Computed Tomographic Evaluation of Patients with Sinonasal Diseases in Maiduguri, North-Eastern Nigeria

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ABSTRACT

Background: Paranasal sinuses (PNS) are air-filled spaces which surround the nasal cavity. Sinonasal diseases (SNDs) are various pathologies ranging from inflammatory to benign and malignant neoplasms of the PNS and nasal cavity. Rhinosinusitis (RS) is the most frequent SND and its prevalence in the general population is relatively high, worldwide. **Objective:** To evaluate the computed tomographic findings of patients with SNDs in Maiduguri, North-eastern Nigeria. **Methods:** This was a retrospective study on CT scans of patients with SNDs who were referred to the Department of Radiology, Federal Neuro-psychiatric Hospital Maiduguri and State Specialist Hospital Maiduguri for computed tomography (CT) scans of PNS from January 2019 to December 2022. Data were retrieved and recorded from archives of the Departments which include age, sex, clinical presentations and CT findings. Data were analysed using IBM SPSS version 23. **Results:** The CT scans of one hundred and forty-six patients were reviewed; the majority of them being adolescents and young adults, with a mean age of 34.6 ± 16.1 years and a male-to-female ratio of 1.8:1. The commonest clinical presentation was nasal obstruction and inflammatory SNDs were the most frequent subgroup of aetiology. Mucosal thickening was the most frequent CT finding, and the most common CT diagnosis was RS. The maxillary sinus was the site that was mostly involved. Also, the lesions of SNDs were mostly multiple and bilateral. **Conclusion:** SNDs are common health conditions and the findings in this study showed that CT was a useful diagnostic tool. CT also helped to establish the extent of disease making it easier for preoperative preparation in case of surgical intervention. Rhinosinusitis was the most common inflammatory SND in this study.

Keywords: Computed tomography, Paranasal sinus, Sinonasal disease, Inflammatory, Rhinosinusitis, Polyposis

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Date Submitted 4th December 2023
Date Accepted 21th April 2024
Date Published online 30th June 2024

Access this article online	
QuickResponse Code	website:www.bornomedicaljournal.com
	DOI: 10.31173/bomj.bomj_2401_21

Introduction

The paranasal sinuses (PNS) are four paired, connected, air-filled spaces which surround and relate to the nasal cavity (NC).[1,2] Sinonasal diseases (SND) are conditions that affect the PNS and NC and encompass a broad range of abnormalities ranging from inflammatory pathologies to benign and malignant tumours.[2,3] Of the 2.7 million outpatient consultations for ENT disorders per year in England and Wales, sinonasal disease is thought to account for at least 120,000 visits per year.[4] Inflammatory pathologies were the most frequently diagnosed SND with sinusitis being the most common.[5,6] Rhinosinusitis (RS) refers to the inflammation of the mucous membrane of the PNS and NC, it accounts for a significant health problem worldwide with a prevalence of about 12 - 16% in the US population.[7,8] The Prevalence of RS reported from South-western Nigeria was 8.3% and it affected the quality of life in 81% of the studied population.[9] Rhinosinusitis commonly presents as a chronic condition and is often recurrent. The condition accounts for a high number of otorhinolaryngology outpatient visits, leading to a low quality of life and productivity with

