Global Advanced Research Journal of Medicine and Medical Sciences (ISSN: 2315-5159) Vol. 5(4) pp. 116-122, April, 2016
Available online http://garj.org/garjmms

Full Length Research Paper

Stature estimation from head length and head breadth of adult *Tiv* and *Idoma* ethnic groups of North Central Nigeria

Terkula Kpela[1]*, B. Danborno[2], S.S. Adebisi[2] and S.A. Ojo[3]

[1]Department of Anatomy, College of Health Sciences, Benue State University, Makurdi, Nigeria.
[2]Department of Human Anatomy, Faculty of Medicine, Ahmadu Bello University, Zaria, Nigeria.
[3]Department of Veterinary Anatomy, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria.

Accepted 15 April, 2016

Stature is the distance between the vertex and the standing surface. It provides one piece of information that may aid individual identification especially where only cephalo-facial remains are available for forensic and postmortem examination. Stature prediction occupies a central position in anthropological research and forensic identification. Stature formulae are population and sex specific. The aim of this study was to set general formulae of stature estimation using head length and head breadth among adult *Tiv* and *Idoma* ethnic groups. The sample consisted of 828 volunteers aged 18-32 years, out of whom 418 were *Tiv* (218 male, 200 female) and 410 were *Idoma* (222 male, 188 female). The protocol was approved by Ahmadu Bello University Teaching Hospital, Zaria and participants gave informed consent. Demographic data was collected through self-administered questionnaire and stature, head length and head breadth was measured. Data was analyzed using statistical package SPSS for windows version 20 (IBM Corporation, New York, USA). Descriptive statistics, independent t-test, correlation and regression analyses were used. Statistical significance was considered at p<0.05. The mean stature of *Tiv* males was 170.4±11.09 and *Tiv* females was 160.8±8.76 with statistically significant difference between both means (p<0.001). The mean stature of *Idoma* males was 173.42±9.46 and *Idoma* females was 162.4±8.74 with statistically significant difference between both means (p<0.001). Ethnic differences were observed in males for which mean values were significantly higher in *Idoma* subjects (p<0.002). Head length and head breadth showed significant positive correlation with stature with multivariate regression equations having lower values of SEE in both ethnic groups. Head length and head breadth are, therefore, good predictors of stature in adult *Tiv* and *Idoma* ethnic groups with head length more accurate than head breadth. Multivariate equations from these measurements are more reliable when compared to univariate equations. There is need to conduct studies on older and younger populations of these ethnic groups so as to develop formulae for those other groups as well.

Keywords: head length, head breadth, regression equation, stature estimation, *Tiv*, *Idoma.*

INTRODUCTION

Stature or standing height is defined as the distance between the head vertex and the standing surface. Because it provides one piece of information that may be an aid in individual identification, stature prediction occupies a central position in anthropological research and forensic identification analysis in the events of accidents, murders, genocide or natural disasters. Stature has a definite and proportional biological relationship with each and every part of the human body.

*Corresponding Author Email: kpelaterkula@gmail.com, dookpelu@yahoo.com; Mobile: +234 806 783 8483

This relationship helps a forensic scientist to calculate stature from any of these body parts of the deceased person. Anthropologists have investigated multiple bones in the body for potential use in stature estimation (Giles and Vallandigham, 1991; Bidmos and Asala, 2005; Bidmos, 2006; Trotter, 1970 and Steele, 1970).

There are two methods currently established for stature estimation: the anatomical method and the mathematical method. The anatomical method, also commonly called the Folly method, introduced by Dwight and slightly developed by Fully in as reported by Raxter *et al.* (2006), determines living stature using the length of many bones in the body, together with correction factors and adjusting with depreciation pattern of stature on ages to attain a final estimation of living stature (Bidmos and Asala, 2005). It reconstructs stature by summing the measurements of the skeletal elements that contribute to height and adding a correction factor for soft tissue. This method is highly accurate, but it is time consuming to attain measurements for many bones in the body before calculation (Bidmos, 2006). The mathematical method determines stature from just one or a few pieces of bone. It takes advantage of the high linear correlation between long bones and stature. Commonly used bones that present high accuracy in stature determination by this method are the long bones found in the upper and lower extremities. Approximate stature can be estimated if multiple long bones of limbs are available, but from any other single bone, it always remains a daunting task for any anthropological/forensic examiner (Adebisi, 2009).

