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Original Research Article

# Estimating the Height of An Individual from The Length of Ulna in Undergraduate Students of a Nepalese Medical College

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## ABSTRACT:

**Introduction:** Estimation of height from bones plays an important role in identifying unknown bodies, parts of bodies, or skeletal remains. Multiple anthropometric techniques have been used to estimate stature from skeletal remains by anthropologists, anatomists, and forensic experts. The ulna is a long bone often used for body height estimation, as it is mostly subcutaneous throughout its length and is easily approachable for measurement. **Methods:** The present study was carried out on 100 (57 male and 43 female) undergraduate students of a medical college of the age group of 18 to 24 years. The parameters studied were height, length of right, and left ulna. The observations were analyzed by Pearson's correlation to examine the relationship between the length of ulna and height. **Results:** The mean height of males was 174.54 ± 13.32 cm and of females was 156.01±11.19 cm. The mean length of the right ulna was 27.36 ± 2.12 cm (males) and 24.35±1.97 cm (females). The mean length of the left ulna was 27.29 ± 2.13 cm (males) and 24.06 ± 2.18 cm (females). Pearson's correlation showed a positive and statistically significant ($p<0.001$) relation between the length of the ulna and the height. The regression equation was derived to estimate the height of an individual from the length of the ulna. **Conclusion:** The ulna bone length is an accurate parameter that can be used in estimating an individual's height. The regression equation derived in this study can be of great help to anatomists, clinicians, anthropologists, and forensic scientists.


**Keywords: Height estimation, Identification, Ulna length**

## INTRODUCTION:

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.[1] Identification is recognition of a person and the primary characteristics of identification are age, sex and stature. Stature can be estimated from skeleton. Thus, the assessment of stature is considered to be important in identifying unknown human remain.[2]

Stature of an individual is defined as the height of the body in upright position which is measured from vertex to the foot. It is one of the most important and useful anthropometric parameters, which determines the physical identity of an individual.[3] The height can be indirectly estimated from different parts of the skeleton. Estimating height from different parts of the human body has been an area of interest to anatomists, anthropologists and forensic experts.[4]

Ulna bone length is a reliable and accurate

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parameter for estimating the height of an individual because it is subcutaneous and surface landmarks such as olecranon and styloid process are easily palpable in bedridden and ill patients as well.The purpose of this study was done to estimate the height of an individual from the length of ulna and to derive regression formulas to estimate height.

## METHODS:

This is a cross-sectional descriptive study conducted in the Department of Anatomy, Lumbini Medical College, Nepal from 16th March 2020 to 30th April 2020. It was carried out in 100 (males=57 and females=43) randomly selected asymptomatic, healthy living Nepalese medical students who were in the age group of 18 to 24 years. Ethical approval was taken from the Institutional Review Committee of the institute (IRC-LMC 04C/20). Informed consents were taken from all the participants.

The sample size was calculated using the following formula,

$N= [Z\alpha+Z\beta /C]^2 +3$

Where N=total number of participants required

Zα and Zβ= the standard normal deviate for α and β

$C=0.5 \text{ X } \ln \{1+r / 1-r\}$

r = expected correlation coefficient. For this study, the expected correlation coefficient (r) = 0.44, the effect of sample size based on the study done by Pandey A et al.[5] with α=0.05 and the power of study=90%. The minimum sample size required was 50. A total of 100 participants were enrolled into the study through simple random sampling.

The participants hailed from various places in Nepal, but were living in Pravas, Palpa at the time of the study. The students with skeletal deformities, physical disabilities, past history of skeletal injuries or diseases affecting bones and joints and those who could not stand erect were excluded.

The ulnar length was measured with help of a measuring tape from the tip of olecranon process to the tip of styloid process of ulna with elbow flexed and palm spread over opposite shoulder. The measurement of length of right and left ulna were taken separately for calculation. Standing height was measured using a stadiometer against the wall on barefoot, with their heels together and the heels, buttocks and back touching the stadiometer. Selection and information bias were minimized as much as possible because all the measurements were taken thrice and the mean value was obtained.

The data was collected in a preformed proforma, entered to and tabulated in Microsoft Excel spreadsheet. Statistical analysis was done using Statistical Package for Social Sciences (SPSS™) software version 20.

## RESULTS:

A total of 100 students of Lumbini Medical College (male=57, female=43) were studied. Pearson's correlation was used to predict the significant relationship between height and length of ulna of the students. In our study, the correlation coefficient (r) was 0.491(left ulna) (Fig. 1) and 0.473 (right ulna) (Fig. 2). Following equations were derived to predict the stature (Y). Y=94.929 – 0.725 (length of right ulna) and Y= 94.929+ 3.496 (length of left ulna). The other measurements are shown in table 1.

