E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.48047/ijprt/16.01.461

Research Article

Anatomical Variations of Nasal Cavity and Frequency of Chronic Sinusitis in Polluted Areas

Naureen Shabbir[1], Junaid Mumtaz[2], Mehak Shafiq[3], Saima Saleem[4], Rahmat Ullah Jan[5], Khalid Shehzad[6]

[1]Senior Lecturer, Department of Anatomy, Margalla Institute of Health Sciences, Islamabad, Pakistan
[2]Post Graduate, Department of Anatomy, Al Nafees Medical College, Islamabad, Pakistan
[3]Assistant Professor, Department of Anatomy, Central Park Medical College, Lahore, Pakistan
[4]Assistant Professor, Department of Anatomy, Federal Medical College, Islamabad, Pakistan
[5]Assistant Professor, Department of Anatomy, Muhammad College of Medicine, Peshawar, Pakistan
[6]Lecturer, Department of Anatomy and Histology, College of Medicine, Qassim University, Saudi Arabia

Corresponding Author: Junaid Mumtaz, Post Graduate, Department of Anatomy, Al Nafees Medical College, Islamabad, Pakistan, Email: www.junaidmumtaz313@gmail.com
Received: 09.02.26, Revised: 24.04.26, Accepted: 07.05.26

ABSTRACT

Background: Chronic sinusitis is an inflammatory disease of the paranasal sinuses that is very prevalent and is related to anatomical and environmental factors. There may also be anatomical differences in the nasal cavity which can constrict the sinus drainage routes and/or polluted air can stimulate irritation and inflammation of the sinuses. These may all be contributing factors to chronic SN symptoms, particularly in urban polluted environments.

Objective: To determine the anatomical variations of the nasal cavity and the frequency of chronic sinusitis among individuals living in polluted areas.

Methods: The study was a descriptive Cross Sectional study conducted in Central Park Medical College, Lahore. The number of 75 people who presented with symptoms suggestive of chronic sinusitis were included using non-probability consecutive sampling. A structured proforma was used to document the demographic details, clinical symptoms, history of exposure and radiological findings. Anatomical variations such as deviated nasal septum, concha bullosa, inferior turbinate hypertrophy, septal spur, Haller cells, paradoxical middle turbinate and osteomeatal complex narrowing were evaluated by CT scan. Chronic sinusitis was defined by a history of symptoms of ≥12 weeks and clinical and radiological evidence. The analysis of the data was done in SPSS version 26. Frequencies and percentages were calculated and Chi-square test was used to evaluate associations. The p-value was set at < 0.05 to indicate statistical significance.

Results: Out of 75 participants, 48 (64.0%) were diagnosed with chronic sinusitis. The most common symptom was nasal obstruction 52 (69.3%), followed by postnasal drip 46 (61.3%), headache 43 (57.3%), and facial pain/pressure 38 (50.7%). The most frequent anatomical variation was deviated nasal septum 39 (52.0%), followed by inferior turbinate hypertrophy 31 (41.3%), narrow osteomeatal complex 28 (37.3%), and concha bullosa 24 (32.0%). Deviated nasal septum, concha bullosa, and narrow osteomeatal complex showed statistically significant association with chronic sinusitis.

Conclusion: Chronic sinusitis was frequent among participants living in polluted areas. Deviated nasal septum, concha bullosa, and narrowing of the osteomeatal complex were the main anatomical variations associated with chronic sinusitis. CT scan evaluation is useful for identifying structural variations that may contribute to chronic sinonasal disease, particularly in individuals exposed to environmental pollution.

Keywords: Anatomical variation, chronic sinusitis, deviated nasal septum, concha bullosa, osteomeatal complex, air pollution, CT paranasal sinuses.

INTRODUCTION

Chronic sinusitis or chronic rhinosinusitis is a chronic inflammatory disease of the nasal cavity and paranasal sinuses. It is typically associated with nasal blockage, nasal discharge or postnasal drip, facial pain and/or pressure, headache and loss of the sense of smell for at least 12 weeks. It can impair functioning in life, affecting breathing, sleep and activities of daily living and work. Chronic sinusitis is now known to be a multifactorial disease, and although infection may be a component of symptoms in some patients, other factors such as mucosal inflammation, anatomic obstruction, environmental exposure, allergy, and host factors may all be important (1, 2).