The first equations for estimating the height of living people for practical application were developed by Zorab, Prime, and Harrison in 1963 (Canda, 2009). Their work was based on a sample of 177 children of European extraction of both sexes with a mean age of 12.8 years. Since then the field of application of stature estimation has widened; it is no longer the sole province of archaeology and forensics but is also used for living persons. Accuracy in stature estimation depends to some extent on the specificity of the samples on which the estimation is based and can be influenced by such factors as age range, sex, ethnicity, and socioeconomic level (Canda, 2009). Over the years, a number of authors have developed equations to be applied to various specific subpopulations. One of the areas in which stature estimation equations may be applied is for persons with a physical disability whose stature cannot be measured by conventional methods due to disorders of the spinal column or the extremities or because their stature may be underestimated due to those disorders (Canda, 2009).

Krishan (2008) attempted the estimation of stature from various anthropometric measurements of cephalo-facial region of individuals belonging to an endogamous group in north India. The material for the study comprised 996 adult male Gujjars of north India ranging in age from 18 to 30 years. Five cephalo-facial measurements were taken on each subject. From the study, it was concluded that cephalo-facial dimensions were useful in estimation of stature and that measurements of the cephalic region gave better reliability of estimate than that of the facial region (Krishan, 2008).

The need for the study of morphological head forms and cephalic indices of *Tiv* and *Idoma* ethnic groups of Central Nigeria has not come under much attention so far. The *Tiv* people, numbering about 2.5 million individuals according to 1991 census, are said to be of Bantu origin from the Central African continent, in the *Shaba* area of the present Democratic Republic of Congo (Shii, 2011). The *Idoma* people, numbering slightly over one million by the 1991 census figures, reportedly migrated from *Apa* in Kwararafa Kingdom after its disintegration (Udo, 1970).

There is paucity of studies pertaining to estimation of stature from head dimensions. This study was carried out to determine the correlation of stature with head measurements and create predictive equations of stature from these measurements among *Tiv* and *Idoma* ethnic groups. The result would provide anthropometric data on these groups that could be useful in identification in forensic practice. The observations and findings of this study would provide platforms for similar extended studies in other ethnic groups for comparison and categorization and contribute to the construction of national anthropometric data.

MATERIALS AND METHODS

This cross-sectional study was conducted on 828 subjects out of whom 418 were *Tiv* (218 males and 200 females) while 410 were *Idoma* (222 males and 188 females). The subjects considered for this study all belonged to either *Tiv* or *Idoma* ethnic group with two generations of indigenization between the ages of 18-32 years. They were born and brought up in Nigeria to harmonize effects of environmental factors. The subjects were healthy individuals free from any apparent skeletal deformity. Subjects with physical deformity, those with craniofacial trauma and those with obstructive hairstyle were excluded from the study. Approval for this study was obtained from Ahmadu Bello University Teaching Hospital's ethical committee and consent was obtained from each respondent. A set of questionnaire comprising the demographic profile, ancestral background and other necessary information were verified before considering volunteers for inclusion. Measurements on the subjects were taken by locating appropriate anatomical landmarks. All the measurements were taken thrice and mean was calculated to ensure accuracy of the measurements. All the measurements were taken following the techniques of Singh and Bhasin (1989) and Ross and Marfell-Jones (1991). Definitions of landmarks, measuring techniques and instrument used were

