

Measurement of Ulnar Length for estimation of Stature in Gujarat

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Abstract : In this study, an attempt has been made out to formulate a linear regression equation for estimation of stature from the ulnar length. The material consists of 310 subjects between 20-40 years of age in Gujarat. The Ulnar (Rt. & Lt.) length was measured by spreading caliper. The Stature (Height) was measured in standing erect, anatomical position with standard height measuring instrument. Data tabulated and statistically analyzed using Microsoft excel. A good correlation of stature was observed with Ulnar length and it was statistically highly significant. The results of present study would be useful for Anthropologist and Forensic Medicine experts.

Key-words: Anthropometry, Correlation, Ulnar length, Total height.

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INTRODUCTION: Anthropometry is often viewed as a traditional and perhaps the basic tool of biological anthropology, but it has a long tradition of use in forensic sciences and it is finding increased use in medical sciences especially in the discipline of Anatomy & Forensic Medicine. 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. Anthropometry, the typical and the traditional tool of physical anthropology, provides the scientific methods and the techniques for estimating the various measurements and the observations on the living as well as the skeleton of man.

Stature is one of the various parameters of identification for establishing individuality of the person. It is well known that there is a definite relationship between the height of the person and various parts of the body like head, trunk and lengths of upper and lower limbs. To assess the height of an individual, from measurements of different parts of the body, has always been of immense interest to Anatomists, Anthropologists and Forensic experts.

Height, like other phenotypic traits, is determined by a combination of genetic and environmental factors. It is sexually dimorphic and statistically more or less normally distributed. Estimation of stature from measurements of various long bones of the extremities has been attempted by many

scientists with varying degree of accuracy. All such calculations depend on the fact that limbs exhibit consistent ratios relative to the total height of a person. These ratios are linked to age, sex and race.¹ Stature reconstruction is important as it provides a forensic Anthropological estimate of the height of a person in the living state; playing a vital role in the identification of individuals from their skeletal remains, regression formulae for stature estimation have been generated for indigenous.

As per physical Anthropologist, Long bones of the limbs are best to estimate the height of a deceased. Many of previous workers have done this study on cadavers but cadavers cannot represent a population & they are largely of persons who are aged and might have suffered from chronic debilitating diseases, likely to have been dying in an abnormal posture and it may not be possible to straighten the body to get accurate stature measurement.

All these short comings in cadaveric material made me interested in undertaking the present study in Living Persons. Forearm bone like Ulna bone length gives more accuracy in devising regression equation of Height than the length of Leg bone like Tibia.² The forearm bone Ulna is mostly subcutaneous throughout its length and easily approachable for measurement. So it is selected for present study. Ossification of the Ulna starts at 8th fetal week and the proximal epiphysis fuses with the shaft in the

14th year in Females and 16th year in Males. The distal epiphysis unites with the shaft in the 17th year in Females and 18th year in Males^{3,4}.

So Ossification of Upper Limb is usually completed within 20-25 years of age and after age of 50 years there occurs some degenerative changes in joints and cartilages. So the present study is done on persons belong to 20-40 years of age group. In the present study an attempt has been made to find out the correlation between Ulna bone Length and body height in Gujarati population.

MATERIAL AND METHODS: The present study has been carried out in Gujarat in a total of 310 (191 males & 119 females) Living subjects. The subjects taken for study were asymptomatic healthy medical students, students of other faculties, staffs, patient’s relatives from Sir T. Hospital, Bhavnagar and other persons belonging to Gujarat.

The age group of 20-40 years was selected and their Height and length of Right and Left Ulna were recorded. Height of the individual was measured in standing erect Anatomical position with bare foot & head in Frankfurt’s plane from crown to heel with Standard Height measuring instrument. Ulnar length was measured with help of Spreading Caliper (0-600 mm) with rounded ends from the tip of Olecranon process to the tip of Styloid process of Ulna with Elbow flexed and palm spread over opposite shoulder. Measurement of length of Right and Left Ulna were taken separately for calculation. Both the Stature and the Ulnar length were measured in centimeter.

After collected data, they were subjected to statistical analysis for calculation of Mean, Standard Deviation, Standard Error, Coefficient of Variation, Correlation Coefficient, Regression Coefficient, Value of Constant & t test for correlation coefficient applied to test the statistical significance using Microsoft Excel file.

RESULTS: The observations were analyzed separately for both Right & Left side in each sex in all 310 subjects. The observations

made in reference to total standing Height and length of Ulna in the all groups.

