



ANTHROPOMETRIC STUDY OF CRANIOFACIAL DIMENSIONS IN SKELETONIZED SKULLS OF NIGERIAN ORIGIN

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ABSTRACT

Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other and are manifestation of the internal structure and tissue components which in turn are influenced by environmental and genetic factors. *The present work aimed to study the anthropometry of craniofacial parameters of skeletonized skulls of Nigerian origin and to verify the presence of sexual dimorphism among them.* Using a spreading and a Vernier caliper craniofacial measurements were taken. The measurements include; Maximum cranial length (MCL), Maximum cranial breadth (MCB), Total cranial height (TCH), Anterior Facial height (AFH), Bizygomatic breadth (BB), Nasal height (NH) Nasal Width (NW), Orbital breadth and Orbital height. Cephalic Index (CI), Nasal Index (NI), Facial Index and Orbital Index (PI) were determined. Analysis of the mean values, standard error of mean, for the values of the craniofacial measurements were carried out using the statistical package for social sciences (SPSS) version 25 software for Microsoft® windows. The mean \pm SD values craniofacial measurements of MCL, MCB, AFH, BB, NH, NW, TCH, OH, OB, NI, OI, CI and FI, for males were 19.24 \pm 1.01, 14.16 \pm 1.66, 13.25 \pm 1.83, 11.40 \pm 0.90, 5.07 \pm 0.33, 2.75 \pm 0.43, 21.90 \pm 1.01, 3.67 \pm 0.25, 4.23 \pm 0.31, 54.67 \pm 10.19, 84.82 \pm 7.34, 72.5 \pm 7.26, 86.83 \pm 6.92 respectively; while the female values were 17.84 \pm 0.49, 14.20 \pm 0.19, 12.22 \pm 0.75, 10.78 \pm 1.21, 4.80 \pm 0.14, 2.56 \pm 0.20, 21.12 \pm 0.77, 3.44 \pm 0.14, 3.89 \pm 0.16, 53.44 \pm 4.55, 88.35 \pm 3.32, 79.64 \pm 2.25, 88.07 \pm 6.42 respectively. Higher mean values were observed for male subjects in the following variables as compared to the female subjects except for the indices which females recorded higher values. The results from this study suggested the presence of statistically significant sexual dimorphism between the male and female variables in this study sample with males being significantly larger for all measurements. The parameter that showed the greatest level of sexual dimorphism is medial cranial length (MCL) with mean values of 19.24cm for males and 17.84cm for females.

Keywords: Craniofacial dimensions, Skeletonized Skulls, sexual dimorphism, Nigerian Origin

INTRODUCTION

Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other and are manifestation of the internal structure and tissue components which in turn are influenced by environmental and genetic factors (Danborn et al. 1997; Abbie et al. 2008). Anthropometry can be subdivided into somatometry, cephalometry and osteometry (krishan, 2006). Somatometry is a subdivision of anthropometry for measurements of different

body dimensions while keeping soft tissues intact either in the living body or cadaver including head and face. It is also considered as a major tool in the study of age estimation from different body segments in a given set of individuals (Zahra et al. 2006; Oladipo et al. 2009).

Anthropometry is being used more often in sexing the skeletal remains. Worldwide, various studies have been conducted on the determination of sex from variety of human bones including skull, pelvis, long bones, scapula, clavicle and the bones like metatarsals, phalanges, patella, vertebrae, ribs etc and the

most statistical model in sex determination has been developed (Reich's et al 1998); (krishan, 2006). Today anthropometry plays an important role in industrial design, ergonomics architecture where statistical data about the distribution of body dimensions in the population are used to optimize products (Rajlakshmi et al. 2001; Safikhani et al. 2007). The change in life styles, nutrition and ethnic composition of populations has led to changes in the distribution of body dimensions for example, the epidemic of obesity which require regular update through the use of anthropometric data collections.