a high cost of treatment.[8,10,11] Diagnostic imaging is usually employed in cases of recurrent and/or complicated SNDs to confirm the diagnosis, localize and determine the extent of the disease, look out for complications, and identify anatomical variations.[11,12] The imaging modalities employed for evaluating SNDs include conventional radiography, computed tomography (CT) scan and magnetic resonance imaging (MRI). However, a CT scan is the best imaging modality in evaluating patients with SND especially inflammatory conditions such as RS, sinonasal (SN) polyposis and SN tumours as it gives a cross-sectional view detailing the complex anatomic relationship of the PNS and NC and the surrounding tissues.[2,5,7,8,10,11] CT scan can also show anatomic structures that are not readily visualized by physical examination or diagnostic nasal endoscopy and hence, it is of immense importance to the surgeon in planning for functional endoscopic sinus surgery (FESS).[13] Conventional radiography is commonly the first imaging modality used in evaluating suspected inflammatory SND and it is mostly employed in evaluating acute and uncomplicated RS. However, it has a limitation of superimposition of structures especially in the regions of the ethmoid and sphenoid sinuses with poor delineation of soft tissue components of pathologies and subtle mucosal lesions.[7,9,11,14] MRI has excellent soft tissue resolution and is widely used to assess the extent of soft tissue components of SN tumours, particularly malignant ones but gives poor bony details.[15,16] So, CT and MRI have complementary roles in the management of SN tumours and fungal sinusitis and its IC involvements.[14,16] However, the limited availability and high cost of MRI and the high rate of out-of-pocket payment of healthcare services in low and middle-income countries including Nigeria affect the utilization of the study.[14] Consequently, a CT scan has become the best imaging modality of choice for the evaluation of patients with SNDs in sub-Saharan African settings due to these limitations with the MRI. Previous studies have shown that CT scan has a very high sensitivity, specificity, positive and negative predictive values and accuracy of more than 90% in the diagnosis of SNDs.[1,3,5]

Previous studies on SNDs showed that inflammatory pathologies, especially RS were the most common diagnosis and maxillary sinus was the commonly involved PNS.[1,3,5,16-19] A previous study on CT findings of RS in Maiduguri, North-eastern Nigeria showed that mucosal thickening and engorged turbinates were the most common findings and the maxillary sinus was the most affected one.[18] However, the study was done about two decades ago and used a small sample size of 52 patients. There is a paucity of literature, to the best of our knowledge, on CT findings of SNDs in our environment (North-eastern Nigeria) and this prompted the study. This study aims to evaluate the CT findings of patients with SNDs in Maiduguri, North-eastern Nigeria and bridge the knowledge gap of this condition in the region and Nigeria at large.

Materials And Methods

This retrospective descriptive cross-sectional study was carried out in the Radiology Departments of Federal Neuropsychiatric Hospital (FNPH) Maiduguri and State Specialist Hospital (SSH) Maiduguri, North-eastern Nigeria. Included patients were referred to the radiology departments of these institutions with signs and symptoms of SNDs for CT of the PNS from January 2019 to December 2022. The CT reports were retrieved from the departmental archives where biometric data of the patients and clinical indications were obtained. The CT scans were reviewed from the workstations of the various departments by two experienced consultant radiologists. The CT scanners used for the examination of the patients were a multi-detector 16-slice GE Bright-speed CT scanner at the FNPH and a multi-detector 128-slice GE Bright-speed CT scanner at the SSH, Maiduguri.

One hundred and forty-six patients were included in the study. Information extracted from the records included age, sex, clinical presentation, CT diagnoses, number of lesions (solitary or multiple), side of the lesions, site/region sinus involved, anatomical variants, and complications of the lesions. However, patients with incomplete information and those with previous sinus surgery were excluded from the study.

Ethical approval for the study was obtained from the research and ethical committees of the institutions. Data obtained were recorded in a structured data collection sheet which was subsequently analysed using IBM SPSS Statistics for Windows version 23 (IBM Corp., Chicago, IL, USA). Descriptive statistics were used and results were presented as percentages, mean, ratio, tables, and figures. Chi-square and Fisher's exact tests were used to analyse the relationship between the categorical variables and $p < 0.05$ was considered statistically significant.

Results

CT scans done between January 2019 and December 2022 were reviewed. The age range of the patients was 1 - 67 years with a mean age±SD of 34.6±16.1 years and the modal age group was 11 - 20 years (23.3%) as seen in Table 1. There were 94 (64.4%) males and 52 (35.6%) females with a male-to-female ratio of 1.8:1. The most common clinical indication for CT PNS was nasal obstruction which was seen in 107 cases (73.3%) followed by headache which was observed in 48 cases (32.9%) as shown in Table 2.

