



Trends in
**Applied Sciences
Research**

ISSN 1819-3579



Academic
Journals Inc.

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Study of Vertical and Transverse Cephalic Indices in Three Ethnic Groups of North-eastern Nigerian Origin

M.B. Maina, O. Mahdi and G.D. Kalayi

Department of Human Anatomy, College of Medical Sciences, Gombe State University, Tudun Wada Quarters, PMB 127 Gombe, Nigeria

Corresponding Author: Mahmoud Bukar Maina, Department of Human Anatomy, College of Medical Sciences, Gombe State University, Tudun Wada Quarters, PMB 127 Gombe, Nigeria Tel: + 2348066011112

ABSTRACT

Cephalometry is a branch of anthropometry through which cephalic index is estimated. Cephalometric studies on head types are useful in paediatrics, forensic medicine, plastic surgery, oral surgery and diagnostic comprehension between patient and normal populations. In Nigeria, literature is lacking on head shapes by vertical and transverse cephalic indices, this study was therefore undertaken to document the different head types in three ethnic groups of North-Eastern Nigeria residing in Gombe. Cephalic length, width and height in Fulani, Tangale and Tera ethnic groups were linearly measured in a total of 322 (152 males and 170 females) 18-40 years old subjects. The result revealed no significant difference in cephalic indices, except in Fulani males, where transverse cephalic index was higher than in the other ethnic groups ($p < 0.05$) and in Tangale females where all the cephalic indices were higher than in other ethnic groups ($p < 0.05$). Head types based on the indices in males and females from all the three ethnic groups are dominantly High Hypsicephalic and Acrocephalic and rarely Chamaecephalic and Tapeinocephalic according to vertical and transverse cephalic indices, respectively. The study revealed that the three ethnic groups share differences on the basis of cephalic indices and share some similarities on the basis of head types and that Nigerians share similarities with Sri Lankans base on their head types.

Key words: Ethnicity, cephalometry, vertical cephalic index, transverse cephalic index, head types

INTRODUCTION

Anthropometry is a field of science that deals with physical measurements of body dimensions to study human variations and through which the health status of a population can be determined (De Onis and Habicht, 1996; Schoenbaum *et al.*, 1995). Anthropometric techniques aid in the study of nutritional intake, energy consumption, malnutrition and body composition (Al-Rewashdeh and Al-Dmoor, 2010; Khattak *et al.*, 2002; Khandare *et al.*, 2008; Eboh and Boye, 2005; Hassan *et al.*, 2008). They also aid in SMS satisfaction (Balakrishnan and Yeow, 2008) identification of body remains, plastic surgery, archaeology and in differentiation between people of different race and sex (Heidari *et al.*, 2006; Umar *et al.*, 2006). The most widely used anthropometric methods in the differentiation of race and ethnicity is cephalometry through which head dimensions can be determined. The most important of cephalometric dimension are height and width of head that they used in cephalic index determination (Vojdani *et al.*, 2009). It has been reported that factors like race, ethnicity, genetic interactions, traditions, nutrition, environment and climate influences head types (Rexhepi and Vjollca, 2008). Head types can be dolicocephalic,

mesocephalic or brachycephalic based on horizontal cephalic index; Chamaecephalic, Orthocephalic or Hypsicephalic based on vertical cephalic index; or Tapeinocephalic, metriocephalic or acrocephalic based on transverse cephalic index (Rexhepi and Vjollca, 2008). Various studies had documented head types based on horizontal cephalic indices (Raji *et al.*, 2010; Garba *et al.*, 2008; Shah and Jadhav, 2004; Oladipo *et al.*, 2010; Golalipour *et al.*, 2003; Golalipour, 2006) few studies however were done on head types by vertical and transverse cephalic indices (Rexhepi and Vjollca, 2008; Ilayperuma, 2011) this study was therefore designed to determine the head types in a north-eastern Nigerian population by vertical and transverse cephalic index classifications. The objective is to compare this study with other similar studies.

MATERIALS AND METHODS

Subjects: This study was conducted on 18-40 years normal randomly selected Fulanis, Tangales and Teras of Gombe state region of North-Eastern Nigeria, from March to June 2011. Gombe State lies in the centre of the North-East geopolitical zone of Nigeria. It shares a common boundary with all the other states in the zone, namely, Adamawa, Bauchi, Borno, Taraba and Yobe. A total of 322 subjects (152 males and 170 females) were used. Prior and informed consent was obtained from the subjects and the study was carried out after obtaining clearance from the ethical committee of Federal Medical Centre Gombe, Nigeria.