Proper function of paranasal sinuses relies on normal ventilation and drainage via narrow anatomical pathways, especially the osteomeatal complex. Any structural changes that alter these pathways can disrupt mucociliary clearance and provide an environment where secretions are able to remain and lead to chronic inflammation. Anatomical variations are common and include deviated nasal septum, concha bullosa, septal spur, inferior turbinate hypertrophy, paradoxical middle turbinate, Haller cells, Agger nasi cells, Onodi cells and narrowing of the osteomeatal complex. In some people, these changes may not have any symptoms, though if they affect the sinus drainage pathways, they can be very important (3, 4).

Computed tomography (CT) of the paranasal sinuses is a useful role in the assessment of chronic sinusitis and nasal cavity anatomy. CT scan will give detailed information on mucosal thickening, opacification of the sinuses, involvement of the maxillary, ethmoid, frontal and sphenoid sinuses, and provide information about the obstruction of the osteomeatal complex. It also can be used to identify anatomical variation that may not be well appreciated on routine clinical examination. Thus, in those with persistent symptoms, recurrent sinusitis and suspected structural abnormalities, CT is particularly useful (5, 6).

Chronic sinonasal inflammation may also be caused by other factors such as environmental pollution. The polluted air includes particulate matter, dust, smoke, traffic-related gases, and industrial pollutants which irritate the nasal mucosa. Inhalation of these irritants may lead to a decrease in mucociliary function, a rise in mucosal edema and heightened inflammatory reactions in the nose and paranasal sinuses. People may be more likely to have chronic sinonasal symptoms in urban centers with heavy vehicle and industry traffic (7).

Lahore is one of the major cities of Pakistan, and is often plagued by air pollution from vehicular, industrial and construction dust emissions, and seasonal smog. People exposed to this high pollution may be more likely to be exposed to irritants in the air that can trigger inflammation of the nose and sinuses. If he/she has anatomical narrowing of the nose or drainage pathways of the sinuses, there may be an even greater risk of chronic sinusitis. Anatomical and environmental features are important to consider when faced with patients with chronic sinonasal symptoms (8).

There are several studies that have reported that deviated nasal septum and concha bullosa are some of the most common anatomical variations in the CT scans of patients with chronic rhinosinusitis. These variations do, however, have different clinical implications based on the population, exposure to environmental factors and the degree of obstruction. A minor narrowing of the sinus may be more symptomatic in polluted areas due to the additional effect of inflamed mucosa which will diminish sinus drainage. Thus, the prevalence of these changes and its correlation with chronic sinusitis could give an idea of the pattern of disease in the local context (9, 10).

There are few local data available on the role of the combination of anatomical variations of the nose and polluted environmental exposure in chronic sinusitis. To date, most available studies examine anatomical variations in CT scans, chronic rhinosinusitis or address burden of chronic sinusitis within the population of people who reside in polluted urban environments. A knowledge of this relationship is clinically significant as early detection of anatomical risk factors may help determine the appropriate medical management, environmental management, and referral for specialist evaluation by the otolaryngologist.
The present study was therefore conducted to determine the anatomical variations of the nasal cavity and the frequency of chronic sinusitis among individuals living in polluted areas. The study also aimed to assess the association between selected anatomical variations and chronic sinusitis using clinical and CT-based findings.

METHODOLOGY

This study was a descriptive cross sectional study in a hospital setting to find out the anatomical variations of the nose and its association with the prevalence of chronic sinusitis among the population living in polluted area. The study was carried out at Central Park Medical College, Lahore in which patients with sinonasal complaints were clinically and radiologically assessed. The cross-sectional design was chosen because of the ability to evaluate anatomical variations and the findings of chronic sinusitis at one time in an unchanging sample without any intervention or follow-up.

This study population consisted of patients who were brought to the outpatient department with complaints of chronic rhinosinusitis, and who had lived or regular exposure to polluted environments. There were 75 participants in the study. The sample size was determined by the practicality of recruiting patients over the course of this study, and the number of patients

who met the inclusion criteria. The sampling technique used was non-probability consecutive sampling, in which the patients were selected as long as the necessary sample size was met.

Adults, or those 18 years and older, with a history of chronic sinusitis (defined as nasal obstruction, postnasal drip, facial pain or pressure, headache, diminished sense of smell and recurrent nasal drainage for 12 weeks or more) were eligible for the study. Eligible participants were those who resided in or were frequently exposed to areas of environmental pollution such as those with congestion, industry, dust exposure, smoke exposure, and/or poor air quality. In order to prevent bias in assessment of anatomical variations, patients with previous history of nasal/sinus surgery, facial trauma, sinonasal tumors, acute sinusitis, congenital craniofacial anomalies or incomplete clinical or CT scan records were excluded from the study.