The most common CT finding was mucosal thickening seen in 71 cases (48.6%), followed by ostiomeatal complex (OMC) obstruction seen in 65 cases (44.5%) as shown in Table 3. Mucosal thickening was also the most observed finding in cases of RS, accounting for 98%. Sinonasal mass was seen in 70 patients (47.9%) of the study, which was the second most frequent CT finding and it included masses from SN polyposis mainly and tumours. It was mainly seen as a solitary mass in 63 patients (90%); while the remaining 10% of cases were multiple masses. The majority of SN masses were observed as SN polyposes which were seen in 40 patients (57.2%). The bony involvements included sinus wall hyperostosis, erosion/thinning and destruction were observed in 36 patients (24.7%) and were primarily associated with neoplastic and a few inflammatory SNDs. Bony destruction was only seen in SN carcinoma. The most common subgroup of CT diagnosis was inflammatory SND seen in 117 cases (80.1%) and then followed by neoplastic SNDs seen in 19 cases (13.0%); with malignant tumours accounting for 11 cases (7.5%). Table 4 showed that RS was the most common CT diagnosis seen in 64 patients (43.3%), followed by RS with coexisting SN polyposis seen in 32 patients (21.9%). Some cases of RS with SN polyps showed mucosal thickening, complete opacification of the sinus and SN mass (Figure 1). The overall CT diagnosis of RS was seen in 96 cases (65.7%) and that of SN polyposis was 43 cases (29.4%). The majority of cases of RS (60%) were adolescents and young adults (11 - 40 years). Furthermore, RS and SN polyposis and carcinoma were more frequent in the males in the index study. However, the relationship between their CT diagnosis and sex was not statistically significant ($p = 0.288$). Sinonasal mass with extension to adjacent structures was also observed in some cases of SN carcinoma as shown in Figure 2.

Maxillary sinus was the most involved sinus in the study accounting for 126 cases (86.3%), followed by the ethmoid sinus involvement noted in 81 cases (55.5%) as shown in Table 5. Also of note is that there were more males than females in all the involved sinuses. Most of the SNDs in this study were bilateral in 79 cases (54.15%), while the remaining were unilateral, with 35 cases (24%) on the left side and 32 (21.9%) on the right side. The bilateral involvement was majorly observed in all PNS. The majority of cases of RS and SN polyposis were bilateral and unilateral cases were more on the left side (24%). The study revealed the involvement of multiple (two or more) regions of PNS and NC, which accounted for 115 cases (78.8%), while the remaining 21.2% were solitary lesions. The lesions involving the nasal cavity were recorded in 52 patients (35.6%) with most of them associated with PNS lesions. However, only 5 cases (3.4%) had isolated nasal cavity lesions (3 cases of rhinitis and 2 cases of choanal atresia).

Anatomical variations on CT scans were noted in 21 patients (14.4%) of the study population with the most frequent one being nasal septal deviation seen in 14 cases (9.6%). Frontal sinus hypoplasia was seen in 5 patients (3.4%), while concha bullosa was seen in only 2 patients. Chronic mastoiditis was seen in 6 patients (14.1%) of which 5 cases had RS and the remaining case had SN carcinoma.

Extension of SN masses to the adjacent structures was termed complications of CT diagnosis and was observed in 18 patients (12.3%). The most frequent complication of SNDs in this study was orbital involvement which was noted in 9 cases including 3 cases in each of RS and SN carcinoma as shown in Table 6. Nasopharyngeal (NP) and IC involvements were mostly observed in patients with SN carcinoma.

Table 1: Age Group and Sex Distribution of Study Population

Age Group (Years)	Males N (%)	Females N (%)	Total N (%)
1-10	2 (1.4)	3 (2.1)	5 (3.4)
11-20	20 (13.7)	14 (9.6)	34 (23.3)
21-30	18 (12.3)	7 (4.8)	25 (17.1)
31-40	16 (11.0)	11 (7.5)	27 (18.5)
41-50	20 (13.7)	9 (6.2	29 (19.9)
51-60	11 (7.5)	8 (5.5)	19 (13.0)
61-70	7 (4.8)	0 (0.0)	7 (4.8)
TOTAL	**94 (64.4%)**	**52 (35.6%)**	**146 (100%)**