In evolutionary science, anthropometric studies today are conducted to investigate the evolutionary significance of difference in body proportion between populations whose ancestors lived in different environments (Singh, 2017). Human population exhibits climatic variation patterns similar to those of other large-bodied mammals following Bergmann's rule, which states that individuals in cold climates will tend to have shorter, stubbier limbs than those in warm climates (Ganong, 2005). Measurement of the head and face in anthropometric study is done carefully by understanding some anthropometric landmarks which must be maintained in a better orientation (Iscan, 2001; 2005). This is anatomically termed as Frankfurt plane meaning the skull head is positioned in a way where a line passes through the inferior border of the left orbit to the upper border of the external auditory meatus. Hominids and primates study use this plane for both pathological and relative studies. Previous research findings put it that anthropometry combined with clinical methodology had produced knowledge on craniofacial framework and features that existed in various ethnic groups (Radovic et al. (2000). It is on this note that treatment of congenital anomalies on the face and head are established and has helped to create craniofacial databank on such anomalies (Bharati et al. (2001).

There is little or no data with regards to the identification of carcasses of Nigerian by archeologist, and forensic or medical specialists due to the fact that little or no major research has been done to decipher a or set standards for these estimations. With the rise in insurgency in the country there have been many cases of unidentified body left in the bush to decompose this research study can help forensic experts identify the sex of the carcass and even the age for investigation.

The present work aimed to study the anthropometry of craniofacial parameters of skeletonized skulls of Nigerian origin and to verify the presence of sexual dimorphism among them.

METHODOLOGY

The present study was undertaken in the Department of Anatomy and Forensic anthropology, Cross River University of Technology, Nigeria. Ethical clearance was taken from the institutional ethical review committee before the initiation of the study. The dry macerated skulls of estimated age group 30-60yrs of known sex 10 Males and 10 female skulls were studied. The measurements were taken after placing the skull in Frankfurt's horizontal plane. Instruments used are vernier sliding caliper and spreading caliper.

Inclusion Criteria

- The skulls must be of Nigerian origin
- The skulls must be skulls prepared and macerated from the Department of Anatomy CRUTECH this is to ensure the sex of the skulls being measured
- All the skulls used must be totally intact and void of cracks
- All skulls must be complete with mandible.

Exclusion Criteria

- Skulls without mandibles were excluded from this study.
- All broken skulls were excluded from this study
- All skulls without proper knowledge of their origin and sex were excluded from this study
- All deformed and broken skulls were excluded from this study.

Measurement Protocol

Maximum cranial length (MCL) was measured as length from frontal bone to occipital bone using spreading caliper, Maximum cranial breadth (MCB) was measured as length between parietal eminences using spreading caliper, Total cranial height (TCH) was measured as distance from maximum point of the skull to the root of the nose using the spreading caliper, Anterior Facial height (AFH) was measured as distance from the root of the nose to mandible, using a spreading caliper, Bizygomatic breadth (BB) was measured as Length between zygomatic arches, Nasal height (NH) was measured as distance between the nasion to the subnasale using sliding caliper and Nasal Width (NW) was measured as distance between two alae of the nose, a digital Vernier caliper was used to take this measurement. Cephalic Index (CI), Nasal Index (NI), Facial Index AND Orbital Index (PI) were determined by; Cephalic index (CI) = Head width/ Head height x 100, Nasal index(NI) = Nasal width/Nasal height x 100, Orbital index (OI) = Orbital breadth/Orbital height X 100, Facial index (FI) = Bizygomatic breadth/facial height x100.

Statistical Analysis

The mean values, standard error of mean, two tailed significance for the values of head and

face measurements, Head, face and nasal indices for both male and female, Sexual dimorphism, Paired T test and independent two samples test respectively for male and female skulls of Nigerian Origin were carried out using the statistical package for social sciences (SPSS) version 25 software for Microsoft® windows.

RESULTS

Tables 1, 2, 3 and 4 present the outcome of descriptive statistics for the male, female and the combined sample of the skulls used in this study. These outcomes present the true details of the minimum, maximum and the mean values recorded for each cranio-facial dimension as well as the standard deviations and standard error of mean recorded respectively.

