ESTIMATION OF STATURE FROM PERCUTANEOUS LENGTH OF ULNA IN LIVING SUBJECTS IN MARATHWADA REGION OF MAHARASHTRA

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ABSTRACT

Background: Estimation of stature plays an important role in medico-legal cases in the identification of unknown bodies, parts of bodies or even skeletal remains. There exists a strong relationship between stature and dimensions of different body parts, particularly bone lengths, which forms the basis for stature estimation. Ulna bone is used as it is subcutaneous and hence surface landmarks such as olecranon and styloid process are easily identifiable and can be used for measurements.

Materials and Methods: The present study was carried out on 300 medical students of Marathwada region of Dr. Shankarrao Chavan Government Medical College, Nanded, Maharashtra. Height and percutaneous ulna length were recorded for each subject.

Result: Mean height of male subjects is 171.99 ± 6.04 . Mean of length of right and left ulna in male subjects are 26.92 ± 1.30 and 26.85 ± 1.32 respectively. The mean height of female subjects is 165.49 ± 3.18 . Mean of length of right and left ulna in female subjects are 21.77 ± 0.93 and 21.69 ± 0.88 respectively. The correlation of stature with ulnar length is 0.66 in males and 0.70 in females, which are positive and statistically highly significant ($P < 0.01$).

Conclusion: In Marathwada region of Maharashtra mean height and length of ulna is more in males than in females and it is statistically significant. Simple linear regression equation so far derived can be used if either of the measurement of length of ulna or total height is known, the other can be calculated. This fact will be of practical use in Medico Legal investigations and in Anthropometry.

KEY WORDS: Ulna Length, Height, Stature Estimation, Anthropometry, Marathwada Region

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INTRODUCTION

Establishment of identity of unknown human remains is a challenging task in medico-legal cases, especially when the remains are partial, mutilated or dismembered. Such situations usually arise in cases of natural disasters, rail and aircraft accidents, wars and terrorist explosions. Many times, only parts of human body,

such as limbs, are available for identification [1]. The height of an individual is one of the important parameters for establishing the identification [2]. Estimation of stature, therefore, plays an important role in medico-legal cases in the identification of unknown bodies, parts of bodies or even skeletal remains. There exists a strong relationship between stature and

dimensions of different body parts, particularly bone lengths, which forms the basis for stature estimation [1].

The ulna is a long bone often used for body height estimation as it lies parallel in the forearm with their ends fairly superficially placed. The ulna is a long bone, prismatic in form, placed at the medial side of the forearm [3]. Ulna bone is used as it is subcutaneous and hence surface landmarks such as olecranon and styloid process are easily identifiable and can be used for measurements.² Ossification of ulna begins at the 8th week of fetal life. The proximal epiphysis fuses with the shaft in 16th year and distal epiphysis with the shaft in 18th year in males [4].

MATERIALS AND METHODS

The present study was carried out on 300 medical students of Marathwada region of Dr. Shankarrao Chavan Government Medical College, Nanded, Maharashtra. Of the 300 subjects 150 were males and 150 females of age group 18-24 years. Height and percutaneous ulna length were recorded for each subject.

Height was measured by stature meter fixed to the wall. The height was measured without shoes bare feet. The subject was made to stand against the wall erect, arms hang loosely by the body and the heels, sacral region and the upper part of the back touching the wall.

Ulna length was measured with the subject sitting and forearm placed on the table flexed 90° at the elbow. Length of ulna was measured as the straight distance between the most proximal point of the olecranon process to the most distal point of the styloid process in the supinated forearm [5].

Measurements were taken during fixed timings of the day between 1pm and 3pm to avoid diurnal variation. All measurements were taken by the same observer and with the same instrument to avoid any technical or inter-observer error and to maintain reproducibility. Both height and lengths of right and left ulna were measured separately and were noted in centimeters [5].

After collection of the data, they were subjected to statistical analysis. Mean, standard deviation, correlation coefficient, simple linear regression, regression coefficient and intercept were

calculated.

RESULTS

Table No. 1 shows that mean height of male subjects is 171.99 ± 6.04 . Mean of length of right and left ulna in male subjects are 26.92 ± 1.30 and 26.85 ± 1.32 respectively. The mean height of female subjects is 165.49 ± 3.18 . Mean of length of right and left ulna in female subjects are 21.77 ± 0.93 and 21.69 ± 0.88 respectively. The mean length of ulna irrespective of side in males and females is 26.89 ± 1.31 and 21.73 ± 0.90 respectively.