After obtaining permission from the relevant institutional authority, eligible participants were enrolled after explaining the purpose of the study. All participants gave written informed consent prior to data collection. Demographical information such as age, sex, place of residence, exposure history to polluted environment and clinical history was recorded using a structured proforma. Symptoms including nasal obstruction, postnasal drip, headache, facial pain or pressure, impaired sense of smell, recurrent sneezing and duration of symptoms were carefully recorded.

A detailed examination of ear, nose and throat was performed in all the participants. The physician examining the patient filled out the clinical findings. Radiological evaluation was done by computed tomography (CT) of the paranasal sinuses when available and clinically warranted. The CT scan findings were compared for presence of chronic sinusitis and nasal cavity anatomical variations. The anatomical variations evaluated in the study were the deviated nasal septum, concha bullosa, inferior turbinate hypertrophy, septal spur, paradoxical middle turbinate, Haller cells, Agger nasi cells, Onodi cells, narrow osteomeatal complex, and others.

Chronic sinusitis was defined as the presence of sinonasal symptoms for at least 12 weeks, together with clinical examination and/or radiological evidence, including mucosal thickening, sinus opacification, osteomeatal complex obstruction and involvement of one or more paranasal sinuses. The CT findings of maxillary sinus, ethmoid sinus and frontal sinus involvement and sphenoid sinus involvement were evaluated. Additionally, unilateral or bilateral sinus disease was noted. Variations were deemed to exist if they were definitely identified during the CT scan evaluation.

The main outcome variable of the study was the frequency of chronic sinusitis among participants living in polluted areas. Anatomical variations of the nasal cavity such as deviated nasal septum, concha bullosa, narrow osteomeatal complex, inferior turbinate hypertrophy and septal spur were the main independent variables. Other factors included age, gender, years living in polluted regions, clinical symptoms and CT scan characteristics.

To ensure reliability of data collection, the same structured proforma was used for all participants. Clinical and radiological findings were recorded in a uniform manner. Records with data missing were not included in analysis. Codes were used to identify patients, and patient confidentiality was maintained throughout the study. Collected data was solely for research purposes.

The data were entered in SPSS version 26.0 and analysed. For quantitative variables like age, data were expressed as mean and SD. Categorical variables like gender, clinical symptoms, anatomical variations, CT findings and presence or absence of chronic sinusitis were represented as frequencies and percentages. A chi-square test was used to evaluate the relationship between anatomical variation and chronic sinusitis. When the cell counts were small, Fisher's exact test was used. A p-value of < 0.05 was deemed to be statistically significant.

RESULTS

There were 75 participants from polluted areas. Participants' mean age was 34.86 ± 10.42 years with ages ranging from 18 to 60 years. The majority of the participants were 31–40 years old, followed by 21–30 years. Out of 75 participants, 43 (57.3%) were males and 32 (42.7%) were females.

Table 1. Demographic characteristics of study participants

Variable	Frequency (n)	Percentage (%)
Age group		
18–30 years	24	32.0
31–40 years	28	37.3
41–50 years	15	20.0
>50 years	8	10.7
Gender		
Male	43	57.3
Female	32	42.7
Duration of residence in polluted area		
<5 years	18	24.0
5–10 years	31	41.3
>10 years	26	34.7

The most frequent clinical symptoms were nasal obstruction (52, 69.3%), postnasal drip (46, 61.3%), headache (43, 57.3%), facial pain or pressure (38, 50.7%) and decreased smell (29, 38.7%). Chronic sinusitis was diagnosed in 48 (64.0%) patients according to clinical and CT examination and 27 (36.0%) patients did not have features of chronic sinusitis.

Table 2. Clinical presentation of participants

Clinical symptom	Frequency (n)	Percentage (%)
Nasal obstruction	52	69.3
Postnasal drip	46	61.3
Headache	43	57.3
Facial pain/pressure	38	50.7
Reduced sense of smell	29	38.7
Recurrent sneezing	25	33.3
Chronic sinusitis present	48	64.0
Chronic sinusitis absent	27	36.0

Commonly observed, on CT scan, was the presence of anatomical variations of the nose. Deviated nasal septum (DNS) was the most common anatomical variation, identified in 39 (52.0%) participants, and inferior turbinate hypertrophy (ITH) was identified in 31 (41.3%) participants, followed by concha bullosa (24, 32.0%), septal spur (19, 25.3%) and paradoxical middle turbinate (13, 17.3%) participants. Twenty-eight (37.3%) people were found to have a narrow osteomeatal complex.

