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Trends of aeroallergen sensitization among children with respiratory allergy in Southern Thailand

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ABSTRACT

Background: Respiratory allergy significantly impacts children's health and quality of life, with inhaled allergens serving as prevalent triggers for respiratory symptoms. Aeroallergen sensitization, confirmed through the skin prick test (SPT), naturally evolves over time and is influenced by environmental factors specific to each region.

Objective: This study aimed to review the updated 6-year trend of aeroallergen sensitization among children with asthma and allergic rhinitis in Southern Thailand.

Methods: This retrospective study involved a review of patients aged ≤15 years diagnosed with asthma and/or allergic rhinitis, who underwent the SPT using 12 standardized aeroallergens.

Results: The medical records of 1,393 children were reviewed, with 63% being male, and the mean age was 7.4±3.3 years. Among them, 55.5% presented with allergic rhinitis alone, followed by 31.6% with asthma and allergic rhinitis, and 12.9% with asthma alone. Over the 6-year period, house dust mites emerged as the most common sensitized allergen, followed closely by cockroaches, maintaining a consistent trend of sensitization. *Dermatophagoides pteronyssinus* ranked as the predominant sensitized allergen across all diagnoses (63% in asthma with allergic rhinitis, 52.7% in allergic rhinitis, and 43.5% in asthma). Children diagnosed with both asthma and allergic rhinitis exhibited a higher prevalence of sensitization to house dust mites, cockroaches, Johnson grass, acacia, *Candida albicans*, and cat pelts compared with those with asthma or allergic rhinitis alone. Additionally, the prevalence of house dust mite and cockroach sensitization was notably higher in older children (≥5 years old) with respiratory allergies.

Conclusion: House dust mites and cockroaches emerge as the 2 most prevalent sensitized aeroallergens among children diagnosed with asthma and/or allergic rhinitis, exhibiting consistent trends of sensitization over the past 6 years. The persistence of these causative allergens underscores the importance of meticulous environmental control measures for children affected by respiratory allergies.

Keywords: Aeroallergen; aeroallergen sensitization; allergic rhinitis; asthma

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The datasets generated during this current study are available from the corresponding author upon reasonable request.

This study was approved by the Ethics Committee and Institutional Review Board of the Faculty of Medicine, Prince of Songkla University (EC.59-390-11-1) on February 25, 2021 by Boonsin Tangtrakulwanich (Chairman of the Ethics Committee).

Written informed consent was obtained from all individual participants included in this study.

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1. Introduction

The International Study of Asthma and Allergies in Childhood (ISAAC) epidemiological research program has demonstrated a global rise in the prevalence of asthma and allergic rhinitis (AR), a trend that is also evident in Thailand [1, 2]. Morbidity and mortality among children with asthma and AR, such as the loss of school days, may deprive children of both academic achievement and social interaction [3, 4]. The development of both asthma and AR involves a multitude of factors, including genetic predispositions and environmental exposures [5, 6], with aeroallergens being a particularly significant environmental exposure.

Several studies have established a connection between aeroallergen sensitization and the onset of asthma and AR. In a study by Stoltz et al. [7], newborns at high risk for asthma and allergic diseases underwent specific IgE level assessments. The 9-year follow-up disclosed that sensitization to perennial allergens is linked to asthma development, while sensitivity to seasonal allergens is associated with the development of AR. In global studies, the skin prick test (SPT) is employed to investigate the association between allergen sensitization and AR. Research conducted by authors such as Hosseini et al. in Tehran, Patil et al. in the UK, and Li et al. in China consistently reveals positive SPT results for

specific aeroallergens in individuals with AR. Notably, a significant percentage of AR patients exhibit positive SPT responses to house dust mites, pollens, and molds [6, 8, 9]. The retrospective studies by Li et al. and Yuenyongviwat et al., along with the cross-sectional study by Li et al., have investigated the prevalence of aeroallergen sensitization in children with respiratory allergies. These studies consistently demonstrate that a majority of asthma patients exhibit positive SPT results for house dust mites [9-11].

Concerning AR patients, Li et al. in China also found these to be SPT positive to grasses (*Artemisia vulgaris* and *Ambrosia artemisiifolia*), and this was also associated with the severity of intermittent rhinitis. Furthermore, Tatar et al. in Turkey found that most patients were SPT positive to house dust mites, while Li et al. [9] also showed that a larger number of allergen sensitizations were related to higher severities of asthma and AR. Carroll et al. [13] also showed that an increasing size of SPT wheal was associated with hospitalization and inhaled corticosteroid use in pediatric asthma patients.

