Thi-Qar Medical Journal (TQMJ): Vol. (28), No. (2), 2024
Web Site: https://jmed.utq.edu Email: utjmed@utq.edu.iq
ISSN (Print):1992-9218 ISSN (Online): 3006-4791

# Sinonasal Anatomical Variants in Duhok: Gender Differences and Ct Correlations

**Maysaloon Shaman Saeed1, Rasha Nadeem Ahmed2, Mohammed Tahseen Yahya3, Imad Nadhim4, Noha Yahia Ebaid[5].**

[1]Consultant Radiologist, Assistant Professor, college of Medicine, university of Duhok

[2] Assistant Professor, Department of surgery (radiology section), College of Medicine, Ninevah University.

[3] Radiology specialist, Ninevah health directorate.

[4] Lecturer, Radiology Department (ENT section), College of Medicine,Ninevah University.

[5] Department of Radiology, Faculty of medicine, Zagazig University, Zagazig, Egypt

## Abstract:

**Background:** Paranasal sinus diseases are increasingly common worldwide. Early diagnosis and timely therapy are vital to avoid prolonged issues. The variable anatomy of these sinuses can significantly impact subsequent pathology.

Objective: To determine the prevalence of sinonasal anatomical variants (SNAVs) in a sample population in Duhok city, assess their correlation with sex, and evaluate the association of these variants with sinonasal inflammatory changes using computed tomography.

Patients and Methods: This retrospective cross-sectional study enrolled 100 patients from specialized imaging centers in Duhok city over 6months (February to July2024). Multiple CT coronal, axial, and sagittal sections were analyzed to evaluate the prevalence of sinonasal variants, affected sinuses, and their association with sinonasal inflammatory changes.

Results: The study included 100 patients aged 12 to 69 years, with an equal gender distribution. The frequency of SNAVs was 1097 (average 10.97 variants per case). SNAVs were more prevalent in females (52.4%) compared to males (47.58%). Ethmoid air cells were the most common (46.7%), followed by sphenoid sinus variation (27.5%). While SNAVs occurred in both genders at varying rates, significant gender-based differences were found only for ethmoidal air cells and frontal sinus variants. The study found no significant differences in sinusitis prevalence for most SNAVs by gender, except for ethmoidal air cells elongation, where females showed an increased prevalence of sinusitis.

**Conclusion:** Understanding SNAVs and their impact on sinus surgery and disease is crucial. Gender influences the prevalence of certain SNAVs and their association with sinusitis, indicating the need for a tailored approach in clinical management.

**Keywords:** Anatomic variants, CT scan, Inflammation, Para nasal sinuses.

**Introduction :**Paranasal sinus diseases are now being reported with increasing frequency worldwide. Their accurate preoperative diagnosis, would guide the physicians and surgeons on proper approach. (1). During fetal development, the paranasal sinuses (PNS) originate as an invagination of multiple different primitive structural origins, the mucosa of the nose, lateral nasal walls, frontal, ethmoid, maxilla and the sphenoid bones. This distinctive development attributes for the significant amount of anatomical variation.(1)

Computed tomography (CT) is an valuable tool for providing information about the anatomy of this region, evaluating extent of the disease, assisting endoscopic evaluation and guiding treatment(2).

The anatomical variants that disrupts the function of the osteomeatal complex (the common channel formed linking frontal, maxillary, anterior and posterior ethmoidal sinuses to the middle meatus) are believed to increase the risk of sinusitis.(3). Many literatures show a significant relationship between sinonasal anatomical variants and the occurrence of rhinosinusitis. (4–7)

Certain osteomeatal variants that may predispose individuals to narrowing and obstruction of meatus include deviated nasal septum (DNS), concha bullosa (CB), paradoxically bent middle turbinate, agger nasi cells and Haller cells. The uncinate anatomy, the depth of olfactory fossa, the proximity of the optic nerves and carotid vessels to the sphenoid sinus walls, anterior clinoid pneumatisation, intersphenoid septum deflection are among the critical anatomical variants that must be identified prior to FESS to avoid serious injuries. (8).The frequency of these variants may vary among different ethnic groups.(9) .

