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# Morphometric Evaluation of Frontal and Maxillary Sinuses and Bizygomatic Distance of Igbos In South-East and Ogonis in South-South Nigeria Using Computerized Tomography Scan

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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:** Radiological identification is important in clinical, surgical and forensic medicine particularly in the absence of comparative deoxyribonucleic Acid **(**DNA) samples and fingerprints. Aim is to establish the morphometry of frontal sinus (FS), maxillary sinus (MS) and bizygomatic distance (BZD) and their relationship with age and gender in Igbos and Ogonis of Nigeria using computed tomography (CT).
**Methods:** Head CT scans of 625 subjects (477 Igbos and 148 Ogonis) between 18 and 85 years, showing normal FS, MS and BZD, were measured using DICOM viewer software. The Igbos and Ogonis were 247 males and 230 females; 84 males and 64 females respectively. The height, width and depth of the sinuses, intermaxillary sinus distances (IMD) and BZD were measured in centimeters (cm). The data were analyzed using SPSS version 20 and difference between groups

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was obtained using one way ANOVA. P-value less than 0.05 was considered as statistically significant.

**Results:** Mean values for the right and left MS volume for the Igbos are 13.79 ±10.91 and 13.81±11.03 and for the Ogonis 20.84±5.83 and 20.19±5.59 cm respectively. All FS dimensions are higher in the Igbos (P<0.001) except right FS depth. Mean IMD are 3.64±0.50 and 3.39±0.45 cm in the Igbos and Ogonis respectively (P<0.001). Ogonis have higher BZD (P>0.05). In both groups, males had larger values in both FS depth, MS dimensions and BZD (P<0.001). Age correlated positively with left FS height and IMD. Prevalence of unilateral FS aplasia was 3.35% on the right and 1.47% on the left among the Igbos while the Ogonis have 2.03% on the right and 2.70% on the left. Bilateral FS aplasia was 2.94% among the Igbos but not observed among the Ogonis.

**Conclusion:** Normative values is established. Ethnic differences exists with Igbos significantly having higher values of FS and IMD while in the Ogonis, the MS dimensions are higher. These findings would act as a guide for facial reconstructive surgeries, forensic experts and classification of fossil remains in anthropology.

*Keywords: Maxillary sinus; morphometric evaluation; frontal; computerized tomography scan; radiological.*

## 1.INTRODUCTION

The Igbos and Ogonis are major tribes in Enugu, South East and Rivers, South South, Nigeria respectively. The sinuses are outgrowth- hollow spaces from the nasal cavity. They are located in the skull and facial bones adjacent to the nose. Their functions and importance includes reducing the heaviness of the skull, warming and humidifying inhaled air, aids in speech, and protection of the delicate structures in the brain in cases of facial injury as well as aiding in human identification. Morphometric evaluation of FS, MS, IMD, BZD help in distinguishing features between various races and ethnic groups thereby aiding in identification in cases of body mutilated. Additionally their evaluation is very valuable in clinical diagnosis, plastic and reconstructive surgery, orthodontics and forensic medicine [1,2,3]. CT, a multiplanar, precise, imaging modality, plays a descriptive crucial role in the study of craniofacial structures etc. especially in the absence of comparative DNA samples and fingerprints [4-7]. There is paucity of data of these essential parameters with the use of CT in our environment, hence the purpose of this study.

## 2.MATERIALS AND METHODS

Inclusion criteria are adults from 18 years of age, well-positioned head CT images and patients with head pathologies not affecting the sinuses/face. The exclusion criteria were head or paranasal sinus CT images with any pathology such as midfacial injuries, tumors, evidence of previous sinus/facial surgery, facial asymmetry or orthodontic treatment. Head CT images of 625 subjects (477 Igbos, 148 Ogonis) of both genders, obtained in radiological centers in Enugu state and those of Port Harcourt, Rivers state, all in Nigeria were evaluated. Images of subjects 18-85 years of age, from 2018-2019 showing normal frontal sinus, maxillary sinus and bizygomatic distance were utilized.