Table 3. Frequency of anatomical variations of nasal cavity

Anatomical variation	Frequency (n)	Percentage (%)
Deviated nasal septum	39	52.0
Inferior turbinate hypertrophy	31	41.3
Narrow osteomeatal complex	28	37.3
Concha bullosa	24	32.0
Septal spur	19	25.3
Haller cells	15	20.0
Paradoxical middle turbinate	13	17.3
Agger nasi cells	12	16.0
Onodi cells	7	9.3

Radiological assessment by the CT revealed that the most common radiological finding was maxillary sinus involvement, which was seen in 42 patients (56.0%). Thirty-four (45.3%) participants had involvement in the ethmoid sinuses, 21 (28.0%) had frontal sinus involvement, and 12 (16.0%) had sphenoid sinus involvement. Thirty (40.0%) participants

Table 4. CT findings among study participants

CT finding	Frequency (n)	Percentage (%)
Maxillary sinus involvement	42	56.0
Ethmoid sinus involvement	34	45.3
Frontal sinus involvement	21	28.0
Sphenoid sinus involvement	12	16.0
Mucosal thickening	44	58.7
Osteomeatal complex obstruction	30	40.0
Bilateral sinus disease	26	34.7
Unilateral sinus disease	22	29.3

The anatomical abnormalities were correlated to chronic sinusitis by chi-square test. The participants with deviated nasal septum had significantly more cases with chronic sinusitis than those without a deviated nasal septum (76.9% vs. 50.0%, p = 0.016). In the same way, participants who had concha bulusa were more prone to have chronic sinusitis than those who did not (79.2% vs. 56.9%, p = 0.049). A statistically significant association was also found between narrow osteomeatal complex and chronic sinusitis (82.1% vs. 53.2%, p = 0.012). Septal spur, Haller cells and paradoxical middle turbinate, however, were not found to be statistically significantly associated with chronic sinusitis.

Table 5. Association between anatomical variations and chronic sinusitis

Anatomical variation	Chronic sinusitis present n (%)	Chronic sinusitis absent n (%)	p-value
Deviated nasal septum present	30 (76.9)	9 (23.1)	0.016
Deviated nasal septum absent	18 (50.0)	18 (50.0)	
Concha bullosa present	19 (79.2)	5 (20.8)	0.049
Concha bullosa absent	29 (56.9)	22 (43.1)	
Narrow osteomeatal complex present	23 (82.1)	5 (17.9)	0.012
Narrow osteomeatal complex absent	25 (53.2)	22 (46.8)	
Septal spur present	14 (73.7)	5 (26.3)	0.281
Septal spur absent	34 (60.7)	22 (39.3)	
Haller cells present	11 (73.3)	4 (26.7)	0.401
Haller cells absent	37 (61.7)	23 (38.3)	
Paradoxical middle turbinate present	9 (69.2)	4 (30.8)	0.672
Paradoxical middle turbinate absent	39 (62.9)	23 (37.1)	

The overall rate of participants with chronic sinusitis in the polluted areas was 64.0%. The anatomical deviations that were most strongly associated with chronic sinusitis were deviated nasal septum, concha bullosa, and narrowing of the osteomeatal complex. The results of this study indicate that structural differences in the nasal cavity might also be related to the development of impaired sinus drainage and may be a risk factor in people exposed to polluted environments for chronic sinusitis.