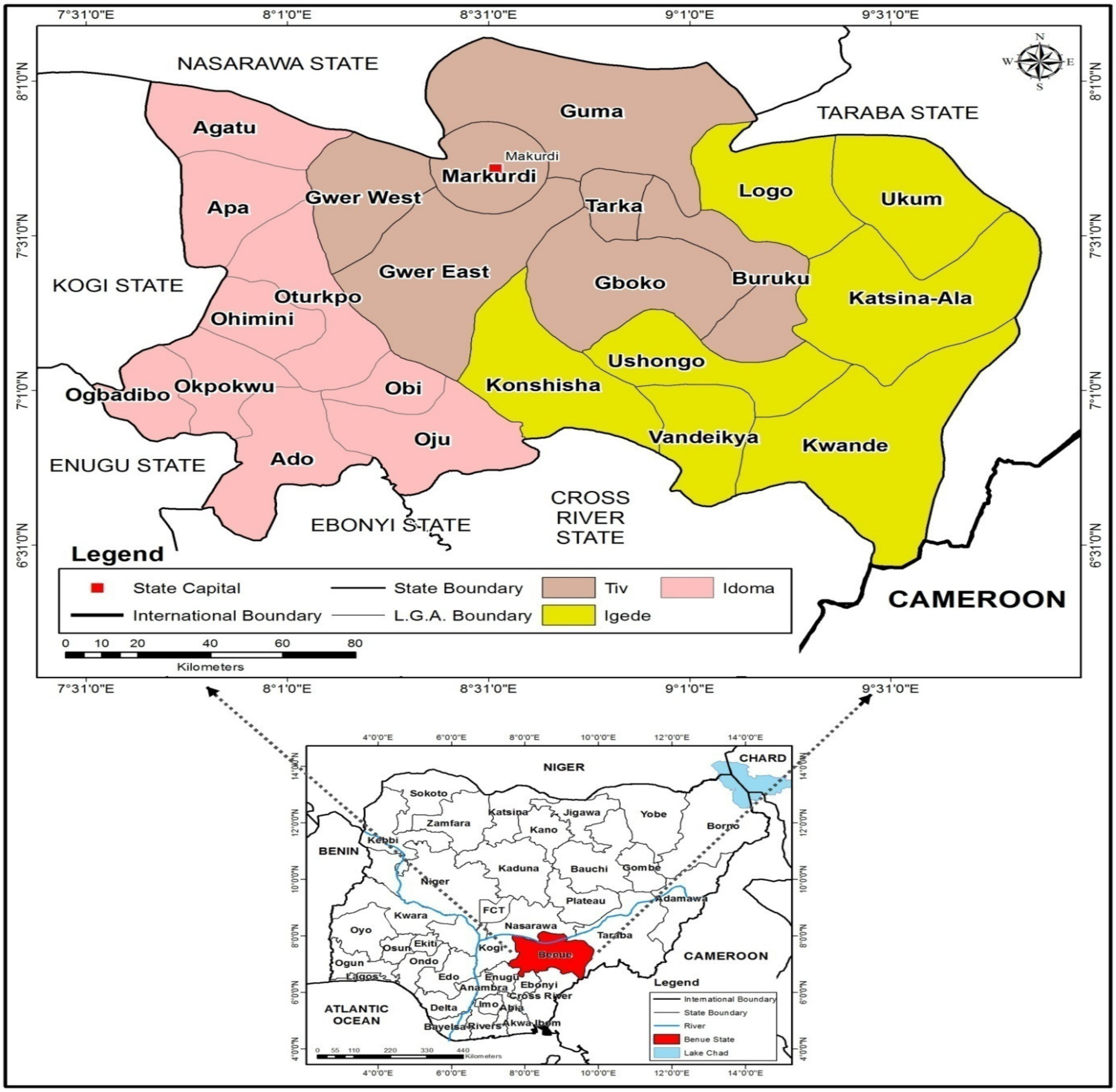

Figure 1. Map of Benue State showing the Three Major Tribes
Source: Modified from the Administrative Map of Benue State

according to Singh and Bhasin (1989) and Ross and Marfell-Jones (1991) and as follow:

i. **Vertex**: The most superior point on the skull, in the mid-sagittal plane, when the head is held in the Frankfort plane.

ii. **Glabella**: A point above the nasal root between the eyebrows and intersected by mid-saggital plane.

iii. **Opisthocranion**: It is the most posterior point on the posterior protuberance of the head in the mid sagittal plane.

iv. **Euryon:** It is the most laterally placed point on the sides of the head.

