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Human Anatomy

Anthropometric Study of the Cephalic Index of Anambra State Students in Madonna University Nigeria

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Abstract **Original Research Article**

Background: Cephalometry is a subfield of anthropometry that involves the estimation of the cephalic index. The cephalic index is a significant metric used to ascertain the race and sex of an unidentified individual. ***Materials and Methods:*** This study was descriptive and cross-sectional and was conducted on Anambra State students at Madonna University. Elele campus, Rivers State, aged 16–24 years. The cephalic index was determined by applying the following formula: the maximum breadth of the head divided by the maximum length of the head, multiplied by 100. Hundred subjects, comprising 150 males and 150 females from Anambra State at Madonna University, were measured. Anthropometrical parameters measured were maximum head breadth and maximum head length. ***Results and Discussion:*** The analysis shows that there is no significant difference in the age groups with the cephalic indices of males and females. The prevalence of hyperbrachycephaly is significantly higher in males and females, while dolicocephaly is observed infrequently. ***Conclusion:*** This study shows that the males and females showed no differences on the basis of the cephalic index. It also reveals that the students in this study share similarities with Urhobo males and females based on their head types. The findings of this study will hold significant implications for the fields of forensics, medicine, and biometrics.

Keywords: cephalic index, Anambra state, head length, head breadth, anthropology.

INTRODUCTION

The systematic measurement of the human body's physical characteristics, particularly its dimensions and shape, is known as anthropometry. Anthropometry is a branch of science that measures body dimensions physically in order to investigate human variability and assess a population's overall health. [1].

Over time, a good number of studies have been undertaken on these cephalic indices in different countries, including Nigeria, but none have been carried out on Anambra State students at Madonna University in Nigeria. This is the first time this project has been carried out on Anambra State students at Madonna University. This is basically what brought about this research work. In this study, we attempted to investigate the various head types of males and females in the study population using the cephalic index for the consumption of forensic anthropologists and cranial surgeons. The Cephalic Index has created much concern in our country, Nigeria, today. This study is made to detect the different head types of the males and females of the Anambra State students at Madonna University through the measurement of the cephalic index.

Over time, a number of quantifiable anthropometric characteristics have been established. One of the most significant anthropometric factors in physical anthropology for determining geographic gender, age, and racial variances is the cephalic index (CI) [2].

Cephalic Index

The cephalic index can be determined by the use of the subsequent equation: the product of the maximum cranial breadth multiplied by 100, divided by the maximum cranial length. The maximum transverse diameter is measured from the parietal eminence (Euryon) from left to right side, and the maximum antero-posterior diameter is measured from the glabella to the opithocranium (or) inion [3]. The details about the anatomical landmark are discussed below: **The glabella:** which means a specific anatomic point located above the nasal root and situated between the eyebrows, is intersected by the mid-sagittal plane. (Fig. 1). **Opistocranion:** It is the most posterior point on the posterior protuberance of the head in the midsagittal planes (Fig. 2). **Inion:** The midsagittal plane's distal-most point, situated on the external occipital protuberance (fig. 1): Euryon: It is the spot on the sides of the skull that is most laterally positioned. The posterior landmark for measuring the anteroposterior is either opitocranion or inion. A spreading caliper (Fig. 2) is used to measure the anteroposterior and transverse distances. It has a rounded end that is placed on the specified landmark, and the corresponding readings are noted on the scale attached to the device.