Cephalic measurements: Cephalic measurements were taken after careful palpation with subjects in a relaxed condition with head in the anatomical position using standard anatomical landmarks (Lobo *et al.*, 2005). Using a spreading calliper three head measurements (cephalic length, width and height) were measured as described below:

- Cephalic length (linear length from glabella to inion)
- Cephalic width (linear length between parietal eminences)
- Cephalic height (length from nasion to gnation)

Vertical and transverse cephalic indices according to Martin and Saller cited in Rexhepi and Vjollca (2008) as shown in Table 1 was determined by:

$$\text{Vertical cephalic index (VCI)} = \frac{\text{Cephalic height}}{\text{Cephalic length}} \times 100$$

Table 1: Range of head shapes according to the Martin-Saller scale

	Range	Scientific term	Meaning
By vertical cephalic index	X-57.9	Chamaecephalic	having a low, flat head
	58.0-62.9	Orthocephalic	Having a head well proportioned to height
	63.0-67.9	Low Hypsicephalic	Having a high forehead that is dolicocephalic in nature
	68-72.9	Moderate Hypsicephalic	Having a very high forehead that is dolicocephalic in nature
	73-X	High Hypsicephalic	Having an extremely high forehead that is dolicocephalic
By transverse cephalic index	X-78.9	Tapeiocephalic	Head that is Flat or depressed
	79.0-84.9	Metriocephalic	Having a head well proportioned to height
	85 - X	Acrocephalic	having a high, pointed head

$$\text{Transverse Cephalic index (TCI)} = \frac{\text{Cephalic height}}{\text{Cephalic width}} \times 100$$

Statistical analysis: Data obtained from the subjects were recorded on a recording sheet and then transferred into SPSS 11.0 for analysis. The means obtained from this study were subjected to Analyses of Variance (ANOVA) for assessment of statistical significance and linearity with a probability level of less than 0.05 considered significant.

RESULTS

Cephalometric values and indices: The minimum values of vertical cephalic indices in males and females of Fulani, Tangale and Tera were 62.77 and 61.85; 66.66 and 62.36 and 68.55 and 63.02, respectively while the maximum values were 94.79 and 91.42; 90.55 and 94.41 and 88.76 and 90.00, respectively (Table 2, 3). The minimum values of transverse cephalic index in males and females of Fulani; Tangale and Tera were 78.68 and 79.35; 88.60 and 87.21 and 92.85 and 85.51, respectively. The result showed no significant difference in means of vertical cephalic index among the three ethnic groups in males (Table 2). Fulani males however had higher transverse cephalic index (109.97±11.93) than Tangales (103.54±7.35) and Teras (105.90±6.01) (p<0.005). In females, the means of vertical cephalic index (79.74±6.31) and that of transverse cephalic index (104.44±10.23) in Tangales were higher than those of Fulani (74.50±5.81 and 97.91±8.62) and Teras (75.83±6.51 and 100.25±9.31), respectively (p<0.005) (Table 3). The result also showed no significant difference in total mean cephalic indices between males and females, except in transverse cephalic index where males had 106.43±9.12 while females had 101.17±9.83 (p<0.005).

Morphological classification of head: According to vertical and transverse cephalic indices the rarest head types in both males and females of the three ethnic groups were Chamaecephaly and Tapeinocephaly, respectively (Table 4), while the dominant head types were High Hypsiccephaly and Acrocephaly, respectively. Orthocephalic and metriocephalic head types, respectively were also found to be rare in Tangales and Teras.