Stature was measured using a portable stadiometer as the distance from the standing surface to the vertex with the body in anatomical position and head in Frankfurk plane. Maximum head length was measured with the help of spreading calliper from glabella to opisthocranion with subject in sitting position and head in Frankfurt plane. Maximum head width was measured as the maximum transverse diameter between euryon to euryon using spreading calliper, also with subject in sitting position and head in Frankfurt plane. All measurements are recorded to the nearest centimetre.

All the data were analysed using Microsoft Excel and SPSS (Statistical Package for Social Sciences) version 20.0 (IBM Corporation, New York, USA). Descriptive statistics, independent t-test, correlation and regression analyses were used. Statistical significance was considered at $p<0.05$.

Table 1. Descriptive statistics for stature, head length and head breadth of *Tiv* and *Idoma* ethnic groups

Parameters	Male Mean±SD	Min	Max	Female Mean±SD	Min	Max	t	p
Tiv	(n=218)			(n=200)				
Stature (cm)	170.4±11.06	143.7	188.4	160.8±8.74	144.3	177.5	9.77	0.001
Head length (cm)	18.0±0.97	15.5	19.7	16.8±1.29	12.8	20.1	10.32	0.001
Head breadth	15.3±0.83	13.0	17.5	14.1±1.23	11.0	16.5	11.59	0.001
Idoma	(n=222)			(n=188)				
Stature (cm)	173.4±9.44	144.8	189.7	162.4±8.72	145.5	180.1	12.22	0.001
Head length (cm)	18.3±1.19	15.3	21.4	17.1±1.34	14.0	18.6	9.20	0.001
Head breadth (cm)	15.4±1.02	13.3	18.1	14.1±1.07	12.0	16.6	6.50	0.001

$P<0.05$

Table 2. Statistical comparison of stature, head length and head breadth of *Tiv and Idoma* ethnic groups

Parameters	*Tiv* Mean±SD	Min	Max	*Idoma* Mean±SD	Min	Max	t	p
Male	(n=218)			(n=222)				
Stature (cm)	170.4±11.06	143.7	188.4	173.4±9.44	144.8	189.7	3.11	0.002
Head length (cm)	18.0±0.97	15.5	19.7	18.3±1.19	15.3	21.4	2.75	0.006
Head breadth (cm)	15.3±0.83	13.0	17.5	15.4±1.02	13.3	18.1	1.73	0.085
Female	(n=200)			(n=188)				
Stature (cm)	160.8±8.74	144.3	177.5	162.4±8.72	145.5	180.1	1.80	0.073
Head length (cm)	16.8±1.29	12.8	20.1	17.1±1.34	14.0	18.6	1.73	0.085
Head breadth (cm)	14.1±1.23	11.0	16.5	14.1±1.07	12.0	16.6	0.22	0.825

$p<0.05$

RESULTS

Table 1 shows the mean, standard deviation (SD) and range values of stature, head length and head breadth of the studied population. The stature of *Tiv* male subjects ranged from 143.7 cm to 188.4 cm (mean 170.4±11.09) while that of female *Tiv* subjects ranged from 144.3 cm to 177.5 cm (mean 160.8±8.76) with statistically significant difference between both means ($p<0.001$). The stature of *Idoma* male subjects ranged from 144.8 cm to 189.7 cm (mean 173.42±9.46) while that of female *Idoma* subjects ranged from 145.5 cm to 180.1 cm (mean 162.4±8.74) with statistically significant difference between both means ($p<0.001$).