Cephalic index is calculated thus: $CI = \frac{MHB}{MHL} \times 100$

Where CI =Cephalic index
MHB= Maximum head breadth and
MHL= Maximum head length

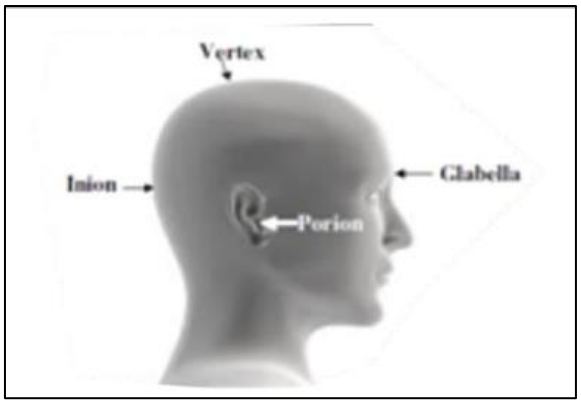

Figure 1: Position of Glabella and Inion

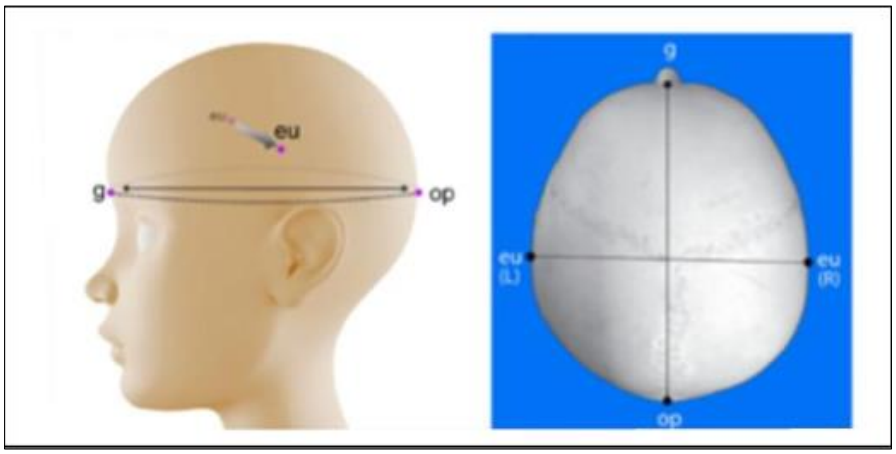

Figure 2: Position of Glabella (g), Opisthocranion (op), and Euryon (eu).

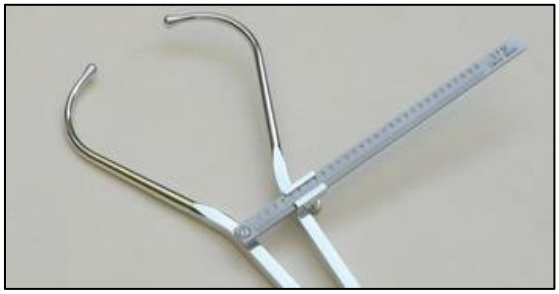

Figure 3: Spreading caliper

Factors Affecting Cephalic Index

Factors related to geography (climate and environment), gender, age, race, ethnicity, genetic interaction, tradition, and nutrition [4].

In 2018 [4], that cephalic index and head shape are affected by geographical, gender, age, racial, and ethnic factors. This study was carried out to determine cephalic index and head shape in 200 students (17–20). After observing the results and comparing them with other studies in the world, they concluded that geographical factors affect the head dimensions.

Types of Cephalic Index

The head shape (cephalic index) is classified into five types using Martin Saller scale which was established in 1957 are; ultrabrachycephalic, hyperbrachycephalic, brachycephalic, mesocephalic, and dolicocephalic [5]. The calculated values are shown in table 1:

Table1: classification of head types according to Martin and Saller (1957)

Head type	***Calculated cephalic index (%) and estimated head type***	
Dolichocephalic	<74.9%	Long head type
Mesocephalic	75-79.9%	Medium head type
Brachycephalic	80-84.9%	Short broad head type
Hyperbrachycephalic	85%	Very short broad head type
Ultrabrachycephalic	90%	Extremely short and unusually broad head type

The most researched craniofacial metric is the cephalic index because it uses the length and width of the skull, which are useful indices for examining secular patterns [6]. The Cephalic Index has created much concern in our country, Nigeria, today. This study is made to detect the different head types of the males and females of the Anambra State students at Madonna University through the measurement of the cephalic index.

MATERIALS AND METHODS

Study Location and Duration

Anambra State is one of the largest Igbo states; it is situated in the eastern part of Nigeria. But the study was carried out at Madonna University, and the subjects were mainly from Madonna University's Elele campus in Rivers State, Nigeria, in Africa. The study covered a period of eight weeks (February 1–April 1, 2020).

Research Design

This research was designed as a correlational cross-sectional study of the anthropometric measurement of the cephalic index to find the different head types of Anambra State students and its application to anthropometry.

Sample Population

The sample is made up of 300 young adults (150 males and 150 females) of Anambra origin within the age range of 16 to 24 years, considering the age range of registered undergraduate students at the time of the study at Madonna University, Nigeria.