The parameters measured were; Maximum cranial Length (MCL), Maximum cranial breadth (MCB), Anterior Facial Height (AFH), Bizygomatic Breadth (BB), Nasal height (NH), Nasal Width (NW), Total cranial height (TCH), Orbital height (OH), Orbital Breadth (OB), and the indices were; Nasal Index (NI), Orbital Index (OI), Cephalic Index (CI) and Facial Index (FI). Table 4 document the results of independent sample t-test for determination of sexual dimorphism between the male and female skulls. This result showed that from the six (6) craniofacial variables measured and calculated, four (4) which include MCL, MCB, AFH and BB recorded statistically significant difference ($P < 0.05$) between the male and female except for NH, NW. This connotes that many cranio-facial dimensions are statistically different between the males and females of Nigerian origin. The male results consistently recorded higher values when compared with the female data across all the measured cranio-facial variables.

Data Presentation

Table 1-Showing results of descriptive statistics of craniofacial dimensions of male skulls of Nigerian origin.

	N	Minimum	Maximum	Mean	Std. Deviation
MCL	10	18	20	19.24	0.689
MCB	10	12.0	16.2	14.160	1.6678
AFH	10	10.50	14.98	13.2520	1.80136
BB	10	10.37	12.40	11.4040	0.90301
NH	10	4.44	5.39	5.0780	0.33962
NW	10	2.18	3.46	2.7560	0.43768
TCH	10	20.5	23.0	21.900	1.0136
OH	10	3.32	4.02	3.6760	0.25863
OB	10	3.75	4.64	4.2320	0.31712
NI	10	40.44	66.21	54.6760	10.19790
OI	10	71.55	93.28	84.8240	7.34052
CI	10	60.00	77.94	72.5840	7.26601
FI	10	82.24	100.00	86.8380	6.92304

Table 1 shows results for descriptive statistics of the measured craniofacial dimensions of male skulls of Nigerian origin including maximum, minimum, mean, and standard deviation.

KEY: MCL=Maximum cranial Length, MCB= Maximum cranial breadth, AFH=Anterior Facial Height, BB= Bizygomatic Breadth, NH= Nasal height, NW= Nasal Width, TCH= Total cranial height, OH= Orbital height, OB= Orbital Breadth, NI= Nasal Index, OI= Orbital Index, CI=Cephalic Index, and FI=Facial Index,

Table 2- Showing results of descriptive statistics of craniofacial dimensions of female skulls of Nigerian origin.

Descriptive Statistics FEMALES					
	N	Minimum	Maximum	Mean	Std. Deviation
MCL	10	17	19	17.84	0.492
MCB	10	13.9	14.5	14.200	0.1947
AFH	10	11.50	13.20	12.2200	0.75505
BB	10	9.14	12.50	10.7800	1.21347
NH	10	4.62	4.93	4.8080	0.14178
NW	10	2.41	2.91	2.5680	0.20990
TCH	10	20.5	22.1	21.120	0.7797
OH	10	3.31	3.68	3.4400	0.14261
OB	10	3.77	4.20	3.8960	0.16879
NI	10	48.88	59.38	53.4460	4.55768
OI	10	83.33	93.40	88.3560	3.32722
CI	10	76.75	82.08	79.6460	2.25809
FI	10	76.80	96.15	88.0720	6.42524

Table 2 shows results for descriptive statistics of the measured craniofacial dimensions of female skulls of Nigerian origin including maximum, minimum, mean and standard deviation.

KEY: MCL=Maximum cranial Length, MCB= Maximum cranial breadth, AFH=Anterior Facial Height, BB= Bizygomatic Breadth, NH= Nasal height, NW= Nasal Width, TCH= Total cranial height, Orbital height, Orbital Breadth, NI= Nasal Index, OI= Orbital Index, CI=Cephalic Index, and FI=Facial Index,

Table 3- Showing results of descriptive statistics of craniofacial dimensions of skulls of Nigerian origin irrespective of sex.