The head length of *Tiv* male subjects ranged from 15.5 cm to 19.7 cm (mean 18.0±11.09) while that of female *Tiv* subjects ranged from 12.8 cm to 20.1 cm (mean 16.8±1.29) with statistically significant difference between both means ($p<0.001$). The head length of *Idoma* male subjects ranged from 15.3 cm to 21.4 cm (mean 18.3±1.19) while that of female *Idoma* subjects ranged from 14.0 cm to 18.6 cm (mean 17.1±1.34) with statistically significant difference between both means ($p<0.001$).

The head breadth of *Tiv* male subjects ranged from 13.0 cm to 17.5 cm (mean 15.3±0.83) while that of female *Tiv* subjects ranged from 11.0 cm to 16.5 cm (mean 14.1±1.23) with statistically significant difference between both means ($p<0.001$). The head breadth of *Idoma* male subjects ranged from 13.3 cm to 18.1 cm (mean 15.4±1.02) while that of female *Idoma* subjects ranged from 12.0 cm to 16.6 cm (mean 14.1±1.07) with statistically significant difference between both means ($p<0.001$).

Table 2 shows statistical comparison of stature, head length and head breadth of *Tiv and Idoma* ethnic groups. In males, ethnic differences were observed for stature for which mean values were significantly higher in *Idoma* subjects ($p<0.002$) and head length for which mean values were significantly higher in *Tiv* subjects ($p<0.006$). In females, no statistically significant differences were observed in the mean values of stature, head length and head breadth between the two ethnic groups.

Table 3 displays Pearson's correlation coefficient between stature and the studied measurements in *Tiv* ethnic group. Both head length and head breadth showed significant positive correlation with stature in males with head length having higher correlation coefficient ($r=0.68$) than head breadth ($r=0.51$). In females, head length showed a significant positive correlation ($r=0.61$) but head bread showed non-significant positive correlation ($r=0.47$).

Table 3. Pearson correlation matrix of stature, head length and head breadth of *Tiv* ethnic group

	1	2	3
Stature (1)	1.00		
Head length (2)	0.68	1.00	
Head breadth (3)	0.51	0.53	1.00

Males

	1	2	3
Stature (1)	1.00		
Head length (2)	0.61	1.00	
Head breadth (3)	0.47	0.56	1.00

Females

Table 4. Pearson correlation matrix of stature, head length and head breadth of *Idoma* ethnic group

	1	2	3
Stature (1)	1.00		
Head length (2)	0.65	1.00	
Head breadth (3)	0.53	0.65	1.00

Males

	1	2	3
Stature (1)	1.00		
Head length (2)	0.64	1.00	
Head breadth (3)	0.47	0.48	1.00

Females

Table 5. Regression equation for estimation of stature (in cm) from head length and head breadth in *Tiv* and *Idoma* ethnic groups

Ethnicity/Sex	Variable	Regression Equation	R^2	SEE
Tiv male	Head length	31.601+(7.720*HL)	0.456	8.163
	Head breadth	66.778+(6.793*HB)	0.258	9.574
	Head length & breadth	11.705+(6.462*HL)+(2.787*HB)	0.489	7.961
Tiv female	Head length	91.482+(4.118*HL)	0.370	6.936
	Head breadth	113.532+(3.355*HB)	0.221	7.754
	Head length & breadth	84.770+(3.407*HB)+(1.327*HL)	0.396	6.845
Idoma male	Head length	79.148+(5.163*HL)	0.422	7.174
	Head breadth	97.398+(4.930*HB)	0.283	8.094
	Head length & breadth	70.529+(4.130*HL)+(1.779*HB)	0.442	7.160
Idoma female	Head length	86.914+(4.401*HL)	0.400	6.773
	Head breadth	105.742+(4.039*HB)	0.224	7.752
	Head length & breadth	72.638+(3.728*HL)+(1.867*HB)	0.441	6.597

SEE: standard error of estimate
HL: head length
HB: head breadth

Table 4 displays Pearson's correlation coefficient between stature and the studied measurements in *Idoma* ethnic group. Both head length and head breadth showed significant positive correlation with stature in males with head length having higher correlation coefficient (r=0.65) than head breadth (r=0.53). In females, head length showed a significant positive correlation (r=0.64) but head bread showed non-significant positive correlation (r=0.47).