Measurement were obtained using Head CT images obtained from GE (64 slice) multidetector spiral CT scanner, personal computer and computer software with an inbuilt caliper example DICOM viewer software. The images were reconstructed to either axial or coronal sections to reveal the desired parameter of choice. Dimensions such as the height (H), width (W) and depth (D) of frontal sinus (FS) and maxillary sinuses (MS) were measured and the intermaxillary sinus distance (IMD) and bizygomatic distance (BZD) were measured directly on computer console using measuring tools available in the inbuilt software. All the parameters were reconstructed in a bone window view and measured in centimeter (cm).The convenient sampling technique was used for the study.

Medial-lateral (width) and anterior-posterior (depth) measurements are made in the same plane and height is measured in a different plane on both sides [8] as shown in Fig. 1 below.

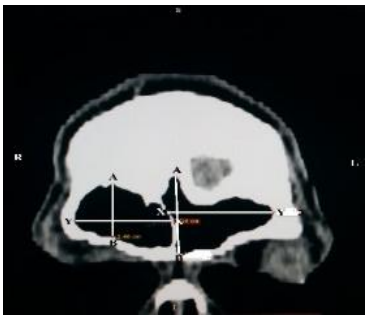

**Fig. 1. CT coronal reconstructed image showing points of measurement of FSH (A-B) and FSW (X-Y)**

The frontal sinus depth (FSD) was measured on the axial reconstructed image as the distance from the most anterior point (A) to the most posterior point (B) of both sides [8] as shown in Fig. 2 below.

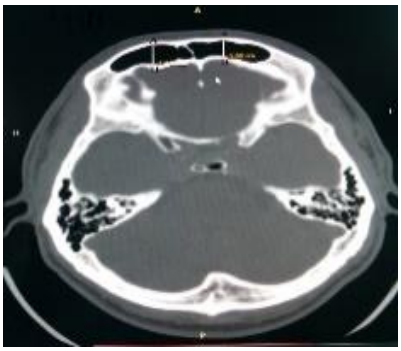

**Fig. 2. CT axial reconstructed image showing points of measurement of FSB (A-B)**

On a coronal image**,** the maxillary sinus height (MSH) was measured as the longest distance from the highest point of the sinus roof (A) to the lowest point of the sinus floor (B), on both sides [9] as shown in Fig. 3 below.

**Fig. 3. CT coronal reconstructed image showing points of measurement of MSH (A-B)**

On an axial CT image, the maxillary sinus depth (MSD) was measured on axial reconstructed image as the longest distance from the most anterior point (A) to the most posterior point (B) on both sides of the maxillary sinus while the maxillary sinus width was measured as the longest perpendicular distance from the medial wall (X) of the sinus to the outermost point of the lateral wall of the lateral process (Y) on both sides of the maxillary sinus [9] as shown in Fig. 4 below.

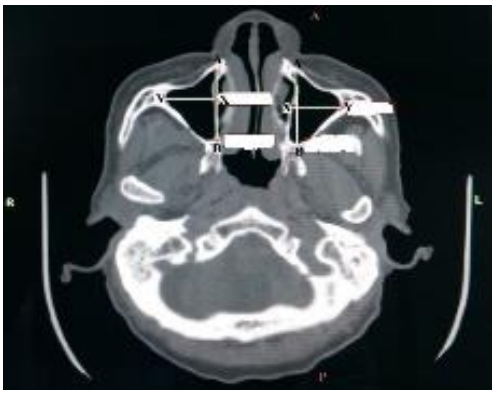

**Fig. 4. CT axial reconstructed image showing points of measurement of MSW (X-Y) and MSD (A-B)**

Intermaxillary distance: IMD was measured on axial reconstructed image as the maximum distance between medial walls of right maxillary sinus (X) and medial wall of left maxillary sinus (Y) [10] as shown in Fig. 5 below.

**Fig. 5. CT axial image showing points of measurement of Intermaxillary distance (X-Y)**

Bizygomatic distance**:** BZD was measured on axial reconstructed image as the maximum distance between the most prominent points on the right zygomatic arch (X) and left zygomatic arch (Y) [5,10] as shown in Fig. 6 below.

