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Original Research Article

Estimation of Stature from Length of Radius: A Postmortem Study on Central Kerala Population

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Abstract

Introduction: Crown heel length is the stature of an individual. It is determined by health, nutrition, infancy, childhood and adolescence. Stature is important in defence department and sports. Height helps in establishing identity in unknown human remains. The aim of present study is to estimate stature from length of radius in deceased individuals between 20 and 70 years.

Primary objectives:

1. To find out correlation between radius length and stature of an individual.
2. To derive linear regression formula to estimate stature from these dimensions obtained, in males and females separately.

Methods: This is a descriptive study done on 250 cases in the age group between 20 and 70 years brought for autopsy in Department of Forensic Medicine, Government Medical College Kottayam. Study tools included semi structured proforma, sliding vernier callipers and measuring scales. Data from total 250 subjects were collected. Stature, length of right and left radius was recorded in centimetres. Data was entered in Microsoft excel and analysed using Statistical Package for Social Sciences (SPSS) soft ware (free version).

Results: In the present study, total 250 cases were taken, of which, 212 males comprising 84.8% and 38 females comprising 15.2% of the total population studied. The mean age of study sample was 40.14 years with standard deviation 10.197 years. The mean height and other numericals showed highest value in males. There was significant correlation between height and radial lengths in both males and females. Right radius length in males showed highest correlation with height (correlation coefficient to 0.980). Left radius length in males showed (correlation coefficient r = 0.708) lowest correlation with height.

Conclusion: Current study supports previous research that radial length can be used to predict height of an individual. It was concluded that the calculated regression formulae have high reliability and applicability for height estimation in the sample.

Keywords: Stature, Length, Radius, Central Kerala.

Introduction

Stature is the natural height of a person in upright posture i.e. crown-heel length. This is determined mainly by genetic factors of the individual, and also by health & nutrition and diseases during infancy, childhood and adolescence. Estimation of stature has a significant importance in the field of forensic medicine and anthropometry [1]. Anthropometry is a series of systematized measuring techniques that express quantitatively the dimensions of human body and skeleton [2]. The ultimate aim of using

anthropometry is to help the law enforcement agencies in achieving "personal identity" in case of unknown human remains. Establishing the identity of an individual from mutilated, decomposed, and amputated 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) [3].

According to Telkka, there should be a separate formula for estimation of stature for each racial group [4]. Most of the research work regarding estimation of stature is done on cadavers. Several fallacies are there in this regard; because most of the cadavers are aged, they might have suffered from chronic illness, or they may have abnormal posture. In this study, we measured the length of a long bone (i.e. radius) in post mortem specimens to estimate the stature. Very few works have been done in this regard especially in a Central Kerala population. Keeping all these facts in mind, we tried to derive a valid formula to estimate stature of a Central Kerala population from length of radius using mathematical method.

Objectives

1. To find out correlation between radius length and stature of an individual.
2. To derive linear regression formula to estimate stature from these dimensions obtained for males and females separately.

Materials and Methods

Type of study: Descriptive Cross–sectional study.

Study period: April, 2021 to November, 2022.

Study duration: One and half years.

Study location: Department of Forensic Medicine, Government Medical College, Kottayam.

Study population: Autopsy cases at Department of Forensic Medicine Government Medical College, Kottayam.

Sample size

Based on study by Das *et al* 2018, on estimation of human stature from length of radius in an Indian population [5], using a mean radial length of 24.80 cm, S.D. of 1.72 and with the limit of accuracy as 1% of the mean, the sample size was calculated to be 194.

N = 1.96 2 x 1.72 2 / 0.248 2 = 194

About 10% of the sample size (20) was added to take care of any attrition and the total sample size arrived for the study was 214. The final sample size was rounded to 250.

Sampling Technique

Purposive Sampling was used for selecting the samples. All bodies brought for autopsy meeting the inclusion and exclusion criteria during the study period was taken up for our study, till the sample size was achieved.

Inclusion criteria

Deceased Keralite individuals between 20 and 70 years of age.

