A MODEL STATURE ESTIMATION FORMULA FOR ADULT MALE NIGERIANS BASED ON METACARPAL BONE LENGTH

By

Blessing C. Didia[1], Blessing N. R. Jaja[2] and Silverline N. Utchay[1]

[1]Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Port Harcourt. [2]Department of Anatomy, Faculty of Basic Medical Sciences, College of Medicine, University of Lagos, Lagos

SUMMARY

Background:
Stature prediction formulas provide a method of preliminary identification of dead individuals from their skeletal remains. No such formula has been reported for indigenous Nigerian populations.

Materials and Method:
Twenty-five adult male cadavers with Nigerian identities were used to evaluate the relationship between stature and the length of the second and third metacarpal bones of both hands. Measurement of crown-heel length of each of the 25 cadavers in supine position was made and recorded in centimetres to the nearest 0.5cm as stature. Stature was adjusted for cadaver length by subtracting 2cm from each cadaver length. The second and third metacarpal bones were harvested from both hands of each cadaver. The midline length of each metacarpal bone was measured with a Helios dial calliper and recorded to the nearest tenth of a millimetre. Correlation and regression analysis were applied to determine the relationships.

Results:
Best association was noted with the right third metacarpal bone length ($r^2 = 0.502$ $P>0.001$) and the equation that best predicted stature was a quadratic equation based on the length of this bone.

Conclusion:
A model stature prediction formula is hereby presented for validation in indigenous adult male Nigerians. This formula would be very useful in forensic research.

Keywords: *Forensic Sciences, Archaeology, Stature, Metacarpal Bone, Cadavers.*

Correspondence Address:
Prof. B. C. Didia
Department of Anatomy,
Faculty of Basic Medical Sciences,
College of Health Sciences,
University of Port Harcourt,
Port Harcourt
Email: Charitymemorialclinic@yahoo.com

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INTRODUCTION

The reconstruction of stature from human skeletal remains is an important aspect of forensic sciences[1]. It is useful in identifying individuals who died in mass disasters and in whom there were gross body mutilations in which only skeletal remains are available[2, 3]. In archaeology, predicted stature of extinct populations can provide insight into their ecology, health and disease profile.

A positive correlation has been established between stature and the length of long bones in humans[4, 5, 6, 7]. And, based on this fact, Meadow et al[8], Musgrave and Hernag [9] have used discriminant analysis to create stature estimation formulas based on the length of metacarpal bones in Americans and British respectively of known stature. Indeed, such stature prediction formulas, like other morphologic traits, have been shown to be population specific thereby limiting their application to only populations in which they were derived[10, 1]. Until now, no technique of reconstructing body stature has been given for indigenous Nigerian population. This is despite the fact that in the last two decades, several man-made mass disasters have occurred in the country and in which preliminary identification of involved victims from their body remains has been particularly difficult.

MATERIALS AND METHOD

Twenty five cadavers with Nigerian identities (from mortuary records) and estimated ages between 25 and 40 years were used in this study. Cadavers were among collections in the gross anatomy laboratories of the University of Port Harcourt, Nnamdi Azikiwe University and Madonna University. Measurement of crown-heel length of each cadaver in supine position was made and recorded in centimetres to the nearest 0.5cm as stature. Stature was adjusted for cadaver length by subtracting 2cm from each cadaver length. This was to correct for post-mortem artifact[8]. The second and third metacarpal bones were harvested from both hands of each cadaver and prepared for preservation. The midline length of each metacarpal bone was then measured with a Helios dial calliper as the length from the midline of the proximal articular surface (see figure I) and recorded to the nearest tenth of a millimeter[8]. All measurements were taken by the same investigator (Utchay) to avoid interobserver variations.

The association between stature and metacarpal bone length was evaluated using Spearman's rank order correlation coefficient and the stature of the cadavers regressed on their metacarpal length to obtain an equation that predicted stature based on a given metacarpal length. Using this equation for the metacarpal bone type that best correlate with stature, a set of predicted stature was derived for the cadavers. The differences between the predicted stature and true stature of the cadavers were tested for significance using the paired t-test. This was done to assess the reliability of the derived equation. All analyses were done separately for the right and left hands.

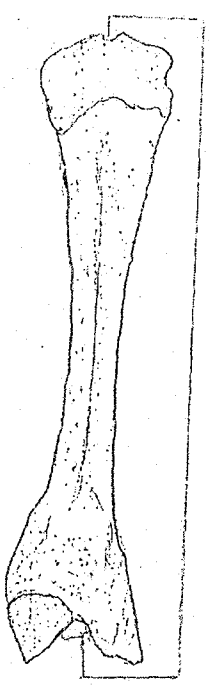

Fig.1. Diagram showing how the Midline Length (ML) is measured on a metacarpal with a helios dial calliper.

RESULTS

The mean values of cadaveral stature and metacarpal bone length are as shown in table 1.

Table 1: Summary Statistic for Adult Male Cadavers (n = 25)

Variable	Mean	SD
Stature (cm)	170.5	9.66
Left (mm) M_2	69.5	4.54
M3	68.1	3.92
Right (mm)M_2	69.3	4.28
M_3	67.5	3.99

M2 = Second metacarpal bone;
M3 = Third Metacarpal bone.

