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ORIGINAL RESEARCH ARTICLE

ESTIMATION OF ULNA LENGTH AS A PREDICTOR OF HEIGHT IN NEPALESE MALE ADULT POPULATION

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ABSTRACT

Introduction: Stature estimation from the skeletal remains bears immense importance for the anatomist, anthropologist for the forensic experts. It is conventionally used long bones, the humerus, femur, tibia, etc. Ulna has also been used for the said purpose since 1952. An attempt was made to formulate a linear regression equation for the estimation of the stature of living adult population from the lengths of their ulna. **Methods**: This study was conducted in the M.B. Kedia Dental College Birgunj from January 2017 to December 2017and participants were chosen from among the patients and their attendants in the OPD. The height was measured from the crown to the heel and the length of the ulna was measured from the tip of the olecranon process to the tip of the styloid process. The documented data was calculated by the standard statistical software. **Results**: The parameters were tabulated and statistically analyzed. The correlation coefficient (r) was found to be 0.399 ($p<0.001$) for the left ulna with stature and it was 0.486 ($p<0.001$) for the right ulna with stature. Supportive regression equations and scatter-plot diagrams could successfully interpret the height from the ulna length of the adult male population. **Conclusion**: The ulna being almost a percutaneous bone, it can be used for the prediction of the height. The ulna length provides an accurate and reliable means in estimating the height of an individual. The regression formulae which were proposed in this study will be useful for clinicians, anatomists, archeologists, anthropologists and forensic scientists when such evidence provides the investigator the only opportunity to gauge that aspect of an individual's physical description .

Key words: Anthropology, Forensic, Height

INTRODUCTION

The estimation of the stature from different parts of the skeleton of the human body by anthropometric analysis is an area of interest to anatomists, anthropologists and forensic experts. The height of an individual, when it cannot be estimated directly, as in bedridden, old or frail patients, or in patients who have limb and/or vertebral column deformity; a indirect estimation can be achieved by correlating the height with other skeletal parameters. The ulna has easily identifiable surface landmarks which make the measurements possible in compromised postures, than in any other bones. Therefore, it can be utilized to formulate the height indirectly. Pearson K et al first introduced the co-relational calculus into the field of work for the prediction of the stature from the measurement of the long bones.[1] Height is one of the factors in the description of impressiveness of an individual and it varies with race, age sex, heredity, climate and nutritional status. Measurements of the bones of the limbs expressed the opinion that each racial group needs a separate formula for the estimation of stature is reported by Telekka et al.[2] Many of the previous workers worked on cadavers or on skeletal remains.[3,4] But cadavers cannot be the representatives of the population; because the cadavers are largely of persons who are aged, and they may have suffered from chronic debilitating diseases. It may be likely that they

had been lying in an abnormal posture and it may not have been possible to straighten the body to get the accurate stature measurement. There is an increase in the height of 2.5 cm after death, when the measurement is taken in the recumbent posture is reported by Tortter M et al.[5] Since over half of the century, the stature estimation has been linearly regretted with the length of the different long bones, especially for which the percutaneous measurement could be taken, like the ulna, the tibia, etc. The linear regression equation of the height on the ulna length has a definitive advantage over that of the tibia length, as it can be useful in the cases where the lower extremities are deformed, along with the deformities of the trunk.[6] Even the ulna length was proven to be superior to the arm span measurement and the hand length in predicting the height.[7,8] Lundy JK discussed the regression equation and the mathematical and the anatomical method of estimating the living stature from the long limb bones.[9] The works of different researchers have postulated the linear regression of the height of an individual with the percutaneous ulna length both in the Indian and the international context.[7-25] The ulna is a long bone often used for body height estimations. It lies parallel in the forearm with their ends fairly superficially placed. Prismatic in form placed at the medial side of the fore arm. Ulna is broader proximally and narrower distally. Ossification of ulna starts at the 8th foetal week of life and proximal epiphysis fuses with the shaft in the14th year of life in females and 16th year in males. The distal epiphysis unites with the shaft in 17th year of life in female and18th year of males.

METHODS

This prospective study was conducted at MB Kedia Dental College Birgunj. The study has been approved by the Institutional Ethics Committee, verbal consent was taken from all participants prior to their inclusion in the study. The data collection was done twice a week Sunday and Tuesday in outpatient department over a period of 1year January 2017 to December 2017. The present study comprised of a total of 150 male participants, were chosen randomly. Asymptomatic healthy medical persons, ranging age between 20–45 years, belonging to various region of Birgunj were included in the study. During this age range, height remains more or less static. Cases having old fractures, any significant disease, orthopedic deformity, metabolic or developmental disorder which could have affected the general growth were excluded from study.

