J Forensic Sci, January 2009, Vol. 54, No. 1
doi: 10.1111/j.1556-4029.2008.00915.x
Available online at: www.blackwell-synergy.com

TECHNICAL NOTE

Blessing C. Didia,[1] *M.D.; Ethelbert C. Nduka,*[2] *Ph.D.; and Okechukwu Adele,*[1] *B.Sc.*

Stature Estimation Formulae for Nigerians

ABSTRACT: In stature estimation, long limbs and the stature formula of Trotter and Gleser easily come to mind. In the recent past, a lot of workers have established formulae specific to their populations using whole length of limbs, fragmented bones, circumference of long bones, and even length of the vertebrae. We have in this work used tibia length, height of subjects, and the regression models to establish formulae specific to Nigerians. We measured height and tibia length of 200 (96 male and 104 female) adult Nigerians. The tibia length was measured from upper limit of the medial condoyle to the tip of medial malleolus using a measuring tape calibrated in meters while the height of individuals were also measured using meter scales. All measurements were made by one person, to avoid interobserver error, and repeatedly until a constant value is obtained. We obtained general formulae for males and females which compares favorably with that of Duyar and Pelin, and can be relied upon.

KEYWORDS: forensic science, tibia, height, regression models, Nigerian population, stature estimations, general formulae, group specific formulae

The science of reconstructing stature from bones has been known since the nineteenth century and forensic medicine scientists have developed regression formulae for different populations (1). The well-known formula of Trotter and Gleser (1) seems to be the most widely utilized. Though a variety of bones have been used to reconstruct stature, the reconstruction of stature from long bones, especially the lower limb bones, seems to be the most popular and is claimed to provide near accurate results.

In 1995, Jantz et al. (2) described how the measure and mismeasure of the tibia could have implications for stature estimation. They concluded that the estimation of stature using Trotter and Gleser's (1) tibia formulae is to be avoided if possible, unless the tibia is to be measured in the same manner that Trotter measured excluding the malleolus. Ousley (3) points out many reasons which include: the standard errors range and secular allometric increase in the long bones make earlier estimation formulae based on earlier populations inaccurate. Meadows and Jantz (4) also remarked that the Trotter and Gleser stature regression equations are inappropriate for estimating the stature of modern Americans due to secular allometric increases.

Attempts have also been made to estimate stature from other bones including metacarpals (5), cervical, thoracic and lumber vertebrae segments (6), femur, and tibia (7). Ross and Konigsberg (7) concluded that the use of Trotter and Gleser formulae underestimates the stature in Balkans. Simmons et al. (8) estimated stature from fragmentary femora in an attempt to revise the Steele (9) method and concluded that the technique they have presented represents an improvement over methods currently in use. Duyar and Pelin (10) constructed a general formula and stature group specific formulae for the Turkish male adults whose anthropometrics measurements were known and concluded that the stature group specific formulae are more reliable for forensic cases (11).

[1]Department of Anatomy, University of Port Harcourt, P.M.B 5323, Port Harcourt, Nigeria.
[2]Department of Mathematics, University of Port Harcourt, P.M.B 5323, Port Harcourt, Nigeria.

Received 14 Aug. 2004; and in revised form 30 Mar. 2005; accepted 4 July 2008.

Our continuous search for literature did not reveal any work on Nigerians even when studies concerning stature estimation have been based on groups of races as geographically diverse as the Chinese, British, Balkans, East Africans, Americans, and South African blacks. The criticisms of the Trotter and Gleser formulae by many authors and the claims of specific accuracy of new formulae by recent workers helped to spur us to do something about the Nigerian situation. In this work, we decided to throw up formulae that can be used for Nigerians using tibia length.

Materials and Methods

Measurements of height and tibia lengths were taken from 200 (96 male, 104 female) adult Nigerians whose height ranged from 140 to 220 cm, and tibia length from 33.8 to 57 cm.

The tibia length was measured from the upper limit of the medial condyle to the tip of the medial malleolus using a measuring tape calibrated in meters as described by Martin et al. (12). The height of the individual was also measured using meter scales calibrated in centimeters as described by Cameron et al. (13). All measurements were made by one person (Adele) to eliminate interobserver error. The measurements were taken repeatedly until a constant value was gotten and recorded.

The data we obtained were then analyzed, for each sex, using the simple regression model as described in SPSS version 10.0 (SPSS Inc., Chicago, IL) for statistical analysis. In calculating our formulae, we used linear for males and logarithm for females as these models best fit the data considering the value of R^2. We also used the range test as described by Davies and Goldsmith (14) to show if the minimum and maximum values are outliers.

Results

The results obtained in this investigation are expressed in Table 1. In Table 1, we have provided a table of summary of the statistics by sex which show that the minimum and maximum values are not outliers. Interestingly, the linear regression analysis for the entire male and female population yielded a coefficient of determination (R^2) of 0.827 or 82.7% (Table 2) for males and 0.508 or

TABLE 1—*Range test for determination of outliers.*

	Male		Female	
Parameter	Stature	Tibia Length	Stature	Tibia Length
Mean	183.44	46.66	162.96	41.14
SD	6.49	4.50	5.90	3.97
Min. value	147	36	108.5	34
Max. value	217	57	191	50
Range	70	21	82.5	16
Range statistics (γT)				
Min. value	−2.51	−2.37	−4.19	−1.96
Max. value	2.32	2.31	2.16	2.23
Critical value	$Y(96) = 3.46$	n.s	$Y(104) = 3.38$	
At $\alpha = 5\%$	0.5		0.05	
	n.s		n.s	n.s

n.s., no outlier.