N = Study population

Table 2: Clinical Presentations of Patients with Sex Distribution

Clinical Presentation	Male N	Female N	Total N (%)
Nasal obstruction	74	33	107 (73.3%)
Headache	34	14	48 (32.9%)
Nasal discharge	26	16	42 (28.8%)
Hyposmia/Anosmia	12	13	25 (17.1%)
Sneezing	10	8	19 (13.0%)
Nasal mass	10	4	14 (9.6%)
Epistaxis	7	5	12 (8.2%)
Facial trauma	2	0	2 (1.4%)

Keywords: *N = Study population, CT = Computed tomography*

Table 3: CT Findings with Sex Distribution

CT Finding	Male N	Female N	Total N (%)
Mucosal thickening	49	22	71 (48.6%)
Sinonasal mass	47	23	70 (47.9%)
- Solitary	*45*	*18*	
- Multiple	*2*	*5*	
OMC obstruction	44	21	65 (44.5%)
Engorged turbinate	33	19	34 (23.3%)
Air-fluid level	14	10	24 (16.4%)
Complete opacification	7	7	14 (9.6%)
SW erosion/thinning	9	5	14 (9.6%)
SW hyperostosis	9	3	12 (8.2%)
SW destruction	7	3	10 (6.8%)
SW fracture	2	0	2 (9.6%)

Keywords: *Computed tomography, N = Study population, OMC = Ostiomeatal complex, SW = Sinus wall,*

Table 4: CT Diagnosis with Sex Distribution

CT Diagnosis	Male N	Female N	Total N (%)
Inflammatory			
Rhinosinusitis	43	21	64 (43.8%)
RS & SN polyposis	18	14	32 (21.9%)
SN polyposis	7	4	11 (7.5%)
Invasive fungal sinusitis	3	3	6 (4.1%)
Rhinitis	1	2	3 (2.1%)
Malignant tumour			
SN carcinoma	7	3	10 (6.8%)
Olfactory neuroblastoma	1	0	1 (0.7%)
Benign tumour			
Inverted papilloma	2	1	3 (2.1%)
Fibrous dysplasia	2	1	2 (1.4%)
Sinus osteoma	2	0	2 (1.4%)
SN haemangioma	1	0	1 (0.7%)
NP angiofibroma	0	1	1 (0.7%)
Others			
SN mucocoele	4	1	5 (3.4%)
Choanal atresia	2	1	3 (2.1%)
Facial injury	2	0	2 (1.4%)
Total	**95**	**51**	**146 (100%)**

Key Words: *Computed tomography, N = Study population, CT = Computed tomography, SN=Sinonasal, NP = Nasopharyngeal*