In each case, the height of the person and length of right and left ulna were recorded. The measurements were always taken at a fixed time, between 3-5 PM, to eliminate discrepancies of diurnal variation. Measurements were taken for stature from crown to heel in standing erect posture with head oriented in Frankfurt's plane with a standard height measuring instrument. The height of participants was recorded in centimeters. The length of ulna was measured with the help of measuring tape from tip of olecranon process to tip of styloid process with elbow flexed and palm spread over opposite shoulder. (Fig:1) Measurements of length of right and left ulna were taken separately for calculation. The obtained values were analyzed by using the SPSS, version 12.0 software. The prediction of a significant relationship amongst the pair of variables was determined by the "Correlation coefficient" i.e., Pearson's 'r'. The relationship between the changes of a dependent variable (say, y) and an independent variable (say, x) was ascertained by simple linear regression, with the "Regression coefficient (b)"; where the model of the regression equation was y = a + bx [where a = y intercept, when x = 0]. As in every equation; a 95% confidence interval (which was equivalent to 1.96 standard deviation) was accepted and the standard error of regression (STE) was calculated. The final equation model was y = (a + bx) ± (1.96 x STE).

Fig 1: showing the measurement of ulna length in adult male participant. Tip of the olecranon process is marked as B and the ulna styloid process is marked as A.

The length A-B demarcates the ulna.

RESULTS

The mean of the heights was extrapolated as 165.03 cm, with a standard deviation of 7.81. Similarly, the means of the left and the right ulna lengths were calculated as 27.88cm (with a Std. deviation of 1.23) and 27.88 cm (with a Std. deviation of 1.23) respectively (Table1,2). The correlation coefficient (r) of the height and the left ulna length was 0.399 ($p<0.001$), with a significant regression coefficient (b) of 2.54 ($p<0.001$). A supportive regression scatter-plot can also be made (Table1,2). Similarly, the right ulna length was also found to bear a significant correlation with the height of the individual, with a correlation coefficient of 0.486 ($p<0.001$) and a regression coefficient 3.26 ($p<0.001$) respectively. Here also, a supportive scatter-plot could be made, thus signifying the interpretation (Graph 1). Thus, the regression equations became:

• Estimated Height (cm) = 94.23 + 2.54 x Left ulna length (cm) ±14.04.

• Estimated Height (cm) = 73.54 + 3.26x Right ulna length (cm) ±13.42.

Table 1: Estimation of height from length of left ulna in adult Nepalese men (N=150)

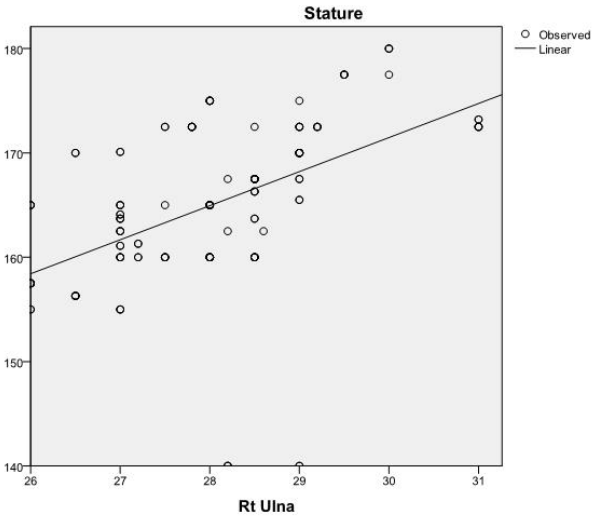
	Independent variable	**Dependent Variable**
	Lt ulna length (cm)	**Height (cm)**
Mean	27.88	165.03
Standard deviation	1.23	7.81
Correlation coefficient (r)	0.399[p<0.001]	
Regression constant (a)	94.23	
Regression coefficient (b)	2.54 [p=0.0001]	
Standard Error of estimate (STExy)	7.18	

Table shows different statistical outcomes showing inter-relationship of left ulna length and height of a male individual.

Table 2: Estimation of height from length of right ulna in adult Nepalese male (N=150).

	Independent variable	**Dependent Variable**
	Lt ulna length (cm)	**Height (cm)**
Mean	28.03	165.03
Standard deviation	1.16	7.81
Correlation coefficient (r)	0.486[p<0.001]	
Regression constant (a)	73.54	
Regression coefficient (b)	3.26[p<0.001]	
Standard Error of estimate (STExy)	6.85	

Table shows different statistical outcomes showing inter-relationship of right ulna length and height of a male individual.



Graph 1: Graphical representation of interpretation of height of an adult male from length of right ulna (N=150)

The graph shows showing inter-relationship of right ulna length and height of a male individual.

