Factors Associated with Allergic Conjunctivitis in School-Aged Children in Pathum Thani Area

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Abstract

Background: Allergic conjunctivitis (AC) affects approximately 40% to 60% of individuals with allergies. The International Study of Asthma and Allergies in Childhood (ISAAC) reports an ocular allergy prevalence of 4.8% to 21% among children aged 13-14 years.

Objective: To evaluate the factors that correlate with AC in junior high school students, in order to support clinical diagnosis, comprehensive care, and patient education.

Materials and Methods: A case-control study was conducted among junior high school students aged 12-15 years at Thammasat Khlongluang Wittayakom School, Thailand. Participants completed the ISAAC questionnaire and underwent ophthalmologic examination, severity grading of allergic ocular disease, SPT, and Schirmer's test. Stratified sampling was used to determine and allocate the sample size.

Results: No significant differences in age or gender were observed between the AC and non-AC groups. A history of allergic rhinitis and exposure to household smoking were significantly associated with AC. In multivariate analysis, allergic rhinitis remained an independent risk factor (adjusted OR 10.31, 95% CI 1.23 to 86.71, p=0.032), while living with a habitual smoker also showed a significant association (adjusted OR 2.89, 95% CI 1.09 to 7.70, p=0.033). Most AC cases presented with mild symptoms, and nearly all participants with AC had never been formally diagnosed.

Conclusion: Allergic rhinitis and exposure to household cigarette smoke are significant factors associated with AC in school-aged children. These findings highlight the importance of early recognition and screening for AC in community and school health settings.

Keywords: Allergic conjunctivitis; Epidemiology; Comorbid allergic disease; Pediatric allergy; Environmental exposure

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Allergic conjunctivitis (AC) is a hypersensitivity disorder that causes an inflammatory response of the conjunctiva to an allergen[1]. There are spectrums of severity ranging from mild, which may cause irritating symptoms, to severe cases that may lead to declination of visual function. AC can be manifested as a standalone condition or associated with other allergic diseases, including atopic dermatitis, allergic rhinitis, or asthma[2-5]. AC is encountered in up to 60% of individuals with allergic diseases[6]. In accordance with the International Study of Asthma and Allergies in Childhood (ISAAC), the first and third phase of a multicounty cross-sectional survey of allergic rhinitis patients in the Asia-Pacific region, ocular allergy prevalence was 3.6% to 17.7% in 6- to 7-year-olds and 4.8% to 21% in 13- to 14-year-olds[7]. The severity

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What is already known about this topic?

AC is a common ocular allergic disease and frequently occurs in patients with other atopic conditions, particularly allergic rhinitis.

Environmental exposures, including aeroallergens and air pollutants, have been suggested to contribute to the development and exacerbation of AC.

However, data regarding factors associated with allergic conjunctivitis among school-aged children in community settings in Southeast Asia remain limited.

What does this study add?

This study demonstrates that allergic rhinitis and exposure to household cigarette smoke are independent factors associated with allergic conjunctivitis among Thai school-aged children.

A substantial proportion of students with symptoms suggestive of allergic conjunctivitis had never received a formal diagnosis, highlighting potential under-recognition in community settings.

These findings emphasize the importance of early screening for ocular allergy in children with allergic comorbidities and environmental risk exposures.

and duration of AC were markedly correlated with the severity and duration of both rhinitis and asthma[8]. The prevalence percentage of AC in other allergic diseases were 51% in Allergic rhinitis, 20% in asthma, and 10% in atopic dermatitis[9]. The majority of individuals with seasonal allergic conjunctivitis (SAC) or perennial allergic conjunctivitis (PAC) in the Asia-Pacific exhibited dust mite sensitization[10,11]. Common skin allergens were house dust mites (65.2%), animal epithelia (15.2%), insects (15.2%), and food (14.1%) in AC[9]. The dominant allergenic dust mites comprise Dermatophagoides pteronyssinus, Dermatophagoides farinae, Euroglyphus maynei, and Blomia tropicalis, which are eight-legged arachnids[12]. Climate change, environmental tobacco smoke, and pollutants also exacerbate allergic conditions[11].

The understanding of the association of each factor with AC would be beneficial in clinical practice in terms of diagnosis, holistic care, and patient education. Thus, this study was conducted to evaluate the factors that correlate with AC in junior high school students.

