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Original Research Article

STATURE ESTIMATION FROM PERCUTANEOUS LENGTH OF ULNA

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ABSTRACT

Introduction: Height plays a vital role in establishing the identity of an individual. Anatomically, it is a linear composite of skull, vertebral column, pelvis and legs and is measured from vertex to foot. Many instances where direct measurement of height is impossible, necessitates an alternative methodology.

Aim: As height is directly proportional to the length of long bones, my present study aims at deriving a regression equation between height and percutaneous length of ulna in gender specific south Indian adolescent population.

Materials and Methods: A total of 153 subjects (76 male and 77 female) with age span of 20 – 22 years were included in this study. Length of ulna was measured using sliding Vernier caliper and height by standard height measuring instrument for all subjects.

Results: The findings of the study indicated significant differences of the ulna length between the genders. A positive correlation between height and ulna length was observed in both sexes and it was statistically significant. Regression equations for stature estimation were formulated using the ulna lengths for both males and females.

Conclusion: The ulna length provides an accurate and reliable means in estimating the height of an individual. The regression formulae proposed in this study will be useful for clinicians, anatomists, archeologists, anthropologists and forensic scientists when such evidence provides the investigator the only opportunity to gauge that aspect of an individual's physical description.

KEY WORDS: stature estimation, ulna length, regression equation, South Indian adults.

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INTRODUCTION

Stature of an individual is defined as the height of the body in upright position which is measured from vertex to the foot. It is an important parameter for a person's identification[1].

Estimation of stature therefore plays a vital role in establishing individuality by medico-legal experts in case of unidentified dead bodies or from mutilated body parts[2,3]. Although, anatomical method is more accurate, but often

complete skeletal remains are unavailable from a crime scene and therefore, it is a challenge for the forensic anthropologists as well as medico-legal experts to reconstruct stature from the relatively less precise mathematical method, which is workable even if only a single long bone is available[4,5,6].

There is always a consistent ratio between the trunk and limbs of an individual among themselves and also in relation to the total body height. Therefore,various long bones have been employed for stature estimation using variety of methodologies.

Professor Karl Pearson (1898-99) was the first to introduce regression formula for stature prediction from longbones[6]. The most detailed description of stature estimation from skeletal remains was compiled by Krogman and Iscan[1].

As the stature varies with race, age, sex, heredity, climate and nutritional status, any study pertaining to stature estimation need to be a population, gender and age specific study [2,3,5,6].

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 olecranon fossa of 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 [7].

Also, its length can be of advantageous when lower limb is deformed along with deformity of trunk or when the upper limb is the only body part available for stature estimation[8,9,10]. Therefore, formulae derived based on the ulna length provide an alternative methodology for the estimation of stature of an individual.

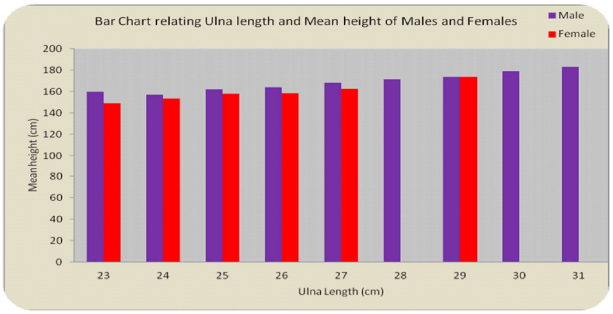
AIM: The length of the ulna bone is a reliable and precise means for predicting the stature in an individual.This study is designed to investigate the relationship and to propose population and gender specific regression formulae between percutaneous ulna length& height of an individual for south Indian adolescent population.

MATERIALS AND METHODS

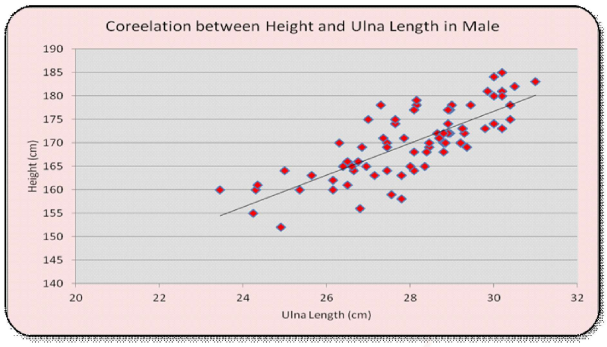
This study was conducted on 153 Medical students of S.R.M. Medical college with their written consent and after getting approval from the institutional ethical clearance.The Age of the subjects ranged from 20 to 22 years.They were apparently healthy & no physical deformity.They were from different parts of south India belonging to different socio-economic status.The ulna length was measured as the direct distance between tip of the olecranon process and the styloid process using a vernier caliper when the elbow is in full flexion.Both the right & left side ulna length taken individually.The height of the individual was measured between vertex and the floor, when the person is standing erect, in anatomical position and the head in the Frankfort plane, using a standard height measuring instrument.Height was measured to the nearest 0.1cm.All the measurements were taken at a fixed time between 14:30 to 15:30 hours to eliminate discrepancy due to diurnal variation. Each measurement was taken thrice and the mean was taken for further analysis.Results were expressed as Mean ±SD and analyzed using statistical package SPSS(version 15) and tabulated (table 1).

Statistical Analysis indicated that bilateral variation was insignificant for the measurements of ulna length in both sexes.So, the mean length of Right ulna taken for further analysis.Gender differences in mean height and ulna length were found highly significant ($P<0.0001$).Mean Ulna lengths of the male were significantly larger than that of females for all ages ($P<0.0001$).Pearson's Correlation coefficient was used to examine the relationship between Ulna length and height according to gender.It was statistically significant and Positive in both genders.

Bar chart 1:showing the relation between ulna length and mean heights of male and female.