Ct imaging criteria of acute PNS sinusitis include osteomeatal complex obstruction , fluid density within the sinuses, underlying sinus mucosal thickening ,gas-fluid levels ,bubbly gases within the fluid density.(10), In chronic cases ,dense thick irregular and sometimes undulating mucosal lining ,hyperostosis, intra-sinus calcifications could be determined.(11) .

This study aimed to examine how often various anatomic variants of the paranasal sinuses (PNS) appear on CT scans. It also sought to determine the distribution of these variants by gender and their association with sinonasal inflammatory changes. Additionally, the study compared its findings with those of previous research conducted in different populations.

**Material and methods:** In this cross sectional retrospective study conducted in Duhok city/Kurdistan Region of Iraq , over 6months (February to July2024), a total of one hundred patients from both sexes with the age range from twelve till sixty nine years were enrolled ,all were referred from medical and otorhinolaryngologists for different sinonasal purposes .Patients were referred for Ct imaging evaluation complained from different sinonasal symptoms , imaging with CT scan was undergone using a multi-detector Scanner Siemens SOMATOM Emotion16-slice , using120 Kvp, 100 mAs, 220mm FOV and slice thickness of 4 mm . All scans were acquired by using a bone algorithm in axial view, complemented by coronal and sagittal reconstructions

with a slice thickness of 0.5 mm in most cases, and up to 4 mm at maximum. Two independent specialized observers assessed the scans. Axial imaging was performed with a 4 mm thickness, parallel to the orbito-meatal plane, extending inferiorly from the upper dental arch to the roof of the frontal sinuses superiorly. Coronal images were obtained with a 4 mm thickness, in a plane perpendicular to the hard palate, extending from the anterior wall of the frontal sinus to the posterior wall of the sphenoid sinus.Sagittal reconstruction undergone to get detailed anatomical relations of the sphenoid sinus.

Patients below 12 years , those with extensive sinonasal polyposis, sinonasal malignancies, previous trauma or sinonasal operations , facial anomalies were not considered in the the study.

The study was approved by the Research Ethical Committee of the college of medicine and university of Duhok. Data about the prevalence of the observed anatomical variations in both genders detected as well as the sinuses affected, their correlation with the sinonasal inflammatory imaging criteria undertaken. Analyzed into tables and figures.

Statistical Analysis: Data entry and analysis were performed using the Statistical Package for the Social Sciences (SPSS) software, version 26. Descriptive statistics were utilized to determine frequencies and percentages, while analytical statistics (Chi-square test and Fisher's exact test) were used for categorical variables. A p-value of $<0.05$ was considered statistically significant. The results were compared with studies in the literature that aimed to detect the same anatomic variants using CT scans.

**Results:** The present study involved a cohort of one hundred patients, aged 12 to 69 years, with an equal distribution of 50% male and 50% female. All patients were selected based on the presence of one or more sinonasal anatomical variants (SNAV). The frequency of reported SNAVs in the current study is 1,097 variants across 100 cases, averaging 10.97 variants per case. SNAVs were found to be more frequent in females (522 variants, representing 52.4%) than in males (522 variants, representing 47.58%). The most frequently encountered SNAVs included ethmoidal air cells (46.7%), sphenoidal sinus variations (27.5%), nasal septal anomalies (13.0%), turbinate variations (8.5%), maxillary sinus variations (3.2%), and frontal sinus variations (1.1%). Refer to Table 1 for details.