Materials and Methods

Questionnaire

The questionnaire consisted of demographic data, screening questions for AC according to the ISAAC, which has been validated in the Thai version[13]. Questions regarding the evaluation of AC have been adopted based on the question regarding the presence of itchy and watery eyes without a history of infection during the past 12 months[14,15]. Children who responded affirmatively to this question were classified as cases of AC, while those who responded negatively were classified as non-AC. Additionally, the questionnaire has been used in previous studies and includes screening questions for allergic diseases such as allergic rhinitis, asthma, and atopic dermatitis. These questions are part of a validated questionnaire for diagnosing those allergic diseases. Asthma was identified through a physician's diagnosis of asthma; allergic rhinitis was determined by physicians diagnosed. Atopic dermatitis was determined by a history diagnosed by a physician.

Ophthalmologic Examination

After the AC diagnosis was initially made using the ISAAC questionnaire, it was confirmed through clinical examination by ophthalmologists, based on the characteristic findings of AC. The primary focus of AC characteristics was on signs of inflammation affecting conjunctival, palpebral and cornea. The grade of severity of allergic ocular diseases was assessed based on standardized evaluation criteria by ophthalmologists. The grading system was based on a scale of 0 to 4, where 0=absent, 1=mild, 2=moderate, 3=moderately severe, and 4=severe, for both signs and symptoms. The total score was 48 points: 0 points=absent, 1-12 points=mild, 13-24 points=moderate, 25-36 points=moderately severe, and 37-48 points=severe[16].

Skin Prick Test

The skin prick test (SPT) was performed using commercial allergen extracts, which included dog hair, cat hair, cockroach, and house dust mites (Greater AllerVACtest®). Histamine served as the positive control, while glycerin was used as the negative control. The test results were interpreted 15-20 minutes after application. A wheal diameter of 3 mm or more, compared to the negative control, was considered a positive SPT.

Schirmer's Test I

The Schirmer's test was administered by placing Schirmer's test strips in the conjunctival fornix of both eyes.

The Schirmer's test score is determined by measuring the length of the moistened area on the strips within a specified duration. A score exceeding 10 mm in 5 minutes is considered normal, while a score below 5 mm in 5 minutes indicates tear deficiency.

Samples

This study was designed as a school-based case-control study conducted among lower secondary school students aged 12-15 years at Thammasat Khlong Luang Wittayakom School, Thailand. The sample size was calculated using the formula for comparison of two independent proportions, as described by Bernard (2000). This approach was selected to ensure adequate statistical power for detecting differences in exposure between students with and without AC.

$$n = \frac{\{Z_{\alpha/2}\sqrt{2\bar{P}(1-\bar{P})} + Z_{\beta}\sqrt{P_1(1-P_1) + P_2(1-P_2)}\}^2}{(P_1-P_2)^2}$$

$Z_{\alpha/2}$=1.96, corresponding to a two-sided significance level of 0.05

Z_{β}=0.842, corresponding to a statistical power of 80%

According to Gao et al.[17], the proportion of males among children with AC was 73.86%, compared with 46.56% among children without AC. The parameters used were:

- P_1=proportion of males in the AC group=0.738

- P_2=proportion of males in the non-AC group=0.466
- $\bar{P}$=average proportion=0.602

The required sample size was calculated to be 50 participants per group. Accordingly, the study included 50 students with AC and 50 students without AC (non-AC), resulting in a total sample size of 100 participants.

A stratified random sampling method was employed to minimize selection bias and ensure representation across grade levels. The study population was stratified by grade (Grade 7-9), after which classrooms within each grade were randomly selected using a lottery method.

Approximately 200 students were initially screened to identify eligible AC cases. Given an average class size of approximately 40 students, two classrooms per grade were randomly selected. Screening was conducted sequentially across grades to ensure that AC cases were distributed across all grade levels. Screening ceased once the target of 50 AC cases was achieved. For the control group, students without AC were randomly selected from the same classrooms as the case group. From each classroom, approximately 8-9 non-AC students were selected using simple random sampling to achieve a total of 50 controls (Figure 1).