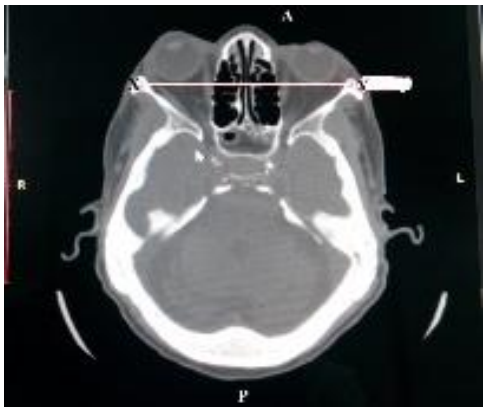

**Fig. 6. CT axial image showing points of measurement of Bizygomatic Distance (X-Y)**

Data Analysis was done using Statistical Package for Social Science (SPSS) version 20. Statistical difference between groups was analyzed using one way ANOVA (Analysis of variance). P-values less than 0.05 were considered as statistically significant.

## 3.RESULTS

A total of 625 CT images were evaluated for this study. In the study population, 76.32% were Igbos while 23.68% were Ogonis. Frequency distribution of the population based on gender is presented in Table 1 below.

**Table 1. Frequency distribution of the population based on gender**

| Gender | Igbo | Ogoni | Both |
|---|---|---|---|
| Males | 247 | 84 | 331 |
| Females | 230 | 64 | 294 |
| Both | 456 | 148 | 625 |

Frequency distribution of the population based on Age is shown in Table 2 below

**Table 2. Frequency distribution of the population based on Age**

| Age- group (years) | Frequency | % Frequency |
|---|---|---|
| < 20 | 74 | 11.8 |
| 20-29 | 115 | 18.4 |
| 30-39 | 105 | 16.8 |
| 40-49 | 122 | 19.5 |
| 50-59 | 132 | 21.1 |
| 60-69 | 61 | 9.8 |
| 70-79 | 8 | 1.3 |
| >80 | 8 | 1.3 |
| Total | 625 | 100 |

The Igbos have higher FS dimensions p<0.001 (except FSD) and IMD values than the Ogonis . The Ogonis have higher MS dimensions p=0.001 and BZD values as shown in Table 3 below.

**Table 3. Mean distribution of the FS and MS dimensions, IMD and BZD of Igbos and Ogonis**

| Parameters | Igbo | Ogoni | P-value |
|---|---|---|---|
| LT. FSH (cm) | 2.31±1.13 | 1.47±0.59 | 0.001** |
| LT. FSW (cm) | 2.31±0.95 | 1.95±0.63 | 0.001** |
| LT. FSD (cm) | 0.96±0.37 | 0.86±0.29 | 0.003** |
| RT.FSH (cm) | 2.17±1.10 | 1.49±0.53 | 0.001** |
| RT.FSW (cm) | 2.35±0.98 | 1.93±0.65 | 0.001** |
| RT.FSD (cm) | 0.92±0.37 | 0.88±0.36 | 0.306 |
| LT.MSH (cm) | 2.69±1.63 | 3.84±0.41 | 0.001** |
| LT.MSW (cm) | 1.89±1.22 | 2.75±0.55 | 0.001** |
| LT.MSD (cm) | 2.90±1.73 | 3.79±0.43 | 0.001** |
| LT.MSV ($cm^3$) | 13.81±11.03 | 20.19±5.59 | 0.001** |
| RT.MSH (cm) | 2.69±1.64 | 3.84±0.43 | 0.001** |
| RT.MSW (cm) | 1.89±1.21 | 2.77±0.46 | 0.001** |
| RT.MSD (cm) | 2.90±1.72 | 3.85±0.40 | 0.001** |
| RT.MSV ($cm^3$) | 13.79±10.91 | 20.84±5.83 | 0.001** |
| IMD (cm) | 3.64±0.50 | 3.39±0.45 | 0.001** |
| BZD (cm) | 10.33±0.42 | 10.38±0.45 | 0.199 |

***Significant at P<0.01*
**Significant at P<0.05*

Males have higher values FS and MS dimensions, IMD and BZD significant in FS and MS dimensions and BZD (p=0.001) as shown in Table 4.

Table 5 below shows that only the left FSH is statistically significant (P<0.05) among the age groups.

Table 6 below shows that FSH (p<0.05) and FSW showed a positive correlation with age.

IMD showed statistical significant positive correlation with age while BZD showed statistical non-significant positive correlation with age as demonstrated in Table 7.

