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Risk Factors for Allergic Conjunctivitis in Children with Grass Pollen-Sensitized Seasonal Allergic Rhinitis

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ABSTRACT

Objective: Allergic rhinitis (AR) is a prevalent chronic pediatric disease that frequently presents with allergic conjunctivitis (AC) as a comorbidity. Despite its impact, the specific prevalence and risk factors associated with ocular involvement in children sensitized to grass pollen have not been sufficiently characterized in the current clinical literature.

To determine the prevalence of AC and evaluate the demographic, clinical, and laboratory factors associated with its development in children with grass pollen-sensitized seasonal AR.

Materials and Methods: This retrospective study evaluated children (aged 6–18 years) diagnosed with seasonal AR according to the Allergic Rhinitis and its Impact on Asthma guidelines criteria and confirmed grass pollen sensitization between January 2023 and December 2025. AC diagnosis was established based on clinical findings, patient-reported symptoms, and documented anti-allergic eye drop use. Assessment tools included the Total Nasal Symptom Score (TNSS), Total Ocular Symptom Score (TOSS), Visual Analog Scale (VAS), and medication scores. Multivariate logistic regression was performed to identify independent risk factors for AC development.

Results: A total of 143 children were evaluated, and AC was present in 78 patients (54.5%). The rhinoconjunctivitis group exhibited significantly higher TNSS and VAS scores compared to the isolated AR group ($p<0.05$). Passive smoking exposure was significantly more frequent in patients with ocular involvement ($p=0.041$). In multivariate analysis, AR severity emerged as the sole independent predictor (OR=7.518; 95% CI: 3.574–15.815; $p<0.001$). No significant differences were observed regarding other demographic or laboratory parameters.

Conclusion: Allergic conjunctivitis is a frequent comorbidity in children with grass pollen-sensitized seasonal AR. Increased AR severity markedly elevates the risk of ocular involvement. These findings suggest that systematic screening for ocular symptoms and reduction of passive smoking exposure are essential components of effective disease management in this population.

Keywords: Allergic conjunctivitis, grass pollen, passive smoking, pediatric, seasonal allergic rhinitis, total nasal symptom score

INTRODUCTION

Allergic rhinitis (AR) is one of the most prevalent chronic diseases in childhood, characterized by IgE-mediated inflammation of the nasal mucosa. Recent systematic reviews and meta-analyses indicate a substantial global upward trend in physician-diagnosed AR prevalence, rising from 8.4% during the 2012–2015 period to 19.9% between 2016 and 2022 (1).

In the etiology of seasonal AR, pollens—particularly grass pollens—are among the most significant triggers. Pediatric skin prick test studies report that sensitization rates to grass pollens, which are among the most frequently identified aeroallergens, occur in approximately 40% of the population (2).

The high frequency of comorbid allergic conjunctivitis (AC) in children with AR has led to the clinical designation

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of "allergic rhinoconjunctivitis" (ARC) (3). Epidemiological data emphasize that ocular symptoms are widespread across all age groups, especially in seasonal AR cases. The literature indicates that adolescents with ARC symptoms face significant limitations in daily activities and a diminished quality of life; furthermore, ocular symptoms have been associated with more severe functional impairment than rhinitis symptoms alone (4).

The "United Airway Disease" concept underscores the physiopathological link between the upper and lower respiratory tracts, demonstrating that allergic responses affect the conjunctival surface and the respiratory tract as a single unit (5,6). In line with this, the Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines recognize conjunctivitis as an integral comorbidity of AR (7). While the impact of rhinitis on asthma development and severity is well-documented, data regarding the role of conjunctival involvement in asthma prognosis remain limited (8).

The primary objective of this study is to determine the prevalence of AC in children with grass pollen-sensitized seasonal AR and to identify potential risk factors by comparing the demographic, clinical, and laboratory parameters of patients with and without ocular involvement.

MATERIALS and METHODS

Study Design and Participants

This retrospective cross-sectional study was conducted between January 2023 and December 2025 at a tertiary referral center for pediatric allergy. Pediatric patients aged 6–18 years who were diagnosed with seasonal AR according to the ARIA guidelines and had confirmed sensitization to grass pollens, demonstrated by skin prick testing and/or serum-specific immunoglobulin E (IgE) measurement, were eligible for inclusion. To ensure objective assessment of pollen-related symptomatology, only patients who presented to the outpatient clinic during the spring season and had complete clinical documentation were included in the analysis.

