



## Original Research Article

## Estimation of stature from left upper limb anthropometry in North Karnataka population: A cadaveric study

P S Bhusaraddi<sup>1</sup>, Vijay Kumar Shinde<sup>1</sup>, Pratik Khona<sup>1,\*</sup><sup>1</sup>Dept. of Anatomy, Gadag Institute of Medical Sciences, Gadag, Karnataka, India

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## ABSTRACT

**Introduction:** Estimation of stature plays an important role in the process of anthropology. This mirrors the culture, built of a person and many factors. Hence the anthropometric technique is exclusively used by medical scientists and anatomists to estimate the body size since many years. The present study was conducted to estimate the left humeral length from the measurements of proximal and distal segments of humerus in region of North Karnataka population using regression equation. This helps in estimating the stature of individual using standard regression formulae and to compare these data with the study conducted in other countries for the use in forensic and archeological studies. The current study was therefore focussed on proximal and distal segments of left humerus and using these, the length of the left humerus was estimated.

**Materials and Methods:** The different measurements of proximal and the distal segments of 47 left humeri and the mean values of the maximum length of the left humerus (MHL) were noted and used in our study to derive the regression equation. Maximum length of humerus, vertical and transverse diameter of proximal segment, transverse diameter and biepicondylar width of distal segment were measured using anthropometric techniques.

**Results:** With the fragment measurements obtained, regression equations for left humeri was derived to estimate the maximum length of the humerus in North Karnataka region population. On applying the regression analysis, among 47 left humeri, it was found that, the vertical diameter of superior articular surface had significant role in estimating the maximum humeral length with maximum correlation coefficient of 0.87 ( $p < 0.05$ ).

**Conclusion:** The result of this study concludes that the length of the left humerus can be estimated from the measures of proximal and distal segments of left humerus.

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### 1. Introduction

Stature estimation from remnant bones plays a key important role in identifying unknown bodies, parts of bodies or skeletal remains. Hence anthropometric technique commonly used by anthropologists and adopted by medical scientists, anatomists to estimate body size since hundred of years.<sup>1</sup> In forensic and also in archeological practice, experts' advice and practice to preserve the fragments of long bones which are the only available source to establish identity. With these preserved fragments, the

stature estimation becomes most important work in such scenario. In this view, application of osteometry is of high rank significance in forensic medicine. With this background, knowledge of morphometric values of fragments of humerus is an important role, in order to identify unknown bodies.<sup>2</sup> When the whole of the long bones becomes unavailable in many situations, some methods have been employed for the usefulness of the fragments of long bone such as ulna and tibia (Mysorekareta., 1984) and also humerus (Wright & Vasquez).<sup>2</sup> Hence its proved by many studies, when the fragment of skeleton is available, pelvic bone and cranium plays major role in estimation of the statue, the next bones

\* Corresponding author.

E-mail address: [drpratikkhona@gmail.com](mailto:drpratikkhona@gmail.com) (P. Khona).

are long bone like femur, tibia, humerus and ulna.<sup>3,4</sup> The humerus is a long bone in the arm, that connects the shoulder to the elbow. Anatomically it connects the scapula and the forearm consisting of the radius and ulna. The humerus has three main parts:-The proximal end, the shaft and the distal end.<sup>5-7</sup>

With this background the present study was attempted to estimate the humeral length from the dimensions of the proximal and distal segments.

## 2. Aims and Objective

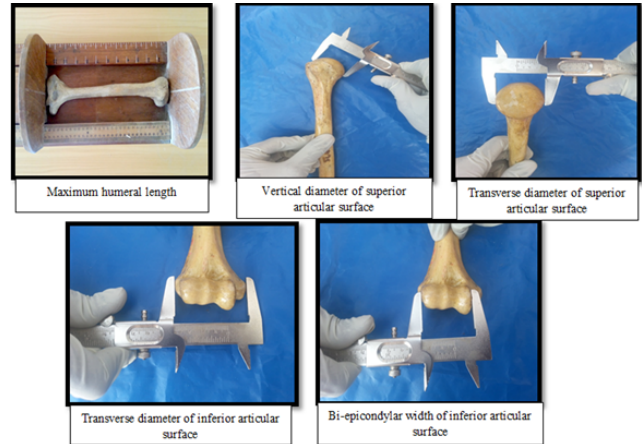
1. To establish the correlation between the proximal and distal segment parameters with maximum humeral length (MHL).
2. To derive regression equations to calculate maximum humeral length from proximal and distal segment parameters which can be useful for the North Karnataka region.