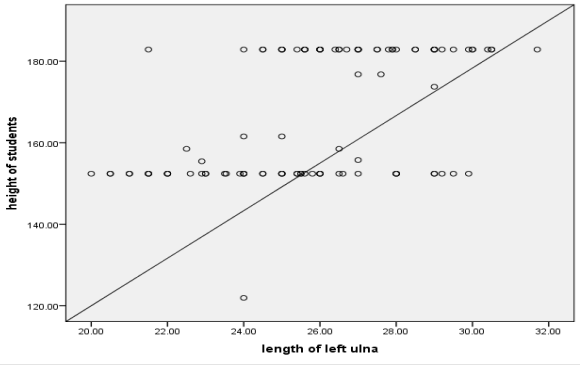


*Fig. 1: Correlation of Height with length of left ulna in both sexes together.*

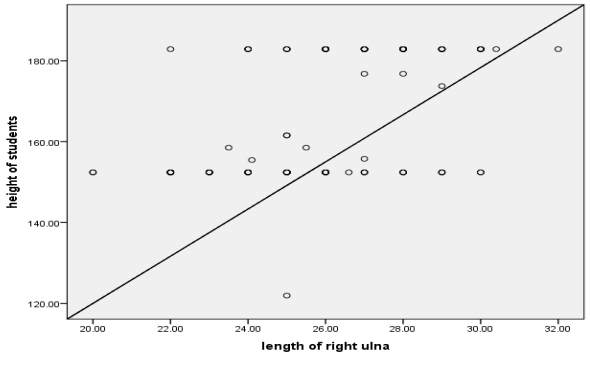


*Fig. 2. Correlation of Height with length of right ulna in both sexes together.*

*Table 1. Gender-wise variations in variables.*

| Gender | | Minimum | Maximum | Mean ± SD |
|---|---|---|---|---|
| **Males** | Length of right ulna (cm) | 20.00 | 32.00 | 27.36 ± 2.12 |
| **(n=57)** | Length of left ulna (cm) | 20.50 | 31.70 | 27.29 ± 2.13 |
| | Height (cm) | 152.40 | 182.88 | 174.54 ± 13.32 |
| **Females** | Length of right ulna (cm) | 20.00 | 29.00 | 24.35 ± 1.97 |
| **(n=43)** | Length of left ulna (cm) | 20.00 | 30.00 | 24.06 ± 2.18 |
| | Height | 121.92 | 182.88 | 156.01 ± 11.19 |
| **Total** | Length of right ulna (cm) | 20.00 | 32.00 | 26.07 ± 2.54 |
| **(100)** | Length of left ulna (cm) | 20.00 | 31.70 | 25.90 ± 2.68 |
| | **Height** (cm) | 121.92 | 182.88 | 166.57 ± 15.44 |

## DISCUSSION:

The regression formula derived using ulna length provides an alternate methodology for stature prediction in old and bedridden patients who cannot stand or those who suffer from vertebral column deformities.[6] Many studies [7,8,9,10] have shown positive correlation of stature and different body parts dimension particularly long bones of the limb which has been found to be true in the present study with strong positive correlation between the stature and ulna lengths in both sexes. The correlation coefficient between the total height and ulna length was found to positive indicating a strong relationship between the two parameters. The positive correlation suggests if length of ulna increases or decreases, the height of the subject also increases or decreases and vice versa. In this study the mean height of males were higher than females (males: 166.57, females: 156.01), which was also observed in other studies done by Illayaperumal I et al.,[6] Mohanty BB et al.,[11] and Prasad A et al.[12] In the present study, mean value of right ulnar length was 27.36 ± 2.12cm and that of left ulnar length was 27.29±2.13in men. Our findings was similar to the study done by Duyar and Perlim[13] and Avantika B et al.[14]

In our study, the coefficient correlation (r) was 0.473 (right ulna) and 0.491(left ulna) and the study done in Nepalese female adult population the correlation coefficient (r) of the height and the length of the left ulna was 0.55 and that for the right ulna was 0.463. [15] In our study, mean of height and length of ulna were higher in males similar to the study done by Maryam et al.[16] The union of epiphyses of the bones takes place sooner in girls, On the other hand, bone in boys continues to grow two more years than girls.[17]

The study done by Mondal MK et al.[18] showed mean height was 164.32 cm, length of right ulna was 27.13 cm and length of left ulna was 27.01 cm and the correlation coefficient for right ulna was 0.78 and left ulna was 0.68. The mean ulnar length of male and females from our study also differed from those study done by Emmanuel et al.[19] and Charisi et al.[20] The linear regression equation of our study showed that Y=94.929–0.725 (length of right ulna) and Y=94.929+3.496 (length of left ulna) and to compare with the study done by Mondal M Ket al.[18] was Y= 50.64+4.18 (length of right ulna) and Y=76.28+3.25 (length of left ulna), the study done by Pandey A et al.[5] was Y=83.224+3.04 (length of right ulna) and Y=81.06+3.14 (length of left ulna) and the study done by Albrook[21] was Y=88.94+3.06 (ulna length).

## CONCLUSION:

In the present study a positive correlation was found between height and length of ulna. Simple linear regression equation derived could be used for estimation of height from ulna and vice versa. Thus, the data of this study would be of practical use in medico-legal investigations and in anthropometry. Although the sample size is not enough for representation of whole Nepalese population but it will serve as a basis of comparison for future studies in Nepalese population.

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**Conflict of Interest:** The authors declare that no competing interests exist.

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