The exclusion criteria included sensitization to perennial allergens (such as house dust mites, molds, and animal dander), the presence of perennial (year-round) symptoms rather than seasonal complaints, and incomplete or missing clinical data. In total, 192 patients were excluded from the study. Among these, 147 were excluded due to sensitization to perennial allergens, while 45 were excluded because of incomplete or missing clinical data.

Demographic variables, including age, sex, and exposure to environmental tobacco smoke, were recorded. Clinical characteristics evaluated included age at AR diagnosis, family history of atopy, prior adenoidectomy, and the presence of comorbid atopic conditions such as allergic conjunctivitis, asthma, and atopic dermatitis. In addition, pharmacological treatments, including oral antihistamines, intranasal corticosteroids, and leukotriene receptor antagonists (LTRA), were retrospectively reviewed and documented for analysis (Figure 1).

The study protocol was approved by the Institutional Ethics Committee (Approval No: GOA-291). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Definitions

Allergic Rhinitis: Diagnosis was based on ARIA guidelines, requiring the presence of characteristic symptoms (rhinorrhea, nasal itching, sneezing, and congestion) consistent with sensitization results (7). Disease severity was classified as «mild» or «moderate-to-severe» based on impact on sleep quality, daily activities, and school performance (9).

Allergic Conjunctivitis: The diagnosis of allergic conjunctivitis was supported by clinical findings and documented use of antiallergic eye drops (10). In our study, all prescribed ophthalmic treatments consisted of dual-acting antihistamine/mast cell stabilizer agents (e.g., ketotifen, olopatadine). No patient received pure antihistamine or topical corticosteroid preparations. Therefore, treatment data were used to support the diagnosis of allergic conjunctivitis, not to classify disease severity.

Passive Smoking Exposure: Defined as regular smoking by parents or other individuals living in the same household, as recorded in the patient's medical history.

Assessment of Disease Severity

Symptom burden and treatment intensity were standardized using the following scoring systems:

Total Nasal Symptom Score (TNSS): Nasal congestion, rhinorrhea, itching, and sneezing were each scored from 0 (absent) to 3 (severe), with a maximum score of 12, based on symptoms experienced over the previous week.

Total Ocular Symptom Score (TOSS): Ocular itching, redness, and tearing were scored on a 0–3 scale, with

