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The Cephalometry of the Yoruba Ethnic Group of Southwestern Nigeria

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Summary: Cephalometry of an ethnic population is determined by sex, diet, geographic location and genetics. Quantitative facial morphometry is necessary in today's contemporary society because of the globalization of crime and justice. The objective of this study is to determine Yoruba ethnic population's cephalofacial uniqueness for gender identification. A total of 222 adults (155 females and 67 males) participants from 10 local government areas in 5 states of the South-west Nigeria were randomly selected. Pre-defined set of cephalometric parameters were measured using standard requirement for anthropometry. Statistical analysis was calculated for gender differences using SPSS 20. Overall, gender differences (male vs female) was exhibited in head length, head width, upper facial height, lower facial height and facial width. Sexual differences were also exhibited in head modulus index (41.43±1.72 cm Vs 42.87±2.18 cm) and the index of the size of head (2361.89±444.53 cm_3 vs 2147.78±316.13 cm_3). Both genders exhibited dolichocephalic/mesocephalic type. Gender identification in this ethnic group may concentrate on five facial morphometry.

Keywords: Cephalometry, Yoruba, Nigeria

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INTRODUCTION

Cephalometry is an aspect of biological anthropology that deals with measuring the head and face of living individuals for the assessment of a population's cephalofacial features. These characteristics in an individual, ethnic group and population results from the interplay of factors such as sex, diet, geographic location and genetic constitution (Argyropoulos and Sassouni, 1989; Bhatia *et al.*, 1955; Del Sol, 2005). The early research in human physical anthropology was focused on characteristic differences of the anthropometric and craniometric measurements between human races (Hall *et al*., 2005). A study by Guha (1935) revealed that anthropometric and craniometric measurements could be used to categorize individuals drawn from a range of ethnic populations. It has been shown that the human face shows variability in size and shape that confers individual and group uniqueness (Ersan, 2014). Identification of facial feature points is an important factor in video surveillance, face detection, face recognition, facial expression classification (Sohail and Bhattacharya, 2008). Ethnic populations require standards for comparison. Careful documentation of anthropologic differences and similarities allows one to distinguish heterogeneity and also provide the basis for the application of techniques in forensic science (Fix, 1979). Craniofacial anthropometry is important in forensic medicine, plastic and reconstructive surgery, orthodontics and clinical diagnosis of dysmorphism (Durtschi et al., 2009; Farkas, 1994). Previous studies have reported differences in craniofacial anatomy among racial groups and these have been documented in a variety of structures but the oral and maxillofacial regions have been shown to be a particularly of defining region of variability between different racial and ethnic groups (Enlow *et al*., 2005; Farkas *et al*., 2005; Mayo *et al*; 1999; Porter *et al*., 2004; Teck *et al*., 2000; Waters, 2000; Yokota, 2005). Comparative anthropometric analysis remains an important investigative tool for understand ethnic groups in countries with such social, cultural, and ethnic diversity as Nigeria. The maxillofacial size and shape differences are essential for determination of the sex and the accuracy of prediction can be up to 91.1% (Bejdova *et al*., 2018).

The hypothesis is cephalofacial characteristics can predict sex among Yoruba ethnic group. This study is to reveal Yoruba ethnic population's cephalofacial characteristics and its possible application in differentiation of gender.

MATERIALS AND METHODS

Sample population and ethical considerations

A total of 222 (155 females and 67 males) participants who are volunteers aged 18 years and above were recruited from 10 local government areas in 5 states of the South-west Nigeria. Sampling

fraction was based on Yoruba ethnic population (Yp) of southwest Nigeria (27,722,452) and Nigeria population (Np) of 140,431,790 (National Population Commission, 2010). The sampling fraction Yp/Np was 0.2, resulting in the selection of two volunteers out of every eligible ten Yoruba volunteers. The target sample size was to attain the minimum of 60-90 volunteers from the ethnic population (Bashalkhanov *et al*, 2009). Volunteers' inclusion criteria are 18 and above years of age; verified pedigree pattern for each volunteer to ensure that parents, grandparents and great grandparents descended from Yoruba ethnic group. Exclusion criteria include previous head injury with cephalofacial deformation, previous facial surgery, and congenital cephalofacial abnormalities.

The procedures outlined in the International Organization for Standardization (ISO) general requirements for establishing anthropometric data bases were followed (ISO15535, 2012).

The Ethical approval for the study was obtained from Ministry of Health Research Ethical Review Committee (Ethical approval number AD 13/479/620).