Table 2: Means of vertical and transverse cephalic indices and their minimum and maximum values in males among the three ethnic groups

Group	Minimum VCI	Maximum VCI	Mean VCI	Minimum TCI	Maximum TCI	Mean TCI
Fulani	62.77	94.79	78.06±5.45	78.68	145.60	109.97±11.93***
Tangale	66.66	90.55	77.30±4.99	88.60	120.74	103.54±7.35
Tera	68.55	88.76	77.62±4.31	92.85	124.41	105.90±6.01
Total	62.77	94.79	77.65±4.92	78.68	145.60	106.43±9.12***

***indicating that the value of TCI is extremely higher in Fulanis than in the other ethnic groups (p<0.005)

Table 3: Means of vertical and transverse cephalic indices and their minimum and maximum values in females among the three ethnic groups

Group	Minimum VCI	Maximum VCI	Mean VCI	Minimum TCI	Maximum TCI	Mean TCI
Fulani	61.85	91.42	74.50±5.81	79.35	125.00	97.91±8.62
Tangale	62.36	94.41	79.74±6.31***	87.21	134.55	104.44±10.23***
Tera	63.02	90.00	75.83±6.51	85.51	125.41	100.25±9.31
Total	61.85	94.41	76.96±6.60	79.35	134.55	101.17±9.83

***indicating that the value of VCI and TCI are significantly higher in Tangales than in the other ethnic groups (p<0.05)

Table 4: Intra tribal percentage distribution of head shapes

Parameters		Fulani (M) N = 50 (%)	Fulani (F) N = 53 (%)	Tangale (M) N = 52 (%)	Tangale (F) N = 67 (%)	Tera(M) N = 50 (%)	Tera (F) N = 50 (%)
Head types by VCI	Chamaecephalic	0	0	0	0	0	0
	Orthocephalic	2	1.88	0	1.49	0	0
	Low hypsicephalic	2	5.66	1.92	2.98	0	12
	Moderate hypsicephalic	4	37.73	15.38	5.97	10	28
	High hypsicephalic	92	54.71	82.69	89.55	90	60
Head types by TCI	Tapeinocephalic	2	0	0	0	0	0
	Metriocephalic	2	1.88	0	0	0	0
	Acrocephalic	96	98.11	100	100	100	100

DISCUSSION

The findings from this study revealed that differences exist among the population of the three ethnicities. This result agrees with reports that postulated the effect of ethnicity on cranial dimensions (Golalipour and Heydari, 2004; Bayat and Ghanbari, 2010). The findings from this study also revealed sexual dimorphism in the cephalic indices, which was best pronounced in transverse cephalic index. This therefore agrees with other findings which revealed sexual dimorphism in head dimensions (Maina *et al.*, 2011; Raji *et al.*, 2010).

The similarities in head shapes of both vertical and transverse cephalic indices among the ethnic groups as shown in the study could be because the main factor that differ the groups is their ethnicity but they are subjected to same environmental, nutritional and geographical conditions. Looking at studies on horizontal cephalic indices in Nigeria head forms of Ogoni males and female of south-eastern Nigeria are Hyperbrachycephalic and mesocephalic, respectively (Oladipo *et al.*, 2009). That of Ibibio males and females of south-south Nigeria is mesocephalic (Oladipo *et al.*, 2010) and that of Ogbia tribes of southern Nigeria is dolicocephalic (Eroje *et al.*, 2010). The head forms of Nigerians in the middle belt (Jos) is Mesocephalic (Umar *et al.*, 2006) those of Hausas and Yorubas of the same region is also mesocephalic (Umar *et al.*, 2011). In North-Eastern Nigeria the head types of Kanuri and Babur newborns are dolicocephaly and mesocephaly, respectively (Garba *et al.*, 2008). In adults of North-Eastern Nigeria, the rarest and dominant head types were hyperbrachycephaly and dolicocephaly (Raji *et al.*, 2010). The present study have revealed that on the basis of vertical and transverse cephalic indices the rarest head types in North-Eastern Nigerians are Chamaecephaly and Tapeinocephaly, respectively; while the dominant are High Hypsicephaly and Acrocephaly, respectively.

