

*Original Research*

## **An Autopsy Based Study About Estimation of Stature of Adult Female Population from Clavicle Bone in Central India Region, Madhya Pradesh**

Jijith J. S.<sup>1</sup>  0009-0006-5141-2859, B.K. Singh<sup>2</sup>  0000-0001-9120-1569, J.S. Tomar<sup>3</sup>,  
Surya Prakash LRA<sup>1</sup>  0009-0004-8574-446X

### **Abstract:**

Establishment of identity of unknown individual or unidentified skeletal remains is one of the main objectives of forensic investigations, especially in various civil and criminal cases. Stature is one of the most significant and primary elements in formulating biological profile for establishing the identity of an unknown skeletal remain or mutilated body part in Forensic anthropology as well as Osteology. [1,2] Evaluation of stature is difficult when, the conditions like dead bodies are found mutilated, burnt, skeletonised or especially from a single skeletal remain like Clavicle bone. The aim of our present study is an attempt to deriving of specific regression equation for estimation of stature for adult female population in central India region, from the length of right and left Clavicle bones. After obtaining the IEC approval, current study was carried out including 60 adult females of age group 18 to 30 years, which were brought for the medico-legal autopsy to the mortuary of Department of Forensic Medicine and Toxicology, M. G. M. Medical College & M. Y. Hospital, Indore (M.P.) during the period of October 2023 to September 2024. Mean stature of female subjects is found to be 160.81 ±5.07 cm. Mean left clavicle length in female population is found to be 140.11±6.10 mm while mean right clavicle length is found to be 139.19±5.96 mm. There is strong positive correlation (P value is < 0.01, with 95% significance) between clavicle length and stature in female population of central India region. The present regression formula, which we derived from the length of both Clavicle bone could be useful for predicting the height of suspected female subjects from the length of either right or left Clavicle throughout the Central India.

**Key Words:** Identification; Stature; Biological profile; Clavicle; Forensic Anthropology.

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### **Introduction:**

According to the “Article 6 of the Universal Declaration of Human Rights” states that every individual has the right to recognition everywhere as a person before the law.” [3] Forensic anthropologists build a biological profile, which consists of stature, age, sex and race or population affinity estimates to assist medicolegal stakeholders for the

identification of unknown human skeletal remains. Stature is defined as natural height of a person in an upright position. For the establishment identity profile of an unidentified, besides the Age, Gender and Ethnicity or population affinity of unknown individual, Stature also contributes as an important parameter for identification. Estimated stature from the single or multiple bones from the available skeletal remains could narrows down the search of missing or suspected person by comparing the unique matches of missing person's records and can recognize the individual with specific height range. Forensic anthropologists use skeletal remains to estimate the height of an individual. Since

<sup>1</sup>Postgraduate, <sup>2</sup>Professor & Head, <sup>3</sup>Associate Professor, Department of Forensic Medicine and Toxicology, M.G.M Medical College, Indore (M.P.), India.

**Correspondence: Dr. Jijith J S**

Email: [jijithpayattuvila1992@gmail.com](mailto:jijithpayattuvila1992@gmail.com)

Contact: 9074599683

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then, especially long bones like the femur, tibia, humerus. etc are proportionally related to an individual's height, anthropological regression factors from these long bones can provide a reliable estimation of stature of specific population. [4] Estimation of Stature from the Clavicle bone length and its regression analysis is most relevant when any other long bones are no longer available.

#### **Materials and Methods:**

The present study is a cross-sectional study, which is conducted prospectively after the approval from the Institutional Ethics committee, on 60 adult deceased female subjects of age group between 18 to 30 years, are subjected for medico-legal autopsy, satisfying the inclusion and exclusion criteria, during the period from October 2023 to September 2024 in the mortuary of Department of Forensic Medicine & Toxicology, M.G.M. Medical College and M.Y. Hospital, Indore. Prior documented informed consent has been taken from next of kin of deceased subject before starting data collection.

