ORIGINAL RESEARCH ARTICLE

Study of the Frequency of Risk Factors for Chronic Rhinosinusitis in Outpatients Aged 6 to 18 Years Visiting Allergy Clinics

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Abstract

Background Rhinosinusitis is a complex disease that impacts the lives of both patients and their families, placing a considerable burden on healthcare systems. This study aimed to examine the frequency of risk factors for chronic rhinosinusitis in outpatients attending the allergy clinics of Shahid Motahari Hospital in Urmia in 2021.

Methods This cross-sectional study was conducted on all outpatients aged 6 to 18 years diagnosed with chronic rhinosinusitis who visited the allergy clinic at Shahid Motahari Hospital in Urmia in 2021. The patients were categorized into two age groups (6-12 years and 13-18 years). Demographic information and medical histories were collected using a checklist and analyzed with SPSS software, version 22.

Results The prevalence of atopy in this study was 63.6%. Asthma was found in 63.9% of patients, and allergic rhinitis was present in 21.9%. The second most prevalent condition was GERD, with an occurrence rate of 20%. The most common sinonasal anatomical variation observed was adenoid hypertrophy (32.3%), followed by septal deviation in 11.5% of patients. No significant association was found between atopy and age, gender, tobacco smoke exposure, or the severity of chronic rhinosinusitis ($p > 0.05$).

Conclusion This study investigated various risk factors associated with chronic rhinosinusitis. The overall prevalence of atopy, GERD, tobacco smoke exposure, adenoid hypertrophy, and septal deviation was significant. Further research with a larger sample size and a control group is essential to assess whether these factors are associated with the diagnosis and improved management of chronic rhinosinusitis.

Keywords Allergy, Atopy, Chronic rhinosinusitis, Epidemiology

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1 Introduction

Chronic rhinosinusitis (CRS) is characterized by persistent inflammation of the sinonasal mucosa lasting for at least 12 weeks.[1] It is estimated that CRS affects approximately 13% of the population in the United States and 10.9% in Europe, with an annual incidence of 1.31 per 100 individuals.[2] CRS leads to the gradual obstruction of the osteomeatal complex due to edema, fibrosis, hyperplasia, and polyposis.[3] In the pediatric population, obstruction of the osteomeatal complex (OMC) is often the initial cause of sinusitis, as this obstruction creates negative pressure within the sinuses, causing mucosal irritation and retention of secretions, which may result in infection.[4]

The mucus and secretions in CRS patients show an increase in neutrophils, eosinophils, mast cells, basophils, and mononuclear white blood cells, alongside higher concentrations of histamines, leukotrienes, and prostaglandin D.[5-7] CRS has two subtypes: chronic rhinosinusitis with nasal polyps (CRSwNP) and chronic rhinosinusitis without nasal polyps (CRSsNP), with varying prevalence and incidence across different countries and age groups.[8] The immune system and tissue-specific inflammatory responses play a crucial role in the pathophysiology of CRS, which explains why both doctors and patients often encounter flare-ups and disease recurrence even after surgical interventions designed to improve sinus ventilation.[3] Diagnostic criteria for CRS include the presence of at least two out of four key symptoms: facial pain or pressure, reduced or complete loss of smell, nasal congestion, and nasal discharge lasting for over three months. The diagnosis is primarily based on clinical signs observed during anterior rhinoscopy or endoscopy, and when there is uncertainty, a coronal paranasal CT scan is used for confirmation.

The primary challenge in managing chronic rhinosinusitis in children is maintaining proper sinus hygiene. Children often struggle to clear their nasal passages effectively and typically do not follow correct hygiene practices. As mentioned earlier, any obstruction in the osteomeatal complex (OMC) contributes to the development of chronic rhinosinusitis. The primary treatment for this condition in children is pharmacological, aimed at reducing inflammation, enhancing sinus ventilation, and eliminating pathogens.[9] Various treatment options, such as antibiotics, nasal irrigation, topical steroids, and, in some instances, oral steroids and allergen immunotherapy, may be necessary. Adenoidectomy surgery can also provide symptom relief.[10-15]

Nasal steroid sprays combined with oral antibiotics are effective in managing chronic rhinosinusitis in children, as they reduce mucosal inflammation and alleviate symptoms like cough and post-nasal drip.[16] Recent studies have explored the association between chronic rhinosinusitis and various social factors, including socioeconomic status, educational level, family dynamics, place of residence, work conditions, use of toxins or recreational drugs (e.g., cigarettes, alcohol), as well as exercise and diet habits.

