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Craniofacial Analysis of Igbo and Efik Undergraduates In A Southern Nigerian University: A Cross-Sectional Study

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ABSTRACT

The classifications of both head and facial shapes are significant for understanding racial and ethnic differences in physical anthropology. The present study was aimed at evaluating the relationship between craniofacial shape classifications and the ethnicities of selected adult Nigerian students residing in a southern Nigerian university. The study was conducted among 166 students of both Igbo and Efik ethnicities of the College of Health Sciences of Madonna University, Elele campus. With the aid of sliding calipers, measurements such as face length and width, as well as head length and width were obtained. The proscopic and cephalic indices were calculated from the measurements to know their prevalence. The Chi-square test statistic was employed to examine the relationships between cephalometric indices and ethnic groups. Results showed that unlike the cephalic Index, the proscopic index classification was significantly associated with the ethnicity of the participants. The Igbo group has a higher proportion of individuals classified as Hyperleptoprosopic (55.9%) compared to the Efik group (23.0%), while the Efik group has a higher proportion in the Leptoprosopic category. The study concluded that the difference observed between the two ethnic student groups in prosopic index classification was significant, hence a better predictor of facial shapes.

Keyword: craniofacial, proscopic, cephalic, Igbo, Efik

ABSTRAK

Klasifikasi bentuk kepala dan wajah sangat penting untuk memahami perbedaan ras dan etnis dalam antropologi fisik. Penelitian ini bertujuan untuk mengevaluasi hubungan antara klasifikasi bentuk kraniofasial dan etnis mahasiswa Nigeria dewasa terpilih yang tinggal di sebuah universitas di Nigeria bagian selatan. Penelitian ini dilakukan di antara 166 mahasiswa dari etnis Igbo dan Efik di Sekolah Tinggi Ilmu Kesehatan Universitas Madonna, kampus Elele. Dengan bantuan kaliper geser, pengukuran seperti panjang dan lebar wajah, serta panjang dan lebar kepala diperoleh. Indeks proscopic dan cephalic dihitung dari pengukuran untuk mengetahui prevalensinya. Statistik uji Chi-square digunakan untuk menguji hubungan antara indeks sefalometri dan kelompok etnis. Hasil penelitian menunjukkan bahwa tidak seperti indeks sefalika, klasifikasi indeks proscopic secara signifikan terkait dengan etnisitas peserta. Kelompok Igbo memiliki proporsi individu yang lebih tinggi yang diklasifikasikan sebagai Hiperleptoprosopik (55,9%) dibandingkan dengan kelompok Efik (23,0%), sedangkan kelompok Efik memiliki proporsi yang lebih tinggi dalam kategori Leptoprosopik. Penelitian ini menyimpulkan bahwa perbedaan yang diamati antara dua kelompok etnis siswa dalam klasifikasi indeks prosopik adalah

signifikan, sehingga dapat menjadi prediktor yang lebih baik dalam memprediksi bentuk wajah.

Keyword: Kraniofasial, proscopic, cephalic, Igbo, Efik

1. Introduction

Craniofacial morphological and morphometric investigations are essential aspects of physical anthropology that are relevant for understanding human evolution, variation, development, and adaptation (Lacruz et al., 2019; von Cramon-Taubadel, 2019; Cunha & Ubelaker, 2020; Kleisner, 2021). Forensic anthropologists can utilize the distinctive features of the skull and facial bones to generate face reconstructions that aid in the identification of persons who are unknown to them. This is crucial when it comes to criminal investigations, missing people cases, and large-scale disasters (Ubelaker et al., 2019; Gupta et al., 2022). Moreover, these morphometrics are important markers of biological diversities both within and across racial groups due to biological differences in genetics and environment (Richmond et al., 2018; Olowo et al., 2021; Afra et al., 2023). They have been shown to assist in determining face diversities by examining the variety of facial traits seen in these racial populations. Various researches have demonstrated that cephalometric indices can differ between ethnic groups, indicating distinct face features (Humphries et al., 2015; Olowo et al., 2021).

In forensic science, sex determination from face morphology and its morphometry is essential for personal identity. When it comes to sex estimate, cephalofacial measurements are quite important since they help with forensic investigations of decayed or mutilated remains (Monteiro et al., 2023). In addition, various studies have examined differences in face length, width, head length, and head width among various ethnic groups which has in turn shed more light on the diversity of facial morphology among global populations (Amini et al., 2014; Krishna & Babu, 2016; Pandian et al., 2018). For example, the length and width of the heads of Chinese and Caucasian young adults differed, according to a cephalometric examination. Males found within parts of South Asia were found to have longer anterior cranial bases, lower anterior facial heights, ramus heights, lower posterior dentoalveolar heights, and longer total mandibular lengths than females based on cephalometric measures (Cristiany et al., 2013; Anh et al., 2016; Nikkerdar et al., 2019).