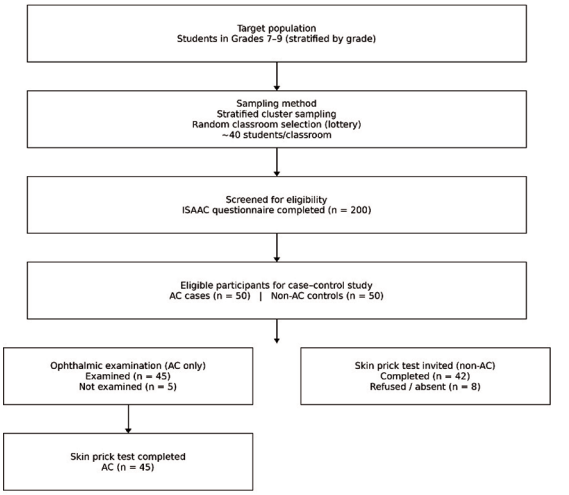

Figure 1. Flow diagram of participant selection.

Statistical Analysis

Baseline characteristics were described using the SPSS Statistics software, as number (percentage), median (range), and mean ± standard deviation (SD). Chi-square or Fisher's exact test was employed to compare proportions between the study groups, the independent t-test was used to compare the means of the two groups, and the Mann-Whitney U test was used for non-normal distributions. All reported p-values were 2-sided with p-value less than 0.05 set as the threshold for statistical significance.

An independent t-test or Mann-Whitney U test was used to compare the means of the 2 groups as appropriate. Chi-square or Fisher's exact test was used as appropriate for comparing proportions. The level of statistical significance was set at p-value less than 0.05.

Chi-square test and Fisher-exact test were used to compare categorical variables, and an independent t-test was used to analyze continuous variables for normal distribution. The Mann-Whitney test was used for non-nominal distributions.

Results

Questionnaires were randomly distributed to 100 students aged 12-15 years at Thammasat KlongLuang Vittayakom School to identify students with AC and those without (non-AC). Thirteen students declined to participate, which includes 5 subjects (AC) and 8 subjects (non-AC). The final analysis included 45 subjects in the AC group and 42 in the control group (non-AC).

Participant Demographic Characteristics

The demographic data of the participants highlight several notable trends and differences that are shown in Table 1. The majority of participants in both groups were female, accounting for 64.4% in the AC group and 61.9% in the control group. The age range for all participants was 13-14 years. Statistical analysis revealed no significant differences in age or gender distribution between the AC and non-AC groups, indicating that these factors were relatively balanced across the study population.

Data on underlying allergic conditions were also collected. Allergic rhinitis emerged as the most commonly reported allergic condition, with 12.6% of all participants affected. Within the AC group, however, the prevalence was higher, at 22.2%. A significant difference in the history of allergic rhinitis was observed between the AC and non-AC groups ($p<0.05$). Asthma, atopic dermatitis, and parental history of allergic diseases were also assessed, but no significant differences were found between the two groups.

Exposure to passive smoking showed a significant disparity between groups ($p<0.05$). In the AC group, 46.7% of participants reported exposure to passive smoking. Among those exposed, the most common pattern was smoking on a balcony, which occurred in 51.7% of the AC group and 55.6% of the control

Table 1. Baseline characteristics of the subjects (n=87)

Characteristics	Total (n=87)		AC (n=45)		Non-AC (n=42)		p-value
	n	%	n	%	n	%	
Class							0.539
Grade 7	7	8.0	4	8.9	3	7.1	
Grade 8	80	92.0	41	91.1	39	92.9	
Age (years)							
12	8	9.2	4	8.9	4	9.5	
13	60	69.0	30	66.7	30	71.4	
14	19	21.8	11	24.4	8	19.0	
Mean±SD	13.13±0.55		13.16±0.56		13.10±0.53		0.609
Gender							0.806
Male	32	36.8	16	35.6	16	38.1	
Female	55	63.2	29	64.4	26	61.9	
Co-morbidities							0.009*
Yes	16	18.4	13	28.9	3	7.1	
No	71	81.6	32	71.1	39	92.9	
History of allergic rhinitis	11	12.6	10	22.2	1	2.4	0.005*
History of asthma	2	2.3	1	2.2	1	2.4	1.000
History of atopic dermatitis	2	2.3	1	2.2	1	2.4	1.000
Parental history of allergy							0.262
Yes	30	34.5	18	40.0	12	28.6	
No	57	65.5	27	60.0	30	71.4	
Lived with a habitual smoker							0.013*
No	57	65.5	24	53.3	33	78.6	
Yes	30	34.5	21	46.7	9	21.4	
• Smoking indoor	6	20.7	4	20.0	2	22.2	
• Smoking without anyone	5	17.2	4	20.0	1	11.1	
• Smoking in the balcony area	3	10.3	2	10.0	1	11.1	
• Smoking outdoor	15	51.7	10	50.0	5	55.6	
Exposed to second-hand smoke							0.496
1-3 times/day	36	90.0	25	92.6	11	84.6	
4-6 times/day	3	7.5	2	7.4	1	7.7	
More than 10 times/day	1	2.5	0	0.0	1	7.7	
Animal petting							0.393
No	45	51.7	21	46.7	24	57.1	
Yes	42	48.3	24	53.3	18	42.9	
• Dog	19	21.8	11	24.4	8	19.0	0.610
• Cat	26	29.9	14	31.1	12	28.6	0.819
• Rabbit	2	2.3	2	4.4	0	0.0	0.495
• Bird	4	4.6	3	6.7	1	2.4	0.617