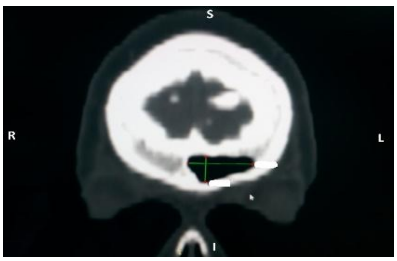


**Fig. 7. CT image of Unilateral FS aplasia**


**Fig. 8. CT image of bilateral FS aplasia**

The Igbos had higher prevalence of right frontal sinus aplasia (3.35%) while the Ogonis had higher prevalence of left frontal sinus aplasia (2.70%). Also the females have higher prevalence of left frontal sinus aplasia in both Igbos (1.26%) and Ogonis (2.03%) Fig. 9.

The Igbos have 2.94% prevalence of bilateral frontal sinus aplasia (females 1.68% > males 1.26%) while among the Ogonis, there was no such occurrence as shown in Table 8.

**Table 4. Mean distribution of FS and MS dimensions, IMD and BZD of Igbos and Ogonis based on gender**

| Parameters | Male (331) | Female (294) | P-value |
|---|---|---|---|
| LT. FSH (cm) | 2.17±1.09 | 2.03±1.08 | 0.126 |
| LT. FSW (cm) | 2.26±0.95 | 2.18±0.82 | 0.258 |
| LT. FSD (cm) | 0.98±0.38 | 0.89±0.37 | 0.003** |
| RT.FSH (cm) | 2.08±1.08 | 1.92±0.97 | 0.060 |
| RT.FSW (cm) | 2.30±0.99 | 2.19±0.85 | 0.177 |
| RT.FSD (cm) | 0.95±0.40 | 0.87±0.31 | 0.005** |
| LT.MSH (cm) | 3.19±1.39 | 2.70±1.62 | 0.001** |
| LT.MSD (cm) | 3.33±1.42 | 2.88±1.69 | 0.001** |
| LT.MSW (cm) | 2.25±1.08 | 1.92±1.22 | 0.001** |
| LT.MSV ($cm^3$) | 16.83±10.28 | 13.64±10.22 | 0.001** |
| RT.MSH (cm) | 3.18±1.40 | 2.72±1.63 | 0.001** |
| RT.MSD (cm) | 3.34±1.41 | 2.88±1.69 | 0.001** |
| RT.MSW (cm) | 2.26±1.07 | 1.92±1.20 | 0.001** |
| RT.MSV ($cm^3$) | 17.05±10.42 | 13.68±10.07 | 0.001** |
| IMD (cm) | 3.61±0.51 | 3.55±0.49 | 0.101 |
| BZD (cm) | 10.45±0.44 | 10.21±0.38 | 0.001** |