**Table (1 ): Frequency of certain anatomic variants in the studied sample .**

| Anatomic Variants | Number | % (N=100) | % Of Total Variants(N=1097) |
|---|---|---|---|
| Ethmoid Variants | 512 | | 46.7% |
| Agger Nasi Cells | 77 | 77 | |
| Haller Cells | 64 | 64 | |
| Onodi Cells | 39 | 39 | |
| Ethmoid Uncinate Process (Elongation). | 67 | 67 | |
| Ethmoid Uncinate Process (Pneumatization). | 23 | 23 | |
| Crista Galli Pneumatization | 42 | 42 | |
| Keros Classification (Type I) | 56 | 56 | |
| Keros Classification (Type Ii) | 124 | | |
| Keros Classification (Type Iii) | 20 | | |
| Nasal Septal Variants | 143 | | 13.0% |
| Nsd | 92 | 92 | |
| Septal Spur | 34 | 34 | |
| Septal Pneumatization | 17 | 17 | |
| Turbinate Variants | 93 | | 8.5% |
| Cb | 71 | 71 | |
| Paradoxical Turbinate | 18 | 18 | |
| Hypoplasic Turbinate | 4 | 4 | |
| Sphenoid Variants | 302 | | 27.5% |
| Asymmetrical Septation | 2 | 2 | |
| Pneumatization( Choncal) | 6 | | |
| Pneumatization(Presellar) | 10 | | |
| Pneumatization(Sellar) | 38 | | |
| Pneumatization(Postsellar) | 46 | | |
| Relation To Optic Nerve 1 | 28 | | |
| Relation To Optic Nerve 2 | 98 | | |
| Relation To Optic Nerve 3 | 66 | | |
| Relation To Optic Nerve 4 | 8 | | |
| Maxillary Variants (Septaion,Hypoplasia) | 35 | 35 | 3.2% |
| Frontal Variants (Extensive,Hypoplastic) | 12 | 12 | 1.1% |

NSD: nasal septal deviation, CB: concha bullosa.

Although SNAV were observed in both genders at varying frequencies, statistical analysis did not reveal a significant difference in prevalence, except for ethmoidal air cells which were more prevalent in females refer to table 2.

Thi-Qar Medical Journal (TQMJ): Vol. (28), No. (2), 2024
Web Site: https://jmed.utq.edu Email: utjmed@utq.edu.iq
ISSN (Print):1992-9218 ISSN (Online): 3006-4791

**Table (2): Frequency of specific anatomic variants in the studied sample by gender.**

| Variants | | Gender | | Total | P Value |
|---|---|---|---|---|---|
| | | M (50) | F(50) | | |
| Ethmoid | Agger Nasi Cells | 32 | 45 | 77 | |
| | Haller Cells | 17 | 47 | 64 | |
| | Onodi Cells | 20 | 19 | 39 | |
| | Ethmoid Uncinate Process (Elongation) | 32 | 35 | 67 | |
| | Ethmoid Uncinate Process (Pneumatization) | 9 | 14 | 23 | |
| | Crista Galli Pneumatization | 24 | 18 | 42 | |
| | Keros Classification Type I | 20 | 36 | 56 | |
| | Keros Classification Type II | 80 | 44 | 124 | |
| | Keros Classification Type III | 7 | 13 | 20 | |
| | Total | 241 | 271 | 512 | 0.000 |
| Nasal Septal | NSD | 47 | 45 | 92 | |
| | Septal Spur | 20 | 14 | 34 | |
| | Septal Pneumatization | 5 | 12 | 17 | |
| | Total | 72 | 71 | 143 | 0.933 |
| Turbinate | CB | 29 | 42 | 71 | |
| | Paradoxical Turbinate | 9 | 9 | 18 | |
| | Hypoplasic Turbinate | 1 | 3 | 4 | |
| | Total | 39 | 54 | 93 | 0.513 |
| Sphenoid | | 150 | 152 | 302 | 0.908 |
| Maxillary | | 16 | 19 | 35 | 0.612 |
| Frontal | | 4 | 8 | 12 | 0.357 |

NSD: nasal septal deviation, CB: concha bullosa.

The study focused on Sinonasal Anatomical Variants (SNAV) concerning their association with sinusitis based on gender. No statistically significant differences in the prevalence of sinusitis were identified in relation to any studied SNAV for either gender. Consequently, gender does not play a significant role in influencing the prevalence of sinusitis in the presence of specific SNAV, except in the case of ethmoidal air cells elongation. In this specific SNAV, being female is associated with an increased prevalence of sinusitis.