Exclusion criteria

Those with physical deformities, Fractures of skull and spine, Fracture of upper limbs, Fracture of lower limbs, Decapitation due to which actual stature could not be ascertained, Burn injuries, Bodies in advanced stages of decomposition.

Study tool

Semi–structured Performa, steel tape, skin marker pen, calipers for measuring radial length.

Data collection procedure

The following measurements were considered for the study. Height of the deceased was measured by placing the body on the autopsy table and measuring the highest point from the vertex to the heel after placing two rectangular wooden blocks at the head end and heel. The length was measured in centimeter. Length of radius was measured using a caliper (Vernier caliper, Standard osteometric, reading to 0.1 cm). Measurements of the right and left radius

were made at autopsy by dissecting the soft tissue and joints at both ends. The distance from the head and styloid process of the radius was recorded. The caliper was held parallel to the bone shaft during measurements. The values were recorded in centimeters.

Ethical consideration

The study was started only after getting clearance from the institutional research committee of Govt. Medical College, Kottayam and ethical clearance from the Ethical committee. The study did not cause any expense to the family of the deceased person, as the details were collected along with the autopsy examination by the researcher. It did not cause any delay in handing over the body to the relatives or did not cause any disfiguration and mutilation to the body after autopsy. An informed written consent from the relative accompanying the body was taken before collecting the data. The privacy of the individual data was be maintained.

Results

Of the 250 study samples included for the study, majority belonged to males (84.8%). The mean age of the study samples was 40.14± 10.197 years. The youngest study sample was 21 years and the eldest 68 years, range being 47 years. 15 (6 %) samples belonged to persons less than 30 years of age, 70 (28%) belonged to the age group 30 to 44 years of age, 162 (64.8%) were between 45 to 59 years of age and 3 (1.2%) samples were 60 years of age or above.

The mean height of the study samples was 167.22± 8.94 cm. The shortest study sample was 139 cm and the tallest 187 cm, range being 48 cm. The mean height of the male study sample was 169.14 ± 7.86 cm and that of the female study samples was 156.47 ± 6.77 cm. The mean weight of the study samples was 64.07 ± 13.11 kg. The lowest weight recorded among the samples was 32 kg and the highest 110 kg, range being 78 kg. The mean weight of the male study sample was 65.34± 12.761kg and that of the female study samples was 56.95± 12.907 kg.

The mean length of the right radius of the study samples was 26.27± 1.74 cm. The mean length of the right radius of the male study samples was 26.70 ± 1.42 cm. The mean length of the right radius of the female study samples was 23.84 ± 1.32 cm.

The mean length of the left radius of the study samples was 26.00 ± 2.30 cm. The mean length of the left radius of the male study samples was 26.41 ± 2.19 cm. The mean length of the left radius of the female study samples was 23.69 ± 1.33 cm.

Scatter plots were drawn to study the association between height in Y-axis and length of left or right radius in X-axis (Figure 1 and 2). The figures showed that association was clearly linear. So, simple linear regression equation and Pearson's correlation coefficient (r) were estimated forindividual scatter plot. The correlation coefficients were statistically significant ($p < 0.001$). In Figure 1, the equation of the regression line for right radius in males is

Stature of males (in cm) = 24.385 + 5.421* length of right radius (in cm)

and the r value is 0.976 with $p < 0.001$. The SEE is 0.95 cm.

The equation of the regression line for right radius in females is

Stature of females (in cm) = 43.717 + 4.729* length of right radius (in cm) and the r value is 0.708 with $p < 0.001$. The SEE is 0.339 cm.

In Figure 2, the equation of the regression line for left radius is

Stature of males (in cm) = 102.124 + 2.537* length of left radius (in cm) and r value is 0.708 with $p < 0.001$. The SEE is 0.18 cm.

The equation of the regression line for left radius is

Stature of females (in cm) = 45.944 +4.666* length of left radius and r value is 0.913 with $p < 0.001$. The SEE is 0.347 cm.