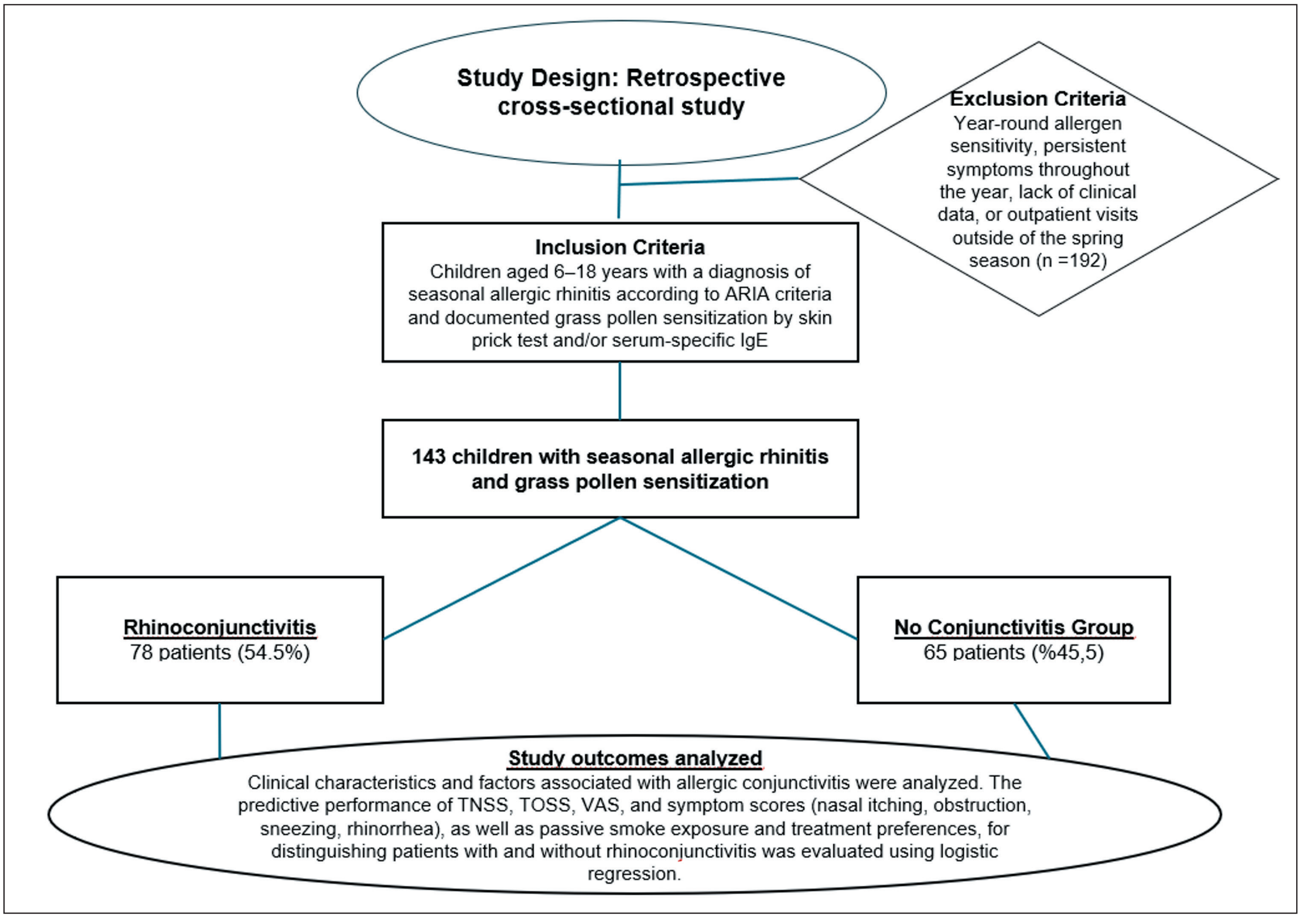

Figure 1: Flowchart of patient selection and study procedures.

a maximum score of 9, based on symptoms experienced over the previous week

Visual Analog Scale (VAS): Patients rated their overall symptom severity on a 10 cm scale (0: worst, 10: best) (11).

Medication Score: Scores were assigned based on daily usage: antihistamines (1 point), topical nasal steroids (2 points), nasal decongestants (1 point), and systemic steroids (3 points) (12).

Laboratory Parameters

Total serum IgE levels, absolute eosinophil counts (AEC), and eosinophil percentages were recorded.

Skin Prick Testing (SPT): Skin prick tests were performed using standardized commercial allergen extracts (ASAC Pharmaceutical, Spain). Sensitization to seasonal pollens was assessed using both individual pollen extracts (Cupressus arizonica, Artemisia vulgaris, Olea europaea, and Parietaria judaica) and a mixed grass pollen extract ("wild grasses"). The mixed extract included a standardized combination of Dactylis glomerata, Lolium perenne, Phleum pratense, and Poa pratensis. All extracts were used at standardized concentrations of 20–30 HEP/mL and contained 0.4% phenol as a preservative. Histamine dihydrochloride (10 mg/mL) and saline were used as positive and negative controls, respectively. Test results were evaluated at 10 minutes for histamine and 15 minutes for allergen extracts. A wheal diameter ≥3 mm greater than the negative control was considered indicative of a positive reaction.

Specific IgE Measurement: Levels were measured using the IMMULITE 2000 system (Siemens Healthcare Diagnostics, Tarrytown, NY, USA). Serum specific IgE levels of ≥0.35 kUA/L were considered positive.

Statistical Analysis

Data were analyzed using statistical software packages. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test; non-normally distributed data were presented as median (minimum–maximum). Intergroup comparisons were performed using Mann–Whitney U and Chi-square tests.

To identify independent predictors of rhinoconjunctivitis development, parameters with p<0.20 in univariate analysis were included in a multivariate logistic regression model. Relationships between parameters were examined using Spearman correlation analysis. Statistical significance was set at p<0.05.

