



# Computed Tomography Assessment of Nasal, Orbital Indices and Volume among Igbo, Calabari and Ogoni Residents of Portharcourt, Rivers State, Nigeria

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

**Background:** Understanding the morphology of the orbital and nasal cavities is essential for human identification, reconstructive surgeries and forensic medicine.

**Objectives:** To evaluate the orbital and nasal dimensions and their relationship with gender in the Igbo-, Calabari- and the Ogoni ethnic groups living in Port-harcourt Nigeria using computed tomography (CT).

**Methods:** Four hundred and sixty-six head CT images were analyzed. 43.8% were Igbos', 28.8% Calabaris' and 27.5% Ogonis' of 20-80 years of age with a mean age of 51.19±15.67. Males and females were 55.8% and 44.2% respectively. Parameters measured were orbital height (OH), orbital width (OW), orbital depth (OD), nasal height (NH) and nasal width (NW) using the ImageJ software. Data analysis was by SPSS version 20. Differences between groups were obtained using the one-way ANOVA. P-value < 0.05 was considered statistically significant.

**Results:** Mean orbital volume for the Igbos', Calabaris' and Ogonis' are 48.57±7.38, 48.97±5.63 and 46.27±5.59 for the right and 48.56±7.31, 48.96±5.62 and 46.32±5.56 for the left respectively

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$P < 0.05$ . Mean OD is highest in the Igbos'  $4.70 \pm 0.32$  while mean OH is highest in the Calabaris  $2.94 \pm 0.18$  ( $P < 0.05$ ). Igbos have the highest mean NI of 89.71. Males have higher NI  $P < 0.05$  in all ethnic groups. Mean OI shows no sexual dimorphism or unilaterality  $P > 0.05$

**Conclusion:** Differences in the measured parameters and sexual dimorphism in the nasal indices only among the ethnic groups is demonstrated. Microseme and platyrrhine categories of orbital and nasal cavities respectively is similar to all. These findings will aid facial reconstructive surgeries and forensics.

**Keywords:** Nasal index; orbital index; computed tomography; dimensions, Igbo; Calabari; Ogoni; Nigeria.

## 1. INTRODUCTION

An objective determination of the head and face dimensions (cephalometry), is of utmost importance in clinical diagnosis, forensic medicine, plastic and reconstructive surgery, orthodontics etc [1]. Craniofacial indices are one of the essential anthropometric study important for intra- and inter-racial morphology classification [1]. Human growth and development are influenced by factors such as age, race, gender, biology, geography etc [2]. Furthermore, variations in nutrition, anatomy, physiology and genetic influence skeletal development that can manifest as differences in skeletal proportions between males and females in different geographical areas [3].

Since anthropometric methods were initiated into clinical practice to evaluate changes in the craniofacial framework, it has aided in distinguishing features between various races and ethnic groups. Normative data of facial measurements are indispensable in precisely determining the degree of deviations from the normal and also in the establishment of a standard anthropometric measurement for any particular population [4]. Determination of the origin and identity of the remains of skeleton collected from example, a crime scene, is an important task which ordinarily can be difficult. Unidentified bodies can be seen in various conditions; some may be mutilated, decomposed, badly burnt, fractioned or whole etc. This has become common especially in recent times with increasing incidents of both natural and man-made disasters- accidents, bomb explosion, terrorist attacks, wars, plane crashes, earthquakes, hurricane, tsunamis, floods etc [5]. Gender identification from skeletal remains has profound medicolegal significance and once gender is determined, estimation of stature and age is said to be more easily ascertained [6]. Different craniofacial measurements and indices are useful for this purpose.

Dimensions of Orbital and nasal cavities, gives detailed information important in clinical diagnosis, treatment, evaluation of craniofacial asymmetry, pre-operative planning, post – operative evaluation, orbital reconstruction and follow-up of orbital diseases etc [7,8,9]. They are also important anthropological tools [10].

The orbital cavity is a complex anatomical structure which is shaped like an inverted cone. It houses the eyeballs, muscles, vessels, nerves, lacrimal apparatus, facial strata etc. They are located on opposite sides in the mid-sagittal plane of the skull and between the cranium and the facial bones. They can be affected by congenital, vascular, tumour/neoplastic, traumatic, endocrine disorders etc [11]. The nasal cavity is pear-shaped; broader inferiorly and narrow superiorly. It extends from the nares anteriorly, through the external nose and between the bones of the face, as far back as the posterior nasal apertures where it communicates with the nasopharynx.