Study results indicate that the following factors may play a significant role in the development of chronic rhinosinusitis:

1. Anatomical changes in the sinonasal region, such as concha bullosa, septal deviation, and uncinate deviation.[17] It has also been suggested that larger adenoids can cause obstruction of sinonasal pathways and act as a reservoir for microbes.[10, 18-21]
2. Gastroesophageal reflux disease (GERD): According to research conducted in Turkey, 38% of children with chronic rhinosinusitis had GERD. Medication for reflux can improve chronic rhinosinusitis symptoms in 79–89% of cases.[22] In some cases, surgical treatment for reflux has successfully alleviated chronic rhinosinusitis symptoms.[23]
3. Frequent exposure to tobacco smoke: Studies show that the role of these factors and their correlation may vary by region and population. For instance, a study by Goldstein-Rudmik et al. found that exposure to cigarette smoke is significantly associated with the increased formation of biofilms consisting of bacteria isolated from the sinonasal cavities of patients with chronic rhinosinusitis.[23, 24] However, in a prospective study, continued smoking after endoscopic sinus surgery did not alter quality of life indicators.[25]
4. Atopy such as allergic rhinitis and asthma.[26, 27] Other eosinophilic processes, including allergic fungal sinusitis (AFS) [4, 28, 29] and aspirin-exacerbated respiratory disease (AERD).[30, 31] A study conducted in the otolaryngology department of Rasoul Akram Hospital in Tehran showed that individuals with elevated serum IgE levels had a higher incidence of chronic sinusitis compared to healthy individuals, and that women with serum IgE levels higher than 100 IU/ml were more likely to develop chronic sinusitis than men.[32]
5. Ciliary motility disorders such as cystic fibrosis, bronchiectasis, and primary ciliary dyskinesia. Cystic fibrosis (CF) is the most common disorder in these patients and is strongly associated with CRSwNP. In fact, the prevalence of chronic rhinosinusitis in individuals with cystic fibrosis is close to 100%.[33-37]

Chronic rhinosinusitis imposes a significant economic burden on healthcare systems, with some studies suggesting that treatment costs are approximately one and a half times higher than those for other similar conditions.[38-44] Additionally, it results in frequent outpatient visits and numerous diagnostic and therapeutic procedures.

The risk factors and comorbidities associated with chronic rhinosinusitis remain a topic of debate, as studies have yielded contradictory results. Given that no recent research on this topic has been conducted in the region, investigating the prevalence of risk factors for chronic rhinosinusitis could help improve patient outcomes and guide the implementation of effective strategies to minimize complications and establish a suitable healthcare framework. Therefore, this study was conducted to evaluate the prevalence of risk factors for chronic rhinosinusitis among outpatients aged 6 to 18 years who visited the allergy clinics of Shahid Motahari Hospital in Urmia in 2021.

2 Methods

This descriptive cross-sectional study was approved under the ethics code IR.UMSU.REC.1400.330 employed a census sampling approach to select patients aged 6 to 18 who had been diagnosed with chronic rhinosinusitis, as defined by the ARIA criteria, and confirmed by an anterior rhinoscopy examination performed by an otolaryngologist. The patients visited the allergy clinics of Motahari Hospital in Urmia in 2021, presenting with at least two out of the four primary symptoms: facial pain or pressure, reduced or complete loss of smell, nasal congestion, and nasal discharge persisting for more than 3 months. After providing the necessary explanations to the patients and obtaining their consent for the anterior rhinoscopy (using a speculum of varying sizes depending on the patient's physique), demographic details such as age, gender, body mass index, place of residence, tobacco use (both active and passive smoking), and family history of chronic rhinosinusitis were recorded in a checklist.

Data on early life factors, such as the type of delivery, gestational age, birth weight, and infant feeding, were also collected. Following this, a checklist covering clinical information and medical history was completed, including underlying conditions such as cystic fibrosis, gastroesophageal reflux, primary Kartagener syndrome, immunodeficiency, and atopy. A physical examination and interview supplemented this.

During the clinical examination, anatomical variations of the sinonasal region, such as nasal polyposis, hypertrophic adenoids, and septal deviation, were assessed and recorded. For patients suspected of having anatomical disorders where diagnosis was not possible without paraclinical support, a coronal CT scan of the nose and paranasal sinuses was requested.

Exclusion criteria for the study included a history of head and neck surgeries, treatment with antibiotics or intranasal corticosteroids in the past three months, and patients or their parents who refused to undergo the anterior rhinoscopy examination.