RESULTS

A total of 143 patients were included in the study, with a median age of 12 (IQR: 10–15) years; 57.3% (n=82) were male. The median age at AR diagnosis was 9 (IQR: 6–12) years. The majority of the patients resided in urban areas (n=98, 68.5%), while 45 patients (31.5%) lived in rural areas. A family history of atopy was present in 55.9% of the participants, and 52.4% were exposed to passive smoking. The most frequent comorbidities were allergic conjunctivitis (54.5%), asthma (48.3%), and atopic dermatitis (7.7%). Regarding disease severity, 45.5% of patients were classified as having mild AR, while 54.5% were in the moderate-to-severe group. The median scores for TNSS and TOSS for the entire cohort were 5 (IQR: 4–6) (Table I).

A history of adenoidectomy was present in 18.2% (n=26) of the patients. In this subgroup, the rate of passive smoking exposure was significantly higher than those without a history of surgery (73.1% vs. 47.9%; p=0.020). Symptom analysis, based on current (postoperative) symptom scores at the time of evaluation, revealed that children with a history of adenoidectomy had significantly lower nasal congestion scores (p=0.015) and TNSS (p=0.019). No significant differences were observed between the groups regarding nasal itching, sneezing, or rhinorrhea.

Patients with rhinoconjunctivitis (n=78) had a median TNSS of 6 (IQR: 4–7), whereas the isolated AR group had a median TNSS of 4 (IQR: 3–5). Children with ARC presented with significantly more severe AR compared to the isolated group (p=0.005). Furthermore, VAS scores, nasal itching (p=0.002), nasal congestion (p=0.015), sneezing (p=0.015), and total TNSS (p<0.001) were significantly higher in ARC cases (Figure 2).

Table I: Demographic, Clinical, and Laboratory Characteristics and Symptom Distribution of the Study Population

Variables	Total (n=143)
Demographic characteristics, n (%)	
Current Age (years)*	12 (10–15)
Sex (Male)	82 (57.3)
Age at AR Diagnosis (years)*	9 (6–12)
Family History of Atopy	80 (55.9)
Passive Smoking Exposure	75 (52.4)
History of Adenoidectomy	26 (18.2)
Place of residence, n (%)	
Urban	98 (68.5)
Rural	45 (31.5)
Atopic comorbidities, n (%)	
Allergic Conjunctivitis	78 (54.5)
Asthma	69 (48.3)
Atopic Dermatitis	11 (7.7)
Allergic rhinitis severity, n (%)	
Mild	65 (45.5)
Moderate-to-Severe	78 (54.5)
Laboratory findings*	
Total Serum IgE (IU/mL)	263 (112–542)
Absolute Eosinophil Count (cells/mm³)	240 (120–490)
Eosinophil Percentage (%)	3.8 (1.9–5.7)
Specific IgE (Grass Mix) (kUA/L)	10.2 (2.55–32.0)
SPT Grass Pollen Wheal Diameter (mm)	7 (6–9)
Medication use, n (%)	
Antihistamines	107 (74.8)
Nasal Steroids	111 (77.6)
LTRAs	42 (29.4)
Medication Score*	2 (2–2)
Nasal symptom scores (n=143)	**n (%) / Median (IQR)**
Nasal Itching	119 (83.2) / 1 (1–2)
Nasal Congestion	114 (79.7) / 2 (1–2)
Sneezing	105 (73.4) / 1 (0–2)
Rhinorrhea	82 (57.3) / 1 (0–2)
Ocular symptom scores (n=78)	**n (%) / Median (IQR)**
Ocular Itching	62 (79.5) / 2 (1–2)
Ocular Redness	61 (78.2) / 1 (1–2)
Tearing	58 (74.4) / 1.5 (0.7–2)
Total scores*	
TNSS	5 (4–6)
TOSS	4.5 (3–6)
VAS	5 (4–6)

*Median (interquartile range), **AR:** Allergic rhinitis; **LTRA:** Leukotriene receptor antagonist; **SPT:** Skin prick test; **TNSS:** Total Nasal Symptom Score; **TOSS:** Total Ocular Symptom Score; **VAS:** Visual Analog Scale.