Orbital index (OI) is defined as the proportion of the orbital height to its width multiplied by 100% while the nasal index (NI) is defined as the proportion of the nasal width to its height multiplied by 100% [11]. Knowledge of these indices could be applied in various fields such as interpretation of fossils record, skull classification in forensic medicine and in exploring trends in evolutionary and ethnic differences etc [10,12-15]. Various ethnic groups has been classified under one of the predetermined categories which are Megaseme (OI =  $\geq 89$ ); Mesoseme (OI = 83 – 89); Microseme (OI =  $\leq 83$ )<sup>11</sup>. For the nasal indices (NI), Leptorrhine (NI =  $\leq 69.9$ ); Mesorrhine (NI= 70 – 84); Platyrrhine: NI =  $\geq 85$ ) [16,17].

The Igbo, Calabari and Ogoni ethnic groups are indigenous groups of PortHarcourt, Rivers State of Nigeria.

Many measuring tools has been used to obtain these values in our environment but to our

knowledge, none has been done using Computed tomography (CT) scan- a cross-sectional radiological imaging modality, which provides detailed, precise, reproducible information of anatomical bony landmarks of the orbit and nasal indices etc,[8,18,19] hence the purpose of this study.

## 2. MATERIALS AND METHODS

Ethical clearance for this study was obtained from the health research ethics committee of our institution. Four hundred and sixty-six (466) CT images of the head (showing the orbital and the nasal cavities) of the Igbos, Calabari, and Ogonis respectively from January –December 2018 were evaluated. Age range was 20-80 years of age. Females were 206 (44.2%) while the males were 260 (55.8%). Inclusion criteria were subjects who had a well- positioned, head CT scans, had CT scan for lesions unrelated to the orbit or nose, and adults 20-80 years of age. Exclusion criteria were patients with midfacial injuries, orbital or nasal tumours, evidence of previous orbital/nasal surgery, craniofacial anomaly, congenital anomalies, facial asymmetry and children. Each of the CT images were retrieved from the database of a radiology facility. The images were reconstructed to reveal the orbital and the nasal cavities using the E-files software which also measured the height, width, and the depth of the orbital and the nasal cavities respectively. Data analysis was done using statistical package for social science (SPSS) version 20. Descriptive statistics for the orbital and nasal parameters of both sexes were analyzed and compared respectively using the student t-test and was reported as mean  $\pm$  standard deviation. Statistical difference in mean between groups was analyzed using the one-way ANOVA (analysis of variance). P-value less than 0.05 is considered statistically significant.

### 2.1 Parameters and Points of Measurement for Orbital [8] and Nasal Dimensions [3]

**Orbital height:** the distance between frontal and maxillary bones as shown in Fig. 1 below

**Orbital depth:** the distance between the plane across the orbital entrance to the optic canal.

**Orbital width:** is the distance between anterior lacrimal crest and orbital border of zygomatic bone as shown in Fig. 2 below.

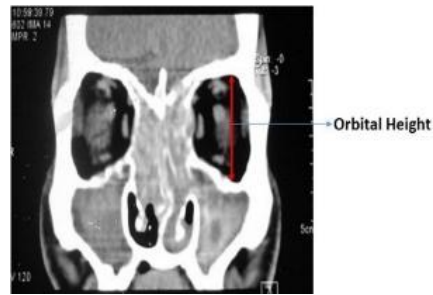


Fig. 1. A CT image showing the orbital height

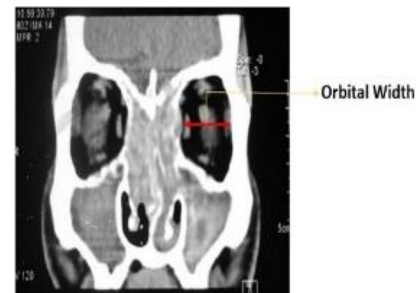


Fig. 2. A CT image showing the orbital width

**Nasal height:** It is the distance between the superior and the inferior margins at the midpoint, perpendicular to the nasal width as shown in Fig. 3 below