Cases with fracture of either of clavicle, Congenital skeletal anomaly especially to spine or long bones, cases with any medical history of hormonal or chromosomal anomalies, those cases in which any of the clavicle showed pathological deformity, subjects with age less than 18 years and age more than 30 years and all the cases out of Madhya Pradesh state are excluded from our study. The subjects were selected by applying above-described inclusion and exclusion criteria. Significant medical history and Personal details mainly the chronological age of study subjects obtained from police requisition paper and then confirmed it date of birth from available identity proof document and strictly maintained throughout our present study.

Stature of the deceased subject is measured in centimetre by using standardised metallic measuring tap, which is affixed to the Autopsy table with an

accuracy of 1 mm. Stature is measured after keeping all limbs are straight and parallel to Autopsy table and body is in lying down and supine position on the Autopsy table. One straight cardboard is placed vertically at vertex of head, and another straight cardboard is placed vertically at lower heel end. The horizontal distance between both card boards reflects the exact stature of the individual and which is measured with standard metallic measuring tap, attached on either side of the Autopsy table and measured by average of two observations to avoid the possible observational bias. Mean value of both observations is taken as the Stature of person. Right and Left Clavicles are dissected out from the body by using scalpel blade and forceps. The important steps in removal of clavicle includes dissection of sternoclavicular joint and acromioclavicular joint.[4] After the removal of muscle attachments and soft tissues, putting the clavicles into solution of hydrogen peroxide for 5 to 10 minutes. The wet bones are then wiped off with a piece of gauze and then air dried for few minutes. Maximum length of each clavicle is measured by approximating the sternal end to acromial end with the help of external jaws of sliding Digital Vernier calliper in millimetres. After documenting the maximum length, both clavicles are replaced back into the body and concurrent autopsy examination completed and body handed over to concerned police.[5]

#### **Statistical Methods**

The data are tabulated in the pre-structured master chart and statistical analysis of Data done with appropriate SPSS version 22.0 and finally derived linear regression formula for estimation of Stature of adult female population.

#### **Results:**

In our present study, total 60 adult female subjects of age group between 18 to 30 years are subjected for medico-legal autopsy are selected and analysed by the authors. Out of the total 60 subjects, the

maximum number of cases are belonging to the age group of 29 to 30 years, that is 10 cases (16.67%). Then followed by the age group of 27 to 28 years, which constitutes 08 subjects which is 13.33% of total population. Least number of cases belongs 24 to 25years age group, i.e. 01 case (1.67%) (Table No.01).

S. No.	Age Group	No of Cases	Percentage (%)
1	18-19	07	11.67%
2	19-20	05	8.33%
3	20-21	03	5.00%
4	21-22	03	5.00%
5	22-23	06	10.00%
6	23-24	07	11.67%
7	24-25	01	1.67%
8	25-26	04	6.67%
9	26-27	03	5.00%
10	27-28	08	13.33%
11	28-29	03	5.00%
12	29-30	10	16.67%
<b>Total</b>		60	100%

**Table No.01: Age wise distribution of Female Subjects**

Mean length of right clavicle among female subjects is  $139.19 \pm 5.96$  mm. Right clavicle length varies in a range of 28.18 mm with maximum right clavicle length of 152.64 mm and minimum right clavicle length of 124.46 mm (Table No.02). The mean length of left clavicle among female subjects is  $140.11 \pm 6.10$  mm. Left clavicle length varies in a range of 27.35 mm with the maximum left clavicle length of 151.96 mm and minimum left clavicle length of 124.61 mm. So, from our current study it

can be interpreted that left clavicle is found lengthier than the right clavicle in female population of central India region. (Table No.02).

From the above table, (Table.03) which can be interpreted that the mean Stature of female population is found as  $160.81 \pm 5.07$  cm. Stature is varies at a range of 18.50cm with the maximum Stature of 169.70 cm and with the minimum Stature of 151.20 cm.