The classifications of both head and facial shapes are significant for understanding racial and ethnic differences in facial morphology as they reflect genetic and environmental adaptations that have evolved over time within different populations (Oladipo & Olotu, 2006; Ahsan et al., 2013; Todorov et al., 2015; Muhammed et al., 2019). For instance, populations in colder climates tend to exhibit brachycephalic head shapes, which may provide advantages in heat retention, while those in warmer climates often display dolichocephalic shapes, facilitating heat dissipation (Márquez et al., 2014; Musilová et al., 2019). Furthermore, orthodontists do consider facial shape when developing treatment plans for malocclusion, as the facial profile can significantly impact the aesthetic and functional outcomes of orthodontic interventions (Reis et al., 2011; Grippaudo et al., 2013). Not enough literature has been shown to report the prevalence of head and facial shape classifications in the southern Nigerian population. The present study was aimed at evaluating the relationship between craniofacial shape classifications and the ethnicities of selected adult Nigerian students residing in a southern Nigerian university.

2. Method

The research design for this study was a cross-sectional study, which took place from April to July, 2024. This design was used for assessing the prevalence of craniofacial morphological features using morphometric variables among southern Nigerian students of Efik and Igbo ethnicity. The study was conducted among students of the College of Health Sciences of Madonna University, Elele campus, Rivers State, Nigeria. Madonna University Elele campus is situated in the Niger Delta region of southern Nigeria – comprising of Nigerian students of diverse ethnicities. Students of both Igbo and Efik ethnicities make up the highest proportion of student population in the institution.

The Fisher (1935) sample size formula for carrying out cross-sectional surveys was used to calculate the sample size from the sample populations. A 95% confidence level and p = 0.05 will be assumed for the equation as shown below;

$$\boldsymbol{Sample\ size} = \frac{\boldsymbol{Z_{\propto}^2\, p(1-p)}}{\boldsymbol{d^2}}$$

Where $\boldsymbol{Z_{\propto}}$ = Standard normal variate (at 5% type 1 error) = 1.96; **p** = proportion of Igbo students was 7%; while that of Efik students was 4.4%; and **d** = absolute error = 0.05

$$Sample\ Size\ (Igbo) = \frac{1.96^2 \times 0.07(1-0.07)}{0.05^2} = 100.04$$

$$Sample\ Size\ (Efik) = \frac{1.96^2 \times 0.044(1-0.044)}{0.05^2} = 64.64$$

A minimum sample size of 166 participants was selected for the study using a stratified random sampling method. Primary data will be collected directly from participants through cephalometric measurements and questionnaires. Informed consent was obtained from all participants prior to data collection. With the aid of sliding calipers, the primary methods of data collection included obtaining cephalometric measurements such as;

- **Head Length**: Head length is the measurement from the most anterior point of the forehead (glabella) to the most posterior point of the occipital bone (inion).
- **Head Width**: Head width is the measurement taken across the widest part of the head, typically from one parietal bone to the other. This is often measured at the level of the external auditory meatus or the widest point of the skull.
- **Face Length**: Face length is measured from the nasion (the bridge of the nose) to the menton (the lowest point of the chin). This measurement reflects the vertical dimension of the face.
- **Face Width**: Face width is measured at the zygomatic arches (the cheekbones), typically from one zygomatic prominence to the other. This measurement indicates the horizontal dimension of the face.

Two indices were deduced from the measurements of the head and the face. They include;

- **Cephalic Index (CI):** The Cephalic Index is a measure of the width of the head relative to its length. It is used to classify head shapes into categories such as dolichocephalic (long-headed), mesocephalic (medium-headed), and brachycephalic (short-headed). Mathematically, it is expressed as;

$$Cephalic\ Index\ (CI) = \frac{Head\ width}{Hand\ length} \times 100$$

A CI of less than 75 denoted dolichocephalic head shape (long and narrow); CI between 75 and 80 indicated a mesocephalic head shape (medium proportions), and a CI greater than 80 indicated a brachycephalic head shape (short and broad).

- **Prosopic Index (PI):** The Prosopic Index is a measure of the width of the face relative to its length. It is used to classify facial shapes and proportions into categories; hyperleptoprosopic, leptoprosopic, mesoprosopic, europrosopic, and hypereuroprosopic. Mathematically, it is expressed as;

$$Proscopic\ Index\ (CI) = \frac{Face\ width}{Face\ length} \times 100$$

Hyperleptoprosopic face has a PI less than 80 (extremely long and narrow); Leptoprosopic face has a PI range of 80 – 90 (long and narrow); Mesoprosopic face had a PI range of 90 – 100 (medium proportions); Europrosopic face has a PI range of 100 – 110 (broad and moderately short), and Hypereuroprosopic face has a PI greater than 110 (very broad and short).