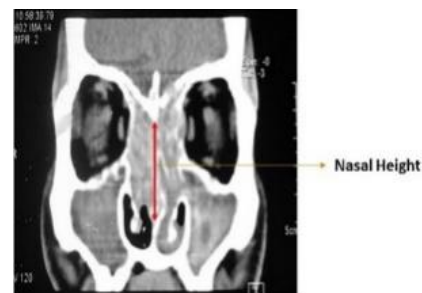


Fig. 3. A CT image showing the nasal height

**Nasal width:** It is the distance between the widest lateral margins of the nasal opening as shown in Fig. 4 below

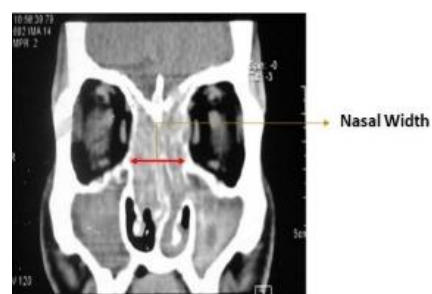


Fig. 4. A CT image showing the nasal width

### 3. RESULTS

The ethnic groups and their percentage distribution were Igbo 204 (43.8%), Calabari 134 (28.8%), Ogoni 128 (27.5%) as presented in Table 1.

Table 2 below summarizes the orbital parameter values, mean and standard deviation of the two orbits which was calculated by using OH and OW and volume. Comparison of all the parameters at p-value < 0.05 showed that there were significant statistical differences except in the values of the right and left orbital indices amongst the three ethnic groups.

Comparison of all the parameters at P-value < 0.05 showed that there were statistically significant differences in the dimensions amongst the ethnic groups except in the nasal index as shown in Table 3 below.

There is sexual dimorphism: the mean values of all orbital and nasal parameters were greater in males and in all linear measurements except in the Calabari ethnic group as presented in Table 4 below.

Table 5 below summarizes the calculated indices of the two orbits and the nasal cavities. Comparison of the all indices at P-value < 0.05 showed that there were significant differences in the nasal indexes value amongst the three ethnic groups while there was no significant difference in the orbital indices.

### 4. DISCUSSIONS

The importance of craniofacial morphometry with the use of a precise imaging tool like CT scan cannot be overemphasized. This study shows that in the orbital cavities in all the ethnic groups considered, depth has the highest of the values followed by the width. Height has the least value. This is similar to a study in Iran which also

demonstrated depth to have the highest of the values [9]. The report from Ghana (although depth was not considered in their study), shows width to have higher values [10]. Their mean OW of 4.0cm is much higher than the mean OW of 3.5 cm obtained from the 3 ethnic groups considered [10].

We demonstrated that the Ogonis generally have the least orbital dimensions of the 3 groups. Comparison of the mean OI of the genders showed a significantly higher OI in males amongst the Igbos and Ogonis. This is in agreement with other reports [9,11,12,20-23] However, the female values were higher than males in the Calabari ethnic group and this is similar to studies in Ghana, Kenya, Turkey and Malawi [8,10,24,25]. Yet a research in India showed no sex difference [26].

This study revealed that there is no statistical difference between the right and left OI. This is in line with other findings [10,12,20,24,26] but contrary to a report in Iran that showed a statistical difference with the right larger than the left [9]. Yet another study demonstrated the left to be higher than the right [27].

The OI in the three groups of this study falls within the microseme category (mean OI=82.52). This is similar to earlier report done on Igbos [12]. Their figure of mean OI=73.09, is however much lower than ours. The disparity in figures, even though they fall within the microseme category, may be due to the different methods utilized: theirs was with plain skull radiographs while ours was with Computerized Tomography scan. This microseme category is also reported in Ghana, Egypt, India [10,11,20,27]. Mesoseme category has been noted in studies in Kenya, Iran and a part of India [9,24,26]. Megaseme category has been described in reports from Turkey, Malaysia, Chinese, Polynesians and also another section of India [8,25,28].

**Table 1. Percentage distribution of respondent on Sex and Ethnicity**

Variables	Frequency	Percentage
Ethnicity		
Igbo	204	43.8
Calabari	134	28.8
Ogoni	128	27.5
Total	466	100.0
Sex		
Male	260	55.8
Female	206	44.2
Total	466	100.0
	Mean	S.D
Age	51.19	15.67