Thi-Qar Medical Journal (TQMJ): Vol. (28), No. (2), 2024
Web Site: https://jmed.utq.edu Email: utjmed@utq.edu.iq
ISSN (Print):1992-9218 ISSN (Online): 3006-4791

**Table (3): Association of specific anatomic variants with sinonasal inflammatory changes.**

| Variants | | Male | Females | p-value* |
|---|---|---|---|---|
| | | No. (%) | No. (%) | |
| Ethmoid | Agger nasi cells | | | 0.86 (NS) |
| | Yes | 20 | 29 | |
| | No | 12 | 16 | |
| | Haller cells | | | 0.34 (NS) |
| | Yes | 11 | 36 | |
| | No | 6 | 11 | |
| | Onodi cells | | | 0.13 (NS) |
| | Yes | 14 | 17 | |
| | No | 6 | 2 | |
| | Elongation | | | 0.017 |
| | Yes | 18 | 29 | |
| | No | 14 | 6 | |
| | Pneumatization | | | 0.65 (NS) |
| | Yes | 5 | 10 | |
| | No | 4 | 4 | |
| | Crista galli | | | 1.00 (NS) |
| | Yes | 16 | 12 | |
| | No | 8 | 6 | |
| | Keros type I | | | 0.49 (NS) |
| | Yes | 13 | 20 | |
| | No | 7 | 16 | |
| | Keros type II | | | 0.12 (NS) |
| | Yes | 45 | 31 | |
| | No | 35 | 13 | |
| | Keros type III | | | 1.00 (NS) |
| | Yes | 5 | 10 | |
| | No | 2 | 3 | |
| Nasal septal | NSD | | | 0.45 (NS) |
| | Yes | 38 | 39 | |
| | No | 9 | 6 | |
| | Septal spur | | | 0.16 (NS) |
| | Yes | 17 | 9 | |
| | No | 3 | 5 | |

| | | | | |
|---|---|---|---|---|
| | **Septal** | | | **1.00 (NS)** |
| | **Yes** | **4** | **8** | |
| | **No** | **1** | **4** | |
| **Turbinate** | **CB** | | | **0.74 (NS)** |
| | **Yes** | **24** | **36** | |
| | **No** | **5** | **6** | |
| | **Paradoxical** | | | **0.59 (NS)** |
| | **Yes** | **7** | **6** | |
| | **No** | **2** | **3** | |
| | **Hypoplastic** | | | **1.00 (NS)** |
| | **Yes** | **1** | **2** | |
| | **No** | **0** | **1** | |
| **Sphenoid** | | | | **0.72 (NS)** |
| | **Yes** | **87** | **85** | |
| | **No** | **63** | **67** | |
| **Maxillary** | | | | **0.49 (NS)** |
| | **Yes** | **12** | **16** | |
| | **No** | **4** | **3** | |
| **Frontal** | | | | **1.00 (NS)** |
| | **Yes** | **3** | **6** | |
| | **No** | **1** | **2** | |

**Discussion:** The prevalence of SNAV is widespread, reported in 89 to 99.8 % of CT examination of paranasal sinuses (12,13), however the prevalence varies according to many factors, like anatomical features and the studied population (14)

Understanding SNAV is crucial for planning endoscopic sinonasal surgery and potential for understanding development of sinusitis (15).

The literature indicated that the most commonly encountered SNAVs are nasal deviation, ethmoidal air cells variants and turbinate variants, particularly in form of concha bullosa(15–21), in studies conducted in Kurdistan region like Rasul et al. 2018 and Dawood Et al. 2020, the Commonest anatomical variations within the nasal cavity and paranasal sinuses, were Agger nasi cells (72% 79%, respectively ), Nasal septal deviation (71.7% and 78% in the first, respectively) and Concha bullosa (61% and 58%, respectively) (22,23) .In agreement with the mentioned studies, our research identifies the mentioned variants as common findings, with the ethmoidal variants being the most prevalent (46.7%), followed by the sphenoidal air cells variants (27.5%) and the nasal septal variations (13.0%) are the commonest in the current study.

Among ethmoidal cell variations, agger cells are encountered frequently, serving as an access point during frontal sinus surgery and predisposing to frontal sinusitis (11,12,24). Haller ethmoid air cells are clinically relevant due to their relation to the risk of orbital injury during surgery and the predisposition to maxillary sinusitis (25). The spheno-ethmoidal air cell or Onodi cell has special clinical importance because of its near location to the optic nerve and internal carotid artery and the risk of injuring such vitals structures in sinus endoscopic surgery(24).

