

# Estimation of Height of an individual from Humerus bone length and foot-length using linear regression

Vijay Sharma<sup>1</sup>, Rajesh Kumar<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Physics, MCM DAV College, Kangra- 176001 (H.P.)

<sup>2</sup>Regional Forensic Science Laboratory, Central Range, Mandi – 175001, Himachal Pradesh, India.

## I. INTRODUCTION

Forensic anthropology is the application the theories and methods of anthropology to criminal investigations. It is a challenging area in forensic science, as it involves identifying unknown individuals from what remains after the flesh and skin i.e. the outer human identification is gone. Forensic anthropologists collect and analyse human remains and try to determine various identifying parameters like age, sex, stature and ancestry as well as evidence of some diseases or injuries. This can provide a clue to the identification of the person and circumstances surrounding death of that person.

In skeletal remains height estimation can be done by arranging different bones to assemble as in a body and finding the total height and statures of the remains adding for skin thickness. In cases of incomplete skeletons long bones like humerus and femur can provide information about the height of the person and various regression equations have been developed using a single bone or a combination of bones. Height and stature have also been attempted using foot length. The stature estimation is also important in other cases of forensic science like theft, break-in or other crime where a foot impression or gait impression is left. This can provide a clue to the number of perpetrator(s) and their stature.

In the present study, anthropological data like humerus bone length femur bone length, foot length and height in centimeters was collected from 127 volunteers; 66 females and 61 males, with a view to finding correlation among various measurements and developing regression models. Correlations were tested among the various parameters particularly height with other parameters. Regression analysis has been a method of choice for such studies and the same has been applied in this work.

## II. MATERIALS AND METHODS

Height of an individual was measured in standing position from floor to the vertex in centimeters with the person standing barefoot. The length of humerus bone was measured as a direct distance in centimeters between appropriate landmarks. Foot length (right foot only) was measured as the distance between most prominent point back of heel and the most anterior point of the longest.

The data was analyzed using JASP software. We have used the linear regression models for estimating height and predicting sex based on humerus bone length and foot-length.

## III. RESULTS AND DISCUSSION

Minimum age of the selected individuals was 18 years and maximum 56 years with 34.6 as a mean age and 11.12 as standard deviation. The regression model of height versus humerus length ( $R=0.74$ ) was worked out by the linear regression. The regression model so developed was

$$\text{Height} = 3.006 * \text{Humerus} + 73.3 \quad (\text{i})$$

Similarly, regression equation for height and foot length ( $R=0.74$ ) was worked out to be

$$\text{Height} = 4.173 * \text{Foot length} + 62.102 - \quad (\text{ii})$$

When the length of Humerus bone and Foot length was used in the multiple regression model with the same model ( $R=0.8$ ) parameters we obtained:

$$\text{Height} = 1.785 * \text{Humerus} + 2.526 * \text{Foot length} + 48.641 \quad (\text{iii})$$

The correlation of height with the humerus length and footlength is quite high and significant ( $p < 0.001$ ). It is also observed that when the models are combined better correlation is observed and the humerus length, foot-length explain about 65.4% variability in height ( $R^2$ ). Also the RMS error is about 5 cm when all the three parameters are used in the model.

It should also be kept in view that the RMS error is not an indicator of actual height and the estimates of height are purely statistical and the actual height should be assigned a probability value.

#### IV. CONCLUSION

The present study signifies the importance of the length of humerus and footlength in estimating the height of a person. The correlation is high and significant. The study also underlines the importance of the estimates to be statistical and points out that the height cannot be estimated precisely and only probabilistic estimates can be made. Further study can also be done to ascertain if these parameters can also predict the sex of the person.

#### V. REFERENCES

- [1] Kewal Krishan, Tanuj Kanchan, Ritesh G Menezes, Stature estimation in forensic examinations: A few technical considerations, 2012, 23(5)692-693.
- [2] Tanuj Kanchan , Ritesh G. Menezes , Rohan Moudgil, Ramneet Kaur, M.S. Kotian, Rakesh K. Garg, Stature Estimation from Foot Length Using Universal Regression Formula in a North Indian Population, 2010, 55(1) 163-166.
- [3] Stature Estimates from Foot Dimensions, J Punjab Acad Forensic Med Toxicol 2011, 11(1) 26-30.
- [4] JASP (Downloaded from: <https://jasp-stats.org/>).