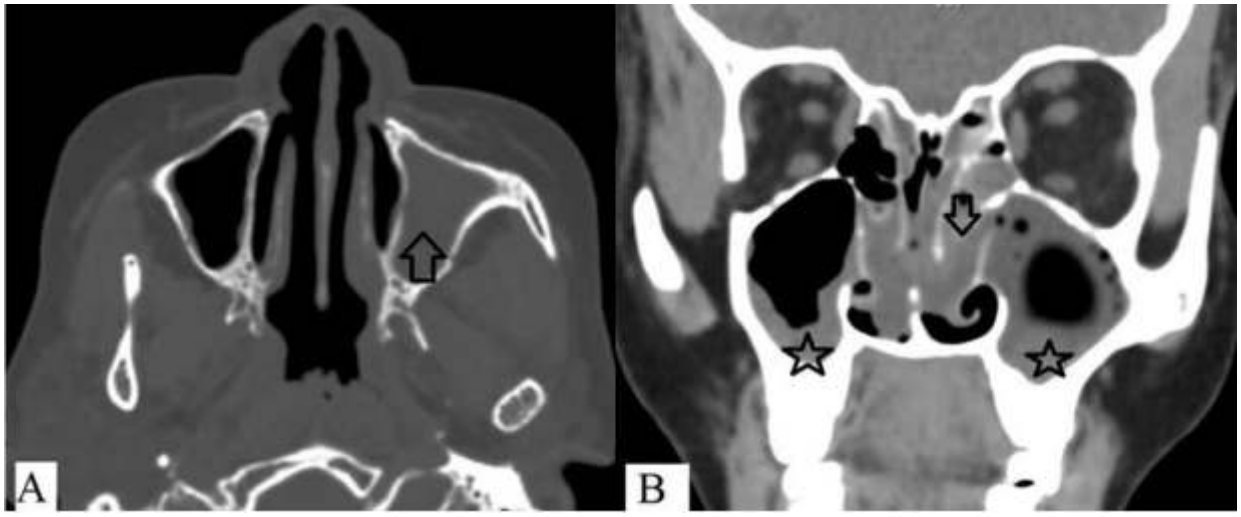

Figure 1(A & B): Axial & coronal reformatted non-contrast (bone window) CT sinuses images showing complete opacification of left maxillary sinus (up arrow), mucosal thickenings (stars) and nasal polyp (down arrow).

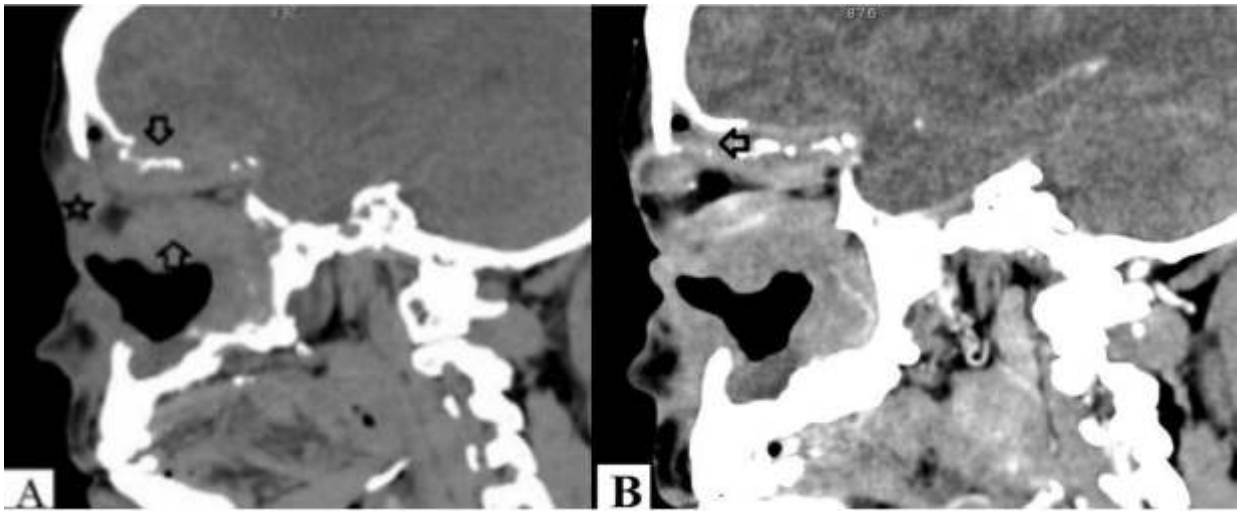

Figure 2(A & B): Coronal reformatted pre-contrast & post-contrast CT sinuses images showing heterogeneously enhanced mass in the maxillary sinus (up arrow) with its extension to the anterior cranial fossa (down arrow), ipsilateral orbital (star) and frontal sinus (side arrow) with adjacent multiple bony destructions.

Table 5: Paranasal Sinus Involved with Sex Distribution

Paranasal sinus	Males N	Females N	Total N (%)
Maxillary	88	38	126 (86.3%)
Ethmoid	52	29	81 (55.5%)
Frontal	32	14	46 (31.5%)
Sphenoid	19	17	36 (24.7%)

N = Study population

Table 6: Distribution of Complications of Sinonasal Diseases with CT Diagnosis

Complications of SND (N)	RS	Fungal Sinusitis	SN Mucocoele	SN Carcinoma	Olfactory Neuroblastoma	Total N
Nasopharyngeal involvement	**-**	**-**	**-**	**4**	**1**	**5**
Orbital	**3**	**1**	**1**	**3**	**1**	**9**
- Mass extension	1	-	-	3	1	5
- Orbital abscess	1	1	-	-	-	2
- Orbital cellulitis	1	0	1	-	-	2
Intracranial	**-**	**-**	**-**	**4**	**-**	**4**
- Skull base destruction	-	-	-	2	-	2
- Subdural abscess	-	-	-	1	-	1
- Dural sinus thrombosis	-	-	-	1	-	1