Sphenoid Sinus Variations, the second most common in our study (27.5%), are notable for their proximate location to vital structures as optic nerve, internal carotid artery, vidian canal and the cavernous sinus. Damage to these structures, whether through direct extension of sinusitis or during surgery, can lead to serious consequences such as blindness (26), the relatively high prevalence of sphenoid SNAVs in our study underscores the radiologists and surgeons being mindful of their presence, demanding further investigation of their clinical relevance, higher prevalence of the forementioned variants could be attributed to the way of sampling in which only cases with SNAV were included.

In this study the Keros classification type II (a classification of the olfactory fossa) is the commonest finding in the contest of sphenoid sinus variation, this type is reported as the commonest of Keros classification according to previous studies (16–18)

Our study, Consistent with previous studies, identifies nasal septal deviation is the commonest variant of nasal septa type (25). The deviation can narrow the middle meatus, disrupting mucus flow and predisposing to sinusitis as well complicating sinus surgery (27,28).

Understanding gender variation in SNAVs is crucial for surgical planning(27).while some SNAVs are more commonly in countered in male patients, such as nasal septal deviation, Onodi cell and agger cell(27,29), our study reveals presence of a significant gender variation affecting the frequency of the reported SNAV reported in the ethmoidal air cells variants and frontal air cells which were found to be more common in female patients from all documented variations.

Association of SNAV and specific sinonasal diseases have been documented (13,30) . The presence of at least one SNAV found to be present in 64.0% to 99.8% regardless having any sinonasal disease (13,14,30), furthermore the presence of SNAV can affect the severity of sinusitis by affecting the patency of the mucosal drainage according to the previous studies (31,32) Regarding chronic rhinosinusitis prevalence, some studies showed that women have the double rate of chronic rhinosinusitis compared to men(7,33) , however, our study and in agreement with previous studies did not find gender to significantly influence sinusitis prevalence in the presence of SNAVs(34) , except in our study in the case of ethmoidal air cells elongation. In this specific SNAVs, being female is associated with an increased prevalence of sinusitis.

The previous literature studied the SNAV according to the gender, in Bora et al, 2021 the SNAV were found to be more common in adult males than in females with statistically significant difference(14) , in the present study the prevalence of various SNAV were studied according to the gender and in contrast to the forementioned study, the gender seems to be an independent factors in prevalence of SNAV in case of nasal septal deviation, turbinate, sphenoidal, maxillary and frontal sinuses, only the ethmoidal air

The limitations of the present study include its retrospective single center study design, which may make it limited by the existing data, additionally relatively small selected sample and selecting patients who were referred to the CT scan imaging may cause selection bias skewing towards individuals complaining of severe sinonasal symptoms and thereby limiting its representativeness. Considering doing a prospective study, taking a larger sample, in a randomized form with collaboration with multiple center , would enhance the validity and the comprehension of research in SNAVs.

**Conclusion:**Our research highlights the importance of understanding SNAVs and their impact on sinus surgery and disease. Gender plays a nuanced role in the prevalence of certain SNAVs and their association with sinusitis, indicating the need for tailored approach in clinical management.