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	
MCL	20	17	20	18.54	0.923	
MCB	20	12.0	16.2	14.180	1.1722	
AFH	20	10.50	14.98	12.736	1.46003	
BB	20	9.14	12.50	11.092	1.10203	
NH	20	4.44	5.39	4.9430	0.29099	
NW	20	2.18	3.46	2.6620	0.35193	
TCH	20	20.5	23.0	21.510	0.9761	
OH	20	3.31	4.02	3.5580	0.23828	
OB	20	3.75	4.64	4.0640	0.30302	
NI	20	40.44	66.21	54.0610	7.82132	
OI	20	71.55	93.40	86.5900	5.90278	
CI	20	60.00	82.08	76.1150	6.40253	
FI	20	76.80	100.00	87.4550	6.62215	

Table 3 shows results for descriptive statistics of the measured craniofacial dimensions of both male and female skulls of Nigerian origin as a combined sample including maximum, minimum, mean and standard deviation.

KEY: *MCL=Maximum cranial Length, MCB= Maximum cranial breadth, AFH=Anterior Facial Height, BB= Bizygomatic Breadth, NH= Nasal height, NW= Nasal Width, TCH= Total cranial height, Orbital height, Orbital Breadth, NI= Nasal Index, OI= Orbital Index, CI=Cephalic Index, and FI=Facial Index,*

Table 4- Showing results for students T-test for sexual dimorphism in craniofacial dimensions of skulls of Nigerian origin for males and females.

	GENDER	N	Group Statistics		
			Mean	Std. Deviation	Std. Error Mean
MCL	MALE	20	19.24*	.689	.154
	FEMALE	20	17.84*	.492	.110
MCB	MALE	20	14.160	1.6678	.3729
	FEMALE	20	14.200	.1947	.0435
AFH	MALE	20	13.2520*	1.80136	.40280
	FEMALE	20	12.2200*	.75505	.16884
BB	MALE	20	11.4040*	.90301	.20192
	FEMALE	20	10.7800*	1.21347	.27134
NH	MALE	20	5.0780	.33962	.07594
	FEMALE	20	4.8080	.14178	.03170
NW	MALE	20	2.7560	.43768	.09787
	FEMALE	20	2.5680	.20990	.04694
TCH	MALE	20	21.900	1.0136	.2266
	FEMALE	20	21.120	.7797	.1744
OH	MALE	20	3.6760	.25863	.05783
	FEMALE	20	3.4400	.14261	.03189
OB	MALE	20	4.2320*	.31712	.07091
	FEMALE	20	3.8960*	.16879	.03774
NI	MALE	20	54.6760*	10.19790	2.28032
	FEMALE	20	53.4460*	4.55768	1.01913
OI	MALE	20	84.8240*	7.34052	1.64139
	FEMALE	20	88.3560*	3.32722	.74399
CI	MALE	20	72.5840*	7.26601	1.62473
	FEMALE	20	79.6460*	2.25809	.50492
FI	MALE	20	86.8380*	6.92304	1.54804
	FEMALE	20	88.0720*	6.42524	1.43673

Table 4 shows the results for independent sample t-test for the determination of sexual dimorphism between the male and female skulls in the measured craniofacial dimensions of Nigerian origin including maximum, minimum, mean, and standard deviation. The parameter that showed the greatest level of sexual dimorphism is medial cranial length (MCL) with mean values of 19.24cm for males and 17.84cm for females ($p < 0.005$; $n = 20$). Values with similar superscripts are statistically significant at $P < 0.005$.

KEY: MCL=Maximum cranial Length, MCB= Maximum cranial breadth, AFH=Anterior Facial Height, BB= Bizygomatic Breadth, NH= Nasal height, NW= Nasal Width, TCH= Total cranial height, Orbital height, Orbital Breadth, NI= Nasal Index, OI= Orbital Index, CI=Cephalic Index, and FI=Facial Index. Values with similar superscripts (*) are statistically significant at $p < 0.005$

DISCUSSION AND CONCLUSION

DISCUSSION

The present research aimed to study the anthropometry of craniofacial parameters of skeletonized skulls of Nigerian origin and to verify the presence of sexual dimorphism among them.