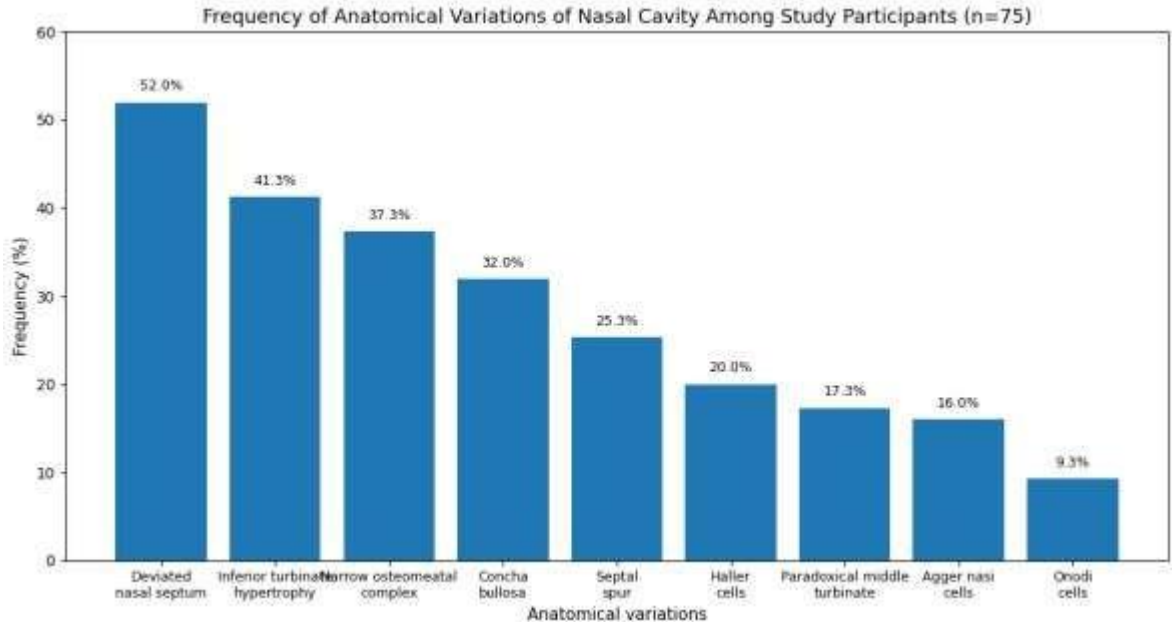

Figure 1. Frequency of anatomical variations of nasal cavity among study participants

The graph shows that **deviated nasal septum** was the most common anatomical variation, observed in **52.0%** of participants, followed by **inferior turbinate hypertrophy** in **41.3%**, **narrow osteomeatal complex** in **37.3%**, and **concha bullosa** in **32.0%**.

DISCUSSION

The present study evaluated anatomical variations of the nasal cavity and the frequency of chronic sinusitis among participants living in polluted areas. In this study, chronic sinusitis was observed in 48 out of 75 participants (64.0%)**,** indicating a high burden of sinonasal disease in the selected population. This finding may be explained by the combined effect of environmental exposure and structural narrowing of the nasal cavity and sinus drainage pathways. Chronic rhinosinusitis is generally defined by symptoms lasting 12 weeks or more, along with objective clinical or radiological evidence of sinonasal inflammation, as described in EPOS 2020 guidelines (11).

In the present study, nasal obstruction was the most common symptom followed by postnasal drip, headache, facial pain and diminished smell. These correspond to the typical clinical course of chronic rhinosinusitis, which involves increased inflammation of the sinus mucosa as a result of impaired ventilation and mucous clearance of the sinuses. The prevalence of symptoms in this study could also be due to living in polluted environments, since chronic exposure to traffic pollution, dust, smoke and particulate pollution can damage the sinonasal mucosa. A systematic review of environmental air pollution and chronic rhinosinusitis concluded that environmental air pollutants could play a role in the development of sinonasal inflammation and an elevated risk of or exacerbation of CRS (12).

The highest incidence of anatomical variation in this study was deviated nasal septum (52.0%). This was followed by poor turbinate hypertrophy, narrow osteomeatal complex, concha bullosa and septal spur. These are consistent with previous computed tomography (CT) studies that found that septal deviation and concha bullosa are common anatomical anomalies in patients with sinonasal symptoms. Another study in Pakistan by Adeel et al. also found that nasal septal deviation was frequent finding among patients referred for CT scan of the nose and sinus for sinonasal complaints (13). Likewise, an anatomical study of variations in chronic rhinosinusitis in 2021 found that deviated nasal septum was the most frequent variation followed by concha bullosa and enlarged ethmoidal bulla (14).

A statistically significant association was found with chronic sinusitis and deviated nasal septum in the present study. Participants that had a septal deviation had chronic sinusitis, with a rate of 76.9%, while those that did not have a septal deviation had a rate of 50.0%. This indicates that septal deviation may play a role in the disruption of airflow, and the decreased sinus drainage along with an osteomeatal narrowing. Septal deviation, however, does not always result in disease, and it is based on the degree and direction of the deviation, and whether it affects the middle meatus or the osteomeatal complex. Past radiologic literature also has pointed out that CT is helpful for identifying these changes and

evaluating the association of these changes and sinonasal disease (15, 16).