Table 5 shows the regression equations for estimation of stature from head length and head breadth. Both univariate and multivariate equations have been calculated. This table also presents standard error of estimate (SEE) calculated separately for each formula. The SEE tends to predict the deviation of estimated stature from actual stature. A low value of SEE is indicative of the greater reliability of the prediction.

DISCUSSION

Determination of stature is an important step in the identification of skeletal remains (Sheta *et al,* 2009). Anthropometric techniques are commonly used by experts to estimate body size for the purpose of identification and different methods have been used aiming at formulating equations for height reconstruction (Sheta *et al.,* 2009). In this study, it was revealed that males presented with higher mean value of stature than females. It can, therefore, be inferred that males are generally taller than females. This is in agreement with previous observations by Bidmos and Asala (2004), Sheta *et al*. (2008) and Krishan (2008). The average height of adult males within a population is said to be significantly higher than that of adult females (Williams *et al*., 2000; Ebite *et al*., 2008; Ilayperuma *et al*., 2010).

The results of this study showed that the mean stature of *Idoma* males was significantly higher than the mean stature of *Tiv* males but there was no significant difference in mean stature between females of both ethnic groups. A study by Goon *et al.* (2011) on students of Benue State University Makurdi reported average stature of 167.2 cm for males and 160.3 cm for females who were of the same age bracket as those in this study. However, that study did not indicate ethnic affiliations of participants and so its findings on stature could not be taken as representative of *Tiv* or *Idoma* ethnic groups and hence could not be used for direct comparison with the findings of our study.

Several studies reported various statures for other ethnic groups and nations across the world. Mean stature of Ijaw males is 175.1 cm and that of Ijaw female is 166.3 cm, while the mean stature of Ikwerre male is 164.5 cm and that of Ikwerre female is 156.4 cm (Fawehinmi *et al*., 2013). Adult Urhobo male has an average height of 172.5 cm and an adult Urhobo female has an average height of 161.7 cm (Ebiye, 2013); while the mean stature of adult Ibo male is 167.6 cm and that of Ibo female is 163.2 cm (Jervas *et al.,* 2014). The mean stature of Turkish adults is 174.4 cm (males) and 160.9 cm (females) (Ozden *et al*., 2005); that of Sri Lankans is 170.1 cm (males) and 157.6 cm (females) (Ilayperuma *et al*., 2010); male Montenegrins are 183.2 cm tall while female Montenegrins are 168.4 cm tall making Montenegro the second tallest nation in the world after Netherlands (male 183.8, female 170.3) (Bjelica *et al*., 2012). Mean stature for populations of adults, therefore, varies from minimum values for the Efe Pygmies of Africa at 144.9 cm for men and 136.1 cm for women to the maximum values for the Dutch of Europe at 184.0 cm for men and 170.6 cm for women (Fawehinmi *et al*., 2013).

In modern humans, stature attained in life is influenced by both genetic and environmental factors. It is known that stature is in part heritable. The heritability has been established around 0.80 (van Stokkom, 2012), or for European men between 0.87-0.93, and for European women 0.68-0.84 / 0.890.93. The environmental aspect of size determines how much of the genetic potential for total stature is attained. Stature attained is negatively affected by lack of nutrition, lack of sleep and disease. Stature is therefore proposed to be determined by a complicated interplay between both genetic factors and ontogenetic circumstances that influence the stature attained by any individual (van Stokkom, 2012).