Sample Size Determination

A total of 300 undergraduate' students at Madonna University's Elele campus were selected as the sample for the study. The sample size was reflected in the population of Anambra students as statistically determined using the Cochran formula for sample size calculation [7].

$$nf = \frac{n}{1 + \frac{n}{N}}$$

Where:

nf: Desired sample size when population is more than 10,000

n = Desired sample size when population is less than 10,000 = 2000 constant

N = Estimated population size (which is 300)

1 = Unit

Since the sample size may be fewer than 10,000 when the population size is less than 10,000, the sample size is deemed sufficient for the current study and represents roughly 75% of the target population. [7].

Eligibility Criteria for Subject Selection

Inclusion Criteria

The consent of the subjects was obtained and agreed upon before recruitment for this study. The subjects were aged 16– 24 years and were students from Anambra State, including parents and grandparents. Data was collected from males and females aged 16 to 24 who are apparently healthy.

Exclusion Criteria

Female subjects with obstructive and massive hair styles. Subjects below or above the age range for this study Subjects who were not from Anambra State Subjects with cephalic deformities.

Sampling Technique

The sampling technique adopted for the study was simple random sampling with the list of registered students from Anambra State as the sampling frame obtained from the student's affairs department of Madonna University, Nigeria. Informed consent and parental consent were necessary and were obtained from participants before recruitment into the study.

Method of Data Collection and Instrumentation

Demographics of participants

The subjects gave information on their age, sex, and state of origin, genealogy.

Parameters Measured

The measurements taken included: cephalic index (Maximum head length and maximum head breadth in cm).

Instrumentation

Spreading caliper with meter rule, book and pen

Data Collection

Each variable (head breath and head length) was measured twice and the average value recorded by the same person to prevent inter-observer error.

Measurement Procedures

Cephalic index: The anatomical landmarks i.e. glabella, inion and euryon were marked. The head length was measured with spreading caliper from glabella to inion. Similarly, head breadth was measured also with spreading caliper between the two fixed points over the parietal bones. All measures were taken in centimeters and to an accuracy of 0.10. All measurements were taken with subject sitting on a chair, in anatomical position relaxed mood and the head in the anatomical position. Cephalic index was calculated as maximum head length divided by maximum head breadth x 100

Maximum Head length: To get this measurement, the spreading caliper was used from the inion to glabella and the measurement recorded.

Maximum Head breadth: To get this measurement, the spreading caliper was used from the 2 parietal eminences. The measurement gotten was recorded.

Formula for cephalic index:-

$$\frac{Maximum\ head\ Breath}{Maximum\ head\ Length} \times 100 = \text{cephalic index}$$

Limitation of Study

Some students did not comply because of their cultural belief. Unwillingness of some people to comply with the study without receiving monetary reward.

Statistical Analysis

Data obtained from the subjects were recorded on a recording sheet and then transferred into the statistical package for social sciences (SPSS) version 20 for analysis. The means obtained from this study were subjected to a student t-test, an ANOVA (one-way analysis of variance), and chi-square for assessment of statistical significance and linearity, with a probability level of less than 0.05 considered significant with a 95% confidence interval. The mean cephalic index was calculated and presented in a bar chart for both males and females. The mean cephalic indices were compared in both sexes with age.

Ethical Consideration

The ethical clearance for this study was obtained from the research ethics committee of Madonna University, Nigeria with REC. 102/13 MU before the commencement of the study.

RESULTS

Table 2: Comparison of age between males and females

Sex	Sample Size	Age (years)		t-test Statistic		
		Range	Mean±SD	t-test	Df	P-value
Male	150	16 – 24	20.07±2.27	0.134	298	0.894
Female	150	16 – 24	20.11±2.05			
Total	300	16 – 24	20.09±2.16			

The age range of male and female is 16-24years with male having mean and standard deviation of 20.07±2.27years, while the female is 20.11±2.05years but no significant difference (P>0.05).

Table 3: Comparison of mean and standard for head length, head breadth and cephalic index

Sex	Sample Size	Head Length (cm)		Head Breadth (cm)		Cephalic Index (%)	
		Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Male	150	16.90-21.50	19.35±0.95	14.00-19.30	16.53±1.13	70.10-95.86	85.53±5.62
Female	150	17.08-21.10	18.95±0.78	13.10-19.30	16.20±1.00	70.10-98.31	85.59±5.27
Total	300	16.90-21.50	19.15±0.89	13.10-19.30	16.37±1.08	70.10-98.31	85.56±5.44

According to Table 2, the mean and standard deviation of head length in total is 19.15±0.89cm; while that of male is 19.35±0.95cm, the female is 18.95±0.78cm. Also, the mean and standard deviation of head breadth in total is 16.37±1.08cm; while that of male is 16.53±01.13cm, the female is 16.20±1.00cm. The mean and standard deviation of cephalic index in total is 85.56±5.44%; while that of male is 85.53±5.62%, the female is 85.59±5.27%.

