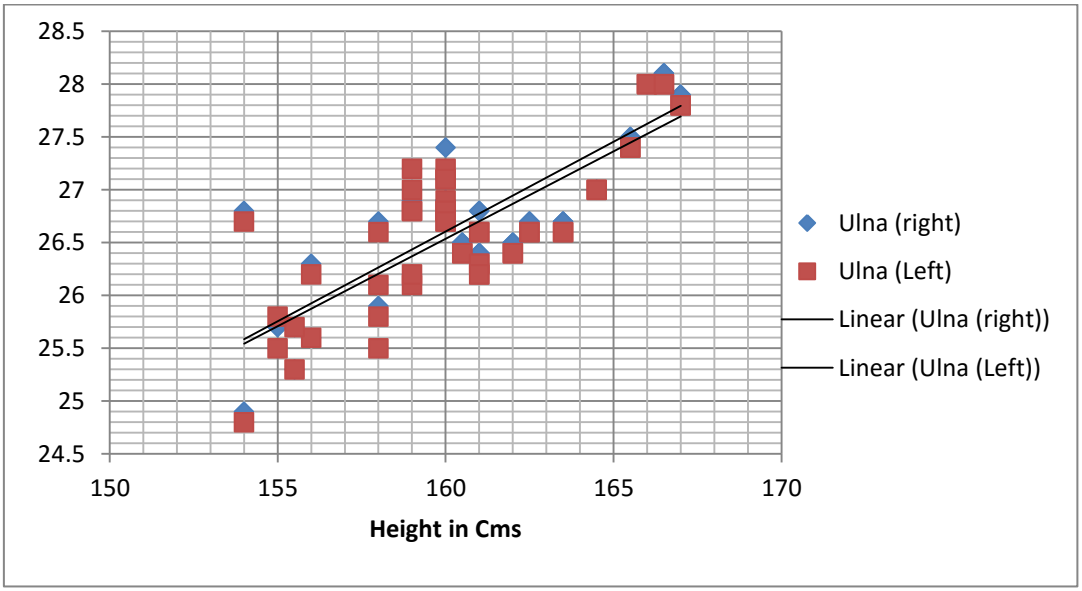

Fig-2: Showing the graph with linear regression line in female subjects

DISCUSSION

The present study was carried to find the regression equations for estimation of height from the length of ulna in this group of population. There appears to be a definitive relationship between different body parts and measurement of extremities and stature. There is a general increase in rate of natural disasters or accidents, often forensic experts have to deal with mutilated and mingled body or may have only some skeletal remains. In such circumstances stature estimation from body part can prove to be of vital importance [3]. In this study we found that the Pearson correlation values between the Height and length of ulna table 2. The values of 'r' in males were +0.93 both for right as well as left ulna and in females the value of 'r' for right ulna +0.63 and left ulna +0.61. In one study by MK Mondal *et al.;* [10] predicting height from length of ulna in females in West Bengal found the values of correlation coefficient(r) of the height and the length of the left ulna was 0.82 and that for the right ulna was 0.67. It nearly agrees with our values of right ulna but they showed slightly more values with left ulna. In a similar study by M Lemtur *et al.;* [12] estimating length of ulna in medical students of Nagaland found the values of correlation in male equal to +0.78 and female +0.62, thus one can see that in the present study as well as the other studies there has always been a positive correlation between the length of ulna and stature. It implies that as the length of ulna increases height also increases proportionately and there is a definite correlation between ulnar length and height of the individual. In the present study we found the average height of male and female equal to 165.72 ± 3.95 and 160.58 ± 3.52 respectively. In similar other studies by Bhavna *et al.;* conducting a study to calculate the height from measurements of tibial length in Delhi Male found average height equal to 167.66±5.69 [13]. In a similar study by A Pandey *et al.;* estimating stature from length of ulna in Bangalore found average height of male 169.46 and female 164.07 cms the mean length of ulna in their study was 27.52 ± 1.63 in male and 26.22 ± 1.61 cms. [14]. The table 3 given below is a comparison of certain studies done in this field with our findings. As the body proportions are likely to change depending on the race and ethnicity therefore regression equations in different areas needs to be formulated for studies. However as we can see in this study as well as other studies there are only limited number of selected subjects are involved to find a truly representative sample of the population such studies must be conducted in a larger area with large number of subjects to get an effective regression equation which can be applied in that group, however until that happens we can use these studies with fair degree of accuracy.

Table 3: Comparison of Linear Regression Equations of other studies

Author	Place	subjects	Linear regression equation
Athwale *et al.;* [15]	Maharashtra	Male	Stature = 56.79 + 3.96 X length of right and left ulna
Ashish Pande *et al.;* [14]	Bangalore Karnataka	Male and Female	Stature = 83.32 + 3.04 x length of right ulna Stature = 81.06 + 3.14 X length of left ulna
Anjali P *et al.;* [16]	Marathawada	Male and Female	Stature = 93.45 + 2.92 X length of ulna
Thummer *et al.;* [17]	Gujarat	Male	Stature = 81.11 + 3.12 x length of right ulna. Stature = 65.76+ 3.67 x length of left Ulna
		Female	Stature = 17.10+ 5.34x length of right ulna. Stature = 18.95+ 5.33x length of left ulna
Yadav SK *et al.;* [18]	Nepal	Male and female	Stature = 77.74+3.33 X Length of ulna
Present study	Vijayawada Andhra Pradesh	Male	Stature = 111.8 + 1.80 X Length of ulna Right and Stature = 112.13 + 1.79 X Length of ulna Left
		Female	Stature = 57.16 + 3.87 X Length of ulna Right and Stature = 47.05 + 4.23 X Length of ulna left

CONCLUSION

Stature of individuals varies with Gender, race, region and ethnicity. The ulna being a percutaneous bone it is easy to measure its length and determine regression equations for estimation of stature in this group of population. Such equations can be used by anatomists, anthropologists, and forensic experts as and when required in this group of population.

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