Analysis of environmental and therapeutic factors showed that passive smoking exposure was more prevalent in the ARC group (62.7% vs. 40.0%; p=0.041). Regarding medication use, antihistamine preference was

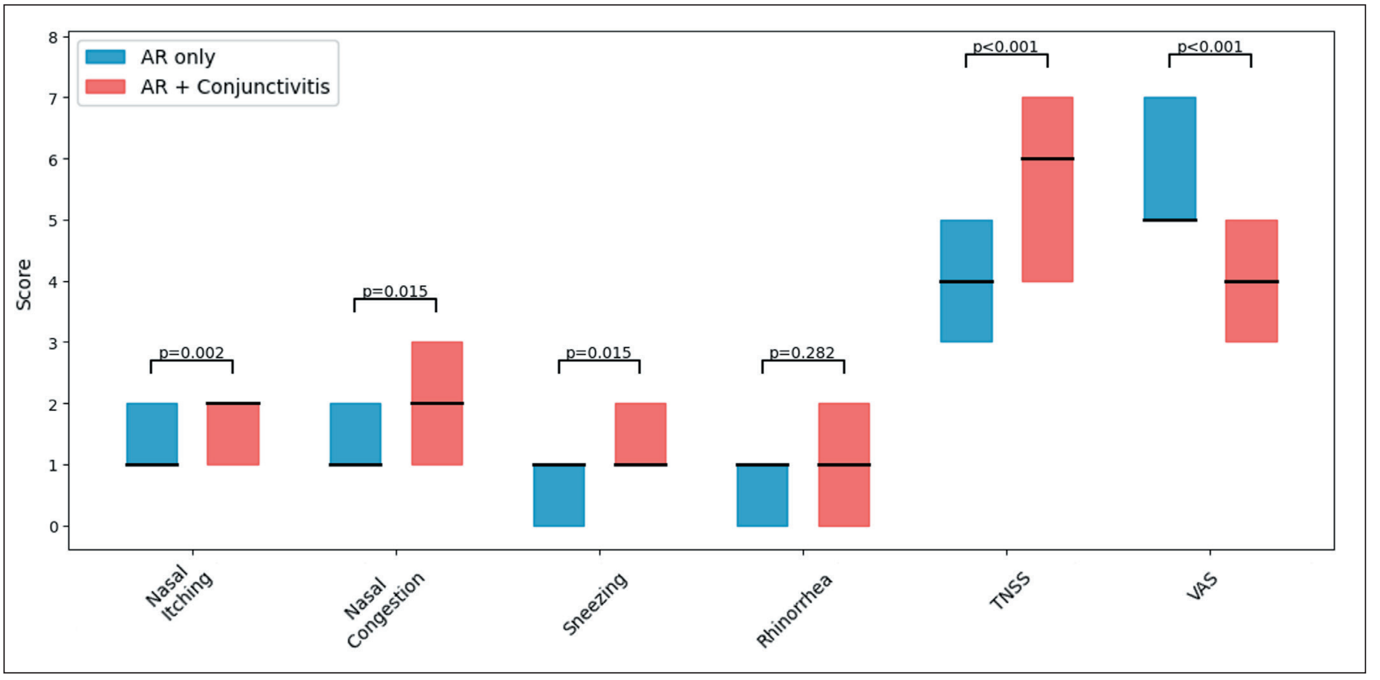

Figure 2: Comparison of Symptom and VAS Scores Between Patients with Allergic Rhinitis With and Without Conjunctivitis
TNSS: Total Nasal Symptom Score, **VAS:** Visual Analog Scale, **AR:** Allergic rhinitis.

more frequent in the ARC group (p=0.029), whereas LTRA use was significantly lower (p=0.011). No significant differences were found between groups for other demographic or laboratory parameters, including specific IgE (grass mix) and SPT wheal diameters for grass pollen (Table II).

A weak positive correlation was observed between TOSS and TNSS values, though it remained at the threshold of statistical significance (r=0.216, p=0.057).

In the multivariate logistic regression analysis performed to identify factors predicting comorbid conjunctivitis, AR clinical severity was identified as the only independent risk factor. As AR severity increased, the likelihood of developing ARC increased 7.5-fold (OR=7.518; 95% CI: 3.574–15.815; p<0.001). Nasal congestion, itching, sneezing scores, TNSS, and passive smoking—which appeared significant in the univariate analysis—did not reach statistical significance in the multivariate model (Table III).