Keywords: *N = Study population, SND = Sinonasal disease, RS = Rhinosinusitis, SN = Sinonasal*

Discussion

Sinonasal diseases are relatively common health conditions of a wide spectrum based on aetiology ranging from inflammatory to benign and malignant conditions involving the PNS and NC. Inflammatory conditions especially RS are the leading diseases involving the PNS and NC. CT scan is usually the main imaging modality of choice in evaluating these patients for optimal management and serves as a guide for possible surgery.[3] It is preferred over conventional radiography because of its superior anatomical details and cross-sectional capability in both paediatric and adult patients with SNDs; it is mainly used in recurrent and chronic cases, especially in those with inflammatory conditions.[10]

Diagnostic imaging has a vital role in the evaluation of SNDs, choice of treatment and planning for surgical interventions.[12] Some previous studies on RS in Nigeria showed that all patients had CT scans.[21,22] While other studies observed that less than 40% of the patients had CT scans, mostly had plain radiography and the remaining few cases had no imaging studies which may probably be because it was not required or due to its high cost.[8,9] Moreover, previous studies have observed a very high sensitivity, specificity and accuracy of CT scans in the evaluation of SNDs.[1,3,15]

The most frequent age group in this study (11 - 20 years) agreed with that reported by Patil *et al*[19] However, it differed from many studies that observed a higher modal age of 21 - 30 years.[1,3,5,16,18] The mean age in this study was 34.6 years which was in agreement with other studies.[1,14] Majority of our

cases were adolescents and young adults (11 - 40 years) constituting 62% of the study population. This was consistent with a study by Kandukuri *et al*[5] who recorded 64% of their patients in this age group. Male preponderance was seen in this study as reported by previous studies[3,5,16,18,19] but differed from a few previous studies that recorded more females.[1,14]

The most common clinical presentation in this study was nasal obstruction and this is in agreement with a study by Umar *et al*[16] but differed from other previous studies[1,3] that recorded headache as the most frequent presenting complaint. In our study, headache was the second most common clinical presentation. Verma *et al*[23] also reported nasal obstruction (82%), nasal discharge (66%), and headache as the dominant presenting complaints, while Usmani *et al*[1] reported headache as being dominant (77%), with alteration in smell (50%), nasal obstruction and nasal discharge. Kandukuri *et al*[5] and Umar *et al*[16] reported nasal obstruction and discharge as the most common complaints. These differences might be due to the different sample sizes in the studies as well as the different pathological entities in the various studies that constituted the SNDs.

The imaging findings/features of RS include mucosal thickening, sinus opacification, air-fluid level and bony wall sclerosis.[7] Mucosal thickening was the most frequent CT finding and was noted in 80% of patients with RS in this study. This agreed with findings in previous studies by Al-Timimy *et al*[17] and Uwaneme *et al*[21] but differed with a report by Ahmed *et al*[20] who reported a higher value of 80.2% in their study. Sinonasal mass was the second most common finding (48%) in this study but it disagreed with a previous study by Umar *et al*[16] who observed only 30%.

Inflammatory SNDs were the most frequent subgroup of diagnosis in this study and this agreed with almost all previous studies.[1,5,18,19] The most common inflammatory SND in this study was RS. This was in concordance with all previous studies reported in North-western Nigeria, Cameroun and India.[1,5,14,18,19,24] Uwaneme *et al*[21] in a study on chronic RS in Lagos, Southwestern Nigeria showed that CT scan had a better role in characterizing lesions involving the sinuses. This high CT diagnosis of RS is not surprising, especially with the fact that RS is a common condition with a prevalence of 6-15% for the acute stage while chronic RS affects approximately 11% of the population worldwide.[4] There was an agreement between our study and previous studies on RS which reported more cases in male patients and adolescents and young adults,[8,9,20,22] but it differed from a study by Uwaneme *et al*[21] who showed that there were more in females. Then, RS with coexisting SN polyposis was the second most frequent CT diagnosis recorded in this study and this agreed with previous studies by Mannel *et al*[14] in Cameroun and Kandukuri *et al*[5] and Usmani *et al*[1] in India. SN polyposis usually coexists with RS and this was similarly reported in previous studies.[1,5,14] Kandukuri *et al*[5] and Azzam *et al*[6] reported that the most common inflammatory pathology was sinusitis similar to our findings. Chronic RS with nasal polyps is one of the most troublesome subgroups of chronic RS and can significantly impact a person's quality of life.[25]