***Significant at P<0.01*
**Significant at P<0.05*

**Table 5. Mean distribution of FS and MS dimensions, IMD and BZD according to age groups**

| Parameters | < 20 (yrs) | 20-29 (yrs) | 30-39 (yrs) | 40-49 (yrs) | 50-59 (yrs) | 60-69 (yrs) | 70-79 (yrs) | 80≥ (yrs) | P-value |
|---|---|---|---|---|---|---|---|---|---|
| LT.FSH (cm) | 2.03±1.25 | 1.91±0.92 | 1.95±1.05 | 2.10±1.03 | 2.29±1.17 | 2.38±1.10 | 2.51±0.47 | 2.50±1.20 | 0.027* |
| LT.FSW (cm) | 2.24±0.99 | 0.95±0.31 | 2.15±0.86 | 2.05±0.84 | 2.37±0.96 | 2.27±0.91 | 2.54±0.62 | 2.32±0.72 | 0.195 |
| LT.FSD (cm) | 0.98±0.45 | 0.95±0.31 | 0.88±0.34 | 0.90±0.35 | 0.95±0.37 | 0.95±0.35 | 0.94±0.28 | 1.11±0.37 | 0.440 |
| RT.FSH (cm) | 1.97±1.15 | 1.84±0.99 | 2.02±0.93 | 1.99±1.03 | 2.05±1.08 | 2.18±1.06 | 2.28±0.78 | 2.64±1.03 | 0.383 |
| RT.FSW (cm) | 2.20±1.04 | 2.22±0.87 | 2.34±0.84 | 2.22±0.92 | 2.21±0.97 | 2.28±1.10 | 2.56±1.04 | 2.42±0.78 | 0.916 |
| RT.FSD (cm) | 0.93±0.41 | 0.92±0.31 | 0.91±0.32 | 0.84±0.32 | 0.93±0.45 | 0.93±0.37 | 1.02±0.39 | 1.12±0.26 | 0.343 |
| LT.MSH (cm) | 3.12±1.63 | 3.01±1.57 | 3.04±1.53 | 3.05±1.43 | 2.73±1.57 | 2.95±1.24 | 2.69±1.72 | 2.37±1.98 | 0.497 |
| LT.MSD (cm) | 3.16±1.62 | 3.07±1.59 | 3.17±1.55 | 3.20±1.46 | 3.00±1.71 | 3.25±1.31 | 3.02±1.87 | 2.35±1.99 | 0.810 |
| LT.MSW (cm) | 2.20±1.21 | 2.15±1.18 | 2.14±1.18 | 2.09±1.05 | 1.98±1.25 | 2.08±0.97 | 2.15±1.39 | 1.51±1.29 | 0.740 |
| LT.MSV ($cm^3$) | 17.44±11.78 | 16.01±11.03 | 16.10±10.48 | 14.96±9.15 | 14.14±10.34 | 13.89±9.12 | 15.68±10.91 | 11.01±10.09 | 0.286 |
| RT.MSH (cm) | 3.08±1.60 | 3.02±1.56 | 3.06±1.56 | 3.07±1.44 | 2.76±1.60 | 2.87±1.24 | 2.62±1.69 | 2.45±2.05 | 0.583 |
| RT.MSD (cm) | 3.14±1.59 | 3.10±1.58 | 3.15±1.55 | 3.23±1.46 | 3.02±1.72 | 3.27±1.30 | 2.92±1.90 | 2.41±2.03 | 0.836 |
| RT.MSW (cm) | 2.11±1.15 | 2.17±1.17 | 2.20±1.19 | 2.10±1.06 | 1.97±1.22 | 2.05±0.92 | 2.19±1.43 | 1.71±1.47 | 0.767 |
| RT.MSV ($cm^3$) | 16.35±10.99 | 16.23±10.57 | 16.77±11.09 | 15.40±9.49 | 14.43±10.56 | 13.30±8.71 | 15.55±11.93 | 13.20±12.20 | 0.417 |
| IMD (cm) | 3.55±0.42 | 3.50±0.52 | 3.56±0.54 | 3.61±0.49 | 3.62±0.51 | 3.67±0.49 | 3.67±0.44 | 3.44±0.32 | 0.388 |
| BZD (cm) | 10.30±0.40 | 10.31±0.41 | 10.43±0.42 | 10.36±0.42 | 10.32±0.48 | 10.30±0.43 | 10.33±0.32 | 10.11±0.25 | 0.286 |

**Significant at p<0.05*

**Table 6. Correlation analysis between frontal sinus dimensions and age**

| Parameters | Age | LT.FSH | LT.FSW | LT.FSD | RT.FSH | RT.FSW | RT.FSD |
|---|---|---|---|---|---|---|---|
| Age | 1 | 0.119** | 0.033 | -0.022 | 0.061 | 0.008 | -0.006 |
| LT.FSH | 0.119** | 1 | 0.627** | 0.593** | 0.670** | 0.413** | 0.464** |
| LT.FSW | 0.033 | 0.627** | 1 | 0.605** | 0.358** | 0.373** | 0.434** |
| LT.FSD | -0.022 | 0.593** | 0.605** | 1 | 0.523** | 0.478** | 0.613** |
| RT.FSH | 0.061 | 0.670** | 0.358** | 0.523** | 1 | 0.666** | 0.537** |
| RT.FSW | 0.008 | 0.413** | 0.373** | 0.478** | 0.666** | 1 | 0.574** |
| RT.FSD | -0.006 | 0.464** | 0.434** | 0.613** | 0.537** | 0.574** | 1 |