AC=allergic conjunctivitis; SD=standard deviation

p-values for mean data were calculated with the use of an independent t-test, for percentages with the use of chi-square test or Fisher's exact test, * Significant at $p<0.05$

group. The majority of participants, approximately 90%, were exposed to second-hand smoke one to three times per day.

Pet ownership was examined, revealing that 48.3% of participants had at least one pet, while 51.7% reported having no pets at home. Cats were the most frequently owned pet among participants. However, no significant differences in pet ownership were observed between the AC and non-AC groups, suggesting that pet exposure was not a differentiating factor in this study.

In the univariate analysis, the presence of

Table 2. Factors associated with allergic conjunctivitis (AC) in school-aged children univariate and multivariate logistic regression analysis (n=87)

Factor	n	Univariate			Multivariate		
		Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Comorbidities	16	5.28	1.383 to 20.161	0.015*	-		
History of allergic rhinitis	11	11.71	1.428 to 96.095	0.022*	10.31	1.225 to 86.705	0.032*
Lived with a habitual smoker	30	3.21	1.252 to 8.225	0.015*	2.89	1.088 to 7.698	0.033*

OR=odds ratio; CI=confidence interval
* Significant at p<0.05

comorbidities was significantly associated with AC (crude OR 5.28, 95% CI 1.38 to 20.16, p=0.015). A history of allergic rhinitis was also significantly associated with AC, with children who had allergic rhinitis being more likely to develop AC than those without such a history (crude OR 11.71, 95% CI 1.43 to 96.10, p=0.022). In addition, living with a habitual smoker was significantly associated with AC, increasing the odds by approximately threefold (crude OR 3.21, 95% CI 1.25 to 8.23, p=0.015) (Table 2).

For the multivariate logistic regression analysis, only a history of allergic rhinitis and living with a habitual smoker were included in the model, as allergic rhinitis is a component of the comorbidities variable. This approach was applied to avoid multicollinearity. The results showed that a history of allergic rhinitis remained independently associated with AC (adjusted OR 10.31, 95% CI 1.23 to 86.71, p=0.032). Living with a habitual smoker also remained significantly associated with AC (adjusted OR 2.89, 95% CI 1.09 to 7.70, p=0.033) (Table 2).

Prevalence and Characteristic of AC Symptoms

Participants in the AC group were required to report symptoms of itching as a criterion for inclusion. The resulted was shown in Table 3. Among these participants, 66.7% experienced itchiness without fever or cold symptoms one to four times in the past 12 months. A smaller proportion, 20%, reported five to ten episodes of itching, while 13.3% experienced more than ten episodes during the same period. Despite the prevalence of symptoms, 97.8% of participants in the study had never received a formal diagnosis of any related ocular disorder, suggesting underdiagnosis of AC in this population.

A distinct seasonal pattern in the occurrence of AC symptoms was identified. The highest frequency of itchiness was reported in May and June, accounting for 35.6% of cases. This was followed by August, April, and July, aligning with the rainy season (Figure 2). This seasonal distribution underscores the potential role of

Table 3. Prevalence and characteristics of AC symptoms in the AC group (n=45)

	Total (n=45)	
	n	%
Tearing/itching frequency		
1-4 times	30	66.7
5-10 times	9	20.0
More than 10 times	6	13.3
Daily life interference		
No	29	64.4
Sometimes	16	35.6
Tearing/itching		
Yes	3	6.7
No	42	93.3
Tearing/itching with light phobia		
Yes	14	31.1
No	31	68.9
Tearing/itching with FB sensation		
Yes	30	66.7
No	15	33.3
Tearing/itching with AR		
Yes	21	46.7
No	24	53.3
Diagnosed AC		
Yes	1	2.2
No	44	97.8