From the above table, (Table No.04), it is evident that  $\alpha$  is a constant and its value is 902.375, and it is common for both right and left Clavicle bones. There is  $\beta_1$  (Slope 1) is 0.191 and  $\beta_2$  (Slope 2) is 4.878 are exclusive for Right and Left clavicle bones respectively. Standard error of estimate ( $\epsilon_1$ ) for right clavicle bone is 3.034 and standard error of estimate ( $\epsilon_2$ ) for left clavicle is 3.106. In the case of Stature determination from both right and left clavicle, the P value is  $<0.01$  with 95% significance.

From the above table, (Table No.05), it is evident that Stature (S) is dependent variable.  $X_1$  and  $X_2$  are the length of Right clavicle and length of Left clavicle bone (in millimetre) respectively. Regression equation for the determination of Stature (in millimetre) from length of Clavicle bone and its particulars are given as follows. The regression equation holds good for certain extent for the Stature prediction even the absence of either Right clavicle bone ( $X_1=0$ ) or Left clavicle bone( $X_2=0$ ). P-value is 0.01  $<0.050$ , that means, our regression equation for Stature prediction is significant and is applicable to 95% of the female population in central India region.

Total No. of Subjects	Variable	Mean (mm)	Std. Dev.	Minimum (mm)	Maximum (mm)	Range
60	Right Clavicle	139.19	$\pm 5.96$	124.46	152.64	28.18
	Left Clavicle	140.11	$\pm 6.10$	124.61	151.96	27.35

**Table No.02. Mean length of Right and Left Clavicle (mm).**

No of Subjects	Variable	Mean	Std. Dev.	Minimum	Maximum	Range
60	Stature (cm)	160.81	±5.07	151.20 cm	169.70 cm	18.50 cm

**Table No.03. Stature Distribution of Female Subjects (cm)**

Variable	Right clavicle	Left clavicle
Mean Stature (cm)	160.81 ±5.07 cm	
Mean Clavicle length (mm)	139.19 ± 5.96 mm	140.11 ± 6.10 mm
$\alpha$ (Constant)	902.375	902.375
Standard error of estimate	3.034 ( $\epsilon_1$ )	3.106 ( $\epsilon_2$ )
P value	< 0.01	< 0.01
Significance	95%	95%

**Table No. 04. Comparison of various regression parameters of Stature and Mean length of right & left clavicle bones of female subjects**

Factors	Regression Equation for Female
Stature (S) X <sub>1</sub> is the Right Clavicle bone length (Variable) X <sub>2</sub> is the Left Clavicle bone length (Variable)	$S=902.375+0.191xX_1+3.034+4.878xX_2+3.106$

**Table No. 05. Regression equation to estimate Stature of female population from clavicle length**

Particulars	Value
S	Stature of the object (Dependent)
$\alpha$ (Constant)	902.375
$\beta_1$ (Slope 1)	0.191
$\beta_2$ (Slope 2)	4.878
$\epsilon_1$ Error term 1	3.034
$\epsilon_2$ Error term 2	3.106
X <sub>1</sub>	Right Clavicle bone length (Variable)
X <sub>2</sub>	Left Clavicle bone length (Variable)
P value	< 0.01
Significance	95%

**Table No. 06. Regression equation to estimate stature of Female population from clavicle length in different study groups (Right Clavicle length = X<sub>1</sub>, Left Clavicle length = X<sub>2</sub>)**

Study	Right Clavicle	Left clavicle
Present study	$Y = 902.375 + 0.191 \times X_1 + 3.034 + 4.878 \times X_2 + 3.106$	
MM Trangadia et. al. [5]	1092.224+3.626 cl	1088.593+3.740 cl
Rani Y et. al. [8]	35.082+0.973 cl	54.714+0.808 cl
Balvir TK et. al. [7]	1707.2-1.31cl	1674.58-1.0385 cl
Prakash D. et. al. [4]	104.883+0.412 cl	

### Discussion:

According to our study mean height of the female population is  $160.81 \pm 5.07$ cm found consistent with the study conducted by Varsha P et al [6] in which their mean stature is  $156.12 \pm 3.58$ cm. As per Varsha P et al [6] mean length of right clavicle is  $13.132 \pm 1.08$  cm and the mean of left clavicle length is  $12.926 \pm 1.11$  cm. But according to our study mean right clavicular length of female population is  $13.91 \pm 0.59$  cm and the mean of left clavicle length is  $14.01 \pm 0.61$  cm. In our study P-value of regression analysis from right and left clavicle are  $< 0.01$  and which is found to be statistically significant and is similar to that of study conducted by Varsha P et al [6].