**Table 2. Mean distribution of orbital parameters based on ethnic groups**

Orbital Parameters	Mean ± SD				P-values
	Igbos	Calabari	Ogoni	Total	
Right Orbital Height	2.91 + 0.21 <sup>a,b</sup>	2.94 + 0.17 <sup>b</sup>	2.86 + 0.18 <sup>a</sup>	2.90 ± 0.19	0.006*
Left Orbital Height	2.91 ± 0.21 <sup>a,b</sup>	2.94 ± 0.18 <sup>b</sup>	2.86 ± 0.18 <sup>a</sup>	2.90 ± 0.19	0.006*
Right Orbital Width	3.54 ± 0.23 <sup>b</sup>	3.54 ± 0.12 <sup>b</sup>	3.46 ± 0.16 <sup>a</sup>	3.52 ± 0.19	0.001*
Left Orbital Width	3.54 ± 0.23 <sup>b</sup>	3.54 ± 0.12 <sup>b</sup>	3.47 ± 0.16 <sup>a</sup>	3.52 ± 0.19	0.001*
Right Orbital Depth	4.70 ± 0.32 <sup>b</sup>	4.60 ± 0.25 <sup>a</sup>	4.65 ± 0.27 <sup>a,b</sup>	4.66 ± 0.29	0.012*
Left Orbital Depth	4.70 ± 0.32 <sup>b</sup>	4.60 ± 0.26 <sup>a</sup>	4.66 ± 0.27 <sup>a,b</sup>	4.66 ± 0.29	0.013*
Right Orbital Index	82.23 ± 4.38	82.86 ± 3.10	82.58 ± 4.02	82.51 ± 3.95	0.352
Left Orbital Index	82.24 ± 4.38	82.86 ± 3.10	82.49 ± 4.07	82.49 ± 3.97	0.364
Right Orbital Volume	48.57 ± 7.38 <sup>b</sup>	48.97 ± 5.63 <sup>a,b</sup>	46.27 ± 5.59 <sup>a</sup>	47.77 ± 6.51	0.006*
Left Orbital Volume	48.56 ± 7.31 <sup>b</sup>	48.96 ± 5.62 <sup>a,b</sup>	46.32 ± 5.56 <sup>a</sup>	47.78 ± 6.46	0.008*

\*Significant  $P < 0.05$ , Superscripts from a post-Hoc test (Bonferroni test) was used, whereby mean values with the same alphabet do not differ significantly from each other along each dimensions/indices

**Table 3. Mean distribution of the nasal parameters based on ethnic groups**

Orbital Parameters	Mean ± SD				P-values
	Igbos	Calabari	Ogoni	Total	
Nasal Height	2.98 + 0.4 <sup>b</sup>	2.84 + 0.40 <sup>a</sup>	3.00 + 0.31 <sup>b</sup>	2.94 ± 0.39	0.001*
Nasal Width	2.67 ± 0.46 <sup>b</sup>	2.52 ± 0.39 <sup>a</sup>	2.66 ± 0.28 <sup>b</sup>	2.62 ± 0.40	0.002*
Nasal Index	89.73 ± 11.34	88.84 ± 12.12	89.09 ± 7.12	89.29 ± 10.59	0.727

\*Significant  $P < 0.05$ , Superscripts from a post-Hoc test (Bonferroni test) was used, whereby mean values with the same alphabet do not differ significantly from each other along each dimensions/indices

**Table 4. Mean distribution of the Nasal and Orbital Dimensions by sex and by ethnicity**

Orbital Parameters	Igbo			Calabari			Ogoni			Total		
	Mean		P - value	Mean		P - value	Mean		P - value	Mean		P - value
	Male	Female		Male	Female		Male	Female		Male	Female	
Orbital Dimensions												
Right Orbital Height	2.9	2.83	0.000*	2.93	2.94	0.630	2.87	2.84	0.322	2.93	2.87	0.001*
Left Orbital Height	2.9	2.83	0.000*	2.93	2.94	0.630	2.87	2.84	0.322	2.93	2.87	0.001*
Right Orbital Width	3.60	3.46	0.000*	3.53	3.55	0.409	3.47	3.45	0.503	3.54	3.49	0.001*
Left Orbital Width	3.60	3.46	0.000*	3.53	3.55	0.409	3.47	3.46	0.731	3.54	3.49	0.002*
Right Orbital Depth	4.77	4.62	0.002*	4.62	4.59	0.432	4.68	4.63	0.392	4.70	4.61	0.002*
Left Orbital Depth	4.76	4.62	0.003*	4.62	4.59	0.518	4.68	4.63	0.414	4.70	4.61	0.004*
Right Orbital Volume	51.12	45.78	0.000*	47.98	47.96	0.982	46.80	45.46	0.188	48.98	46.23	0.000*
Left Orbital Volume	51.07	45.51	0.000*	47.94	47.99	0.959	46.80	45.46	0.238	48.94	46.29	0.000*
Nasal Dimensions												
Nasal Height	3.00	2.96	0.562	2.85	2.81	0.635	2.96	3.06	0.068	2.95	2.94	0.950
Nasal Width	2.68	2.65	0.556	2.58	2.46	0.084	2.65	2.68	0.550	2.65	2.60	0.206