The incidence of concha bullosa was 32.0% and was significantly related with chronic sinusitis. Chronic sinusitis was more commonly seen in the participants who had concha bullosa compared to those who were without concha bullosa. This is biologically plausible as the pneumatization of the middle turbinate may cause constriction of the middle meatus and affect the flow of mucous secretions. A 2021 computed tomography (CT) study revealed concha bullosa is a frequent anatomical finding and its presence is correlated with septal deviation and sinonasal symptoms. A 2023 study of paranasal sinus anatomical variations in patients with chronic rhinosinusitis stressed the need for CT scan assessment of anatomical variations in different populations prior to planning treatment (17).

In this study narrow osteomeatal complex was also found to have a significant association with chronic sinusitis. The osteomeatal complex is a vital drainage system of the maxillary, frontal and anterior ethmoid sinuses. Any narrowing of the anus, vagina, or rectum can limit airflow and cause the mucous membranes to rub against each other, causing them to continue to swell and become inflamed. This current study showed that patients with narrowing of the OMC were more likely to have chronic sinusitis when compared to patients with no narrowing of the OMC. This is in keeping with the idea that the structural obstruction is more significant when added to the mucosal irritation from exposure to polluted air (18).

In the present study, the CT results indicated that the involvement of the maxillary sinus was the most frequent radiological finding, whereas ethmoid, frontal and sphenoid sinus involvement came second. This pattern is to be expected, as the drainage of the maxillary sinus passes through the osteomeatal complex and hence is frequently disrupted when there is a problem with the osteomeatal complex. Osteomeatal complex obstruction and thickening of the mucosa were also common. The results confirm that CT scan is a valuable diagnostic instrument in the persistent case with sinonasal symptoms and with a suspected anatomical variation or in the planning of surgery (19).

Sinusitis may have occurred at an increased rate in this study because of the presence of environmental pollution. Epithelial barrier disruption, changes in mucociliary clearance, and increased inflammatory responses in the nasal and sinus mucosa due to exposure to particulate matter, nitrogen dioxide, smoke and dust. The possible environmental contribution to sinonasal disease is supported by a 2022 study showing increased risk for chronic rhinosinusitis with exposure to air pollutants. Thus, in polluted urban areas like Lahore, the anatomical variations may augment with environmental irritation to cause frequent and chronic sinusitis (20).

There are clinical implications of this study. Patients with chronic nasal obstruction from polluted areas who present with nasal congestion, postnasal drip, facial pain, and/or recurrent sinus symptoms should be evaluated for both mucosal disease and underlying anatomic variations. The recognition of these abnormalities (septal deviation, concha bulla, narrowing of the osteomeatal complex) may facilitate better planning for medical management, advise for environmental protection and select those who might need further evaluation or correction by an ENT surgeon. The results were, however, to be treated with some caution as this was a single center study with limited sample size. Air pollutant levels were not directly measured, and exposure was either based on site of residence or history of exposure in areas with high air pollution. Multicenter studies with larger sample size and objective pollution measures are recommended in the future.

CONCLUSION

This study concluded that chronic sinusitis was common among participants living in polluted areas, with a frequency of 64.0%**.** The most frequent anatomical variation was deviated nasal septum, followed by inferior turbinate hypertrophy, narrow osteomeatal complex, concha bullosa, and septal spur. Deviated nasal septum, concha bullosa, and narrowing of the osteomeatal complex showed significant association with chronic sinusitis. These findings suggest that anatomical variations of the nasal cavity may contribute to impaired sinus drainage and increase the risk of chronic sinusitis, particularly in individuals exposed to polluted environments. CT scan evaluation is useful for identifying these variations and guiding appropriate clinical management.