DISCUSSION

In this study, the coexistence of conjunctivitis in children with grass pollen-sensitized seasonal AR was comprehensively evaluated. The most significant finding of our study is that the clinical severity of allergic rhinitis was identified as the strongest independent predictor for the development of ARC (OR=7.51).

Consistent with our results, the literature indicates that ocular symptoms—such as itching, tearing, and conjunctival hyperemia—are more frequently observed in moderate-to-severe AR cases (13,14). Furthermore, Sánchez-Hernández et al. reported a significant correlation between the severity of AR and the severity of AC (15). These data suggest that an increase in AR severity not only exacerbates nasal symptoms but also markedly elevates the probability of ocular involvement. Consequently, AR should not be viewed as an isolated disease affecting only the nasal mucosa; rather, it should be managed as a systemic inflammatory process with functional continuity to the conjunctival surface, within the framework of the "united airway disease" concept (6,14,16).

The comorbid disease burden in the pediatric AR population is remarkably high. In our cohort, conjunctivitis (54.5%) and asthma (48.3%) were the most prevalent comorbidities. Previous studies have reported AC prevalence in children with AR ranging from 46% to 73%, and asthma coexistence between 22% and 50% (16-19). Our findings reinforce the systemic nature of allergic inflammation and highlight the necessity of a multidisciplinary approach, including screenings for both ocular and lower airway involvement.

Table II: Comparison of Demographic, Clinical, and Laboratory Parameters According to the Presence of Allergic Conjunctivitis

Variables	No conjunctivitis (n=65)	With conjunctivitis (n=78)	p-value
Current Age (years)*	12 (11–15)	12 (9–15)	0.769
Age at AR Diagnosis (years)*	10 (7–12)	8 (6–12)	0.124
Family History of Atopy, n (%)	64 (60.4)	37 (56.8)	0.902
Passive Smoking Exposure, n (%)	31 (45.6)	47 (62.7)	**0.041**
History of Adenoidectomy, n (%)	17 (16.0)	9 (24.3)	0.096
Atopic comorbidities, n (%)			
Asthma	50 (47.2)	19 (51.4)	0.647
Atopic Dermatitis	8 (7.5)	3 (8.1)	0.529
Medication use, n (%)			
Antihistamines	75 (70.8)	32 (86.5)	**0.029**
Nasal Steroids	81 (76.4)	30 (81.1)	0.558
LTRAs	32 (30.2)	10 (27.0)	**0.011**
Medication Score*	2 (2–2)	2 (2–2)	0.475
Laboratory findings*			
Total Serum IgE (IU/mL)	210 (117–470)	304 (110–571)	0.426
Absolute Eosinophil Count (cells/mm³)	270 (130–430)	235 (90–500)	0.766
Eosinophil Percentage (%)	4.0 (2.1–6.2)	3.7 (1.5–5.4)	0.291
Specific IgE (Grass Mix) (kUA/L)	15.7 (2.3–35.3)	7.2 (2.7–28.9)	0.175
SPT Grass Pollen Wheal Diameter (mm)	8 (5–9)	7 (6–9)	0.983
AR severity, n (%)			
Mild	46 (70.8)	19 (24.4)	**<0.001**
Moderate-to-Severe	19 (29.2)	59 (75.6)	
Symptom scores (0–3)*			
Nasal Itching	1 (1–2)	2 (1–2)	**0.002**
Nasal Congestion	1 (1–2)	2 (1–3)	**0.015**
Sneezing	1 (0–1)	1 (1–2)	**0.015**
Rhinorrhea	1 (0–1)	1 (0–2)	0.282
Total scores*			
TNSS	4 (3–5)	6 (4–7)	**<0.001**
VAS	5 (5–7)	4 (3–5)	**<0.001**

Median (interquartile range), **AR:** Allergic rhinitis, **LTRA:** Leukotriene receptor antagonist, **SPT:** Skin prick test, **TNSS:** Total Nasal Symptom Score, **TOSS:** Total Ocular Symptom Score, **VAS:** Visual Analog Scale.