Multiple linear regressions were used to develop a predictive equation to estimate stature based on age and left & right radius

lengths. The coefficient of determination (R2)was 0.94. This means that nearly 95% of the variability in stature was explained by the three selected predictors. The SEE was 1.65 cm.

The final regression equation for stature estimation of Central Kerala population is:

Stature =37.359 + (5.012 * length of right radius) - (0.014 * length of left radius) - (0.031 *age).

Discussion

The study showed a significant correlation between the length of radii and the stature of the individual. Several investigators obtained the regression equations to calculate stature from length of limb bones. The equations are different from each other. This may be due to different racial population in the world. Athawale [6] tried to estimate stature from the length of long bones of forearm in Maharastrian people and made a regression formula (irrespective of gender):

Stature = 59.2923 cm + 4.1442 x average length of right and left radius in cm ± 3.66. He found an error of 5-8% when compared with that of Western formula. Sarojini Devi *et al* [7] calculated correlation coefficient as r = 0.619 for male and 0.584 for females and made the regression equation to estimate stature from length of upper arm among living population of Maring tribes of Pullel area, Chandel district, Manipur.

In our study, the scatter plot shows positive linear relationship between stature and length of left and right radius. Here correlation coefficient exceeds 0.70 for both left and right radius. The p value was < 0.001 which indicates that the association observed in the sample population might also be there in the whole population. Thus, length of radius is quiet acceptable for estimation of stature. Some research workers report that regression formulas using combination of multiple bones length is more accurate than using a single bone. Keeping all these things in mind, in this study we have taken age, left and right radius lengths as parameters to produce a predictive equation. The quality of the regression equation is assessed on the basis of its standard error of estimate (SEE). Here SEE is quite low as compared to the values of Trotter and Gleser [8] (4.24–5.05 cm), of Athawale [6] (3.66 cm), of Dayal *et al* (3.58 cm) and of Mahakkanukrauh *et al* (5.63 cm). The low value of SEE in our study is highly indicative of acceptance of the regression equation.

In the study titled "Estimation of stature from forearm length in North Indians- An Anthropometric study" it was found that male North Indians exhibit greater dimensions than the females for the forearm length and the stature. In the study by Song-in K *et al*., stature and forearm lengths were measured from a total of 90 (45 males and 45 females) children in the central region of Thailand.[9] The results show that the mean stature and all forearm lengths of males are higher than those of females; similar findings were observed in previous studies.

Poorhassan M *et al*. in their study found that there was a relation between height and upper arm length of subjects in all cases. [10] There was also a relation between stature and forearm length in male subjects. But this was not found in case of female subjects. Mean stature was higher for males than females.

Forearm length was found to be a moderate predictor for stature estimation in medical students in Iranian population. This study is quite similar to our present study in that radius length is used to calculate stature. The findings in the study by Geetha G *et al*. may be used to predict stature in cases where whole length of hand and foot were not available for investigation. [11]

The data obtained can be used for getting certain population specific anthropometric indices amongst the tribal population. This is the first ever documented anthropological work among the tribal population of Kasargode, North Kerala. In this study stature was estimated using multiple parameters while our present study used

only a single parameter, length of the radii, for stature estimation in Central Kerala population.

Ghanbari K *et al*. showed the range of ulna length in girls of Kurdish ethnic subgroup and the data obtained in this study was used to estimate stature in Kurdish ethnic subgroup on the basis of ulna length. [12] In this study also a single forearm bone length was used for stature estimation like the study done by Bamne *et al*. in 2015. Sandhya A proved in her study that from the length of forearm the height of an individual can be estimated. This study also paved way for future studies to focus on estimating height using other different body parameters. This study also uses forearm length to determine stature like our present study which utilizes radii length for the same. [13]

The study by Yadav S *et al*. showed that second highest degree of correlation was found for forearm length with regression coefficient. The regression coefficient in this study showed stature and dimension of hand was the third most correlated value. [14] Our study uses multiple parameters like forearm length, hand length, leg length and foot length for stature estimation while our present study uses only a single parameter.

