



## Original Research Article

## Estimation of stature using Humerus length among adult population in South India

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## ABSTRACT

**Background:** The humerus can be broken down into four segments. If the humerus is found in its entirety, then its length can be used to estimate stature. However, if only segments of the humerus are recovered then a combination of segments can be used to estimate stature.

**Objective:** To estimate the stature using Humerus length among adult population in South India.

**Materials and Methods:** A Cross sectional study was carried out using purposive sampling among Medical Students at CIMS, Chamarajanagar. Study duration was 6 months from July 2019 to December 2020. 100 Male and 100 Female Medicos were included in the study after taking informed consent. Differently abled adults were excluded from the study to reduce the error. Structured questionnaire was used to collect the data such as age, gender, height, arm length or Humerus length and distance between medial and lateral condyle.

**Results:** In the study among males there was significant positive correlation between Humerus length and height and distance between medial & lateral epicondyle among females there was negative correlation between Humerus length and age. Among Males equation for estimation of height using Humerus length =  $103.1 + 1.903 \times \text{Arm length}$ . Among Females equation for estimation of height using Humerus length =  $108.34 + 1.608 \times \text{Arm length}$ .

**Conclusion:** As a result, these measurements may help to indicate the characteristic morphological features of humeral segments in south Indian population and also help the orthopedic surgeon to place the various implants in the reconstruction of humeral fractures.

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### 1. Introduction

Stature estimation is obtained from measurements of long bones; namely the humerus, femur, and tibia. If these bones are unavailable, the ulna, radius, and fibula can also provide a good range for the expected height of an individual. As many elements as possible should be used in a regression equation to estimate stature. Incomplete fragments can be used to estimate height, by first estimating the complete length of bone from a regression equation before applying the original formula to estimate stature.<sup>1,2</sup>

Since stature is variable among population and sex, there are different regression formulas for different populations. Therefore, determining which regression formula to use is an important aspect of stature estimation. It is necessary to know the population from which an individual is from and the individual's sex when selecting a formula.<sup>3</sup>

The humerus can be broken down into four segments. If the humerus is found in its entirety, then its length can be used to estimate stature. However, if only segments of the humerus are recovered then a combination of segments can be used to estimate stature.<sup>4,5</sup>

Segment 1 is identified as the entirety of the humeral head

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Segment 2 is identified as between the most distal point of the head and the most proximal margin of the olecranon fossa.

Segment 3 is identified as the entirety of the olecranon fossa, from the most proximal to the most distal margins.

Segment 4 is identified as between the most distal margin of the olecranon fossa, and the most distal point of the trochlea.

## 2. Objectives

1. To determine the correlation between Height and Humerus length among males and females.
2. To estimate Height using Humerus length among males and females.

## 3. Materials and Methods

A cross sectional study was carried out using purposive sampling among Medical Students at CIMS, Chamarajanagar. Study duration was 6 months from July 2019 to December 2020. 100 Male and 100 Female Medicos were included in the study after taking informed consent. Differently abled adults were excluded from the study to reduce the error. Structured questionnaire was used to collect the data such as age, gender, height, arm length or Humerus length and distance between medial and lateral condyle.

### 3.1. Equipment's used are as follows<sup>6,7</sup>

#### 3.1.1. Anthropometer II spreading caliper III skin marking pencil

Measurements were taken at a fixed time, to avoid diurnal variations. Any obvious deformity or limb defects were not included in the present study. The height of the subject was measured by standard height measuring instrument in anatomical position. The length of humerus was taken by asking the subject to flex the elbow joint. The flexor surfaces of arm and forearm made an angle of 90 degrees. Lateral epicondyle was felt and marked with skin marking pencil. Acromion point was traced by moving finger over clavicle's lateral end and was marked and the distance between two points was measured by spreading caliper, both side humerus length was taken. The measured length was subtracted by 2.0 mm as the acromion point is 2 to 5 mm above humeral head.

### 3.2. Statistical methods

Data was analyzed using SPSS 22 version software (IBM SPSS Statistics, Somers NY, USA). Categorical data was represented in the form of Frequencies and proportions. Continuous data was represented as mean and standard deviation. Independent t test was used as test of significance to identify the mean difference between two quantitative

variables.

Pearson correlation was done to find the correlation between two quantitative variables.

**Table 1:**

Correlation coefficient (r)	Interpretation
0 - 0.3	Positive Weak correlation
0.3-0.6	Positive Moderate correlation
0.6-1.0	Positive Strong correlation
0 to (-0.3)	Negative Weak correlation
(-0.3) to (-0.6)	Negative Moderate Correlation
(-0.6) to - (1)	Negative Strong Correlation

### 3.3. Regression

Linear regression was done to find the regression equation and to estimate the unknown quantitative variables when one quantitative variable is known.