## 3. Materials and Methods

The data was collected from Department of Anatomy, Gadag Institute of Medical Sciences, Gadag. Fully ossified dry humeri from the skeletal sets of medical students of Gadag Institute of Medical Sciences, Gadag, were also considered. All left humerus when considered accounted for 47 in number which included irrespective of the sex, age group, the bone belonged to. Those bones which were unossified, had deformity, suffered injury were excluded. With the help of osteometric board and vernier calipers, the following parameters were measured:-

1. Maximum length of the humerus (MHL)- measured from the top of the head to the distal point of trochlea.
2. The vertical diameter of the superior articular surface (PS-VD of SAS)- maximum distance between two points on the humeral in vertical plane passing through greater tuberosity tip.
3. The transverse diameter of the superior articular surface (PS-TD of SAS) measured as the maximum width between two points on the head of the humerus in transverse plane of head anteroposteriorly.
4. The transverse diameter of the inferior articular surface (DS-TD of IAS): measured as the maximum combined width of the trochlea and the capitulum on the anterior surface
5. The biepicondylar width (DS-BECW): It was measured as the maximum distance between the medial and the lateral epicondyles.

Three readings for all the above measurements were taken to the nearest millimeter. If the readings differed, then the average of the three readings was considered as the final reading.



**Fig. 1:** Figures showing the procedure of measuring the dimensions.

## 4. Results

### 4.1. Descriptive analysis

The mean values of the maximum length of the left humerus (MHL) and the different measurements as mentioned above in methodology of proximal and the distal segments of 47 left humeri were noted. These values are expressed as minimum and maximum value along with mean and Standard deviation values as in table 1.

Table 1 shows the vertical diameter of superior articular surface of proximal segment ranged from 3.7 – 4.6 cms with the mean of  $4.06 \pm 0.25$  cm, while the transverse diameter of the same ranged from 3.4 – 4.3 cm with the mean of  $3.71 \pm 0.25$  cm. The transverse diameter of inferior articular surface of distal segment ranged from 3.6 – 4.5cm with the mean of  $3.94 \pm 0.25$  cm, while the bi-epicondylar width of distal segment ranged from 5.0 – 6.3 cm with the mean of  $5.59 \pm 0.29$  cm. The maximum humeral length ranged from 26.6 – 33.8 cm with the mean of  $29.55 \pm 1.73$  cm.

On analysis of the correlation co-efficient of left humeral fragments with the maximum humeral length, we observed that, all the measured fragments are strongly and positively correlating with maximum humeral length, since the correlation co-efficient is close to +1, Among the measurements taken in our study, the vertical diameter of superior articular surface of the proximal segment is very close to +1 and hence is more strongly correlating than any other parameters considered same is depicted in the below Figure 2.

\*measurements in terms of centimeters.

### 4.2. Simple linear regression

[Table 2 shows the regression Co-Efficient (COE) and the significance (P value) for the dimensions of the proximal and the distal segments of left humeri.

**Table 1:** Showing the Max, Min, Mean+SD of various parameters in 47 left humeri.

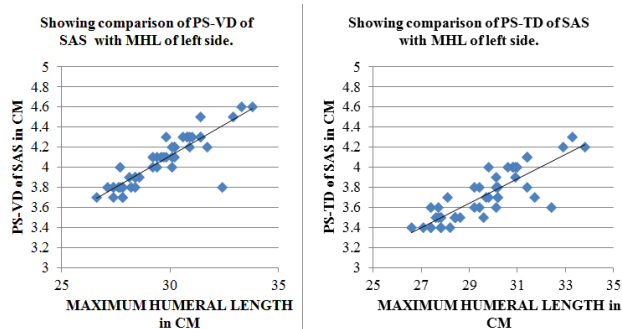
Parameters	N	Min	Max	Mean	Std. deviation
PS - VD of SAS	47	3.7	4.6	4.06	0.25
PS - TD of SAS	47	3.4	4.3	3.71	0.25
DS - TD of IAS	47	3.6	4.5	3.94	0.25
DS – BECW	47	5	6.3	5.59	0.29
MHL	47	26.6	33.8	29.55	1.73

**Table 2:** Showing correlation co-efficient between the parameters and MHL in 47 left humeri.

Parameters	N	Correlation co-efficient	Remarks
PS - VD of SAS	P1	0.87	Strong positive correlation
PS - TD of SAS	P2	0.85	Strong positive correlation
DS - TD of IAS	D1	0.82	Strong positive correlation
DS – BECW	D2	0.72	Strong positive correlation

**Table 3:** The regression co-efficient and their P-value for various parameters in present study.

Parameters	N	Regression co-efficient	P – Value
PS - VD of SAS	47	6.11	< 0.05
PS - TD of SAS	47	5.85	< 0.05
DS - TD of IAS	47	5.54	< 0.05
DS – BECW	47	4.23	< 0.05



**Fig. 2:**

From the above table, it is clear that the p value is less than 0.05 and hence the regression coefficient derived are statistically significant for all the parameters on both sides.