TABLE 2—*Regression models of height on tibia length, linear for both sexes and log for females.*

Dependent	Sex	Mth	Rsq	df	*F*	Sigf	b0	b1
HGHT	M	LIN	.827	94	448.58	0.000	46.8421	2.9289
HGHT	F	LIN	.506	102	104.59	0.000	67.2502	2.3265
HGHT	F	Log	.508	102	105.14	0.000	−190.42	95.1913

50.8% for female. For the male population where $n = 96$ the general formula; $Y = a + bx$ will equate to:

$$\text{Stature} = 46.8421 + 2.9289(\text{tibia})$$

For females, stature = −190.42 + 95.191 log (tibia length). The value of the coefficient of determination (R^2) in both cases throws up the simple regression as very adequate and making the error to be expected <20% especially in the case of the males. The use of log(tibia) for females (Table 2) instead of linear as applied in males is because we are looking for the model that fits the data best as expressed by the value of R^2 which in females is 0.508, as against linear which is 0.506 and quadratic which is 0.507. Our formulae compare favorably with general formulae of Duyar and Pelin (10) and we therefore assert that when statures of Nigerians are to be reconstructed using tibia length our formulae should be used as formulae specific for Nigerians.

Discussion

Most workers on body stature agree that stature derived from various formulae in use are mere estimations and are by no means exact, just as they also assert that the formula for one population may not be adequate for the other due to differential limb proportions among sexes and different populations (2,5,8,12).

These observations make it imperative that a specific formula should be derived for Nigerians and in fact every other population. Skeletal remains, or collections, such as the Terry collections are not common in Nigeria thereby making it impossible for skeletal remains, in the required quantity, to be used for this study. Forensic medical practice is also not regarded as a priority and so its utilization remains in its infancy. Apart from the recording of finger prints (in the realms of dermatoglyphics), there are no known legislative and or legal practices requiring the utilization of forensic experts. Nevertheless, recent happenings like increased intertribal and religious wars, political assassinations, secret cult killings, deaths due to road traffic accidents, and the like, point to the fact that time has come for Nigeria to employ forensic experts in the reconstruction of statures of affected individuals. Our pilot study here is therefore a right step in the right direction, because we have used the least squares method of estimating stature of Nigerians from whole tibia length. For our entire sample of 96 males and 104 females, stature = 46.8421 + 2.9289 × tibia length for males and −190.42 + 95.191 log (tibia length) for females.

References

1. Trotter M, Gleser G. Estimation of statures from long bones of American Whites and Negro. Am J Phys Anthropol 1952;10:463–514.
2. Jantz RL, Hunt DR, Lee Meadows MA. The measure and mis-measure of the tibia; implications for stature estimation. J Forensic Sci 1995;40(5):758–61.
3. Ousley S. Should we estimate biological or forensic stature? J Forensic Sci 1995;40(5):768–73.
4. Meadows L, Jantz RL. Secular change in long bone length and proportion in the United States, 1800–1970. Am J Phys Anthropol 1996; 110:57–67.
5. Meadows L, Jantz RL. Estimation of stature from metacarpal lengths. J Forensic Sci 1992;37(1):147–54.
6. Jason DR, Taylor K. Estimation of stature from length of the cervical, thoracic, and lumber segments of the spine in American Whites and Blacks. J Forensic Sci 1995;40(1):59–62.
7. Ross AH, Konigsberg LW. New formulae for estimating stature in Balkans. J Forensic Sci 2002;4(1):165–7.
8. Simmons T, Jantz RL, Bass WM. Stature estimation from fragmentary femora: a revision of Steele method. J Forensic Sci 1990;35(3):628–36.
9. Steele DG. Estimation of stature from fragments of long limb bones. In: Stewart TD, editor. Personal identification in mass disaster. Washington, DC: Smithsonian Institution Press, 1970;85–97.
10. Duyar I, Pelin C. Body height estimation based on tibia length in different stature groups. Coll Anthropol 2002;26(Suppl.):60 (Abstract).
11. Pelin C, Duyar I. Estimating stature from tibia lengths: a comparison of methods. J Forensic Sci 2003;48(4):708–12.
12. Martin LD, Carter JEL, Hendy KC, Malina RM. Segment length. In: Lohman TG, Roche AF, Martorell R, editors. Anthropometric standardization reference manual. Champaign, IL: Human Kinetics, 1988;9–26.
13. Cameron N, Hiernaux J, Jarman S, Marshall WA, Tawner JM, Whitehouse RH. Anthropometrics. In: Weiner JS, Lowe JA, editors. Practical human biology. London: Academic Press, 1981;25–52.
14. Davies OL, Goldsmith PL. Statistical methods in research and production, 4th edition. London: Longman Group Ltd, 1980;48–50.

Additional information and reprint requests:
Blessing C. Didia, M.D.
Professor
Department of Anatomy
University of Port Harcourt
P.M.B. 5323
Port Harcourt
Nigeria
E-mail: charitymemorialclinic@yahoo.com