The regression equation is a linear equation of the form:  $y = b_0 + b_1x$

Y = Dependent variable, X = Independent variable,  $b_0$  = Constant B,  $b_1$  = Unstandardized Coefficients of Independent variable.

### 3.4. Graphical representation of data

Scatter plots was used to represent correlation between two quantitative variables.

p value (Probability that the result is true) of  $<0.05$  was considered as statistically significant after assuming all the rules of statistical tests.

## 4. Results

Mean age of Males was  $19.20 \pm 0.91$  years and females were  $19.24 \pm 0.82$  years. There was no significant difference in mean age between two groups.

Mean Height of males was  $163.16 \pm 4.55$  cm and among females was  $156.83 \pm 3.77$  cm. There was significant difference in mean height between males and females.

Mean Average Arm Length among males was  $31.55 \pm 1.56$  cm and among females was  $30.15 \pm 1.07$  cm. There was significant difference in mean average arm length between males and females.

Mean Distance between medial & lateral epicondyle among males was  $13.73 \pm 1.70$  cm and among females was  $11.84 \pm 1.42$  cm. There was significant difference in mean Distance between medial & lateral epicondyle between males and females.

In the study among males there was significant positive correlation between Humerus length and Height and Distance between medial & lateral epicondyle i.e. with increase in Humerus length there was increase in height and Distance between medial & lateral epicondyle and vice versa.

**Table 2:** Age and anthropometric parameters distribution between males and females

	Gender			Gender			P value
	Male	Male	Male	Female	Female	Female	
	Mean	SD	Median	Mean	SD	Median	
Age	19.20	0.91	19.00	19.24	0.82	19.00	0.744
Height (cm)	163.16	4.55	163.00	156.83	3.77	156.00	<0.001*
Average Arm Length	31.55	1.56	31.20	30.15	1.07	29.70	<0.001*
Distance between medial & lateral epicondyle	13.73	1.70	13.50	11.84	1.42	12.00	<0.001*

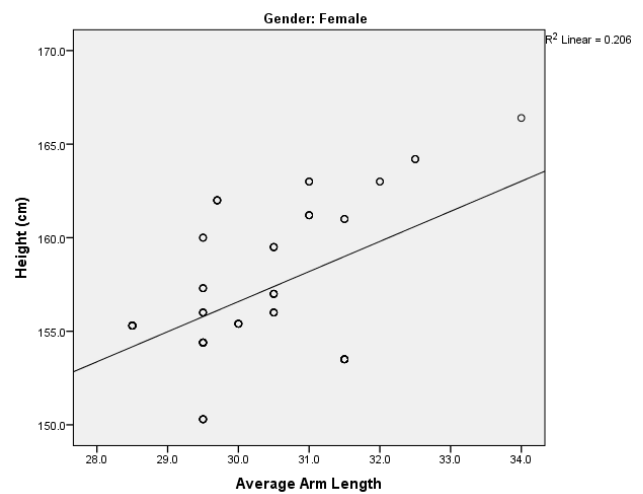
**Table 3:** Correlation between arm length/humerus length with age, height and distance between medial & lateral epicondyle

		Average Arm Length	
		Male	Female
Age	Pearson Correlation (r)	-0.100	-0.610**
	P value	0.322	<0.001*
Height (cm)	Pearson Correlation (r)	0.650**	0.454**
	P value	<0.001*	<0.001*
Distance between medial & lateral epicondyle	Pearson Correlation (r)	0.715**	0.385**
	P value	<0.001*	<0.001*

\*\* Correlation is significant at the 0.01 level (2-tailed)

Among females there was negative correlation between Humerus length and age i.e. with increase in age there was decrease in Humerus length and vice versa. The correlation was statistically significant.

Among females there was significant positive correlation between humerus length and height and distance between medial & lateral epicondyle i.e. with increase in Humerus length there was increase in height and Distance between medial & lateral epicondyle and vice versa.

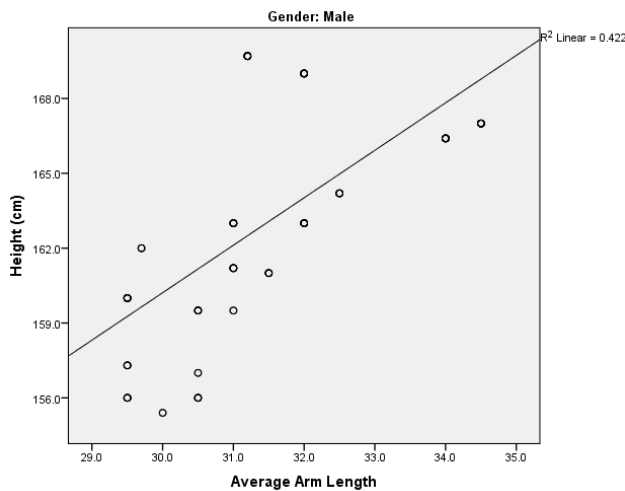


**Fig. 2:**

medicine throughout the world. But in this present study we have tried to evaluate the height of the stature of the persons from the long bones of Upper body.