***Significant at P<0.01*
**Significant at p<0.05*

**Table 7. Correlation analysis between MS dimensions, IMD, BZD and Age**

| Parameters | Age | LT. MSH | LT. MSD | LT. MSW | LT. MSV | RT. MSH | RT. MSD | RT. MSW | RT. MSV | IMD | BZD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | -0.051 | 0.010 | -0.033 | -0.088* | -0.054 | 0.013 | -0.035 | -0.084* | 0.100* | 0.020 |
| LT. MSH | -0.051 | 1 | 0.953** | 0.905** | 0.865** | 0.974** | 0.950** | 0.911** | 0.845** | -0.106** | 0.092* |
| LT. MSD | 0.010 | 0.953** | 1 | 0.896** | 0.834** | 0.945** | 0.979** | 0.910** | 0.820** | -0.087* | 0.067 |
| LT. MSW | -0.033 | 0.905** | 0.896** | 1 | 0.916** | 0.902** | 0.896** | 0.948** | 0.865** | -0.230** | 0.107** |
| LT. MSV | -0.088* | 0.865** | 0.834** | 0.916** | 1 | 0.840** | 0.810** | 0.876** | 0.921** | -0.218** | 0.175** |
| RT. MSH | -0.054 | 0.974** | 0.945** | 0.902** | 0.840** | 1 | 0.956** | 0.925** | 0.879** | -0.118** | 0.105** |
| RT. MSD | 0.013 | 0.950** | 0.979** | 0.896** | 0.810** | 0.956 | 1 | 0.919** | 0.839** | -0.094* | 0.060 |
| RT. MSW | -0.035 | 0.911** | 0.910** | 0.948** | 0.876** | 0.925** | 0.919** | 1 | 0.925** | -0.225** | 0.121** |
| RT. MSV | -0.084* | 0.845** | 0.820** | 0.865** | 0.921** | 0.879** | 0.839** | 0.925** | 1 | -0.222** | 0.199** |
| IMD | 0.100* | -0.106** | -0.087* | -0.230** | -0.218** | -0.118** | -0.094* | -0.225** | -0.222** | 1 | 0.255** |
| BZD | 0.020 | 0.092* | 0.067 | 0.107** | 0.175** | 0.105** | 0.060 | 0.121** | 0.199** | 0.255** | 1 |

***Significant at P<0.01*
**Significant at P<0.05*

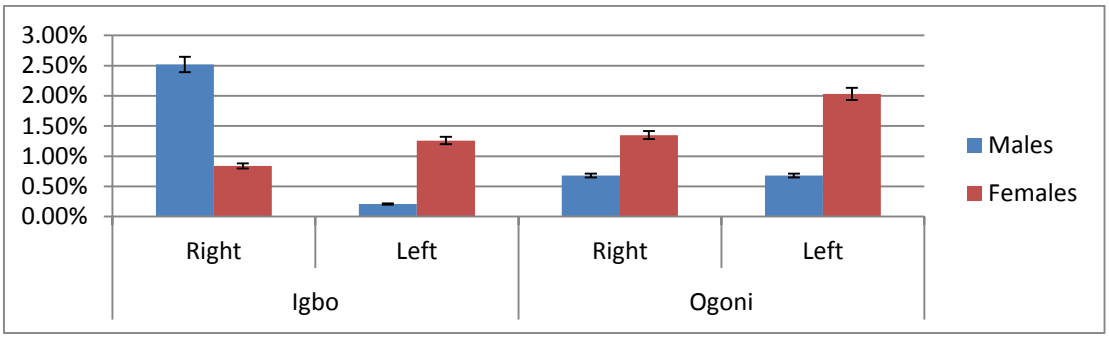


**Fig. 9. Prevalence of unilateral frontal sinus aplasia amongst Igbos and Ogonis**

**Table 8. Prevalence of Bilateral Frontal Sinus Aplasia amongst Igbos and Ogonis**

| Ethnic Group | Males | Females | Both |
|---|---|---|---|
| Igbo | 1.26% | 1.68% | 2.94% |
| Ogoni | - | - | - |

## 4.DISCUSSION

CT scan, a multiplanar imaging, offers precise details regarding the anatomy of the sinuses and its variations, which is an essential prerequisite before surgery and also for anthropometry. Studies have shown that craniofacial dimensions vary among different ethnic and racial groups [11-14]. Ethnic differences was observed with the Igbos have higher FS dimensions (except FSD) and IMD values than the Ogonis while the Ogonis have higher MS dimensions and BZD values than the Igbos. This suggests that the two tribes have different body stature which could be as a result of differences in nutrition and/or weather conditions of the two ethnic groups: the Ogonis are in the tropical rainforest area of Nigeria while the Igbos are in the tropical savannah area. Additionally, a combination of other factors like genetic and environmental factors, difference in osteoclastic and osteoblastic activities as well as pneumatization process of FS etc affect its dimensions [15-19].