Table-1: Regression analysis for Prediction of Total Height in Males & Females

| | Simple Linear Regression Formula | Males (191) | Females (119) |
|-------|----------------------------------|----------------------|----------------------|
| Right | $Y_1=a + bX_1$ | $Y_1=81.11+3.117X_1$ | $Y_1=17.10+5.314X_1$ |
| Left | $Y_2=a + bX_2$ | $Y_2=65.76+3.667X_2$ | $Y_2=18.95+5.335X_2$ |

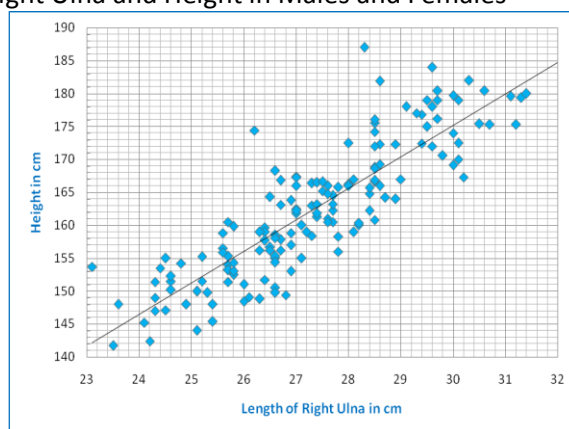
Where, Y= Height, X= Length of Ulna, a = Intercept/ Constant, b = Regression Coefficient

Table-2: Regression analysis for Prediction of Height in all cases

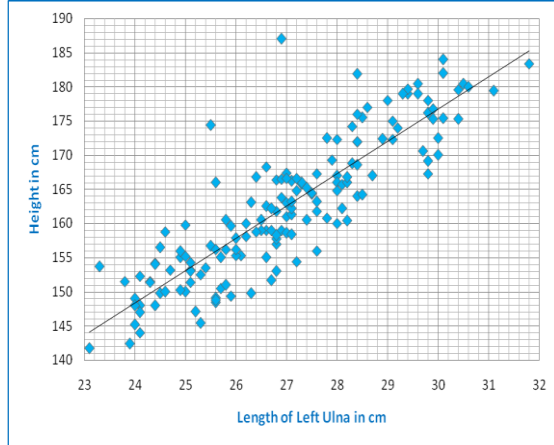
| Simple Linear Regression Formula | Males & Females (310) | |
|----------------------------------|------------------------|------------------------|
| | For Right Ulna | For Left Ulna |
| $Y=a + bX$ | $Y_1= 21.17+5.212 X_1$ | $Y_2= 14.92+5.440 X_2$ |

The regression analysis was carried out to find the strength of relationship of Ulna bone length with body Height. The relationship between Ulna length and body Height is positive for every unit increase in Ulna bone length. There is significant 5.212 for Rt. Ulna increase in body height and 5.440 for Lt. Ulna increase in body height. Student t test (two tailed) for correlation has been used to find the significance of degree of correlation. So here value of t test is strongly significant : $P \leq 0.01$

Scatter Graph: 1: Correlation between length of Right Ulna and Height in Males and Females



Scatter Graph: 2 : Correlation between length of Left Ulna and Height in Males and Females



Graphical representation above shows that length of Ulna (X) is plotted on the x-axis and height (Y) on y-axis. The scattered graphs clearly show that the linear relationship exist between X and Y. So there is Positive Correlation between X and Y.

DISCUSSION: The present study deals with the observations on correlation of Total Standing Height with length of Ulna. Total 310 living subjects taken for study from Gujarat. The age groups of 20-40 years were selected and in present study approximate stature has been estimated from Ulna bone length. The stature of an individual mainly being genetically predetermined is an inherent characteristic, the estimate of which is considered to be an important assessment in the identification of unknown human remains.

Height-estimation formulae based on ulna length show similar levels of accuracy to calculations based on the length of other upper limb long bones. This is supported by the standard errors of the estimations reported in several studies.

For example, the standard errors of estimations from formulae that Trotter and Glessner(1958)⁵ devised for several ethnic groups (whites, blacks, Mongoloids and Mexicans) based on Humerus, Radius, and Ulna length were quite similar (approximately $\pm 4-4.8$ cm).

In previous study: Maloykumar⁶ selected 20-50years of males, results showed that mean height: 164.32cm, length of Rt.Ulna:27.13cm & of Lt.Ulna:27.01cm. Correlation Coefficient for Rt.Ulna:0.78 & Lt.Ulna:0.68.

In present study we have selected both sexes of 20-40 years age group.

- Mean height: males:169.87cm, females:155.21cm, combined:163.86cm.
- Rt.Ulna length: males:28.48cm, females:25.99cm, combined:27.35cm.
- Lt.Ulna length:males:28.39cm,females:25.54cm, combined:27.38cm

Various workers⁷⁻¹³ had shown significant Correlation between Height and Ulna bone length, other long bones and different parts of the body.

Allbrook D⁷:derived regression formulae for estimation of stature from the length of Ulna as- Stature: $88.94 + 3.06(\text{ulnar length}) \pm 4.4$ (Standard error).