Cephalometric measurements

Cephalometric measurements were taken from voluntary participants according to internationally accepted landmarks for human anthropometry (Hall *et al.* 2007). All the measurements were taken by the same person to avoid inter-observer error. All parameters taken were recorded in a spread sheet from the field and transferred into a log book in the laboratory. Cephalometric variables (in centimetres) were taken on the right side of the volunteers using digital calliper (Mitutoyo, Illinois, U.S) calibrated to 0.01mm. Informed consent was obtained from each of the volunteers.

The measured parameters were as follows:

- Head circumference (HC),
- Head length (HL),
- Maximum biparietal diameter (MBD)
- Head (Skull) height (HH),
- Nasal height (NH),
- Facial height (FH),
- Upper facial height (UFH),
- Lower facial height (LFH,
- Bizygomatic distance (BZD) (facial width) (Hall *et al.,* 2007).

Calculation of cephalometric indices and Cranial/Cephalometry Index classification

The cephalometric indices were calculated according to Garson (1885) as follows:

$$\text{Cephalic Index (CI)} = \frac{\text{Maximum Head Breadth}}{\text{Maximum Head Length}} \text{ X } 100$$

$$\text{Head Lenght Index (HLI)} = \frac{\text{Head Height}}{\text{Maximum Head Length}} x\ 100$$

Schmidt's Head Modulus Index (SMHI) =
Max. Head Lenght + Max. Head Breadth + Head Height

Index of size of the Head (ISH) =
Max. Head Length X Max. Head Breadth X Max. Head Height

$$\text{Morphological Facial Index (MFI)} = \frac{\text{Facial Height}}{\text{Bizygomatic Breadth}} x\ 100$$

$$\text{Sagittal Naso-Facial Index (SNFI)} = \frac{\text{Nasal Height}}{\text{Morphological Facial Height}} x\ 100$$

Statistical analysis

Data are presented as Mean ± SD. Software package for statistical analysis (SPSS 20) was used to calculate the mean, standard deviation and T- test for gender differences within the population. Frequency distribution of head and facial morphology were estimated based on Linear Measurements.

RESULTS

In this study, the mean HC was 56.59±3.40 cm for both sexes. The female HC of 56.62±3.01 cm was not significantly different from male HC of 56.52±4.22 cm. The mean HL was19.43±1.03 cm for both sexes. The male HL of 19.95±1.17 cm was significantly higher than female HL of 19.21±0.87 cm ($p<0.05$).

Table I: Cephalometric parameters according to sex in Yoruba ethnic group

Variable	All (N=222)	Female (n=155)	Male (n=67)
Age (years)	49.90±17.94	47.78±18.33	54.97±15.97
Head circumference (cm)	56.59±3.40	56.62±3.01	56.52±4.22
Head length (cm)	19.43±1.03	19.21±0.87	19.95±1.17*
maximum biparietal diameter (cm)	14.69±0.88	14.58±0.78	15.08±0.99*
Head height (cm)	7.73±1.06	7.68±0.94	7.85±1.31
Nasal height (cm)	5.75±0.92	5.68±0.96	5.90±0.78
Facial height (cm)	12.52±1.45	12.40±1.30	12.81±1.72
Upper facial height (cm)	5.37±1.16	5.39±0.98	5.40±1.35*
Lower facial height (cm)	7.11±0.85	6.98±0.80	7.41±0.91*
Bizygomatic distance (cm)	13.30±0.97	13.10±0.89	13.76±0.99*

Mean ± SD *P < 0.05 Male versus Female

Table 2. Cephalometric gender indices of male and female Yoruba ethnic group

Variable	All (N=222)	Female (n=155)	Male (n=67)
Cephalic index (%)	75.69±4.25	75.67±3.87	75.72±5.05
Vertical index (%)	52.78±7.68	53.02±6.97	52.23±9.15
Height length index (%)	39.89±5.85	40.07±5.29	39.46±7.01
Morphological facial index (%)	94.36±10.86	94.83±9.93	93.24±12.78
Sagittal Naso-facial index (%)	46.02±6.82	45.63±4.81	46.92±10.04
Head modulus index (cm)	41.67±3.48	41.43±1.72	42.87±2.18*
Index of the size of head (cm^3)	2202.00±399.56	2147.78±316.13	2361.89±444.53*

Mean ± SD *P < 0.05 Male versus Female

Table 3: Percentage distribution of head and facial morphology in Yoruba ethnic population based on linear measurements