FB=foreign body; AR=allergic rhinitis; AC=allergic conjunctivitis

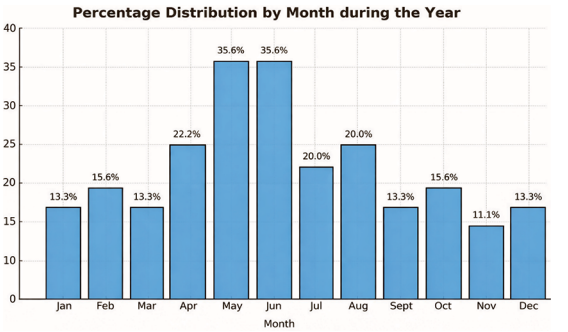

Figure 2. Percentage distribution by month during the year.

Table 4. Allergy-associated symptoms and skin prick test result (n=87)

	Total (n=87)		AC (n=45)		Non-AC (n=42)		p-value
	n	%	n	%	n	%	
Associated symptom							
AR symptoms	43	49.4	30	66.7	13	31.0	0.001*
Diagnosed AR	17	19.5	13	28.9	4	9.5	0.023*
Difficulty in breathing	41	47.1	27	60.0	14	33.3	0.013*
Wheezing	32	36.8	21	46.7	11	26.2	0.048*
Diagnosed asthma	5	5.7	4	8.9	1	2.4	0.362
Diagnosed AD	3	3.4	2	4.4	1	2.4	1.000
Skin prick test							
Positive	35	40.2	21	46.7	14	33.3	0.205
Dog hair	3	3.4	1	2.2	2	4.8	0.608
Cat hair	6	6.9	4	8.9	2	4.8	0.677
Cockroach	9	10.3	4	8.9	5	11.9	0.733
House dust mites	31	35.6	19	42.2	12	28.6	0.184

AC=allergic conjunctivitis; AR=allergic rhinitis; AD=atopic dermatitis

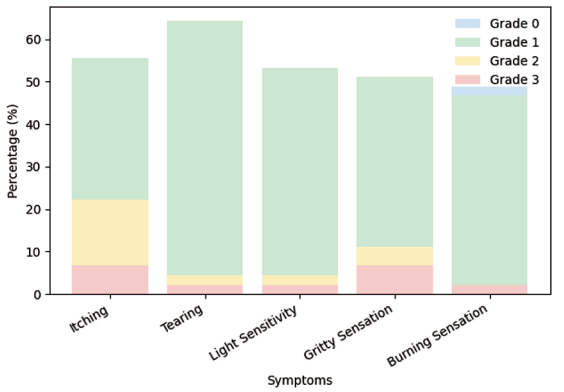

Figure 3. AC symptoms grading.

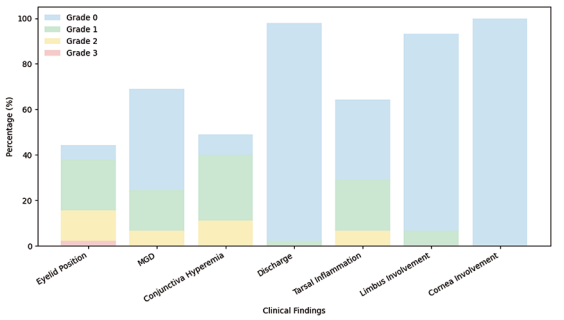

Figure 4. AC clinical severity grading.

environmental factors, such as humidity and pollen levels, in triggering or exacerbating AC symptoms.

Ophthalmic Examination in the AC Group

In the AC group, participants reported various ocular symptoms, including itching, tearing, light sensitivity, gritty sensation, and burning. All symptoms were graded as mild (Grade 1) based on the study's grading system, which categorized symptom severity (Figure 3). These findings suggest that most participants experienced relatively mild discomfort associated with their condition.

The study assessed various clinical signs, including eyelid position and skin appearance, eyelid margin Marx's line (MGD), conjunctival hyperemia and swelling, conjunctival discharge, tarsal conjunctival inflammation, limbal involvement, and corneal involvement (Figure 4). The results showed that the mean clinical sign and symptom score was 6.36±3.28, with the majority of participants (91.1%) classified as having mild symptoms and signs (score range 1-12). This indicates that although symptoms and signs were present, they were generally not severe. To further assess the prevalence of dry eye among AC participants, the Schirmer's test was conducted. This test evaluates tear production to identify dry eye. Results revealed that 66.7% of participants had normal tear production, while the remaining 33.3% exhibited varying degrees of reduced tear production, potentially contributing to their ocular symptoms.