Scatter diagram 1: showing the correlation between height and ulna length in male



Scatter diagram 2: Showing the correlation between height and ulna length in female

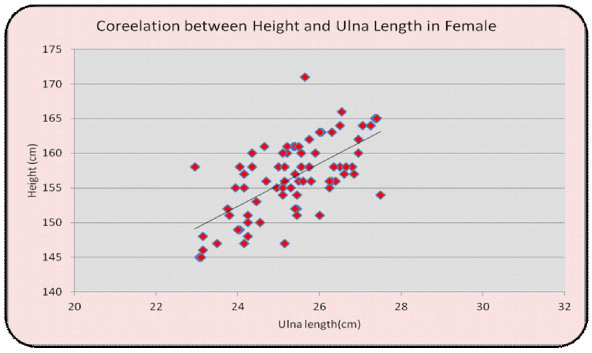


Table 1: Showing the results

Parameter	Male	Female	Total	P value
Total Number	76	77	153	
Mean Height (cm)	169.97 ± 7.32	156.57 ± 5.55	163.23 ± 9.33	0.0001
Height Range (cm)	152 - 185	145 - 171	145 - 185	
RUL Mean	27.972 ± 1.69	25.365 ± 1.18	26.660 ± 1.96	0.0001
RUL Range	23.4 – 31.0	23.0 – 27.5	23.0 – 31.0	
LUL Mean	28.067 ± 1.68	25.364 ± 1.20	26.707 ± 1.99	0.0001
LUL Range	23.5 – 31.0	22.9 – 27.5	22.9 – 31.0	
Average	28.02 ± 1.68	25.36 ± 1.18	26.68 ±1.96	0.0001
Average Range	23.45 – 31.00	22.95 – 27.50	22.95 – 31.00	
Correlation Coefficient	0.78	0.659	0.864	0.0001
Regression Coefficient	3.392	3.095	4.096	0.0001
Value of Constant	74.94	78.06	53.92	

Table 2: A comparison of linear regression equation of the present study with the previous studies.

S.no	Authors	Place & year	Subjects	Linear regression equation
1	Allbrook [15]	Africa 1961	Males	Stature = 88.94 + 3.06 x ulna length ± 4.4 (Standard error)
2	Athwale [16]	Maharashtra 1963	Males	Stature = 56.97 + 3.96 x average length of right and left ulna ± 3.64
3	Maloy [17]	West Bengal 2009	Males	Stature =50.642+4.1896x right ulna± 7.7302. Stature = 76.289 + 3.256x left ulna ± 9.0826.
4	Thummer [18]	Gujarat 2011	Males	Stature = 81.11 + 3.12 x length of right ulna. Stature = 65.76+ 3.67 x length of left ulna
			Females	Stature = 17.10+ 5.34x length of right ulna. Stature = 18.95+ 5.33x length of left ulna
5	Anjali P. [19]	Marathwad 2012	Males Females	Stature = 93.45 + 2.92x length of ulna Stature = 113.89 + 2.37X length of ulna
6	Avantika bamne [20]	Maharashtra 2014	Males Females	Stature = 65.77 + 3.81 x right ulnar length Stature = 64.17 + 3.89 left ulnar length Stature = 70.75 + 3.46 x right ulnar length Stature = 102.82 + 2.21 x left ulnar length
7	Present study	South India	Males Females	Stature = 74.94 + 3.392 (Ulna Length) Stature = 78.06 + 3.095 (Ulna Length)

Regression equations for stature estimation

For males - Height = 74.94 + 3.392 (Ulna Length)

For females Height = 78.06 + 3.095 (Ulna Length)

For both males and females Height = 53.92 + 4.096 (Ulna Length)

DISCUSSION

One of the most important aspects in forensic sciences and anthropological studies is to determine the sex and stature of an unknown individual. Stature estimation is also essential for calculating the body mass index in order to determine the nutritional status of an individual. However practical difficulties are encountered in old or frail bedridden patients who cannot stand or those who suffer from vertebral column deformities. In such patients, the regression formula derived using ulna length provides

an alternate methodology for stature prediction [11].

The establishment of identity of an individual has an important judicial and criminal significances. Mass accidents and disasters like earth quake and victims of traffic accidents deserve a special concern in identity establishment. Thus, appropriate practice and experience in identification by the collection of the available and appropriate data concerning the victims is indispensable [12].

Many studies [2,3,5,6,11,13] proved positive co-relation of stature and different body parts dimension particularly long bones of the limb which has been found to be true in the present study with strong positive correlation between the stature and ulna lengths in both sexes. This positive co-relation suggests if the length of ulna increases or decreases, the height of the subject also increases or decreases and vice versa.

Pan did a cadaveric study to derive the relation between the total ulna length and height of an individual [14]. But according to Trotter M et al., height increases by 2.5 cm after death [13]. Hence stature prediction using ulna length in the living has a definitive advantage over the studies done in the cadavers.

In the present study, there is a significant statistical difference between the length of ulna between males and females. Distinct sexual dimorphism in the ulna length in my study group indicates the rate of skeletal maturity in males and females tend to vary during the course of development in agreement with the observation of many researchers [3,11,13].

In the present study, the linear regression formulae for the estimation of stature using ulna length has been derived for both the sexes and compared with the previous studies in the table 2 given below. By comparing the results, it is evident that each population has a different regression formula for calculating the stature.

CONCLUSION

In accordance with the studies done by many researchers, the present study shows distinct sexual dimorphism in stature and ulna length with a positive correlation between the two dimensions. As relatively very less studies has been done in this ethnic adolescent age group, the linear regression equations derived may be of value in estimating the stature on this population, and this may be particularly important to the medicolegal experts and the anthropologists.

Conflicts of Interests: None

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