Head/Facial Type	Male		Female				
	Range	Frequency %	Range	Frequency %	chi-square	df	p value
VERY SHORT	≤16.90	0	≤16.1	0			
SHORT	17.00 – 17.70	1.6	16.20 – 16.90	15.8			
MEDIUM	17.80 – 18.50	19.5	17.00 – 17.60	63.2	1313	158	<0.0001
LONG	18.60 – 19.30	76.4	17.70 – 18.40	20.4			
VERY LONG	≥19.40	2.5	≥18.50	0.6			
	Maximum biparietal diameter (Head width)						
	Range	%	Range	%	chi-square	df	p value
VERY NARROW	≤13.90	6.1	≤134	7.1			
NARROW	14.00 – 14.70	11.8	13.50 – 14.10	39.2			
MEDIUM	14.80 – 15.50	36. 4	14.20 – 14.90	28.5	966.4	152	<0.0001
BROAD	15.60 – 16.30	39.6	15.00 – 15.70	21.4			
VERY BROAD	≥16.40	6.1	≥15.8	3.8			
	Bizygomatic diameter (facial width)						
	Range	%	Range	%	chi-square	df	p value
VERY NARROW	≤12.70	15.2	≤12.00	14.7			
NARROW	12.80 – 13.50	10.3	12.10 – 12.70	24.7			
MEDIUM	13.60 – 14.30	19.7	12.80 – 13.50	40.4	862.8	148	<0.0001
BROAD1	4.40 – 15.10	51.8	13.60 – 14.20	11.2			
VERY BROAD	≥15.20	3	≥14.30	9			
	Facial height						
	Range	%	Range	%	chi-square	df	p value
VERY LOW	≤11.10	2.1	≤10.20	3.8			
LOW	11.20 – 11.70	6.1	10.30 – 10.70	4.5			
MEDIUM	11.80 – 12.30	13.7	10.80 – 11.30	40.7	834.3	148	<0.0001
HIGH	12.40 – 12.90	33.6	11.40 – 11.90	35			
VERY HIGH	≥13.00	44.5	≥12.00	16			

+ Head and facial morphology Range according to Lebzelter and Saller classification (Singh and Bhasin, 2004).

The mean MBD was 14.69±0.88 cm in both sexes, the value in male of 15.08±0.99 cm was significantly higher than that of female of 14.58±0.78 cm. The HH, NH and FH were not significantly different in both sexes. UFH for both sexes was 5.37±1.16 cm, the male UFH of 5.40±1.35 cm was significantly higher than female UFH of 5.39±0.98 cm ($p<0.05$). The LFH in both sexes was 7.11±0.85 cm, LFH value in female of 6.98±0.80 cm was significantly lower than the male value of 7.41±0.91 cm ($p<0.05$). The BZD in both sexes was 13.30±0.97 cm, the female BZD was 13.10±0.89 cm, the male BZD of 13.76±0.99 cm was significantly higher than that of female (Table 1). Five of the cephalometric measurements revealed significant gender difference ($P<0.05$). The Yoruba male had longer, broader head and wider face than Yoruba female. The lower face was significantly longer in the male.

Seven cephalometric indices were calculated and compared between sexes of the Yoruba ethnic group. The CI for both sexes was 75.69±4.25%, CI showed no significant difference in male and female. The VI was 52.78±7.68% for both sexes, VI showed no significant difference for the male and female Yoruba ethnic group. The HLI, MFI, and SNFI indices were not significantly different in both sexes ($p>0.05$). The HMI for both sexes was 41.67±3.48 cm, the Yoruba male had HMI of 41.43±1.72 cm and female HMI was 42.87±2.18 cm. Male HMI was significantly higher than female ($p<0.05$). The ISH in both sexes was 2202.00±399.56 cm^3, male ISH of 2361.89±444.53cm^3 was significantly higher than that of female ISH of 2147.78±316.13 cm^3 ($p<0.05$). These indices also showed that the Yoruba male had higher dimensions of vertical height, length and breadth than the female and that male head had higher volume than the female head (Table 2).

Cephalometric range variations within the Yoruba male and female ethnic group was classified according to Lebzelter and Saller of head and face morphology (Singh and Bhasin, 2004) (Table 3).

The head morphology based on head length classification showed that 1.6% of male and 15.8% of female had short head, 19.5% male and 63.2% female had medium head, 76.4% male and 20.4% female had long head while 2.5% male and 0.6% female had very long head.

Head morphology based on maximum biparietal diameter (head width) showed that 6.1% of male and 7.1% female of the population had very narrow head width. 11.8% male and 39.2% female had narrow head width, 36.4% male and 28.5% female had Medium head width. 39.6% male and 21.4% female had broad head width while 6.1% of the male and 3.8% of the female had very broad head width.

Head morphology based on Bizygomatic diameter (facial width) revealed 15.2% of the male and 14.7% of the population had very narrow facial width. 10.3% male and 24.7% female had narrow facial width. 19.7% male and 40.4% female had medium facial width. 51.8% male and 11.2% female had broad facial width. 3.0% male and 9.0% female had very broad facial width.

Head morphology based on facial height showed that 2.1% male and 3.8% female had very low facial height, 6.1% male and 4.5% female had low facial height. 13.7% male and 40.7% female had medium facial height. 33.6% male and 35.0% female had high facial height while 44.5% male and 16.0% female had very high facial height.