Limitation

The study was done in a population of Kottayam and nearby districts of Kerala. Though this may give insights on stature estimation in a Central Kerala population, it may not be a good representative sample of a universal study group.

Conclusion

In the present study an attempt was made to document a relationship between the radius and height in Central Kerala population. There was no statistical significance difference between the lengths of the right and left radius. A positive correlation was found between stature and length of radius. Simple linear regression equation derived can be used for estimation of height from radius and vice versa.

The following formulae were derived for the estimation of stature in the study.

Stature of males (in cm) = 24.385 + 5.421* length of right radius (in cm)

Stature of females (in cm) = 43.717 + 4.729* length of right radius (in cm)

Stature of males (in cm) = 102.124 + 2.537* length of left radius (in cm)

Stature of females (in cm) = Stature of females = 45.944 +4.666* length of left radius

Stature=37.359+ (5.012 * length of right radius)-(0.014 * length of left radius)-0.031*age).

The first four formulae exhibit the sexual dimorphism in estimating stature from the length of forearm in both the sexes. The last two formulae were common for both genders. The data of this study will be of practical use in Medico legal investigations and in anthropometry. Hence the present study would be useful for Forensic Medicine experts and Anthropologists in stature estimation.

References

1. Krishan K. Anthropometry in Forensic Medicine and Forensic Science-'Forensic Anthropometry'. Internet J Forensic Sci [Internet]. 2012 Jun 28 [cited 2022 Dec 28];2(1).
2. Tovée MJ. Anthropometry. Encycl Body Image Hum Appear. 2012;1:23–9.
3. Pal A, De S, Sengupta P, Maity P, Dhara PC. Estimation of stature from hand dimensions in Bengalee population, West Bengal, India. Egypt J Forensic Sci. 2016 Jun 1;6(2):90–8.
4. Telkka A, Palkama A, Virtama P. Estimation of stature from radiographs of long bones in children. Ann Med Exp Biol Fenn. 1962;40:91-6.
5. Das B, Deka R, Talukdar K. A Study on Height of Human Being in Relation to Length of Radius. 2018
6. Athawale MC. Estimation of height from lengths of forearm bones. A study of one hundred Maharashtrian male adults of

ages between twenty-five and thirty years. Am J Phys Anthropol [Internet]. 1963 Jun 1 [cited 2023 Jan 6];21(2):105–12.
7. Sarojini Devi et.al. Estimation of stature from upper arm length among the marings Of Manipur. Indian medical journal agust 2006;100(8):271-73.
8. Jeong Y, Jantz LM. Caveats in Using Trotter and Gleser's (1958) Asian Equations for Stature Estimation. Korean J Phys Anthropol [Internet]. 2016 [cited 2022 Dec 28];29(3):81
9. Song-In K, Riengrojpitak S, Tiensuwan M. Estimation of Stature from Forearm Length in Thai Children. SDU Res J. 6(1).
10. Poorhassan M, Mokhtari T, Navid S, Rezaei M, Sheikhazadi A, Mojaverrostami S, *et al*. Stature estimation from forearm length: an anthropological study in Iranian medical students. J. Contemp. Med. Sci. 2017;3(11): 270–2.
11. Geetha GN, Swathi, Athavale SA. Estimation of Stature From Hand and Foot Measurements in a Rare Tribe of Kerala State in India. J Clin Diagn Res. 2015 Oct;9(10):HC01-4.
12. Ghanbaril K, Nazari AR, Ghanbari A, Chehrei S. Stature estimation and formulation of based on ulna length in Kurdish racial subgroup. Ital J Anat Embryol. 2016;121(1):43-50.
13. Sandhya A. Estimation of the height of an individual to the forearm length. Int J Sci Res. 2016;5(8):1532-1535.
14. Yadav S, Pathak B. Estimation of Stature from the Measurement of Forearm, Hand, Leg, and Foot Dimensions in Uttar Pradesh Region. Int J Ther Appl. 2018;35.