Table III: Logistic regression analysis of risk factors associated with rhinoconjunctivitis development

Variable	Univariate OR (95% CI)	p-value	Multivariate OR (95% CI)	p-value
Nasal congestion	1.475 (1.063–2.047)	0.020	1.117 (0.763–1.635)	0.569
Nasal itching	1.900 (1.275–2.833)	0.002	1.444 (0.918–2.269)	0.112
Sneezing	1.604 (1.085–2.373)	0.018	0.928 (0.568–1.514)	0.764
TNSS	1.638 (1.309–2.050)	<0.001	1.057 (0.666–1.679)	0.814
Passive smoking exposure	2.003 (1.027–3.909)	0.042	1.967 (0.926–4.180)	0.078
AR severity	7.518 (3.574–15.815)	<0.001	7.469 (3.515–15.871)	**<0.001**

OR: Odds ratio, **CI:** Confidence interval, **TNSS:** Total nasal symptom score, **AR:** Allergic rhinitis.

The geographic characteristics of the study region may also have influenced our findings. The study was conducted in Izmir, a coastal city in western Türkiye with a Mediterranean climate, characterized by mild, rainy winters and hot, dry summers. This climatic profile is associated with a prolonged and intense grass pollen season, particularly during the spring months. Previous aerobiological studies from this region have demonstrated that grass pollens (Poaceae family) constitute one of the most dominant airborne allergens (20), which may be associated with the relatively high prevalence of ocular involvement observed in our cohort.

The impact of ocular involvement on the quality of life was another primary focus. The significantly lower VAS scores in the ARC group (p<0.001) demonstrate that ocular symptoms impair daily comfort independently of nasal symptoms (21,22). This reminds clinicians that ocular symptoms in children with rhinitis should not be dismissed as "secondary findings" but should be treated as a core parameter determining quality of life.

Regarding environmental factors, passive smoking exposure was significantly higher in the ARC group (62.7%; p=0.041). This aligns with prior studies identifying passive smoking as a major risk factor for both rhinitis and ocular allergy (23,24). Beyond causing direct irritation to the ocular surface, tobacco smoke is thought to exacerbate allergic responses by upregulating pro-inflammatory cytokines. Therefore, environmental protection strategies must be emphasized as an indispensable step in managing seasonal symptoms.

Notably, children with a history of adenoidectomy in our study had a higher prevalence of passive smoking exposure (73.1%), supporting previous evidence linking parental smoking to an increased risk of adenotonsillar disease (25). Tobacco smoke may contribute to chronic nasopharyngeal inflammation through mucosal irritation and the upregulation of pro-inflammatory pathways, potentially promoting adenoid hypertrophy. From a clinical perspective, this finding highlights passive smoking as a potentially modifiable environmental risk factor that may exacerbate upper airway inflammation. However, given the cross-sectional nature of our study, a causal relationship cannot be established, and passive smoking may also reflect shared environmental or socioeconomic factors associated with disease burden. Conversely, the lower nasal congestion and TNSS scores observed in children who underwent adenoidectomy may be attributed to improved nasal airflow following surgical intervention (26,27).

The primary limitations of our study include its retrospective, cross-sectional design and the lack of a standardized ophthalmological examination performed by a specialist. In particular, the absence of slit-lamp examination, which is considered the gold standard for the evaluation of allergic conjunctivitis, may have limited the diagnostic precision. However, the diagnosis of conjunctivitis was not based solely on patient self-reports; it was supported by objective data, including clinical findings and the documented use of anti-allergic eye drops, which enhances the scientific validity of our results. In addition, pollen counts were not systematically monitored during the study period (2023–2025), and therefore, potential year-to-year variability in environmental allergen exposure could not be accounted for, which may have influenced symptom severity and clinical outcomes. Future prospective studies incorporating detailed ophthalmologic assessments and environmental monitoring are warranted to improve diagnostic accuracy.

Allergic conjunctivitis is a frequent comorbidity in children with grass pollen-sensitized seasonal AR. Increased disease severity dramatically elevates the risk of ocular involvement. In managing these patients, systematic screening for ocular symptoms and the mitigation of modifiable risk factors—such as passive smoking exposure—are critical for optimizing patient outcomes and quality of life.

Conflict of Interest

The authors declare no conflict of interest.

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Author Contributions

Concept: **AH, OS, DC,** Design: **AH, OS, DC,** Data collection or processing: **SG, FCC, CSK,** Analysis or Interpretation: **AH, SG,** Literature search: **AH, FCC,** Writing: **AH, OS, SG, DC,** Approval: **AH, OS, SG, FCC, CSK, DC.**

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