Method of data analysis: Data was conducted using the Statistical Package for Social Sciences version 23. Descriptive statistics was calculated to summarize the demographic characteristics of the sample, including means, standard deviations, and frequency distributions. Chi-square test statistic was employed to examine the relationships between cephalometric indices and ethnic groups. The significance level was set at $p < 0.05$.

3. Result and Discussion

Results from table 1 show that the Igbo group had a higher mean head length and head width compared to the Efik group. The Cephalic Index (CI), which relates to head shape, showed a slightly higher mean in the Igbo group. The Prosopic Index (PI), which relates to the facial shape, also showed a higher mean in the Igbo group.

In table 2, the results of independent t-tests comparing various craniofacial measurements between the Igbo and Efik ethnic groups were shown. There was a significant difference in head length between the Igbo and Efik groups, with the Igbo group having a significantly longer head length on average ($p < 0.001$). There was a significant difference in head width between the two groups, with the Igbo group having a significantly wider head width ($p < 0.001$). The difference in face length between the Igbo and Efik groups was statistically significant, with the Igbo group having a slightly longer face length ($p < 0.05$). The Efik group had a significantly wider face compared to the Igbo group ($p < 0.01$). There was no significant difference in the Cephalic Index between the Igbo and Efik groups ($p > 0.05$). However, there was a significant difference in

the Prosopic Index, with the Igbo group having a higher index, indicating a longer face relative to its width ($p < 0.001$).

The data presented in table 3 is a chi-square test of independence, analyzing the relationship between the Cephalic Index classification and ethnicity (Igbo and Efik). The chi-square test indicated that the Cephalic Index classification was not significantly associated with the ethnicity of the individuals in this sample. The distribution of head shapes (as classified by the Cephalic Index) was relatively similar between the Igbo and Efik groups.

Finally, table 4 shows a chi-square test of independence that analyzed the relationship between the Proscopic Index classification and ethnicity (Igbo and Efik). The chi-square test shows that there is a significant association between ethnicity and Prosopic Index classification, with the Igbo and Efik groups differing in the distribution of face shape categories. The Igbo group has a higher proportion of individuals classified as Hyperleptoprosopic (55.9%) compared to the Efik group (23.0%), while the Efik group has a higher proportion in the Leptoprosopic category.

Table 1. Descriptive statistics of the observed variables based on ethnicity in the studied population

Tribe	Variables	N	Minimum	Maximum	Mean	Std. Deviation
Efik	Head Length (cm)	65	12.0	19.0	15.262	1.5858
	Head Width (cm)	65	10.0	15.0	12.157	1.3225
	Face Length (cm)	65	10.0	13.0	11.489	0.8269
	Face Width (cm)	65	11.0	14.5	12.688	0.9139
	Cephalic Index (%)	65	70.0	88.2	79.446	4.3550
	Prosopic Index (%)	65	76.0	109.0	90.282	6.0877
Igbo	Head Length (cm)	100	12.0	20.0	16.917	1.6203
	Head Width (cm)	100	9.0	16.0	13.659	1.4296
	Face Length (cm)	100	10.0	14.0	11.792	0.8846
	Face Width (cm)	100	10.0	14.0	12.227	0.9329
	Cephalic Index (%)	100	55.5	96.9	80.888	6.5568
	Prosopic Index (%)	100	76.0	120.0	96.185	8.5385

Table 2. T-test inferential statistics of the observed variables based on ethnic groups in the studied population

Variables	Ethnicity	N	Mean	Std. Deviation	T-test	Df	P-value
Head Length (cm)	Igbo	100	16.917	1.6203	6.466	163	0.001a
	Efik	65	15.262	1.5858			
Head Width (cm)	Igbo	100	13.659	1.4296	6.790	163	0.001a
	Efik	65	12.157	1.3225			
Face Length (cm)	Igbo	100	11.792	0.8846	2.203	163	0.029a
	Efik	65	11.489	0.8269			
Face Width (cm)	Igbo	100	12.227	0.9329	-3.124	163	0.002a
	Efik	65	12.688	0.9139			
Cephalic Index (%)	Igbo	100	80.888	6.5568	1.562	163	0.120
	Efik	65	79.446	4.3550			
Prosopic Index (%)	Igbo	100	96.185	8.5385	4.831	163	0.001a
	Efik	65	90.282	6.0877			

a = significance at $p < 0.05$

Table 3. Chi-square test of association between ethnic group and the cephalic index classification in the studied population