### 4.3. Simple linear regression equations

Globally, the regression formulae have been accepted as important way of determination of stature from various anthropometric dimensions. In the present study, regression formula was related to the dimensions of the proximal and the distal segments of the humerus was derived as shown in Table 4 :

As the bones were of unidentified sex, the inference based on sexual dimorphism could not be studied.

## 5. Discussion

Projection of stature from remnant bones has been assumed to play the significant role in identification of missing person in forensic anthropology. Height of individual is one of the most variable parameter which is influenced by a many confounding factors like nutrition, age, sex, ethnicity, health, general body size, sexual dimorphism etc. Therefore, many studies have shown that stature can differ from one individual to another according to different populations.<sup>8</sup>

The humerus is the largest and the longest bone in the upper limb and estimating the humeral length from the segmental measurements plays an important step. Steele and Mckern defined a method based on the proportionality between the determined distances among the fixed points of the bones and their total length.<sup>9</sup> According to anthropometric studies, the mean value of the humerus length gives an important evidence to indicate the characteristic features of a population.<sup>10–12</sup>

Regression analysis is one of the most appropriate methods for defining the relationship between the length of the long bones and living height of individuals, and between the length of the measurements of the long bone fragments and their maximum length.<sup>13,13</sup> Estimation of the long bone length from its fragments is done by using the accurate landmarks as mandatory. Usually, the transverse diameters of diaphysis are not appropriate for estimating the length because of their inability in defining the precise landmarks. Therefore, the only left over location points is measured on the fragments of proximal or distal diaphysis. Hence, for our present study, the dimensions of the proximal

**Table 4:** Showing the regression equations derived for the various parameters in the present study.

Parameters	Left humeri N	Regression equation
PS - VD of SAS	47	MHL=4.77+6.11A
PS - TD of SAS	47	MHL=7.86+5.85B
DS - TD of IAS	47	MHL=7.73+5.54C
DS – BECW	47	MHL=5.89+4.23D

and the distal segments of the humeri alone are selected. In our present study, we used regression equations to measure the length of the humerus, among North Karnataka population, which have not yet reported. Considering the proximal measurements, the vertical diameter of the superior articular surface alone showed significance in estimating the maximum length of the humerus on the left side.

On comparison of correlation co-efficient of present study with the previous workers in left humeri, it was observed that all measurements had positive correlation (correlation co-efficient > 0.5) but more so in the present study ranging from 0.72 to 0.87. The difference in correlation co-efficient may be due to regional and racial variation. The difference was statistically significant ( $P < 0.05$ ) for all parameters when we compared the values with study by K Udhaya et al. Whereas the difference showed statistical significance for the vertical diameter of superior articular surface of proximal segment (PS-VD of SAS) and transverse diameter of superior articular surface (PS- TD of SAS) when we compared the values with other study conducted by Salles AD et al<sup>4,14</sup>

Regression equation was derived from the available measurements of the fragment of left humeri. This showed that MHL=4.77+6.11 A, 7.86+5.85B, 7.73+5.54 C, 5.89+4.23 D. where A-PS - VD of SAS, B- PS - TD of SAS, C- DS - TD of IAS, D- DS – BECW. When compared with other study conducted by K Udhaya and Salles AD, the regression equation was 11.53+4.49 A, 13.83+4.27 B, 11.91+4.6 C, 23.56+1.18D and 15.4+3.55A+1.2 6, not given, 19.8+2.7C+1.1 3, 16.8+2.39D+1.28 respectively.

The difference in equations of present study with previous workers may be because of difference in correlation co-efficient. This indicates that we have to consider different equations for calculating the maximum humeral length (MHL) in different regions and races.

## 6. Conclusion

The parameters of proximal and distal segment of 47 left humerus studied showed strong positive correlation with the maximum humeral length (MHL). The strongest positive correlation was observed between vertical diameter of superior articular surface of proximal segment (PS-VD of SAS) with maximum humeral length (MHL). On comparison of present study with the previous workers, it showed that there is regional and racial variations in

the regression equations derived for calculating maximum humeral length (MHL). The regression equation thus derived can be useful for the measurement of maximum humeral length (MHL) from the fragments of humerus in North Karnataka region.

## 7. Source of Funding

None.

## 8. Conflict of Interest

None.

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**Author biography**

**P S Bhusaraddi** Professor and Head

**Vijay Kumar Shinde** Associate Professor

**Pratik Khona** Assistant Professor

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