Table 2: Correlation coefficient values related to equation type for each given metacarpal bone type

Variable	Correlation Values		
	Linear	Quadratic	Cubic
Left M2	0.026	0.223	0.23
M3	0.016	0.240	0.23
Right M2	0.020	0.375	0.309
M3	0.013	0.502	0.497

Tables 2 and 3 give correlation coefficient and regression constants for different equation types for each given metacarpal bone type. It could be seen that there is a poor linear correlation between stature and metacarpal length for the sampled cadavers. Quadratic and cubic correlation values are better than linear correlation values but are still low.

Table 3: Regression equation related to metacarpal bone type for sampled male cadavers

Variable	Regression Constants and Equation			
	Linear	Sig	Quadratic	Sig
Left M2	y=146.47 +3.46x	0.44	y=1068.47 – 273.39x + 20.66x^2	0.063
M3	y=149.52 +3.08x	0.55	y=1266.78 – 336.92x + 25.75x^2	0.049
Right M2	y= 148.57 + 3.17x	0.50	y=1665.64 – 454.64x + 34.38x^2	0.006
M3	y=152.21 + 2.17x	0.59	y=2255.69 – 643.20x + 49.36x^2	0.000

Sig. = level of significance
y = stature (cm) and x = metacarpal length (cm)

The best correlation was demonstrated with the right third metacarpal bone for which a moderate quadratic coefficient value was obtained (Table 2). Therefore, the equation that best predicted stature was a quadratic equation in which the independent variable is the length of the right third metacarpal bone. It can be stated as:

Stature = 2255.69 – 643.20x + 49.36x^2 where x = length of right third metacarpal bone in cm.

The predicted stature obtained with the above equation for the sampled cadavers was not significantly different from the true cadaver stature at P>0.001

DISCUSSION

Past studies concerning stature estimation have been based on such racially and geographically diverse groups as Chinese, British, Mesoamericans, East and South Africans[5] among others. The highest single correlation between stature and a given long bone is usually with the femur[5]. In the absence of a measurable femur, as may occur in air and road traffic crashes, the metacarpal bones have been employed for stature estimation. Our choice of adult male cadavers is informed by two reasons. One is the relative availability of adult male cadavers in comparison to adult female cadavers and the other is the higher preponderance of adult males in trauma-related mortalities.

It is of significance that in our study, a weak linear correlation exists between stature and metacarpal bone length (r u 0.8). This is despite the allometric similarity that exists between the two sets of metacarpal bones used in the two studies. The implication of this observation is that the linear regression equation of Meadow and Jantz[8] for black Americans may be inappropriate for estimating the stature of indigenous Nigerians. In this study, the right third metacarpal bone is better correlated to stature than the other metacarpal bone types. We are unable to adduce a reason for this observation. Also, it is reasonable to expect that a larger sample size may improve on the correlation values obtained in this study as it is the case between the work of Musgrave and Harnega[9] and that of Meadow and Jantz[8]. However, considering

that the differences between predicted and true stature for the sampled cadavers were not statistically significant, it stands to reason that the right third metacarpal length – specific quadratic equation for stature is reliable in our environment.

In conclusion, therefore, we present this model stature estimation formula for further testing and validation in indigenous adult male Nigerians

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REFERENCES

1. Pelin C. and Duyer I. Estimating Stature from Tibia Length: A Comparison of Methods. J Forensic Science 2003; 48 (4): 708-712.
2. Trotter M, Glesser G. C. A Re-evaluation of Estimation of stature Based on Measurements of Stature Taken During Life and of Long Bones after Death. Am J Phys Anthropol 1958; 16:79-123.
3. De Mendonga M. C. Estimation of height from the length of long bones in a Portuguese adult population. Am J. Phys Anthropol 2000; 112: 39-48.
4. Lundy J. and Feldesman M. Revised Equation for Estimating Living Stature from the long Bones of the South African Negro. Journal of Science 1987; 83: 54-55.
5. Simmons T. Tantz R and Bass WM. Stature Estimation from Fragmentary Femora: A Revision of the Steele Method. J. of Forensic Science 1990; 35(3): 628-636.
6. Munoz J. I., Linares-Iglesias M., Suarez-Peneranda JM, Mayo M. et al. Stature Estimation from Radiographically Determined Long Bone Length in a Spanish Population Sample, J Forensic Science 2001; 46 (2): 363-6.
7. Duyer I and Pelin C. Body Height Estimation Based on Tibia length in Different Stature Groups. Cell Anthropol. 2002; 26 suppl: 60.
8. Meadow L. and Jantz R. L. Estimation of Stature from Metacarpal Length. Journal of Forensic Sciences 1992; 37: 147-154.
9. Musgrave J.H. and Herneja N.K. The Estimation of Adult Stature from Metacarpal Bone Length. Am J Phys Anthropol 1978; 48: 113-119.
10. Rose A.H. Konigaberg L.W. New Formulae for Estimating Stature in the Balkans. J Forensic Science 2002; 47 (1): 165-167.