**Conflict of interest:** no any conflict of interest**.**

**Financial Disclosure:** No any financial interests, no relationship and affiliation relevant to subject of manuscript.

## References:

1. Paranasal Sinuses: A Systematic Review. Cureus. 2021;13(1). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7883520/
2. Yousef M, Sulieman A, Hassan H, Ayad C, Bushara L, Saeed A, Gamerddin M, Ahmed B. Computed Tomography Evaluation of Paranasal Sinuses Lesions. Sudan Med Monit. 2014;9(3):123–126. https://www.researchgate.net/publication/271325257_Computed_tomography_evaluation_of_paranasal_sinuses_lesions
3. AJR. CT of Anatomic Variants of the Paranasal Sinuses and Nasal Cavity: Poor Correlation With Radiologically Significant Rhinosinusitis but Importance in Surgical Planning. Am J Roentgenol. 2014;202(6):1255–1260. https://pubmed.ncbi.nlm.nih.gov/26001236/
4. Tomovic I. High-Resolution Computed Tomography Analysis of the Prevalence of Onodi Cells. Laryngoscope. 2012;122(11):1180–1184. https://pubmed.ncbi.nlm.nih.gov/22685058/
5. Alkire S. An Assessment of Sinonasal Anatomic Variants Potentially Associated with Recurrent Acute Rhinosinusitis. Laryngoscope. 2010;120(8):1645–1651. https://pubmed.ncbi.nlm.nih.gov/20131360/
6. Smith KD, Edwards PC, Saini TS, Norton NS. The Prevalence of Concha Bullosa and Nasal Septal Deviation and Their Relationship to Maxillary Sinusitis by Volumetric Tomography. Int J Dent. 2010;2010. https://pubmed.ncbi.nlm.nih.gov/20862205/
7. .Busaba NY, Sin HJ, Salman SD. Impact of Gender on Clinical Presentation of Chronic Rhinosinusitis with and without Polyposis. J Laryngol Otol. 2008;122(11):1180–1184. https://pubmed.ncbi.nlm.nih.gov/18184447/
8. Roman RA, Hedeşiu M, Gersak M, Fidan F, Băciut G, Băciut M. Assessing the Prevalence of Paranasal Sinuses Anatomical Variants in Patients with Sinusitis Using Cone Beam Computer Tomography. Clujul Med. 2016;89(3):423–429. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4990440/
9. Badia L, Lund V, Wei W, Ho WK. Ethnic Variation in Sinonasal Anatomy on CT-Scanning. Rhinology. 2005;43:210–214. https://pubmed.ncbi.nlm.nih.gov/16218515/
10. Cornelius RS, Martin J, Wippold FJ, Aiken AH, Angtuaco EJ, Berger KL, et al. ACR Appropriateness Criteria Sinonasal Disease. J Am Coll Radiol. 2013;10(4):241–246. https://pubmed.ncbi.nlm.nih.gov/23420025/
11. Kroll KE, Camacho MA, Gautam S, Levenson RB, Edlow JA. Findings of Chronic Sinusitis on Brain Computed Tomography Are Not Associated with Acute Headaches. J Emerg Med. 2014;46(6):753–759. https://pubmed.ncbi.nlm.nih.gov/24750900/

12. Jagannathan D, Kathirvelu G, Hithaya F. Prevalence of Variant Anatomy of Paranasal Sinuses in Computed Tomography and Its Correlation to Sinusitis. IOSR JDMS. 2017;16(03):01–07. https://www.iosrjournals.org/iosr-jdms/papers/Vol16-issue3/Version-13/A1603130107.pdf
13. Dasar U, Gokce E. Evaluation of Variations in Sinonasal Region with Computed Tomography. World J Radiol. 2016;8(1):98–108. https://tinyurl.com/kzbksccv
14. Bora A, Koç M, Durmuş K, Altuntas EE. Evaluating the Frequency of Anatomical Variations of the Sinonasal Region in Pediatric and Adult Age Groups According to Gender: Computed Tomography Findings of 1532 Cases. Egypt J Otolaryngol. 2021;37(1):58. https://ejo.springeropen.com/articles/10.1186/s43163-021-00122-9
15. Al-Abri R, Bhargava D, Al-Bassam W, Al-Badaai Y, Sawhney S. Clinically Significant Anatomical Variants of the Paranasal Sinuses. Oman Med J. 2014;29(2):110–113. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3976721/
16. Roman RA, Hedeşiu M, Gersak M, Fidan F, Băciut G, Băciut M. Assessing the Prevalence of Paranasal Sinuses Anatomical Variants in Patients with Sinusitis Using Cone Beam Computer Tomography. Clujul Med. 2016;89(3):423–429. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4990440/
17. Choby G, Thamboo A, Won TB, Kim J, Shih LC, Hwang PH. Computed Tomography Analysis of Frontal Cell Prevalence According to the International Frontal Sinus Anatomy Classification. Int Forum Allergy Rhinol. 2018;8(7):825–830. https://pubmed.ncbi.nlm.nih.gov/29457874/
18. Hung K, Montalvao C, Yeung AWK, Li G, Bornstein MM. Frequency, Location, and Morphology of Accessory Maxillary Sinus Ostia: A Retrospective Study Using Cone Beam Computed Tomography (CBCT). Surg Radiol Anat. 2020;42(2):219–228. https://pubmed.ncbi.nlm.nih.gov/31456002/
19. Keast A, Sofie Y, Dawes P, Lyons B. Anatomical Variations of the Paranasal Sinuses in Polynesian and New Zealand European Computed Tomography Scans. Otolaryngol Head Neck Surg. 2008;139(2):216–221. https://pubmed.ncbi.nlm.nih.gov/18656718/
20. Dasar U, Gokce E. Evaluation of Variations in Sinonasal Region with Computed Tomography. World J Radiol. 2016;8(1):98–108. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4731353/
21. 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. Am J Roentgenol. 2015;204(6):1255–1260. https://pubmed.ncbi.nlm.nih.gov/26001236/