Patients were categorized into different age groups, and the frequency of each variable was examined across the patient population. Finally, the collected data were analyzed using SPSS software version 22, with the Chi-square test applied for statistical analysis.

3 Results

The data collected from 96 patients were analyzed, with an overall prevalence of 4% among these patients. Initially, we present the demographic characteristics and features of the patients, followed by an examination of the correlation between variables and the research questions. The mean age of the patients was 8.84 ± 2.82 years, ranging from 6 to 18 years old. The patients were divided into two age groups: Group A (6 to 12 years), comprising 24 patients (25%), and Group B (13 to 18 years), comprising 72 patients (75%).

Regarding gender distribution, 61 patients (63.5%) were male, and 35 patients (36.5%) were female. In terms of residential area, 69 patients (71.9%) were urban dwellers, while 27 patients (28.1%) resided in rural or suburban areas. Additionally, 29 patients (30.2%) were only children, 49 patients (51%) had only one sibling, and 18.7% came from families with three or more children. Among the patients, 52 (54.2%) were firstborn, and 39 (40.6%) were the secondborn.

The patients were also categorized according to the BMI/Age percentile chart. The results revealed that 26 patients (27.1%) were below the 5th percentile, 53 patients (55.2%) were within the 5th to 85th percentile, seven patients (7.3%) were in the 85th to 95th percentile, and 10 patients (10.4%) were in the 95th percentile or higher. Among the study participants, 54 patients (56.3%) had a family history of a similar condition in first-degree relatives, while 42 patients (43.8%) had either no family history or a family history in second- or third-degree relatives.

The study also assessed environmental factors to which the patients were exposed. Of the patients, 36 (37.5%) were exposed to tobacco smoke (either actively or passively), 9 (9.3%) were in contact with cleaning chemicals, 9 (9.4%) had contact with pets, and only 3 (3.1%) reported alcohol exposure. Additionally, 49 patients (51%) had no exposure to any of these environmental factors.

The patients were also evaluated based on early life factors, including the type of delivery, gestational age, birth weight, and infant nutrition. The findings are summarized as follows: 38 patients (39.6%) were born via vaginal delivery, and 58 patients (60.4%) were delivered by cesarean section. Among the patients, 84 (87.5%) were born at term, and 12 (12.5%) were born preterm. At birth, 18.7% of the patients weighed less than 2500 grams, 79% weighed between 2500 and

4000 grams, and 2.2% weighed more than 4000 grams. Additionally, 37 patients (56.5%) were exclusively breastfed during infancy, 15 patients (23.1%) were only formula-fed, and 13 patients (20%) had a mixed feeding regimen. Among the patients, 61 (63.6%) had a history of atopy, 20 (20.9%) had gastroesophageal reflux disease, and 26 (27.1%) had no prior medical history. Among the atopic patients, 39 had asthma, 21 had allergic rhinitis, 11 had eczema, and 7 had food allergies. Finally, no cases of cystic fibrosis, primary ciliary dyskinesia (Kartagener syndrome), or immunodeficiency were identified in the study population (Table 1).

Table 1 Distribution of underlying diseases in patients with chronic rhinosinusitis

	Variable	Frequency	Percent
Atopy	Asthma	39	40.6
	Allergic rhinitis	21	21.9
	Eczema	11	11.5
	Food allergies	7	7.3
	No of previous illnesses	18	18.7
	total	96	100

An otolaryngology specialist examined all patients in the study for anatomical variations of the sinonasal region. If necessary, a coronal CT scan of the paranasal sinuses was requested and reviewed to confirm the diagnosis. Among the observed anatomical variations, adenoid hypertrophy was the most common, detected in 31 patients (32.3%). Nasal septal deviation was found in 11 patients (11.5%), and nasal polyps were observed in 2 patients (2%). No cases of concha bullosa were identified. According to the results in Table 2, nasal obstruction was a symptom present in all patients. Additionally, 85 patients (88.5%) experienced nasal discharge and postnasal drip (PND), 21 patients (21.9%) had sneezing, 29 patients (30.2%) reported itching, 37 patients (38.5%) had a cough, 18 patients (18.8%) complained of headaches, one patient (1%) had reduced sense of smell, and one patient (1%) had ear pain. Among these, 20 patients (20.8%) reported severe symptoms, 47 patients (49%) had moderate symptoms, and 29 patients (30.2%) had mild symptoms. Using Pearson's chi-square test, the relationship between exposure to tobacco smoke, age, gender, and the severity of chronic rhinosinusitis with atopy was examined. As shown in Table 3, no significant relationship was found between age, gender, and the severity of chronic rhinosinusitis with the presence of atopy ($p > 0.05$). Although a weak correlation was observed between these variables based on the Fisher, Cramér, and concordance coefficients, it was not statistically significant. At the 5% and 10% significance levels, the relationship between atopy and exposure to tobacco smoke was found to be non-significant at the 5% level but significant at the 10% level. Although no significant relationship was observed between atopy and tobacco smoke exposure at the 5% significance level, an important relationship was evident at the 10% level.