Various author in the past have shown that there is statistical significant between the height of the person and different parts of the body but mostly and majority of them had done on lower extremity of long bones, further the study on estimation of height from the long bone of the upper extremity of the body had been very sparse and very minimal data is available.

It is to be noted that for identification of any person in the field of forensic the height of the person is one of the method. In order to obtain he height of the person the long bones are usually evaluated and if the long bones are



**Fig. 1:**

**5. Discussion**

The estimation of height of the person from the long bones is practiced worldwide in clinical and forensic field of

**Table 4:** Linear regression between Humerus length and height

Coefficients		Unstandardized Coefficients		Standardized Coefficients	t	P value
Model		B	Std. Error	Beta		
Male	(Constant)	103.140	7.101		14.525	<0.001*
	Average Arm Length	1.903	.225	0.650	8.462	<0.001*
Female	(Constant)	108.343	9.615		11.268	<0.001*
	Average Arm Length	1.608	0.319	0.454	5.046	<0.001*

Among Males equation for estimation of height using Humerus length =  $103.1 + 1.903 \times \text{Arm length}$ .

Among Females equation for estimation of height using Humerus length =  $108.34 + 1.608 \times \text{Arm length}$ .

fractured the fractured fragments of the long bone need to be assembled and height is estimate. In this study we are calculating the stature of the person by examining the length of the Humerus.

In the present study it was estimated that the average length of Male was  $103.1 + 1.903 \times \text{Arm length}$  and among female it was  $108.34 + 1.608 \times \text{Arm length}$  by using regression equation. In the study done by Borkar M P et al.<sup>8</sup> also demonstrated that regression equation can be used in estimating length of stature from the size of the humerus. In studies done by Krishan and Kanchan et al.<sup>9</sup> also opined in their study that stature estimation can be evaluated using regression analysis method than multiplication factor method.

Few other studies done by Kapoor et al., Vijetha et al. findings were also co relating and similar to our study findings.<sup>10,11</sup>

Further it was also established that by knowing the length of the humerus it will be possible for estimating stature of the person.

## 6. Conclusion

The present study enhance the known knowledge of the fact that estimation of the stature is one of the important method used in the identification of the person can be done by long bones of the upper extremities also. It will help further in the field of forensic, anatomy and even in archeological case where unknown bodies need to be examined. It is also helpful for the clinician in the treatment of proximal and distal humeral fractures. Therefore, the present study supplies the mean values of the different morphometric measurements from the humerus.

## 7. Source of Funding

None.

## 8. Conflict of Interest

The authors declare that there is no conflict of interest.

## References

1. Krogman WM, Charles C. The Human skeleton in forensic medicine. USA: Thomas Publisher; 1980. p. 302–49.
2. Krogman, Skeleton WM. The Human Skeleton in Forensic Medicine. Spring Field, US: Manouvrier and vide supra. vol. 1962. 1st ed. Thomas C, editor. US: Manouvrier and vide supra: Spring Field; 1962. p. 179–80.
3. Bhatnagar DP, Thapar SP, Batish MK. Identification of personal height from the somatometry of the hand in Punjabi males. *Forensic Sci Int*. 1984;24(2):137–41. doi:10.1016/0379-0738(84)90093-8.
4. Jadhav HR, Shah GV. Determination of personal height from the length of head in Gujarat region. *J Anat Soc India*. 2004;53(1):20–1.
5. Holland TD. Estimation of adult stature from fragmentary tibias. *J Forensic Sci*. 1992;37(5):1223–9.
6. Kantha BML, Kulkarni R. Estimation of total length of humerus from its fragments in south Indian population. *Int J Anat Res*. 2014;2(1):213–20.
7. Utpal D, Mukhopadhy PP, Ghosh TK, Biswas S, Biswas S. Estimation of stature from fragment of long bone (Tibia) In Indian Benagal population. *J Anat Soc India*. 2009;58(2):169–72.
8. Borkar M. Estimation of height from the length of humerus in western region of Maharashtra. *Int J Res Med Sci*. 2014;2(2):498–500. doi:10.5455/2320-6012.ijrms20140524.
9. Krishna K, Sharma K. Multiplication factor versus regression analysis in stature estimation from hand and foot dimension. *J Forensic Legal Med*. 2012;19:211–4.
10. Kapoor AK, Saini M, Choudhary V. Estimation of Stature from hand length prints among ladakhis of Kashmir. *Int Res J Life Sci*. 2013;1(1):1–7.
11. Vijeta, Kapoor AK. Estimation of Stature from Hand Length and Hand Breadth among Population Groups of Himachal Pradesh. *Asian J Sci Appl Technol*. 2012;1:50–4.

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