Earlier reports on head forms of vertical and transverse cephalic indices showed that Negrito, Melanesian, Caucasian and Malay are hypsicephalic (Sullivan, 1923). More recent studies suggest that Waxiang people of China are Hypsicephalic and metriocephalic (Pi *et al.*, 2011), Yunnan Mongols are also Hypsicephalic (Lian-Bin *et al.*, 2011) Sri Lankans are Hypsicephalic and Acrocephalic (Ilayperuma, 2011) and Kosovans are Hypsicephalic and Tapeinocephalic (Rexhepi and Vjollca, 2008). Therefore, comparison of mean cephalic indices from this study and that of other closely related studies in Sri Lanka and Kosova (Table 5) revealed some variations between the populations. Mean vertical cephalic index in males and females from this study are significantly higher ($p < 0.05$) than those in Kosova (Rexhepi and Vjollca, 2008) but lower than those of Sri Lankans (Ilayperuma, 2011). Transverse cephalic indices in males and females from this study are significantly higher ($p < 0.05$) than those in Kosova and Sri Lanka. According to vertical cephalic index classification, Nigerians, Kosovans and Sri Lankans are Hypsicephalic. But

Table 5: Comparison of vertical and transverse Cephalic Index with other population

Place and/People	Reference	Age	N	Vertical Cephalic Index (VCI)	Transverse Cephalic Index (TCI)
Kosova/Males	Rexhepi and Vjollca (2008)	18-35	561	64.41±3.80	77.14±4.85
Sri Lanka/Males	Ilayperuma (2011)	20-23	220	78.53±4.91	101.12±8.57
Nigeria/Males					
(Fulani, Tangale and Tera)	Present study	18-40	152	77.65±4.92***	106.43±9.12***
Kosova/Females	Rexhepi and Vjollca (2008)	18-35	193	63.72±4.26	75.22±5.07
Sri Lanka/Females	Ilayperuma (2011)	20-23	180	78.91±7.46*	99.61±7.29
Nigeria/females					
(Fulani, Tangale and Tera)	Present study	18-40	170	76.96±6.60***	101.17±9.83***

*** Indicates that VCI and TCI from this study are extremely higher than in Kosovans.* indicates that VCI in Sri Lankans is significantly higher than in the present study (p<0.05)

Nigerians are more related to Sri Lankans because their vertical cephalic indices both placed them in High Hypsicephalic head type while that of the Kosovans placed them in low Hypsicephalic head type. While on the basis of transverse cephalic index classification Kosovans are Tapeinocephalic while Nigerians and Sri Lankans are Acrocephalic. Thus, the differences observed in the indices between the populations could be attributed to the differences in environmental, genetic/biological, social, geographical, ethnic and age factors which existed between these studies which have been reported to influence bodily dimensions (Kobyliansky, 1983; Kobyliansky and Livshits, 1985; Nagaoka *et al.*, 2011; Okupe *et al.*, 1984; Golalipour *et al.*, 2003; Rexhepi and Vjollca, 2008). On the basis of head forms, the similarities that exists between Nigerians and Sri Lankans is supported by a similar study (Leary *et al.*, 2006) and could be because Nigerians and Sri Lankans belong to tropical zone, while the difference between Nigerians and Kosovans could be because the Kosovans belong to a temperate zone therefore, confirming the work of Bharati *et al.* (2001) who postulated that head forms in tropical zone differ from those in temperate zone.

Cephalic dimensions are affected by climatic, genetic, nutritional, environmental, ecological, biological, geographical, racial, gender and age factors (Buretic-Tomljanovic *et al.*, 2007; Bharati *et al.*, 2001; Kasai *et al.*, 1993; Okupe *et al.*, 1984; Heidari *et al.*, 2006; Golalipour and Heydari, 2004; Golalipour *et al.*, 2003, 2005; Tuli *et al.*, 1995; Rajlakshmi *et al.*, 2001; Maina *et al.*, 2011). Time has also been shown to influence cephalic dimensions (Nakashima, 1986; Vojdani *et al.*, 2009). This study has therefore provided valuable information in 18-40 years old Fulanis, Tangales and Teras ethnic groups of North-Eastern Nigeria that can be used in diagnosis and treatments in orthodontics (Grau *et al.*, 2001) plastic and oral surgery (Williams *et al.*, 1995) and in forensics for the reconstruction of craniofacial remnants (Ilayperuma, 2011) and for the study of ethnicity and race in this region.

CONCLUSION

The study revealed that the three ethnic groups share differences on the basis of cephalic indices and share some similarities on the basis of head types and that Nigerians share similarities with Sri Lankans base on their head types.

ACKNOWLEDGMENT

Authors wish to record their appreciation to Aisha Umar Yaro, Abdulkadir Halliru, Hajara Isah Jibrin, Maisamari Chailau Abare, Maryam, the staffs and students of Gombe State University for their support and assistance during this study.

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