Table 2 Distribution of symptoms and disease severity

Variable		Percent	Frequency
Symptoms	Obstruction	10	96
	Discharge	88.5	85
	Sneezing	21.9	21
	Itching	30.2	29
	Cough	38.5	37
	Headache	18.8	18
	Decreased sense of smell	1	1
	Earache	1	1
Severity of symptoms	Weak	30.2	29
	Medium	49	47
	Weak	20.8	20

The relationship between tobacco smoke exposure and the severity of clinical manifestations in patients was also examined using the Pearson chi-square test. According to the findings, 65% of patients with severe disease had no history of tobacco smoke exposure, while 35% reported such exposure. Among patients with a history of tobacco smoke exposure, 33.3% had mild disease severity, 47.2% had moderate severity, and 19.4% had severe disease. According to Table 4, based on the chi-square statistic, no significant relationship was found between tobacco smoke exposure and the severity of chronic rhinosinusitis ($p > 0.05$).

4 Discussion

As one of the most common chronic diseases, and due to the differences in findings across various studies regarding the occurrence of chronic rhinosinusitis (CRS), further research is needed to identify additional risk factors. The variation in prevalence and frequency across different studies could be related to various genetic and environmental factors. According to the results of this study, chronic rhinosinusitis is more prevalent in males and among individuals aged 13 to 18. This finding is consistent with the study by El-Hakima H. et al., which also reported a higher prevalence in males.[45] However, the study by Mohammadi et al. found a higher prevalence of CRS in the 5 to 9-year-old age group, which does not align with the findings of the present study.[34] These results may indicate the significant role of age-related changes in airway inflammation and CRS pathogenesis, where eosinophilic inflammatory responses might decrease with age. Further investigations into the

Table 3 Cross-tabulation of atopy with age, gender, tobacco smoke exposure, and disease severity

Variable		Atopic		P value
		Frequency	Percent	
Age group	6-12	18	27.3	0.446
	12-18	48	72.7	
Gender	Male	42	63.6	0.977
	Female	24	36.4	
Exposure to cigarette smoke	Positive	29	43.9	0.053
	Negative	37	56.1	
The severity of symptoms	Severe	14	21.2	0.833
	Medium	31	47	
	Weak	21	31.8	

biological changes affecting CRS in older age groups are essential to guide more effective management. Sixty percent (60.4%) of the patients were born via cesarean section, while 39.6% were born via vaginal delivery (NVD). Additionally, 80.2% of the patients came from families with one or two children, and 54.2% were the firstborn. Furthermore, 71.9% of the patients were urban residents, which aligns with the findings of Ahn et al. Although patients and unofficial sources often attribute sinusitis to air quality, few studies examine the relationship between air pollution and sinusitis using accepted diagnostic criteria for CRS.[38] Min et al., in their first epidemiological study to determine the prevalence of CRS in South Korea, found no difference in CRS prevalence between urban and rural areas. [43]

of the disease in first-degree relatives. According to the study by Orb et al., a family history of CRS significantly increases the risk of developing chronic rhinosinusitis in first- and second-degree relatives, as well as in cousins. [44] Furthermore, according to the present study, 55.2% of the individuals fell into the 5th to 85th percentile of BMI/Age, in contrast to the study by Hwang et al., which demonstrated a significant association between obesity in patients and the occurrence of chronic rhinosinusitis with nasal polyps.[42]

The most common anatomical variation observed in this study was adenoid hypertrophy, found in 31 cases (32.3%), followed by nasal septum deviation, which was found in 11 cases (11.5%). In the study by Bezhani et al., the most common anatomical variations identified

Table 4 Concordance table of tobacco smoke exposure and disease severity

Variable		Negative		Positive		P value
		Percent	Frequency	Percent	Frequency	
The severity of symptoms	Severe	58.6	17	41.4	12	0.872
	Medium	63.8	30	36.2	17	
	Weak	65	12	35	7	