Stature is one of the most commonly used criteria in studies on body structure (Pelin *et al*., 2010). Body stature (height) has been reported as one of the most important and useful anthropometric parameters which determines the physical identity of an individual. It is a composite of linear dimensions of skull, vertebral column, pelvis, legs and some parts of the foot. Stature and its estimation are continually applied in forensic medicine, clinical practice, anthropology, and other medical sciences. Measurement of body height is important in many settings: it is an important measure of body size and gives an assessment of nutritional status (Datta, 2011) as well as an important measure of determination of basic energy requirements, standardization of measures of physical capacity and adjusting drug dosage, and evaluation of children's growth, prediction and standardization of physiological variables such as lung volumes, muscle strength, glomerular filtration and metabolic rate (Zverev, 2003; Goon *et al*., 2011). It is also common knowledge that exact body height cannot always be determined through direct measurements because of various deformities of the extremities or in patients who have undergone amputations or similar injuries. Measuring stature can also be difficult in physically and mentally frail nursing home patients, e.g. patients that are wheelchair-bound or bedridden and those with osteoporosis, sequelae after hip fractures, or stroke. In such circumstances, an estimate of body height has to be derived from other reliable anthropometric indicators (Goon *et al*., 2011; Sah *et al*., 2013).

The findings of this work demonstrated that there is a statistically significant difference between males and females with respect to mean head length and head breadth. All male measurements showed higher mean values than female ones suggesting sexual dimorphism. These are supported by previous observations of Krishan (2008) who suggested the use of head length and head breadth as tools of sex diagnosis.

The results of this study showed that stature is positively correlated with head length and head breadth. This is in agreement with the findings of Krishan (2008) and Krishan and Kumar (2007) who successfully estimated stature from cephalofacial measurements in Koli adolescents – an endogamous population of north India.

The reliability of stature estimation using regression equation is revealed by the standard error of estimate. In this study a lower SEE is obtained from the use of head length for stature estimation in both ethnic groups. This means that the regression formulae from head length give higher degree of reliability and accuracy than that from head breadth. This is in agreement with Krishan and Kumar (2007). Multivariate equations in both ethnic groups than univariate ones which points to the fact that a higher accuracy in stature estimation is obtained with the use of more than one bone (Sheta *et al*., 2008; Choi *et al*., 1997 and Dayal *et al*., 2008).

CONCLUSION

In conclusion, head length and head breadth are good predictors for the estimation of stature in adult *Tiv* and *Idoma* ethnic groups of Nigeria in the age range of 18-32 years. In both ethnic groups and both sexes, head length is more accurate than head breadth. Multivariate equations from these measurements are more reliable when compared to univariate equations. There is the need to conduct studies on older and younger populations of these ethnic groups so as to develop formulae for these other age groups.

REFERENCES

Adebisi SS (2009). Finger print studies, the recent challenges and advancements. A literary review. *The Internet J. Biol. Anthropol.* 2: 1-15.

Bidmos M, Asala S (2005). Calcaneal measurement in estimation of stature of South African blacks. *Am. J. Physical Anthropol.* 126(3): 335-342.

Bidmos M (2006). Adult stature reconstruction from the calcaneus of South Africans of European descent. *J. Clin. Forensic Med.* 13(5): 247-252.

Bjelica D, Popovic S, Kezunovic M, Petkovic J, Jurac G, Grasgruber P (2012). Body height and its estimation utilising arm span measurements in Montenegrin adults. *Anthropological Notebook*. 18 (2): 69-83.

Canda A (2009). Stature estimation from body segment lengths in young adults. Application to people with physical disabilities. *J. Physiol. Anthropol.* 28 (2): 71-82.

Choi BY, Chae YM, Chung IH and Kang HS (1997). Correlation between the post-mortem stature and dried limb bone lengths of Korean adult males. *Youns Med. J.* 38 (2): 79-80.

Datta BS (2011). Arm span as a proxy measure for height and estimation of nutritional status: A study among Dhimals of Darjeeling in West Bengal India. *Annals Hum. Biol.* 38(6): 728–735.

Dayal MR, Steyn M, Kevin L, Kuykendall L (2008). Stature estimation from bones of South African whites. *South Afr. J. Sci.* 104: 124-128.

Ebeye OA (2013). Stature estimation from upper extremity long bones in a Southern Nigerian population. *Austr. J. Basic and Appl. Sci.* 7(7): 400-403.

