*Original Article*

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# Estimation of Stature of an Individual from Forearm Length in Maharashtra Population

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**Abstract**

*Background*: The estimation of stature from forearm length holds a special place in the field of Forensic Anthrpometry. *Aim:* The aim of present study was to find out a regression equation that could calculate the height of a person precisely from forearm length. In this study the height and forearm length of 200 Ist M.B.B.S. students of Rajarshee Chhatrapati Shahu Maharaj Government Medical College, Kolhapur was measured. The data obtained was subjected to statistical analysis, to derive regression equation. The correlation coefficient was found 0.8146 for forearm length with stature in males and that of in females was 0.6985. Regression coefficient was 3.84 in males for forearm length and stature and 3.09 in females for forearm length and stature. The observed data was subjected to't' test for correlation coefficient. The value of 't' was found to be statistically significant. The regression equations for estimation of statures were formulated using length of forearm. *Conclusion*: A good correlation of stature with forearm length was observed and it was statistically highly significant.

**Keywords**: Anthropometry; Forearm Length; Height; Stature.

## Introduction

Estimation of stature of individual has a significant importance in the field of Forensic medicine and Anthropometry. Establishing the identity of individual from decomposed,mutilated and amputed body fragments has become important in recent times due to natural disasters such as earthquakes,Tsunamis,cyclones,and floods and man made disasters such as terror attacks,bomb blasts,wars and plane crashes.It is important for both legal and humanitarian reasons [1].

The ultimate aim of using anthropometry in medical science is to help the law enforcement agencies in achieving personal identity in case of unknown human remains [2]. The length of ulna has been shown to be a reliable and precise means in predicting stature of a individual [3]. In 1961 Allbrook [4] attempted to develop Standards for estimation of stature from a British sample using ulnar length which was measured from the tip of olecranon process the distal margin of hand with forearm flexed and semipronated. In 1964 Athawale [5] carried out a study on forearm bones .

Many different body parts can be used in the estimation of stature. Certain long bones and appendages can be aptly used in the calculation of height of a person. Many studies have shown the correlation of stature of body appandages but there are inter-racial, inter-geographical differences in measurement of their correlation with stature. What may be true for one race or one region may not be true for the other [1].

## Material and Methods

The study was carried out on 200 students of 1st year M.B.B.S. of age group 19-23 years. The procedure, aims and objective were informed and explained in a group. A written valid informed consent was taken from each of the participants. A

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small group of students were taken for measurements each at a fixed time to avoid diurnal variations. The forearm length was measured from tip of olecranon process to midpoint joining radial and ulnar tuberosity using Standard measuring tape with elbow flexed and palm spread over opposite shoulder. The subject included in the study were healthy and free from any apparent symptomatic deformity.

The students were placed in the Standard anatomical position with the head held in the Frankfurt's horizontal plane.The dimensions were taken in 1 cm unit and with measuring tape. The height is maximum distance from vertex to floor. To ensure accurate results all the measurements were done by one person. The measurements were repeated to avoid errors.

The collected data was subjected to statistical analysis for calculation of Mean, Standard deviation, Standard error, correlation coefficient, regression coefficient, value of constant and t -test for correlation coefficient applied to test the statistical significance using Microsoft Excel file.

## Results

It is found that as height increases the number of samples increases in males. The maximum number of samples were found at the height range of 175.1-180cm.

But in case of females that as height increases the number of samples decreases. The maximum number of samples were found at height range of 155.1-160cm

The correlation coefficient is found 0.8146 for forearm length with stature in males and that of in females is 0.6985. These values implies that there is positive correlation.

The value of 't' was found to be 13.25 in males and 10.09 in females.This shows that height of individual is related to forearm length.The value of p is <0.0001 in males as well as females.

The significant correlation was further interpreted by linear equation in males and females. Regression equation for height of males is calculated from Table 2 as follows

Height of males [Y]=59.96+3.84[X]

59.96 is intercept and 3.84 is slope, X is forearm length of individual

Regression equation for height of females is calculated from Table 3 as follows

Height of females [Y]=77.80+3.09[X]

77.80 is intercept and 3.09 is slope, X is forearm length of individual.