Table 4: Comparison of head length between males and females

Sex	Sample Size	Head Length (mm)		t-test Statistic		
		Range	Mean±SD	t-test	df	P-value
Male	150	16.90-21.50	19.35±0.95	3.979	298	0.000
Female	150	17.08-21.10	18.95±0.78			
Total	300	16.90-21.50	19.15±0.89			

The mean and standard deviation of head length in male is 19.35±0.95cm, while that of the female is 18.95±0.78cm. Although there is no statistical difference between the males and females head length, the head length of the male is slightly longer than that of the female (P<0.05).

Table 5: Comparison of head breadth between males and females

Sex	Sample Size	Head Breath (mm)		t-test Statistic		
		Range	Mean±SD	t-test	df	P-value
Male	150	14.00-19.30	16.53±1.13	2.662	298	0.008
Female	150	13.10-19.30	16.20±1.00			
Total	300	13.10-19.30	16.37±1.08			

The mean and standard deviation of head breadth in male is 16.53±1.13cm, while that of the female is 16.20±1.00cm. Although there is no statistical difference between the males and females head breath, the head breadth of the male is slightly broader than that of the female (P<0.05).

Table 6: Comparison of cephalic index between males and females

Sex	Sample Size	Cephalic Index (%)		t-test Statistic		
		Range	Mean±SD	t-test	df	P-value
Male	150	70.10-95.86	85.53±5.62	0.091	298	0.927
Female	150	70.10-98.31	85.59±5.27			
Total	300	70.10-98.31	85.56±5.44			

The mean and standard deviation of cephalic index in male is 85.53±5.62%, while that of the female is 85.59±5.27%. There is no significant difference in the cephalic index between the male and female (P>0.05).

Table 7: Correlation of cephalic index of males with bracket 16-24years

Statistical parameters	Cephalic index
Pearson Correlation Coefficient	0.039
P-value	0.632
Sample size	150

There was no significant correlation between the cephalic index and the age of male (r=0.039, P>0.05).

Table 8: Correlation of cephalic index of females with age bracket 16-24years

Statistical parameters	Cephalic index
Pearson Correlation Coefficient	-0.014
P-value	0.867
Sample size	150

There was no significant correlation between the cephalic index and the age of female (r=-0.014, P>0.05).

Table 9: Comparison of the types of cephalic index with gender

Head Types for Cephalic Index	Sex		Total	$\chi 2$	P-value
	Male (n=150)	Female (n=150)			
Dolicocephaly	4 (2.7%)	7 (4.7%)	11 (3.7%)	8.055	0.090
Mesocephaly	24(16.0%)	16(10.7%)	40(13.3%)		
Brachycephaly	37(24.7%)	44(29.3%)	81(27.0%)		
Hyperbrachicephaly	44(29.3%)	57(38.0%)	101(33.7%)		
Ultrabrachicephaly	41(27.3%)	26(17.3%)	67(22.3%)		

One third of the study participants 101(33.7%) had head types of cephalic index to be hyperbrachicephaly, while about one-quarter of them 81(27.0%) had brachycephaly, and 40(13.3%) of them had mesocephaly. Those that had dolicocephaly and ultrabrachicephaly was 11(3.7%) and 67(22.3%) respectively. This is no significant between the male and the female in this study (P>0.05).