The Subjects with Other Concomitant Diseases and Sensitization by SPT were Divided into Two Groups

The study also evaluated coexisting allergic conditions among participants with and without AC. Associated symptoms of AC are summarized in Table 4. The most frequently reported coexisting allergic condition was rhinitis symptoms, such as

a blocked, itchy, or runny nose. These symptoms were reported by 49.4% of all participants. A formal diagnosis of allergic rhinitis was made in 19.5% of the total population. Asthma-related symptoms, including difficulty breathing or wheezing, were reported by 47.1% of participants. However, only 5.7% received a formal diagnosis of asthma. Atopic dermatitis was observed in a smaller proportion of participants, affecting 3.4% of the overall population. There was a significant difference in the prevalence of both allergic rhinitis and asthma between the AC group and the non-AC control group, highlighting the strong association between these conditions and AC.

The study also conducted a SPT to assess sensitization to allergens. The results showed no significant differences in overall sensitization rates between the AC and non-AC groups. However, the most commonly identified allergen across both groups was house dust, affecting 35.6% of participants. Other allergens were included: cockroach allergens (10.3%), cat hair (6.9%), and dog hair (3.4%).

Discussion

In this study, participants with AC were identified using the ISAAC questionnaire. This tool was adapted to detect symptoms of AC as well as other allergic conditions. The primary symptom of AC is itching. Additionally, other ocular symptoms and ophthalmologic examinations were included to confirm the diagnosis and assess the severity of AC in the study participants.

This study was conducted in a school setting, providing a community-based perspective. Results from the ISAAC questionnaire revealed that 97.8% of participants with AC symptoms were undiagnosed. Therefore, we aimed to evaluate the severity of ocular symptoms and signs. The severity of AC was assessed primarily based on conjunctival, palpebral, and corneal findings, with severity classified as mild, moderate, or severe[16].

Most participants in our study demonstrated mild severity (scores ranging from 1 to 12) across various clinical parameters, including eyelid position and skin appearance, eyelid margin Marx's line (MGD), conjunctival hyperemia and swelling, conjunctival discharge, tarsal conjunctival inflammation, and limbal involvement. No cases of corneal involvement were observed. The mean clinical sign and symptom score was 6.36±3.28.

Previous studies have also indicated that pronounced ocular signs in children are often absent[17]. In our population, participants with AC may not have been experiencing active allergic conditions at the time of evaluation, which could explain the lower ocular sign severity observed in this community setting. Mild forms of SAC and PAC are frequently underdiagnosed, and the ocular symptoms associated with allergic rhino conjunctivitis often go untreated[16].

To prevent delayed diagnosis and subsequent disease progression, it is crucial to screen patients who report at least one ocular symptom. Early detection can lead to timely management and better health outcomes.

Anterior ocular surface diseases (e.g., AC, infectious, blepharitis, and dry eyes) are prone to undiagnosed in the primary care center, leading to inappropriate treatment[8]. The manifestation symptoms in SAC and PAC patients are including irritation, burning, and foreign body sensation[16]. All these manifestation symptoms might be related to increased tear film lipid layer thickness or even alterations of the lipid secretions, causing tear instability[16]. To evaluate ocular allergy or AC, it is essential to focus on obtaining a detailed case history, utilizing appropriate diagnostic tests (e.g., IgE levels, patch tests, Schirmer's test), and identifying markers of inflammation such as tear osmolarity. In mild to moderate cases of SAC and PAC, Schirmer's test values of <10 mm were observed in 39.1% and 36.4% of patients, respectively. In our study, Schirmer's test results of <5 mm were found in approximately 33.3% of AC patients. Based on our findings, we recommend incorporating tear osmolarity testing to prevent ocular surface damage and improve management of AC.

There were no significant age or gender differences between the AC and non-AC groups. However, a higher percentage of females was observed in both the AC and non-AC groups, which may reflect the higher number of females in the general population. These findings differ from a previous study, which reported that males had a higher prevalence of AC and were at greater risk of developing the condition compared to females[17]. The prevalence of AC in the teenage group (age 12-14 years) was 27%[14]. Our result shown mean age of 13.13 in the total population because there are more population in the age of 13. A history of allergic rhinitis and living with a habitual smoker were identified as independent factors associated with AC. The strong association between allergic rhinitis and AC supports the concept of shared atopic mechanisms involving the upper and ocular mucosa. In addition, exposure to household cigarette smoke may contribute to ocular surface inflammation and immune dysregulation, thereby increasing susceptibility to AC. These findings emphasize the role of both atopic background and

environmental exposure in the development of AC among school-aged children.