These discrepancies could be due to the fact that, in addition to outdoor air pollution, the adverse effects of indoor air pollution (such as exposure to mice, cockroaches, pets, dust mites, mold, and indoor pollutants like particulate matter and NO2 levels) can significantly contribute to respiratory diseases. The frequency of patients with a history of exposure to tobacco smoke, chemical cleaning products, pets, and alcohol was 58.2%, which aligns with the research by Goldstein, Darouch et al., who found an association between exposure to cigarette smoke and chronic rhinosinusitis.[23] In the study by Wen-Xiang Gao et al., the prevalence of patients exposed to pets and those working in cleaning-related occupations was significantly higher in the chronic rhinosinusitis group compared to the control group.[41] Additionally, 56.3% of patients with chronic rhinosinusitis had a positive family history

among patients with chronic rhinosinusitis were nasal septum deviation and concha bullosa. However, no cases of concha bullosa were observed in this study.[39] In this study, the prevalence of atopy in children with chronic rhinosinusitis was 63.6%, with asthma in 40.6%, allergic rhinitis in 11.9%, eczema in 11.5%, and food allergies in 7.3%. This contrasts with the study by Sedaghat et al., which found allergic rhinitis to be present in 27% and asthma in 17.5%.[46] The study by Görgülü et al. showed that the prevalence of allergies in patients with chronic rhinosinusitis and nasal polyps was 25%, which was lower than in the control group (28%).[47] Therefore, conflicting data exist regarding whether allergies influence the development or duration of rhinosinusitis. Additionally, in this study, gastroesophageal reflux disease (GERD) was the second most common disease,

observed in 20.9% of the sample. Research conducted by Yüksel F. et al. in Turkey found that 38% of children with CRS had reflux.[20] The study by Bothwell MR et al. also showed that reflux treatment (using proton pump inhibitors) could improve CRS symptoms in 79–89% of cases.[48]

According to the data obtained from the clinical manifestations of chronic rhinosinusitis, the most common symptom was nasal obstruction, present in 100% of the patients. Nasal discharge and post-nasal drip (PND) were the second most common symptoms, with a prevalence of 88.5%. Sneezing, itching, coughing, headache, reduced olfactory function, and ear pain were common reasons for patients with chronic rhinosinusitis to seek treatment at allergy clinics. In a study by Mohsen et al. conducted in 2019 on chronic rhinosinusitis patients before and after endoscopic sinus surgery, the most common complaint was nasal obstruction, with a prevalence of 93.5%, followed by reduced olfactory function (40%) and post-nasal drip (36.3%).[49] Furthermore, this study found no significant relationship between age, gender, smoking exposure, atopy, and the severity of chronic rhinosinusitis.

A significant relationship was observed at the 10% significance level between atopy and exposure to tobacco smoke, though this relationship was not significant at the 5% significance level.

5 Conclusion

Based on the findings, the prevalence of chronic rhinosinusitis (CRS) was higher in males, individuals aged 13 to 18 years, urban residents, atopic patients, those with gastroesophageal reflux disease (GERD), patients with a positive family history of the disease, and individuals with adenoid hypertrophy. To determine the significant relationship between CRS prevalence and these factors, further studies with proper controls are needed. Chronic rhinosinusitis in children is a condition with significant clinical impact, both in terms of economic burden and healthcare resource utilization. Given the multiple factors influencing CRS in children, various treatment options must be considered. However, definitive and well-conducted studies are necessary to identify the safest and most effective treatments for addressing CRS in young patients, improving both symptoms and quality of life.

Further studies involving a larger number of patients, diverse populations, and rare cases, as well as the inclusion of a control group, are necessary to evaluate whether these factors are suitable for improving the diagnosis and management of uncontrolled CRS.

Declarations

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Authors' Contributions
The methodology, sampling, and data curation aspects of this study were handled by Seyed Reza Ghaemi, who also contributed to the investigation and resource gathering. Statistical analysis was conducted by Niloufar Ahmadi, who collaborated with Seyed Reza Ghaemi, Hamidreza Houshmand, and Amir Nasimfar in writing the original draft of the manuscript.

Availability of Data and Materials
The data that support the findings of this study are available on request from the corresponding author.

Conflict of Interest
There are no conflicts of interest between the authors regarding the contents of this paper.

Consent for Publication
All authors have read and approved the final manuscript and have provided their consent for publication.

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Ethical Considerations
The study protocol was approved by the Institutional Ethics Committee of Urmia University of Medical Sciences, Urmia, Iran (Code: IR.UMSU.REC.1400.330).

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