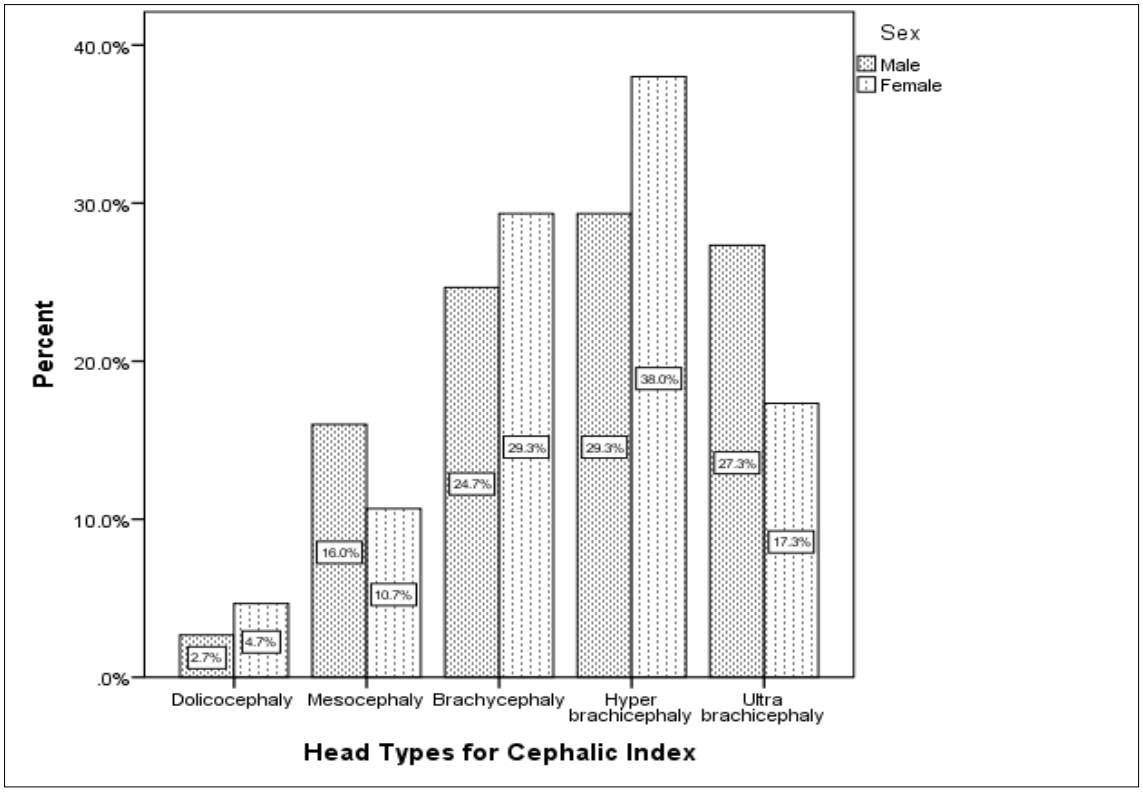

Fig 4: A bar chart showing the comparison of the types of cephalic index with gender

Table 10: Comparison of the types of cephalic index with age

Head Types for Cephalic Index	Age Group (years)			Total	$\chi 2$	P-value
	16-18 (n=73)	19-21 (n=151)	22-24 (n=76)			
Dolicocephaly	0 (0.0%)	7 (4.6%)	4 (5.3%)	11 (3.7%)	5.963	0.654
Mesocephaly	8 (11.0%)	22(11.6%)	10(13.2%)	40(13.3%)		
Brachycephaly	21(28.8%)	40(26.5%)	20(26.3%)	81(27.0%)		
Hyperbrachicephaly	27(37.0%)	52(34.4%)	22(28.9%)	101(33.7%)		
Ultrabrachicephaly	17(23.3%)	30(19.9%)	20(26.3%)	67(22.3%)		

One-third of the study participants 101(33.7%) had head types of cephalic index to be hyperbrachicephaly, while about one-quarter of them 81(27.0%) had brachycephaly, and 40(13.3%) of them had mesocephaly. Those that had dolicocephaly and ultrabrachicephaly was 11(3.7%) and 67(22.3%) respectively. This is not significant difference among the age group in this study (P>0.05).

DISCUSSIONS

Summary of Results

The age range of male and female is 16-24years with male having mean and standard deviation of 20.07±2.27years, while the female is 20.11±2.05years but no significant (P>0.05) (Table 2). The mean and standard deviation of head length in total is 19.15±0.89cm; while that of male is 19.35±0.95cm, the female is 18.95±0.78cm. Also, the mean and standard deviation of head breadth in total is 16.37±1.08cm; while that of male is 16.53±01.13cm, the female is 16.20±1.00cm. The mean and standard deviation of cephalic index in total is 85.56±5.44%; while that of male is 85.53±5.62%, the female is 85.59±5.27%. (Table 6)

There was no significant correlation between the cephalic index and the age of male (r=0.039, P>0.05) (Table 7). There was no significant correlation between the cephalic index and the age of female (r=-0.014, P>0.05). (Table 8)

Implications of the Study

The observation from this study implies that the Anambra male and female students', amongst other

students, have hyperbrachycephalic (very broad head) head shapes. Again, the observation also shows that an average Anambra indigene can be identified amongst other tribes by their dominant head shape (hyperbrachycephalic head shape). Furthermore, the observation from this study implies that the females have a slightly broader head shape than the men. The mean for females is 85.59 and that of males is 85.53, respectively. In addition, the observations and results from this study can be utilised by forensic anthropologists, cranio-facial surgeons, and ergonomicists.