DISCUSSION:

In the present study, the correlation coefficient(r) of the height and the length of the left ulna was 0.399 and that for the right ulna was 0.486. The value of r implied that there was a positive correlation. This implied a significant contribution of the length of the ulna towards the height. The simple linear regression equation which has so far been derived can be used for the estimation of the height. Our findings are at par with the findings of the previous researchers, as were reported in 1952. Stature of American whites and negroes from the ulna with linear regression equations was estimated by Trotter M et al.[5] A study which was done by Lundy JK et al discussed the regression equation and the mathematical and the anatomical method of estimating the living stature from the long limb bones in the south African population.[9] The reports of Agnihotri AK et al from Mauritius and those of Barbaosa VM et al. from Portugal also found the linear regression model to depict an individual's stature from the percutaneous ulna length.[14,15] In India, Lal CS et al worked on a population of 258 in north Bihar, whose ages ranged from 12 to 21 years, for the estimation of the height from the surface anatomy of the long bones e.g. the tibia and the ulna.[10] The ulna mean multiplication factor was comparable in all the series. They claimed that the ulna multiplication factor was a better guide for the calculation of the height, when it was not definitely known as to which part of the country the individual belonged.[14] A similar study was done by Nath S et al. in Delhi in 1990.[11] Devi S et al. computed the correlation coefficient (r = 0.619 for males and 0.584 for females) and the regression equation formula for the estimation of stature by using the upper arm length among the living population of the Maring tribes of the Pallel area in the Chandel district, Manipur.[12] In the Bengali population, Mondal M et al postulated the height estimation in males from the ulna.[13] The present study could highlight such a relationship in females. Since the height of an individual progressively increases upto a certain age (till adolescence) and then decreases after a certain age due to vertebral column erosion, so the inclusion of a wider range of age groups could overcome its limitation for its applicability of the regression model.

CONCLUSION:

The regression formulae which are proposed will be of immense practical use in the clinical practice and in medico-legal, anthropological and archeological studies, where the total height of a subject can be calculated if the ulna length is known.

LIMITATION :

A more precise estimation of the average body height and its prediction utilizing length of the ulna measurements in Nepalese adults would require a larger sample with sufficient geographical and social heterogeneity or a national survey that measures the whole population. Thus, the obvious limitation of this research study was the composition of the measured sample that consisted of population from different societies.

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REFERENCES:

1. Pearson K. A mathematical contribution to the theory of evolution. On the reconstruction of the stature of the prehistoric races. Philos Trans R Soc. 1898;192:169-244.

2. Telekka A. The prediction of the human stature from the long bones. Acta Anatomica1950;(9):103-111.

3. Mall G, Hubig M, Büttner A, Kuznik J, Penning R, Graw M. Sex determination and estimation of stature from the long bones of the arm. Forensic Sci Int. 2001;117(1-2):23-30. (available in http//: www.pubmed.gov. accessed on 23 June 2012).

4. Celbis O, Agritmis H. Estimation of the stature and the determination of sex from the radial and the ulnar bone lengths in a Turkish corpse sample. Forensic Sci Int. 2006;158(2-3):135-9. Epub 2005 Jun 28. (available in http//:www.pubmed.gov. accessed on 23 June 2012).

5. Trotter M, Glesser GC. Estimation of stature from the long bones of American whites and negroes. Am J Phy Anthropol. 1952;(10):463-514.

6. Joshi NB, Patel MP, Dongre AV. Regression equation of the height from the ulnar length. Ind J Med Res. 1964;52:1088-91.

7. Gauld LM, Kappers J, Carlin JB, Robertson CF. Height prediction from the ulnar length. Dev Med Child Neurol. 2004;46(7):475-80.

8. Ilayperuma I, Nanayakkara BG, Palahepitiya KN. A model for the reconstruction of the personal stature, based on the measurements of the foot length. Galle Med J. 2008;13:6-9.

9. Lundy JK. The mathematical versus anatomical methods of stature estimation from the long bones. Am J Forensic Med Pathol. 1985;6(1):73-76.

10. Lal CS, Lala JK. Estimation of height from the tibial and the ulnar lengths in north Bihar. J Indian Med Assoc. 1972;58(4):120-21.

11. Nath S, Krishan G. Determination of stature by using the percutaneous measurement of the upper and the lower limb bone among the Hindu females of Delhi. J Anthropol Survey Ind. 1990;(39):151-66.

12. Devi S, Das H, Purnabati BK, Singh SD, Devi J. Estimation of stature from the upper arm length among the Marings of Manipur. Ind Med J. 2006;100(8):271-73.

13. Mondal M, Jana TK, Das J, Biswas S. Use of the length of the ulna in the estimation of stature in living adult males in the Burdwan district and in the adjacent areas of West Bengal. J Anat Soc Ind. 2009;58(1):16-19.

14. Agnihotri AK, Kachhwaha S, Jowaheer V, Singh AP. Estimating stature from the percutaneous length of the tibia and the ulna in an Indo-Mauritian population. Forensic Sci Int. 2009;187(1-3):109. e1-3. Epub 2009 Mar 14. (available in http//:www. pub.ed.gov. accessed on 23 June 2012).

15. Barbosa M, Stratton RJ, Lafuente E, Elia M. Using the ulnar length to predict the height in English and Portuguese patient populations; European Journal of Clinical Nutrition 2012;66:209–215. doi:10.1038/ejcn.2011.177; published online 12 October 2011.