The differences in the values of the sinuses between population from South East and those of South South Nigeria reported in this study, is in line with earlier reports that demonstrated significant differences in some body morphometry of individuals from different regions of the country. For example, MS dimensions of different populations of Nigeria as well as other countries have been reported with varying values derived from CT scan [6,20-22].

This study shows that there is sexual dimorphism with most of the FS, MS, IMD and BZD dimensions higher in males with MS and BZD significant. This is similar to other reports [5,10,23-28] but contrary to study by Ariji et al which reported no significant difference between the genders [21]. Our study shows that generally, the left FS has higher dimensions than the right which is similar to other reports [29-32], but in contrast to another study done in India in which the right FS has higher values [27]. Furthermore, this study shows a positive correlation between left FS height and age. This suggests that the left FSH continues pneumatization with age, while another report observed that at about 49 years of age, the value of the FS in females increases while that of men reduces [30]. Yet another noted that this sinus stops developing at 18 years of age [33].

Researchers has reported prevalence of unilateral FS aplasia from as low as 0.73% to as high as 58% [34,35], although the former values were obtained by dental volumetric tomograph. This present study shows a prevalence of unilateral FS aplasia in both the Igbos and Ogonis similar to other reports [34,36,37], but contrary to other works which noted bilateral aplasia to be more prevalent [35,38]. While the Igbos have a higher prevalence on the right, the Ogonis have higher prevalence on the left. The findings in the Igbo tribe is similar to that in India and Saudi Arabia [38,39], while that of the Ogonis are closer to that reported in Osun state, Nigeria [35]. Bilateral FS aplasia ranging from as low as 0.73% to as high as 50% has been reported [34-39]. The value of 2.94% found in the Igbo population is close to that of a study in Saudi Arabia which reported incidence of 3.3%

but contrary to that demonstrated in western part of Nigeria and also in India that showed an incidence as high as 50% [35,38]. Absence of bilateral FS aplasia is noted in the Ogonis which is similar to report in Turkey population [29]. The higher prevalence of bilateral FS aplasia in females in this study has similarity to another report [36]. However, this is in contrast to study by Al-Balas HI et al in which males showed higher prevalence [37].

With regards to MS dimensions, this study showed significant difference between the ethnic groups with the Igbos having smaller dimensions. However, the dimensions in the Igbos are close to the values reported in Osun and Sokoto states of Nigeria [35,40]. The values of the Ogonis are similar to that reported in the Indian population [16]. These differences in values may also be as a result of differences in methodology used for each study. This study showed significant gender difference with the males having higher MS dimensions however, in another researches, no significant difference between MS in males and female was observed [21,41]. The right MS is larger than the left from our findings. This has a similarity with a past report [9] but different from another report that noted left MS to be larger than the right [30,40].

Ethnic difference is also observed with IMD as the Igbos in this study, are observed to have significantly higher IMD. No gender difference was observed. This is similar to another report [41]. We observed a significant positive correlation between IMD and age. This suggests that the MS volume can be used in estimation of age.

With regards to BZD, there is no difference between these two ethnic groups. This could be attributed to the fact that the two ethnic groups are from the same race. They have been characterized as having mesocephalic head shape with receded zygomas and wide nasal aperture [42]. Furthermore, our study found no correlation between BZD and age which suggests no reduction or increase in BZD despite loss of minerals in the bone matrix of the elderly. This is similar to another research carried out in another part of Eastern Nigeria [42].

## 5.CONCLUSION

Normative values is established. Ethnic differences exists with Igbos significantly having higher values of FS and IMD while in the Ogonis, the MS dimensions are higher. The Igbos have higher prevalence of right frontal sinus aplasia while the Ogonis have higher prevalence of left frontal sinus aplasia. Left frontal sinus height and intermaxillary sinus distance increases with age. Frontal sinus depth, maxillary sinus dimensions and bizygomatic distance are sexually dimorphic. Normative values are established. The overall knowledge from this study will add value to certain surgical procedures and also broaden anthropometric knowledge.

## CONSENT

Informed consent was sent to each of the radiological centers where study was done.

## ETHICAL APPROVAL

Ethical clearance with protocol number 075/08/2019 was obtained from our institution.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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