In the present study, the mean cephalic index in males was 85.53 and in females was 85.59. The result of this study is close to the study by Ogut *et al*.,'s cephalic index for males (88.75) and females (84.90) [8].

The dominant type of head shape in males in this study was (29.3%) hyperbracycephaly followed by (27.3%), ultrabrachycephalic (24.7%), brachycephalic and (16.0%) mesocephalic (2.7%), dolicocephalic whereas in females, the dominant type of head shape was (38.0%), hyperbracycephaly followed by (29.3%), brachycephalic (17.3%), ultrabrachycephalic (10.7%), mesocephalic and (4.7%), dolicocephalic according to the classification given by the Martin-Saller scale.

The effect of racial factors on the cephalic index is very evident. It was stated by Ghosh R *et al*., [4] that cephalic index and head shape are affected by age, geographical, racial, gender, and ethnic factors. This study was carried out to determine the cephalic index and head shape of 200 students (17–20). After observing the results and comparing them with other studies in the world, they concluded that geographical factors affect the head dimensions.

The current study offers a valuable resource for forensic specialists in the identification process, specifically in cases when only the skull is recovered within the Anambra region. The observed differences in cephalic indices within and within populations have been ascribed to a multifaceted interplay of genetic and environmental variables [4- 10]. As can be observed, the cephalic index of Anambra students (the present study) is in variance with Urhobo males, which is 86.50, and Urhobo females, which is 87.09.

Table 11: Comparative Data on Cephalic Indices of Various Populations in Nigeria

Country /Populations	Name of the worker/ References	Mean Cephalic Index	Head type
Ijaw males	Oladipo and Olotu, 2006	80.98	Brachycephaly
Ijaw females	Oladipo and Olotu, 2006	78.24	Mesocephaly
Nepal Males	Lobo,Chandrashekhar, Kumar	83.01	Brachycephaly
Nepal females	Lobo,Chandrashekhar, Kumar	84.06	Brachycephaly
Ibibio males	Oladipo, Okoh, Isong 2010	79.85	Mesocephaly
Ibibio females	Oladipo, Okoh, Isong 2010	78.36	Mesocephaly
Itsekiri males	Oladipo and Paul, 2009	94.41	Ultrabrachycephaly
Itsekiri females	Oladipo and Paul, 2009	82.16	Brachycephaly
Urhobo males	Oladipo and Paul 2009	86.50	Hyperbrachycephaly
Urhobo females	Oladipo and Paul 2009	87.09	Hyperbrachycephaly
Turkish males	Ogut, Guzelad, Yidirim, 2023	88.75	Hyperbrachycephaly
Turish females	Ogut, Guzelad, Yidirim, 2023	84.90	Hyperbrachycephaly
Anambra males	Present study	85.53	Hyperbrachycephaly
Anambra females	Present study	85.59	Hyperbrachycephaly

From table 7 and table 8 in the result above there is no correlation between cephalic index and age, among the males and females student population, therefore there is no relation between cephalic index and age in the males and females student population.

The finding of this study, i.e., hyperbrachycephalic dominant head shape both in males and females, was similar to the study done on Turkish adults males and females by Ogut *et al*., [8], in which the mean cephalic index of males was 88.75 and females was 84.90, in which hyperbrachycephaly was the dominant head shape.

Similar studies were conducted in different groups, and the cephalic index was found to be different for different groups due to geographical and genetic factors. The observations and results of this study may provide a platform for similar extended studies on cephalic index based on various communities, castes, and races in particular geographical zones.

CONCLUSION

The present study has confirmed that the Anambra students of the Madonna University Elele campus in Rivers State, Nigeria, have hyperbrachycephaly, or a very broad head shape. This data is recommended to forensic experts, anthropologists, medical practitioners, geneticists, and who may find it very useful. The study observed that both

parameters were not statistically significant in males and females; hence, it shows no sexual dimorphism.

RECOMMENDATION

We recommend this work be used as a baseline for the population and further studies on tribes to raise anthropological data for the nation.

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