Study conducted by MM Trangadia et. al. [5] at Saurashtra region of Gujarat, the mean Stature of female population is found to be  $156.68 \pm 5.44$  cm whereas, the mean Stature of female population of our study is found to be  $160.81 \pm 5.07$  cm. As per the study conducted by MM Trangadia et. al. [5] mean right clavicle length is  $13.08 \pm 0.92$  cm and the left clavicle length is  $12.95 \pm 0.96$  cm, whereas mean length of right clavicle among female subjects in our study is  $13.91 \pm 0.59$  cm and the mean left clavicle length among female subjects is  $14.01 \pm 0.61$  cm. In this study conducted by MM Trangadia et. al. [5], P-value for Stature determination from right and left clavicle length is  $< 0.01$  and thus it is found statistically significant, which is same as that of our present study.

In our present study left clavicle found lengthier than the right clavicle in female subjects which is consistent with the studies conducted by Prakash D et. al. [4], Rani Y et. al. [8]. Which is not in line with the studies conducted by MM Trangadia et. al. [5] and Pati S et al [9].

Conducted by Balvir et al. [6] at Vidarbha area of Maharashtra found that average living Stature from the length of clavicle bone among the female population found to be  $154.22 \pm 3.92$  cm ( $1542.25 \pm 39.26$  mm), which is consistent with our present study, which states average Stature of female population is found to be  $160.81 \pm 5.07$ cm.

Rani Y et. al. [8] was conducted study on Correlation of Stature of Adult with the Length of Clavicle, in this study the mean right clavicle length found to be  $11.56 \pm 0.3$  cm and the mean left clavicle length is  $11.84 \pm 0.5$  cm. But in our study mean right clavicular length of female population is  $14.05 \pm 0.5$  cm and the mean left clavicle length among female subjects is  $13.87 \pm 0.6$  cm.

Pati S et al [9] was conducted multiple regression analysis to predict stature based on clavicle length, adjusting for other factors of biological profile. Their regression estimates found as statistically significant ( $F(4, 95) = 27.3, P < 0.001$ ) and could explain approximately 53% of the variance in stature ( $R^2 = 0.53$ ). Clavicle length emerged as a significant predictor of stature ( $\beta = 0.61, P < 0.001$ ).

Stature can be reliably estimated by the regression method especially from the

skeletal remnants for the specific population [10]. There is limited number of studies, which describes the Stature estimation from the length of Clavicle especially in Central India region. The regression formula, which we derived specifically for the female population of central India region, holds good since it is statistically Significant (P value 0.01) for length of intact right and/or left Clavicle bones.

#### **Conclusion:**

Take into account of our study and other related study findings into consideration, Stature plays a crucial role in a person's physical appearance and can be used as a major factor for identification of unknown individual. The present research concluded that there is a positive correlation between clavicle length and stature, with a linear relationship had observed between the cadaveric stature and the clavicle length on either side. As per our study, average Stature of female population in central India region has found to be  $160.81 \pm 5.07$ cm. Stature of female subject of central India, can be estimated by this regression formula which is based on the clavicle length from all unidentified skeletonised or mutilated remains with intact right or left clavicle bone. Regression analysis of Clavicle length for Stature prediction would be deemed helpful for forensic experts and anthropologists in handling various medicolegal cases. Similarly, skeletal maturity is influenced by various factors such as lifestyle, diet, climate, ethnicity and behaviour, highlighting the **need for promoting regional studies across India for both academic and judicial purposes.**

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