Ebite LE, Ozoko TC, Eweka AO, Otuaga PO, Oni AO, Om'Iniabohs FAE (2008). Height: Ulna Ratio: A method of stature estimation in a rural community in Edo State, Nigeria. *The Internet J. Forensic Sci.* 3(1).

Fawehinmi HB, Ogoun TR, Okoseimiema SC (2013). Determination of femur stature ratio of the Ijaw and Ikwerre ethnic groups in Nigeria. *Sci. Afric.* 12 (2): 28-39.

Giles E, Vallandigham PH (1991). Height estimation from foot and shoeprint length. *J. Forensic Sci.* 36:1134–1151.

Goon DT, Toriola AL, Musa DI, Akusu S (2011). The relationship between arm span and stature in Nigerian adults. *Kinesiol.* 43(1):38-43.

Ilayperuma I, Nanayakkara G, Palahepitiya N (2010). A Model for the estimation of personal stature from the length of forearm. *Int. J. Morphol.* 28 (4): 1081-1086.

Jervas E, Ikechukwu PAC, Chinedu AF, Emeka AG, Kingsely OC, Chinedu UG (2014). Stature estimation using right digits and palm length in Igbo population, Nigeria. *Annals Bioanthropol.* 2:23-28.

Krishan K (2008). Estimation of stature from cephalofacial anthropometry in north Indian population. *Forensic Sci. Int.* 181 (1-3): 52e1-52e6.

Krishan K, Kumar R (2007). Determination of stature from cephalo-facial dimensions in a North Indian population, *Legal Med.* 9: 128–133.

Ozden H, Balci Y, Demiru C, Turgut A, Ertugrul M (2005). Stature and sex estimate using foot and shoe dimensions. *Forensic Sci. Int.* 147: 181–184.

Pelin C, Özener B, Kürkçüoğlu A, Zağyapan R (2010). Effect of living conditions on somatotype components of young individuals belonging to different socioeconomic strata: a preliminary study. *Eur. J. Anthropol.* 1(1):26–32.

Raxter MH, Auerbach BM, Ruff CB (2006). A revision of the Fully technique for estimating statures. *Am. J. Phys. Anthropol.* 130:374-384.

Ross WD, Marfell-Jones MJ (1991).Kinanthropometry. In: MacDougall, J.D. (Ed.), *Physiological tes ting of the high-performance athlete.* 2nd edition. Canadian Association of Sports Sciences, Sports Medicine Council of Canada.

Sah RP, kumar A, Bhaskar RK (2013). Body height and its estimation utilizing arm span measurements in population of Birgunj area of Nepal: An anthropometric study. *J. College Med. Sci.-Nepal.* 9 (4): 9-14.

Sheta A, Hassan M, Elserafy M (2009). Stature estimation from radiological determination of humerus and femur lengths among a sample of Egyptian adults. *Alexandria Bulletin Faculty of Medicine.* 45(2).

Shii BI (2001). *Christianity in Tivland: A History of NKST*. Oracle Business Limited, Makurdi, Benue State.

Singh IP, Bhasin MK (1989). *A laboratory Manual on Biological Anthropology.* 2nd Revised Edition, Delhi: Nazia Offset Press.

Steele G (1970). Estimation of stature from fragments of long limb bones, In: *Personal identification in mass disasters,* T. D. Stewart, Ed., Smithsonian Institution Press, Washington, DC, 85-97.

Trotter M (1970). Estimation of stature from intact long limb. In: *personal identification in mass disasters*, T.D. Stewart, ed. Smithsonian Institute Press, Washington, D.C. 71-83.

Udo RK (1970). *Geographical regions of Nigeria*. University of California Press, Los Angeles. PP. 138-147.

Van Stokkom IS (2012). Body stature estimation methods based on femur length evaluated for *Homo erectus.* [dissertation]. Leiden.

Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussak JE, Ferguson MWJ (2000). *Gray's Anatomy: Skeletal System*, 38th Edition, Churchill Livingstone, Philadephia.

Zverev YP (2003). Relationship between arm span and stature in Malawian adults. *Annals Hum. Biol.* 30 (6): 739-743.