Table 1: Mean height, length of right and left ulna in Males and Females.

Parameter	Males		Females		Both	
	Mean	SD	Mean	SD	Mean	SD
Height (cm)	171.99	6.04	165.49	3.18	168.74	5.81
Length of Right Ulna	26.92	1.3	21.77	0.93	24.35	2.81
Length of Left Ulna	26.85	1.32	21.69	0.88	24.27	2.81
Mean of Right & left length of ulna	26.89	1.31	21.73	0.9	24.31	2.81

Table No. 2 shows that the correlation of stature with ulnar length is 0.66 in males and 0.70 in females, which are positive and statistically highly significant ($P < 0.01$) i.e. if length of ulna increases or decreases, the stature of the subject also increases or decreases and vice versa.

Table 2: Pearson's correlation coefficient.

Sex	Correlation coefficient	P value
Males	0.6612	<0.0001
Females	0.7003	<0.0001
Both	0.7338	<0.0001

Graph 1: Correlation between Length of ulna and Height in Males.

Graph 2: Correlation between Length of ulna and Height in Females.

Graph 3: Correlation between Length of ulna and Height irrespective of sex.

Table No. 3 shows the linear regression equation for stature with ulnar length in male and female where, Y = Height/ Stature (cm), X = Length of ulna (cm), 90.15 and 112.1 are intercept (constant) for male and female. 3.044 and 2.455 are regression coefficient for male and female. From the table below it is seen that the regression formula within a region also varies between male and female population of that region.

Table 3: Regression equation for height with length of ulna.

Sex	Regression Equation	P value
Males	$Y = 3.044 * X + 90.14$	<0.0001
Females	$Y = 2.455 * X + 112.1$	<0.0001
Both	$Y = 1.516 * X + 131.9$	<0.0001

DISCUSSION

In the present study, mean height of subjects is 171.99 cm in males and 165.49 cm in females which are comparable with previous studies. The difference between mean height of male and female subject's i.e. gender difference are

statistically significant ($P < 0.05$). So the males of a population are taller than females.

From the table No.4 & 5, it is clear that mean height of subjects within an age group varies within different regions of a country. It may be due to geographical, racial as well as genetic factors or may be due to dietary habits, lifestyle and physical stress. So if the differences in mean height of subjects of different population are due to geographical, racial and genetic factors, we can safely presume that it will remain constant for a long period of time. But if predominate influence is observed to be plastic ones (i.e. dietary habits, lifestyle and physical stress), it is hypothesized that the anthropometric standards will have to be evaluated from time to time in the perspective of such influences for their validity [6].

In present study, mean length of right and left ulna in males and females were 26.92 cm, 26.85cm and 21.77cm, 21.69cm respectively. The difference between mean ulnar length of male and female subjects i.e. gender difference is statistically significant ($P < 0.05$) which coincides with that of previous studies.

Table 4: Comparison of mean of total height and mean of length of ulna in Males.

Author	Year	Region	Mean Height (cm)	Mean length of Ulna (cm)	
				Right	Left
Anjali Prasad [3]	2012	Marathada	171.93	26.92	26.86
Avantika Bamne [7]	2014	Maharashtra	172.31	27.9	27.75
A Anupriya [2]	2016	Tamilnadu	164.4	27.7	27.6
Acharya Veena Anand [8]	2016	Gulbarga	172.13	28.1	27.69
Anjali Krishna Prasad [6]	2016	MP	172.93	27.52	27.26
Ashish Pandey [9]	2016	Bangalore	169.46	27.52	27.62
Chintala Durga Sukumar [10]	2017	Vijaywada	165.72	29.84	29.78
Martula Lemtur [11]	2017	Nagaland	168.12	27.45	27.42
Present Study	2018	Marathwada	171.99	26.92	26.85

From Table No. 6 & 7 it is observed that all workers got positive correlation between stature and length of ulna indicating strong relation between the two parameters.