Data obtained from 20 skulls (10 Males and 10 Females) were of adult age ranges with clearly significant ossification. Higher mean values were observed for male subjects in the following variables as compared to the female subjects except for the indices which females recorded higher values. The results from this study suggested the presence of statistically significant sexual dimorphism between the male and female variables in this study sample with males being significantly larger for all measurements. The parameter that showed the greatest level of sexual dimorphism is medial cranial length (MCL) with mean values of 19.24cm for males and 17.84cm for females ($p < 0.005$) as shown on table 4. Babatunde, (2014) reported that the cephalic index for males was significantly higher than those of females ($p = 0.04$); the reason for this difference cannot be immediately explained but it agrees with sexual dimorphism as reported by Olotu et al. (2009) but contrary to the findings of the present study. These findings suggests not many craniofacial dimensions are statistically different between males and females.

Harihara, (1958) studied Japanese skulls by discriminant analysis using measurements like maximum cranial length of skull, maximum cranial breadth of skull and height of skull with 89.7% accuracy. Deshmukh and Deveshi, (2006) studied parameters like maximum cranial length, maximum cranial breadth, cranial height, maximum cranial circumference, maximum bizygomatic diameter, basion-nasion length, biasterionic breadth, bregma lambda length, mastoid length, palatal breadth. They were found to be significant with p -value < 0.05 and also revealed 90% accuracy of male crania and 85.29% accuracy of female crania. Sanjai sangvichien et al., (2007) studied 30 measurements on 101 skulls and showed 26 of 30 measurements and 5 of 14 indices showed a statistically significant difference between males and females. Multiple logistic regression analysis

to predict gender on 4 skull measurements including nasion–basion length, maximum breadth of cranium, facial length and bizygomatic breadth of face. In another study by Sudke and Diwan, (2012) studied 73 skulls using parameters like maximum cranial length, maximum cranial breadth, orbital height, orbital breadth, nasal height, nasal breadth, bizygomatic diameter, nasion- prosthion length. It showed percentage of skulls identified was 95.5% for males and 86.2% for females. Giles et al and kajanoja had done the statistical analysis using the anthropometric parameters as glabella occipital length, max width, basion bregma height, max bizygomatic diameter, prosthion nasion height, basion prosthion, nasal breadth. And obtained the accuracy level of 82-89% and 79.4% by applying discriminant functional analysis.

Direct measurements of craniofacial dimensions are reliable, relatively easy and quick to apply. Furthermore this approach has the added advantage as it does not require any sophisticated techniques. Taken together, these measurements continue to be one of the most versatile techniques in the investigations of the craniofacial skeleton.

CONCLUSION

The purpose of this research was to study the craniofacial dimensions of skulls from Nigerian origin using anthropometry. This research has contributed to the existing body of work by supplying a data bases for the classification of sex based on sexual differences from measurements Anthropometric data are important for product design and development in global markets. Sex could be determined very well from the cranium using Anthropometry. The gender differences in cranial morphology emphasize the significance of applying data to an individual subject in a given population. Such knowledge is not only applicable to forensic scientists but also in plastic surgery and oral surgery with craniofacial deformity.

Appropriate use of anthropometric measures may improve wellbeing, health, comfort security and safety. Further exploration and testing with a larger sample is required to confirm the value of these dimensions. With a larger sample and more equal representation of

males and females it is anticipated the data here in would be comparable to other results albeit the current results are valuable.

Despite the efforts made to increase the sample size the final sample was smaller than desired. Larger Ethnic specific studies should be conducted on these same parameters in order to test the effect of genetics and environment to enhance forensic anthropological investigation. This same study should be conducted on another population for the purpose of comparison. Other than these potential size limitations, the sample appeared to be representative of the Nigerian population.

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