REFERENCES

1. Davies-Barrett AM, Antoine D, Roberts CA. Respiratory disease in the Middle Nile Valley: the impact of environment and aridification. The Routledge Handbook of the Bioarchaeology of Climate and Environmental Change. Routledge; 2020. p. 122–140.
2. Papadopoulou A-M, Bakogiannis N, Skrapari I, Bakoyiannis C. Anatomical variations of the sinonasal area and their clinical impact on sinus pathology: a systematic review. International Archives of Otorhinolaryngology. 2022;26 (03): e491–e498.
3. Papadopoulou A-M, Chrysikos D, Samolis A, Tsakotos G, Troupis T. Anatomical variations of the nasal cavities and paranasal sinuses: a systematic review. Cureus. 2021;13(1).
4. Lee J, Park SM, Cha S-W, Moon JS, Kim MS. Does nasal septal deviation and concha bullosa have effect on maxillary sinus volume and maxillary sinusitis?: a retrospective study. Journal of the Korean Society of Radiology. 2020;81(6):1377.
5. Шушляпіна Н, Потапов С, Горголь Н, Аврунін О, Носова Я, Абделхамід І. Clinical aspects and cytomorphological and functional features of the nasal mucosa in chronic pathology of the intranasal structures and their verification from CT data. Ukrainian Radiological and Oncological Journal. 2023;31(1):38–59.
6. Cellina M, Gibelli D, Cappella A, Martinenghi C, Belloni E, Oliva G. Nasal cavities and the nasal septum: anatomical variants and assessment of features with computed tomography. The Neuroradiology Journal. 2020;33(4):340–347.
7. Malpani SN, Deshmukh P. Deviated nasal septum a risk factor for the occurrence of chronic rhinosinusitis. Cureus. 2022; 14(10).
8. Tengirşenk ZE, Toprak U, Özcan M. Relationship of chronic rhinosinusitis with individual characteristics and environmental factors in Central Anatolia. Kulak Burun Bogaz Ihtisas Dergisi. 2021;22 (3):178–184.
9. Niknami M, Emami E, Mozaffari A, Sharifian H, Safari S. Correlation between the opacification degree of paranasal sinuses on CT, clinical symptoms and anatomical variations of the nose and paranasal sinuses in patients with chronic rhinosinusitis. Frontiers in Dentistry. 2021;18:33.
10. Lopatin A, Azizov I, Kozlov R. Microbiome of the nasal cavity and the paranasal sinuses in health and disease (literature review). Part I. Russian Rhinology Review. 2021;29(1):23.
11. Fokkens WJ, Lund VJ, Hopkins C, Hellings PW, Kern R, Reitsma S, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020. Rhinology. 2020;58(Suppl S29):1–464.
12. Leland EM, Vohra V, Seal SM, Zhang Z, Ramanathan M Jr. Environmental air pollution and chronic rhinosinusitis: a systematic review. Laryngoscope Investigative Otolaryngology. 2022;7(2): 349–360.
13. Adeel M, Rajput MSA, Akhter S, Ikram M, Arain A, Khattak YJ. Anatomical variations of nose and para-nasal sinuses; CT scan review. Journal of the Pakistan Medical Association. 2013;63(3):317.
14. Pant B. Anatomical Variations in Chronic Rhinosinusitis: A Clinical Study. 2016.
15. Shpilberg KA, Daniel SC, Doshi AH, Lawson W, Som PM. CT of anatomic variants of the paranasal sinuses and nasal cavity: poor correlation with radiologically significant rhinosinusitis but importance in surgical planning. American Journal of Roentgenology. 2015;204(6):1255–1260.
16. Poluan FH, Zebua KS, Marlina L. Overview of the quality of life of chronic rhinosinusitis patients at the ENT polyclinic in 2019–2021. International Journal of Health Sciences and Research. 2023;13(5):268–280.
17. Kristyono I, Abdullah B. Anatomical variations of the paranasal sinuses in Javanese patients with chronic rhinosinusitis. Russian Journal of Pharmaceutical and Technology. 2023; 16(8):3701–3704.
18. Zubova A, Moiseyev V, Ananyeva N, Stulov I, Andreev E. Chronic maxillary sinusitis recorded in archaeological samples: geographical distribution and predisposing factors. Archaeology, Ethnology & Anthropology of Eurasia. 2022;50(1):147–157.
19. Riccomi G, Casaccia J, Minozzi S, Felici C, Campana S, Giuffra V. Maxillary sinusitis as a respiratory health indicator: a bioarchaeological investigation into medieval central Italy. International Journal of Paleopathology. 2021;35:40–48.
20. Chen S-W, Lin H-J, Tsai SC, Lin C-L, Hsu CY, Hsieh T-L, et al. Exposure to air pollutants increases the risk of chronic rhinosinusitis in Taiwan residents. Toxics. 2022;10(4):173.