Regression formulae is population specific and sex specific due to genetic differences, isolation differences, differences in bio-cultural history and other factors. The researchers determined that the stature estimation formulae should be recalculated within appropriate time intervals, even for same racial Populations [12].

Table 5: Comparison of mean of height and mean of length of ulna in Females.

Author	Year	Region	Mean Height (cm)	Mean length of Ulna (cm)	
				Right	Left
Anjali Prasad [3]	2012	Marathada	165.43	21.75	21.68
Avantika Bamne [7]	2014	Maharashtra	172.31	27.9	27.75
A Anupriya [2]	2016	Tamilnadu	153.7	25.6	25.4
Acharya Veena Anand [8]	2016	Gulbarga	157.28	25.48	25.05
Anjali Krishna Prasad [6]	2016	MP	166.53	21.75	21.68
Ashish Pandey [9]	2016	Bangalore	164.07	26.22	26.22
Chintala Durga Sukumar [10]	2017	Vijaywada	160.58	26.7	26.63
Martula Lemtur [11]	2017	Nagaland	157	25.15	21.1
Present Study	2018	Marathwada	165.49	21.77	21.69

Table 6: Comparison of Regression equation in Males.

Author	Year	Region	Regression Equation	
			Right	Left
Anjali Krishna Prasad [3]	2012	Marathwada	$Y = 93.45 + 2.92X$	
Avantika Bamne [7]	2014	Maharashtra	$Y = 65.77 + 3.81 X$	$Y = 64.17 + 3.89 X$
A Anupriya [2]	2016	Tamilnadu	$Y = 63.984 + 3.631X$	$Y = 66.232 + 3.551X$
Acharya Veena Anand [8]	2016	Gulbarga	$Y = 69.4 + 3.65 X$	$Y = 64.1 + 3.90 X$
Anjali Krishna Prasad [6]	2016	MP	$Y = 93.45 + 2.92X$	
Chintala D. Sukumar [10]	2017	Vijaywada	$Y = 111.8 + 1.80 X$	$Y = 112.13 + 1.79 X$
Balkrishna Thummar [14]	2011	Gujrat	$Y = 81.11 + 3.117X$	$Y = 65.76 + 3.667X$
Martula Lemtur [11]	2017	Nagaland	$Y = 84.34 + 3.05X$	
Present Study	2018	Marathwada	$Y = 90.14 + 3.044 X$	

Table 7: Comparison of Regression Equation in Females.

Author	Year	Region	Regression Equation	
			Right	Left
Anjali Krishna Prasad [3]	2012	Marathwada	$Y = 113.89 + 2.37X$	
Avantika Bamne [7]	2014	Maharashtra	$Y = 70.75 + 3.46X$	$Y = 102.82 + 2.21 X$
A Anupriya [2]	2016	Tamilnadu	$Y = 57.995 + 3.745X$	$Y = 56.048 + 3.839X$
Acharya Veena Anand [8]	2016	Gulbarga	$Y = 80.2 + 3.03X$	$Y = 74.0 + 3.33X$
Anjali Krishna Prasad [6]	2016	MP	$Y = 113.89 + 2.37X$	
Chintala D. Sukumar [10]	2017	Vijaywada	$Y = 57.16 + 3.87 X$	$Y = 47.05 + 4.23 X$
Balkrishna Thummar [14]	2011	Gujrat	$Y = 17.10 + 5.314X$	$Y = 18.95 + 5.335X$
Martula Lemtur [11]	2017	Nagaland	$Y = 74.83 + 3.29X$	
Present Study	2018	Marathwada	$Y = 112.1 + 2.455X$	

Body ratios within specific population groups also changes over time due to changes in diet, lifestyle and socio- economic status, and therefore the present regression formulae may need readjustment [12].

Furthermore, racial variation in the relationship between ulna length and height has been clearly demonstrated by comparative studies between Black, White and Asian subjects [13].

The present study further highlights the racial diversity in mean ulna length.

CONCLUSION

Mean height and length of ulna is more in males than in females and it is statistically significant. There is positive correlation between stature and length of ulna. Simple linear regression equation so far derived can be used if either of the

measurement of length of ulna or total height is known, the other can be calculated. This fact will be of practical use in Medico Legal investigations and in Anthropometry. Study would be useful for Anthropologist and Forensic Medicine experts.

Conflicts of Interests: None

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