\*Significant  $P < 0.05$

**Table 5. Orbital indices and Nasal indices**

Orbital Parameters	Igbo			Calabari			Ogoni			Total		
	Mean		P-value	Mean		P-value	Mean		P-value	Mean		P - value
	Male	Female		Male	Female		Male	Female		Male	Female	
Right Orbital Index	82.59	81.81	0.209	82.85	82.89	0.954	82.74	82.36	0.604	82.71	82.28	0.245
Left Orbital Index	82.59	81.81	0.208	82.85	82.88	0.955	82.73	82.12	0.406	82.70	82.21	0.187
Nasal Index	89.93	89.49	0.783	90.69	86.75	0.060	90.02	87.69	0.070	90.16	88.20	0.047*

\*Significant  $P < 0.05$

The nasal index in this study also demonstrated sexual dimorphism with males having higher values, similar to most works done within Nigeria and also beyond [14,29-33]. However, within the study by Eliakin- Ikechukwu et al 2013, females of Yakurr ethnic groups of South Southern part of Nigeria, were shown to have higher values [33].

This study shows that the mean NI in the Igbos', Calabaris' and Ogonis' were 89.71, 88.72, 88.86 respectively -all have significant differences with that of the Igbos highest. These values are close to those in Urbobors and Itsekiris' which has mean NI of 89.63 and 90.74 respectively [34]. Higher figures of 91, 92.3, 95.7, 96.37, 97.32 has been demonstrated in the Isoko ethnic group of Delta state, Idoma, Tiv, Ijaw, and Bini tribes all in Nigeria respectively [17,29,35,36]. Additionally, the Yorubas, the ethnic group in the Western part of Nigeria, has been reported to have mean NI values as high as 103.5 [37]. Lower values of 72 and 66.78 has however been reported in the northern Nigeria [3,14]. These lower range of values are closer to values of 50.7 reported in Iran; 59.2 reported in the Baluchi ethnic group and 69.7 reported in the Sistani group [2,38] as well as those reported in Afro American 79.7, North America 62.1 and Korea America 68.5 [38], 79.56 was demonstrated in the Chinese and 81 in Malaysia [39]. The later however was done in a much younger age- group.

It has been reported that the shape of the nose is influenced by the environmental, climatic conditions, race, tribe etc [40,41]. The colder and drier the climate, the narrower the nose and the warmer and moister the climate, the broader the nose [42]. The studied ethnic groups fall within the platyrrhine type of nose which had been described as generally prevalent in the African continent [40]. Our report is similar to the demonstrated NI of other Nigerian ethnic groups which includes for example Ejagham in Cross river state [43], the Urhobos' Itsekiris' [34], Tiv, Idomas' [35], Isokos' in Delta state [17], the Yorubas', Ijaws, the Okirikas in Rivers state [15,44], the Bini ethnic group [36] etc This however, is contrary to a study by Oladipo et al. 2009 who reported the mesorrhine nose type in the Adoni ethnic group of Rivers State [15].

It is of note that varying values may be obtained in same tribe depending on the measuring tools utilized. For example, past studies done on nasal dimensions and indices in the Igbo ethnic group, shows varying figures. In the study done on Igbo ethnic group by Akpa et al and Eliakin-Ikechukwu

et al, tape rule was used [31,33]. Olotu J et al and Oladipo GS et al in their study used sliding caliper for obtaining their measurements [45,46]. Our study, carried out with computerized tomography scan, a cross-sectional, reproducible, imaging tool, has a superior advantage of precision, compared to the other methods. Additionally a dedicated maxillofacial CT using Sn100-kVp with ultra-low-dose protocol has been demonstrated to maintain image quality for diagnosis with much significant reduction in radiation dose especially in cases of craniofacial trauma [47]. However from our knowledge this is the first study of Nasal, Orbital Indices and dimensions in the south east and south southern Nigeria using CT scan.

## 5. CONCLUSIONS

There is sexual dimorphism in the nasal, orbital indices and volume amongst the Igbo-, Calabari- and Ogoni- ethnic groups of Port-harcourt, Rivers state, Nigeria. Although their mean nasal indices were significantly different, there is no significant difference in their orbital indices. The ethnic groups has the microseme and platyrrhine categories with the Igbos having the highest nasal index. Normative values has been established. Findings from this study will be very relevant for reference in reconstructive facial surgeries, rhinology and rhinoplasty, forensic medicine, oncology, clinical diagnosis, and anthropology in classification of fossil remains, in years to come.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

Ethical clearance for this study was obtained from the health research ethics committee of our institution.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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