Neoplasms were the second most frequent subgroup of diagnosis in this study and this was similar to findings observed in previous studies.[1,5,19] In this study, a malignant tumour was the most frequent tumour which was similar to a study by Vaghela *et al*[24] but it was in disagreement with previous studies by Usmani *et al*[1] and Kandukuri *et al*[5] who independently reported more benign tumours. The difference may be due to different ethno-racial and environmental factors of the study populations.

The maxillary sinus was the most commonly involved in the index study and this was in agreement with all previous studies reviewed.[1,3,5,14,18,19,23,24] This might be due to the proximal relationship between the nasal cavity and the maxillary sinus through OMC with the pathologies between the two usually co-existing and commonly preceded by rhinitis. The majority of the lesions involving MS were bilateral in this study and this agreed with a previous study by Handi *et al*[18] in India. The ethmoid sinus is the second most frequently involved sinus in our study and this was similar to most previous studies[3,5,14,18,24] but differed from a study by Usmani *et al*[1] Ugwuani *et al*[26] in a study which showed that RS of maxillary sinus were mostly bilateral and if unilateral, they were more to the left side and this was similar to our findings. Many previous studies on RS showed maxillary sinus was the most frequently involved sinus and then followed by the ethmoid sinus,[8,9,20,21,22] and these observations were in concordance with our findings.

The nasal septal deviation was the most frequent anatomical variation in the index study which was in agreement with a study by Handi *et al*[18] but they reported a higher value of 41.2% compared to 9.6% that we recorded. However, it disagreed with a study by Mannel *et al*[14] who observed concha bullosa as the most frequent one. Frontal sinus hypoplasia and concha bullosa were next encountered anatomical variations after deviated nasal septum in this study. However, this finding also differed from other previous studies.[18,27] These anatomical variations are thought to be important in the pathogenesis of SND. Several studies have established a statistically significant association between these anatomical variations and SNDs.[28-31] Complications of SNDs were reported in our study which includes orbital, IC and pharyngeal involvements of which, orbital

involvement was the commonest one and agreed with a report by Patil *et al*[19]. Similar to our finding, Ahmed *et al*[20] and Tuladhar *et al*[32] reported orbital complications as the most common complication in RS. No intracranial involvement was noted in cases of RS in our study similar to a previous study by Ahmed *et al*[20] in Maiduguri, Nigeria. This may be due to early presentation for treatment or the patients are immuno-competent in our environment.

This study is however not without limitations which included some patients not being able to do CT scan of PNS because of financial constraints; while some had incomplete records in the departmental archives.

Conclusion

Sinonasal diseases (SNDs) are common health conditions seen in otorhinolaryngology and general outpatient departments worldwide including North-eastern Nigeria. Computed tomography (CT) scan is the 'gold standard' imaging modality in evaluating patients with SNDs for diagnosis, illustrating the extent of the lesions, and follow-up. The role of CT in describing and delineating findings of SNDs as well as identifying life-threatening complications and its ability to make aetiology-based diagnosis was documented. This provides information for proper planning of the patients for treatment and follow-up. In this study, RS was the most frequent SND and the maxillary sinus was the most common involved sinus.

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Cite this Article as: Umar UH, Adamu A, Yunusa DM, Farate A, Lawan MM, Ahmadu MS, Ahidjo A, Mustapha Z. Computed Tomographic Evaluation of Patients with Sinonasal Diseases in Maiduguri, North-Eastern Nigeria. **Bo Med J** 2024; 21 (1):7-16 **Source of Support**: Nil, **Conflict of Interest**: None declared