DISCUSSION

The HC of the Yoruba female of 56.62±3.01 cm and male of 56.52±4.22 cm are similar with the results of cephalic anthropometry of the Igbo ethnic group (Esomonu and Badamasi, 2012) and of Oladipo *et al*., (2010) for Ijaw ethnic group. Fulani ethnic group of northern Nigeria HC as reported by Maina *et al*. (2012) was less than the HC of southern ethnic groups. Head circumference is an indicator of health and global cranial growth in early childhood (Gonzalez Bejarano *et al*., 2014). Multicentre longitudinal cohort study will be necessary to evaluate the effect of geographical location and ethnic diet on head circumference of Nigerian ethnic populations as well as establishing growth pattern by age, ethnic group and sex.

The HL, MBD, HH, NH, FH, UFH, FH, BZD are comparable to cephalofacial parameters from other Nigeria ethnic groups (Oladipo and Olotu, 2006; Oladipo and Paul, 2009), however, this study showed that linear measurements of head length, head width, facial width and lower facial height were less in values in females than in males. This may be due to the males being generally larger than females. Garson (1885) reported that craniometric measurements showed average of 5-9% larger measurements in males than females. Facial anthropometric measurements were also found to be of higher numerical values in the male than in the female in west African ethnic groups (Darko *et al*., 2017). The cranial measurements in determination of population affinity in South Africans also revealed larger measurements in males than females (Iscan and Steyn, 1999). Thai population also expressed larger cranial measurements in males than females (Mahakkanukrauh et al., 2015). Craniometric analysis of the modern Cretan population also showed that males are statistically significantly greater than females in all dimensions. Cephalometry is important for gender recognition and identification and had been reported that apart from pelvis, skull exhibits higher sexual dimorphism in human body (Janson *et al*., 2011; Kranioti *et al*., 2008; Fortes de Oliveira *et al*., 2012). The cephalometrics of HL, MBD, UFH, FH, and BZD in this study showed significant difference between male and female Yoruba ethnic population of southwestern Nigeria.

The cephalic index of 75.72% for Yoruba female and 75.67% for Yoruba male in this study classified the head type to be upper end of dolichocephalic and lower end mesocephalic according to Saller's Length Breadth index of head scale (Singh and Bhasin, 2004). Dolichocephalic and mesocephalic head type had been reported for the Yoruba ethnic population living other regions of Nigeria (Oladipo *et al*., 2015; Umar *et al*., 2011). Beals (1972) observed range of mesocephalics to be the characteristic head type for populations living in zones having a wet and hot climate. Change in CI was only reported for generation of migrants born under the new environmental conditions (Kobyliansky, 1983).

The head modulus index (HMI), and the Index of the size of head (ISH) showed sexual dimorphism within the Yoruba ethnic population. These indices are factors of head length and head width. The significant volumetric differences of female and male Yoruba ethnic group were due to cephalic length and breadth and not the height. The extent of growth of the head had been shown to have significant substantial involvement of genetic factors. The determination of head-size and head-shape by genetic traits has been firmly established (Jelenkovic *et al*., 2008; Jelenkovic *et al*., 2010; Karmakar *et al*., 2007). The skull is considered by Anthropologists to be the best indicator of ancestry as well as indicator of sex second only to pelvis in sex determination (Sanger *et al*., 2013). In medicolegal cases, identification of sex is of prime importance, skull had been found to be useful in this regard because of resistance to adverse environmental conditions over time (Sudke and diwan Chhaya, 2013). Heritability of specific facial traits had been shown to range from 28 to 67%, and that over half of facial traits of greater than 90% can be explained by common genetic variation (Cole *et al*., 2017). The value of the

facial measurements of the present study was subjected to frequency of head and facial types between Yoruba ethnic group sexes. 95.9 percent of male had medium/long head while 79 percent of female had short/medium head length. 76 percent of male had medium/broad head width while 67.7 percent of the female had narrow/medium head width. Male face are broader (51.8%) than the face of female (11.2%) in comparison to narrow/medium facial width of 65.1% of the female that had narrow/medium facial width. The higher percentage of male exhibited high/very high facial height (78.1%) while female had 75.7 percent medium/high facial height. These findings are in conformity with established anatomical principle that females have smaller crania with shorter facial features than males (Moore *et al*., 2006). The human face reveals differences between the sexes and this result indicates that different degrees of masculinity and femininity can be constructed from witnesses' description and/or facial morphometry which can be of use in forensic investigation. Thus, based on this study, all cephalometric values cannot distinguish male from female. The gender identity of the Yoruba ethnic group may rely on head length, head width, facial height, facial width and lower facial height.

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