**Table** 1: Height Versus number of samples

| Height in cm | No. of male students | No. of female students |
|---|---|---|
| 140-145 | - | 2 |
| 145.1-150 | 2 | 8 |
| 150.1-155 | 3 | 22 |
| 155.1-160 | 6 | 43 |
| 160.1-165 | 13 | 21 |
| 165.1-170 | 17 | 11 |
| 170.1-175 | 19 | - |
| 175.1-180 | 21 | 2 |
| 180.1-185 | 10 | - |
| Total | 91 | 109 |

**Table** 2: Height in relation to forearm length,standard deviation,standard error in males

| Height in cm | Minimum forearm length | Maximum forearm length | Average forearm length in cm | Standard deviation | Standard error |
|---|---|---|---|---|---|
| 140-145 | - | - | - | - | - |
| 145.1-150 | 25 | 25 | 25 | - | - |
| 150.1-155 | 25 | 26 | 25.6 | 0.583 | 0.336 |
| 155.1-160 | 26 | 27 | 26.83 | 0.753 | 0.308 |
| 160.1-165 | 26 | 29 | 27.34 | 0.852 | 0.236 |
| 165.1-170 | 27 | 30 | 28.7 | 0.98 | 0.237 |
| 170.1-175 | 27 | 31 | 29.3 | 0.884 | 0.203 |
| 175.1-180 | 28 | 32 | 29.9 | 1.396 | 0.30 |
| 180.1-185 | 28 | 32 | 30.6 | 1.429 | 0.451 |

**Table 3:** Height in relation to forearm length,standard deviation,standard error in females

| Height in cm | Minimum forearm length | Maximum forearm length | Average forearm length in cm | Standard deviation | Standard error |
|---|---|---|---|---|---|
| 140-145 | 24 | 24 | 24 | - | - |
| 145.1-150 | 23 | 27 | 24.5 | 1.195 | 0.422 |
| 150.1-155 | 22 | 27 | 24.8 | 1.235 | 0.263 |
| 155.1-160 | 24 | 28 | 26.2 | 0.977 | 0.149 |
| 160.1-165 | 25 | 28.5 | 26.6 | 0.981 | 0.214 |
| 165.1-170 | 26 | 28 | 27.1 | 0.985 | 0.297 |
| 170.1-175 | - | - | - | - | - |
| 175.1-180 | 29 | 29 | 29 | - | - |
| 180.1-185 | - | - | - | - | - |

## Discussion

In 1952 Trotter and Gleser [6] published a definitive study on stature calculation for American Whites and Blacks. All six long bones were measured for maximum length. Different equations for estimation of stature were established for Whites and Blacks and for males and females.

The average height of adult males within a population is significantly higher than that of adult females [3]. The results obtained in this study also show the same results. Allbrook [5] derived regression formulae for estimation of stature from length of ulna as stature=88.94+3.06 [ulnar length]

Our findings correlate with those of Illayperuma et al [3]. They studied 258 subjects in Srilanka and concluded that significant correlation exist between total height and ulna length, indicating strong relationship between two parameters. . In this study the mean value of forearm length in male is 27.85 and that of in female is 26.02.Our findings were correlated with those of Thummar [7] study. He studied 310 subjects 191 males and 119 females in Bhavnagar Gujrat, in India. Stature estimation is also done by Mondal et al. who studied 300 male subjects in Burdwan district of West Bengal in India and derived regression equation [8].

Mohanty et al [9] also derived regression equation between forearm length and total height in population of eastern India. Our findings also correlated with those of Bamne et al. [10], they found regression equation for stature from ulnar length as follows,

In males stature=65.77+3.81 [ulna length] in females stature=70.75+3.46 [ulna length]

Furthermore racial variation in the relationship between ulnar length and height has been clearly demonstrated by comparative studies between Black, White and Asian subjects [11].

## Conclusion

After calculating regression equation it is found that there exists a positive correlation between height and forearm length which is similar to previous studies. But there is some difference in the slope and intercept of the equation which may be due to racial variation of the subjects. In this study male students showed higher mean values in each anthropometric measurements than females. Stature and forearm length are positively and significantly correlated with each other ($p < 0.0001$).The regression equation derived from this study can be applied reliably for estimation of stature on population of Maharashtra. If either of the measurement (ulna length or total height) is known,the other can be calculated. This fact will be of practical use in medicolegal investigations and in anthropometry. The regression equation can be of help in artificial limb centres for construction of prosthesis required in cases of amputations, trauma, frost bite etc. The study is helpful to provide database for biometrics.

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