According to a previous study, the most common comorbidity of AC is allergic rhinitis[14]. The comorbidity of AR in children was AC. It has been reported as 97% in an outpatient clinic[14]. In the current study, allergic rhinitis was found to be the most common comorbidity, affecting 12.6% of the total study population. We observed that a history of allergic rhinitis showed a statistically significant difference between the AC and non-AC groups. Other allergic conditions, such as rhinorrhea without a formal diagnosis of allergic rhinitis and asthma-like symptoms (difficulty breathing or wheezing) without a diagnosis of asthma, also showed significant differences between the groups. A review of medical records from a tertiary referral hospital revealed that 44% of asthmatic patients reported at least one ocular symptom suggestive of AC[15]. It was demonstrated that many patients are misdiagnosed or have had a delayed diagnosis.

To validate the aeroallergen sensitization, a SPT was conducted. House dust mites are the most common allergen in both AC and non-AC. This approach aligns with a similar study that examined the relationship between ocular symptoms/signs and SPT results[17]. There were no correlations between the scores of ocular symptoms/signs and the SPT results for house dust mite allergens. The difference between our findings and those of Gao et al.[17] may be attributed to differences in control group characteristics and background allergen sensitization. Unlike Gao et al., who reported negative SPT results in all non-AC controls, our study found a high prevalence of positive SPT results to house dust mites in both allergic and non-AC groups. This likely reflects widespread exposure and high background sensitization in children living in tropical environments, where a positive SPT may indicate environmental exposure rather than disease-specific sensitization. This finding suggests that additional factors, such as local ocular immune responses, environmental exposure, and genetic susceptibility, may play important roles in the development of clinical disease.

This study also examined the percentage of participants exposed to second-hand smoke. To our knowledge, no previous studies have investigated the association between smoking and ocular allergy or AC. Our findings revealed a statistically significant difference in smoke exposure between the AC and non-AC groups.

Implication for practice

The findings of this study suggest that healthcare providers and school health personnel should maintain a high index of suspicion for AC in children presenting with recurrent ocular symptoms, particularly in those with allergic comorbidities. Early recognition and appropriate referral may reduce symptom chronicity and improve quality of life.

Limitations

First, selection bias may be present, as participants were recruited from a specific population, which may limit the generalizability of the findings to all school-aged children. Additionally, the case-control design relies on symptom-based classification, which may be subject to recall bias.

However, detailed inclusion and exclusion criteria were applied consistently to both cases and controls to minimize differential misclassification and selection bias.

Conclusion

This study highlights the association between ocular allergy, particularly AC, and other allergic conditions, such as allergic rhinitis and asthma. These findings emphasize the interconnected nature of allergic diseases, where multiple conditions frequently coexist. Importantly, undiagnosed AC often presents with mild to moderate symptoms, such as itching, tearing, and light sensitivity, which are commonly overlooked. This underdiagnosis may lead to delayed treatment, prolonged discomfort, and the potential for worsening symptoms. In the context of holistic healthcare, accurate diagnosis of AC is essential to ensure timely and appropriate treatment. Recognizing even mild symptoms can help prevent progression and improve patients' quality of life. Additionally, evaluating for comorbid allergic conditions, such as rhinitis and asthma, is critical for comprehensive care. Integrating the management of AC into broader allergy care allows healthcare providers to address the systemic nature of allergic diseases. This approach not only alleviates ocular symptoms but also improves the overall well-being of affected individuals by identifying and managing associated conditions. Early diagnosis and intervention are key steps in achieving better outcomes for patients with AC and related allergic disorders.

Author Contributions

The authors confirm contribution to the paper as follows: Study conception and design: TS and OP; Data collection: all authors; Analysis and interpretation of results: TS; Draft manuscript preparation: TS and NM.

All authors reviewed the results and approved the final version of the manuscript.

Clinical Trial Registration

This study was an observational case-control study conducted among school-aged children and did not involve any clinical trial intervention; therefore, clinical trial registration was not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

The datasets generated and analyzed during this study at Thammasat Khlongluang Wittayakom School are not publicly available due to privacy and ethical restrictions involving school-aged participants. However, the data are available from the corresponding author upon reasonable request and with permission from the relevant institutional authority.