22. Rasul S, Abdullah K, Ali T. Frequency of Anatomical Variations of Nose and Paranasal Sinuses in Clinically Suspected Rhinosinusitis Patients by Computerized Tomography. J Sul Med Coll. 2018;8(3):139–148. https://jsmc.univsul.edu.iq/index.php/jsmc/article/view/jsmc-10161
23. Dawood SN. Normal Anatomic Variants of Paranasal Sinus Region Studied by Computed Tomography. Zanco J Med Sci. 2020;24(2):187–196. https://zjms.hmu.edu.krd/index.php/zjms/article/view/770
24. Nair S, Bhat S, Nambiar S. The Role of Onodi Cells in Sphenoiditis: Results of Multiplanar Reconstruction of Computed Tomography Scanning. [Internet]. [cited 2024 Mar 12]. Available from: https://pubmed.ncbi.nlm.nih.gov/27161189/ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9444771/
25. 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. Neuroradiol J. 2020;33(4):340–347. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7416352/
26. Sethi KS, Choudhary S, Ganesan PK, Sood N, Ramalingum WBS, Basil R, et al. Sphenoid Sinus Anatomical Variants and Pathologies: Pictorial Essay. Neuroradiology. 2023;65(8):1187–1203. https://link.springer.com/article/10.1007/s00234-023-03163-4
27. Bora A, Koç M, Durmuş K, Altuntas EE. Evaluating the Frequency of Anatomical Variations of the Sinonasal Region in Pediatric and Adult Age Groups According to Gender: Computed Tomography Findings of 1532 Cases. Egypt J Otolaryngol. 2021;37(1):58. https://ejo.springeropen.com/articles/10.1186/s43163-021-00122-9
28. Roman RA, Hedeşiu M, Gersak M, Fidan F, Băciut G, Băciut M. Assessing the Prevalence of Paranasal Sinuses Anatomical Variants in Patients with Sinusitis Using Cone Beam Computer Tomography. Clujul Med. 2016;89(3):423–429. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4990440/
29. Kulich M, Long R, Reyes Orozco F, Yi AH, Hao A, Han JS, et al. Racial, Ethnic, and Gender Variations in Sinonasal Anatomy. Ann Otol Rhinol Laryngol. 2023;132(9):996–1004. https://pubmed.ncbi.nlm.nih.gov/36200783/
30. Marino MJ, Riley CA, Wu EL, Weinstein JE, Emerson N, McCoul ED. Variability of Paranasal Sinus Pneumatization in the Absence of Sinus Disease. Ochsner J. 2020;20(2):170-176. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7310164/
31. Sunyecz I, Hunt C, Ramadan HH, Makary CA. Role of Sinonasal Anatomic Variants in Recurrent Acute Rhinosinusitis. Laryngoscope. 2024;134(3):572–580. https://pubmed.ncbi.nlm.nih.gov/38451036/

32. Papadopoulou AM, Bakogiannis N, Skrapari I, Bakoyiannis C. Anatomical Variations of the Sinonasal Area and Their Clinical Impact on Sinus Pathology: A Systematic Review. Int Arch Otorhinolaryngol. 2022;26(3)–e498. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9282972/

33. Ference EH, Tan BK, Hulse KE, Chandra RK, Smith SB, Kern RC, et al. Commentary on Gender Differences in Prevalence, Treatment, and Quality of Life of Patients with Chronic Rhinosinusitis. Allergy Rhinol (Providence). 2015;6(2)2015.6.0120. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4541639/

34. Qureshi MF, Usmani A. A CT-Scan Review of Anatomical Variants of Sinonasal Region and Its Correlation with Symptoms of Sinusitis (Nasal Obstruction, Facial Pain and Rhinorrhea). Pak J Med Sci. 2020;37(1):139–148. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7794148/