Cephalic index classification	Ethnicity		Chi-sqaure	Df	P-value
	Igbo	Efik			
Dolicocephalic	14 (14.0)	10 (15.4)	1.406	2	0.495
Mesocephalic	43 (43.0)	33 (50.7)			
Brachycephalic	43 (43.0)	22 (33.7)			

Table 4. Chi-square test of association between ethnic group and the prosopic index classification in the studied population

Prosopic index classification	Ethnicity		Chi-sqaure	Df	P-value
	Igbo	Efik			
Hypereuroprosopic	2 (1.9)	1 (1.5)	20.183	4	0.001a
Europrosopic	8 (7.9)	16 (24.6)			
Mesoprosopic	12 (12.0)	12 (18.5)			
Leptoprosopic	22 (21.9)	21 (32.2)			
Hyperleptoprosopic	56 (55.9)	15 (23.0)			

a = significance at $p < 0.05$

The findings indicate that the Igbo group has a significantly longer head length compared to the Efik group ($p < 0.001$). Several literatures on cephalometric analyses have shown that head length can be influenced by genetic, environmental, and nutritional factors, which may vary significantly across populations (Humphries et al., 2015; Olowo et al., 2021). Similarly, the significant difference in head width ($p < 0.001$) further emphasizes the morphological distinctions between these two groups. The Igbo group's wider head may be indicative of a broader cranial base, which has been associated with certain functional and aesthetic traits in various populations. Also, the Igbo group had a slightly longer face length compared to the Efik group ($p < 0.05$). Conversely, the Efik group exhibits a significantly wider face ($p < 0.01$). These differences may be attributed to various factors, including genetic drift, sexual dimorphism, and environmental influences (Todorov et al., 2015; Muhammed et al., 2019).

The cephalic index (CI) is a widely used anthropometric measure that quantifies the shape of the head by calculating the ratio of head width to head length. It categorizes head shapes into three primary classifications: dolichocephalic (long and narrow), mesocephalic (medium), and brachycephalic (short and broad). The current study results indicated no significant association between cephalic index classification and the ethnicities; suggesting that the head shapes of individuals from both ethnic groups was distributed similarly. Related studies examined the cephalic indices of South Asian individuals, revealing a predominance of mesocephalic head shapes. The findings indicated that the average cephalic index was around 75 – 80, suggesting a balanced head shape that is neither too long nor too broad (Yadav et al., 2011; De Leon & Santos, 2012). A study focusing on Nigerian adults (Odukoya & Akinwande, 2013) earlier reported a higher prevalence of brachycephalic head shapes, with an average cephalic index exceeding 80, while another study analyzing the cephalic indices of Anatolian Turks found that the population predominantly exhibited dolichocephalic characteristics, with an average cephalic index below 75 (Alper & Yilmaz, 2010).

The study results showed that the distribution of face shape categories differs significantly between the two groups, with the Igbo group exhibiting a higher proportion of individuals classified as hyperleptoprosopic (55.9%) compared to the Efik group (23.0%). Conversely, the Efik group has a higher proportion of individuals in the leptoprosopic category. The significant differences in prosopic index classification between the Igbo and Efik groups suggest that these ethnic groups may have distinct genetic backgrounds or environmental influences that shape their facial morphology. Related studies done in a Serbian and Kurdish population showed that the dominant facial phenotype was leptoprosopic followed by mesoprosopic (Jeremić et al., 2013; Amin et al., 2016) unlike another related study that found mesoprosopic as the most prevalent facial type in Malaysian population followed by leptoprosopic (Yesmin et al., 2014), while another research found hypereuryprosopic as the most prevalent followed by euryprosopic in Gujarati Indian population (Shah et al., 2015). The major strength of this research was that proscopic index showed a positive association with ethnicity. Although, a significant limitation to this current study is the use of a small sample size thereby making the generalization of study findings slightly difficult to the entirety of Igbo and Efik adult population.

4. Conclusion

This study has determined the cranial and facial forms in adult males and females of Igbo and Efik ethnic groups concluded that there was no significant difference between the two ethnic groups in cephalic index classification. However, the difference observed between the two-ethnic groups in prosopic index classification was significant. This may be due to genetic factor which has been known to determine the physical traits of an individual, including the shape of the head and face. Also, it could be due to environmental factors, dietary factor, climate, and cultural practices which have also been implicated in differences in head and face shapes among populations.

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Conflicts Of Interest
There is no form of competing interests that exists among the authors.

Author's Contributions
All authors contributed to the various components of the study such as research design, collection of data and its analysis, write-up of the initial and final manuscript, and the submission of the finalized manuscript.

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