Ethics Approval and Consent to Participate

Ethical approval for this study (Project No. MTU-EC-OP-1-068/66) was provided by the Human Research Ethics Committee of Thammasat University on May 18, 2023. The Human Research Ethics Committee of Thammasat University (Medicine) is in full compliance with international guidelines such as the Declaration of Helsinki, the Belmont Report, CIOMS Guidelines, and the International Conference on Harmonization-Good Clinical Practice (ICH-GCP). This document is a record of review and approval/acceptance of a clinical study protocol. The Human Research Ethics Committee of Thammasat University (Medicine) has approved the above study and the accompanying documents for use in the study at the EC meeting on 7/2023, Date April 11, 2023.

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Use of Artificial Intelligence

Artificial intelligence (AI) tool (ChatGPT, OpenAI, version GPT-5.3) was used to assist in language editing and improving the clarity of the manuscript. All scientific content, data interpretation, and conclusions were developed by the authors. The authors take full responsibility for the accuracy and integrity of the manuscript.

References

1. La Rosa M, Lionetti E, Reibaldi M, Russo A, Longo A, Leonardi S, et al. Allergic conjunctivitis: A comprehensive review of the literature. Ital J Pediatr 2013;39:18.
2. Singh K, Axelrod S, Bielory L. The epidemiology of ocular and nasal allergy in the United States, 1988-1994. J Allergy Clin Immunol 2010;126:778-83.e6.
3. Mehta R. Allergy and asthma: Allergic rhinitis and allergic conjunctivitis. FP Essent 2018;472:11-5.
4. Gradman J, Wolthers OD. Allergic conjunctivitis in children with asthma, rhinitis and eczema in a secondary outpatient clinic. Pediatr Allergy Immunol 2006;17:524-6.
5. Bielory L. Allergic conjunctivitis and the impact of allergic rhinitis. Curr Allergy Asthma Rep 2010;10:122-34.
6. Ono SJ, Abelson MB. Allergic conjunctivitis: Update on pathophysiology and prospects for future treatment. J Allergy Clin Immunol 2005;115:118-22.
7. Asher MI, Montefort S, Björkstén B, Lai CK, Strachan DP, Weiland SK, et al. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC phases one and three repeat multicountry cross-sectional surveys. Lancet 2006;368:733-43.
8. Bielory L, Delgado L, Katelaris CH, Leonardi A, Rosario N, Vichyanoud P. ICON: Diagnosis and management of allergic conjunctivitis. Ann Allergy Asthma Immunol 2020;124:118-34.
9. Miranda-Machado PA, De la Cruz-Hoyos Sánchez B. Skin reactivity in allergic conjunctivitis. Rev Alerg Mex 2018;65:208-16.
10. Arej N, Irani C, Abdelmassih Y, Slim E, Antoun J, Bejjani R, et al. Evaluation of allergic sensitization in Lebanese patients with allergic conjunctivitis. Int Ophthalmol 2018;38:2041-51.
11. Thong BY. Allergic conjunctivitis in Asia. Asia Pac Allergy 2017;7:57-64.
12. Miller JD. The role of dust mites in allergy. Clin Rev Allergy Immunol 2019;57:312-29.
13. Vichyanond P, Jirapongsananuruk O, Visitsuntorn N, Tuchinda M. Prevalence of asthma, rhinitis and eczema in children from the Bangkok area using the ISAAC (International Study for Asthma and Allergy in Children) questionnaires. J Med Assoc Thai 1998;81:175-84.
14. Feng Y, Wang X, Wang F, Liu R, Chen L, Wu S, et al. The prevalence of ocular allergy and comorbidities in Chinese school children in Shanghai. Biomed Res Int 2017;2017:7190987. doi: 10.1155/2017/7190987.
15. Geraldini M, Chong Neto HJ, Riedi CA, Rosário NA. Epidemiology of ocular allergy and co-morbidities in adolescents. J Pediatr (Rio J) 2013;89:354-60.
16. Robles-Contreras A, Santacruz C, Ayala J, Bracamontes E, Godinez V, Estrada-Garcia I, et al. Allergic conjunctivitis: An immunological point of view. In: Pelikan Z, editor. Conjunctivitis: A complex and multifaceted disorder. Rijeka: InTech; 2011. p. 33-56.
17. Gao X, Hong L, Xiang Q. A survey of allergic conjunctivitis in children in China. Sci Rep 2022;12:21026. doi: 10.1038/s41598-022-25591-7.