Athawala M.C⁸ :derived a regression formula for estimation of stature and Left Radius(cm) ± 3.66 cm. Stature = $56.9709\text{cm} + 3.9613 X$ average length of Right and Left Ulna(cm) ± 3.64 cm.

Sarojini Devi H.,Das B.K.,Purnabati S.,Singh D⁹:computed correlation coefficient ($r = 0.619$ for male and 0.584 for female) and Regression equation formula for estimation of stature by using upper arm length among living population of Maring tribes of pallel area, Chandel district, Manipur.

Trotter M et al¹⁰ : have stated requirement of different regression equations among different races after studying different races for relationship between lengths of long bones and stature. It is important to note that every race of particular age group and sex should have its own table for estimation of height using various parameters.

Harsh M.P.¹¹: studied that head length is correlated with stature in both sexes aged between 8-12 years. Correlation Coefficient between head length and

height is 0.45(male), 0.49 (female), 0.45(combined). Regression analysis is carried out to find the strength of relationship between head length and body height. The relationship between head length and body height is positively correlating.

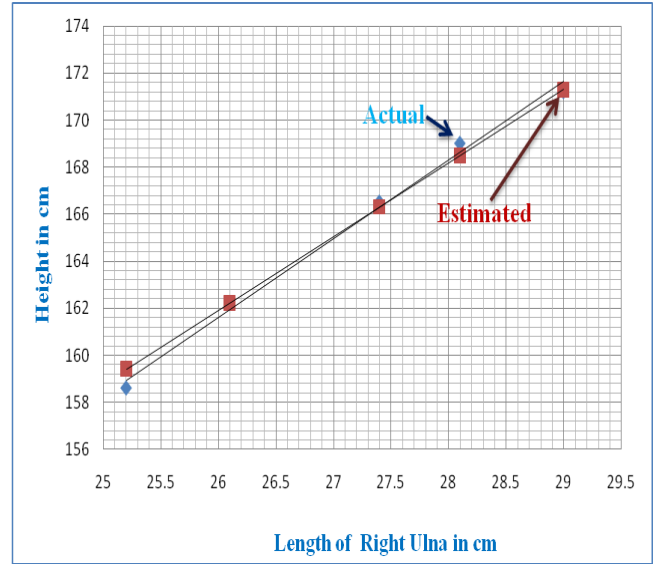
Saxena et al¹²:derived a regression equation between head length and height in Agra population(U.P.). Their correlation coefficient between head length and height was +0.2048. This was cephalometric study on males aged between 25-30 years where head length measurements were taken from nasion to inion.

Similarly Jadav et al¹³ have showed positive correlation between head length and height with correlation coefficient +0.53 which is most significant. Patel, Joshi and Dongre¹⁴ have derived regression equation between Tibia and total Height in Gujarati population.

In present study separate formulae were derived in males & females for estimation stature from measurement of Ulnar length in Gujarat region. Comparison of Actual Height & Estimated Height from the Regression equation (In present study) in Males to check validity of results is shown in table below.

| Sr. No. | Rt. Ulna length (cm) | Actual Height (cm) | Estimated Height (cm) | Difference |
|---------|------------------------|----------------------|-------------------------|------------|
| 1 | 25.2 | 158.6 | 159.4 | + 0.8 |
| 2 | 26.1 | 162.2 | 162.2 | 0.0 |
| 3 | 27.4 | 166.5 | 166.3 | - 0.2 |
| 4 | 28.1 | 169 | 168.5 | - 0.5 |
| 5 | 29.0 | 171.2 | 171.3 | + 0.3 |

For the estimation of Stature from length of Ulna, Regression equation has been derived and with these equation Lines have been plotted and displayed on chart. We can see that Normograms have been successively developed for length of Ulna.



CONCLUSION: The Height is more if the length of Ulna is more. This holds true for the sample size taken. ‘t’ test for regression coefficient was found to be statistically significant. It suggests that a significant contribution of length of Ulna towards height. Two separate formulae were derived:

- For Male : $Y_1 = 81.11 + 3.117X_1$
where, Y=Height,
 $X_1 = \text{Rt. Ulna length}$, $Y_2 = 65.76 + 3.667X_2$,
- For Female: $Y_1 = 17.10 + 5.314X_1$
 $X_2 = \text{Lt. Ulna length}$, $Y_2 = 18.95 + 5.335X_2$

For Combined: $Y_1 = 21.17 + 5.212X_1$
 $Y_2 = 14.92 + 5.440X_2$

The result shows that there is Positive Correlation between Stature and Ulna bone length. Simple linear regression equation so far derived can be used for estimation of height. 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 Medico Legal investigations and in Anthropometry. Study would be useful for Anthropologist and Forensic Medicine experts.

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