In Thailand, studies conducted by Yuenyongviwat et al. in Southern Thailand and Sritipsukho in Bangkok revealed the highest prevalence of positive SPT in children diagnosed with asthma and AR for house dust mites and cockroaches. Sritipsukho suggested that the number of aeroallergen sensitizations was linked to the presence of multiple allergic diseases, such as asthma and AR. In contrast, Yuenyongviwat et al. did not find any association between aeroallergen sensitization and the severity of allergic diseases [11, 14].

Respiratory allergies are influenced by various factors, including the type of aeroallergen [15]. It is important to note that the variety of aeroallergens differs for each allergic disease and is influenced by the geographic environment. The trend of each aeroallergen has likely undergone changes over time [16, 17]. Therefore, the objective of this study is to assess the prevalence of aeroallergen sensitization among children with asthma and AR over the past 6 years.

2. Methods

2.1. Study design

This study was a retrospective review from the hospital records of Songklanagarind Hospital.

2.2. Study population

Pediatric patients (age ≤15 years) having been diagnosed with asthma or AR, who underwent the SPT for aeroallergens, at the Pediatric Outpatient Clinic, of Songklanagarind Hospital.

2.3. Skin prick tests

The test was performed with Uni-test devices (ALK-Abello, Royston Lane, Round Rock, Texas, USA) and 12 standardized aeroallergen extracts from Greater Mybacin (Phutthamonthon, Nakhon pathom, Thailand) and AllerTech (Lumphini, Pathum Wan, Bangkok). These were divided into 4 groups: grass pollen (Johnson grass, acacia, careless weeds), molds (Alternaria, Aspergillus mix, *Candida albicans*), pets (cat pelt, dog epithelium), and insects (*Dermatophagoides pteronyssinus* [*Dp*], *Dermatophagoides farinae* [*Df*], American cockroach, German cockroach), including histamine for positive control and glycerin for negative control. All patients withheld antihistamines for at least 1 week prior to SPT. SPTs were performed on the upper back, and the results were recorded 15 minutes thereafter. Study protocol adheres to Australasian Society of Clinical Immunology and Allergy and European Academy of Allergy and Clinical Immunology guidelines, defining a positive skin test as ≥3 mm greater than the negative control. A positive control was necessary to assess the skin response and a robust reaction to the positive control ensured good overall test response.

2.4. Statistical analysis

The data for this study were retrieved using the following International Statistical Classification of Diseases and Related Health Problems 10th revision diagnostic codes: J459 (asthma, unspecified), J450 (predominantly allergic asthma), J458 (mixed asthma), J46 (status asthmaticus), J301 (AR due to pollen), J302 (other seasonal AR), J303 (other AR), J304 (AR, unspecified), and J329 (chronic rhinitis, unspecified). In addition to these codes, procedure codes for the SPT were also considered, and the corresponding results were recorded from the allergy department. Data were initially collected on a paper record form and subsequently entered into a computer program using Epidata version 3.1 (EpiData Association, Odense, Denmark). The R software (R Foundation for Statistical Computing, Vienna, Austria) was employed for data analysis, which involved transforming the data into percentages for further examination. Due to the retrospective nature of this study, some data were not recorded and were consequently excluded as missing data. These excluded data encompassed underlying atopies, other comorbidities, environment exposure, and family history of atopy. Variable comparisons were conducted using the χ^2 test, with a significance level set at a P value of less than 0.05.

3. Results

A total of 1,393 patients were enrolled in this study, with approximately 300 patients from each year, except for 2020 and 2021, where there were 151 and 53 patients, respectively. The reduced numbers during these years were attributed to the cancelation of elective investigations amid the SARS-CoV-2 (COVID-19) pandemic. Sixty-three percent of patients were male and the mean age was 7.4 ± 3.3 years. The most common diagnosis was AR alone (55.5%), followed by both asthma and AR (31.8%) and asthma alone (12.9%). Less than half of the patients had underlying atopies, in which the highest was allergic dermatitis (n = 1,157, 13.9%). Most patients had a comorbidity presenting as snoring (n = 788, 64.6%) and chronic rhinosinusitis (n = 85, 54.7%). The allergy-risk environments patients were exposed to consisted of indoor smoking (n = 696, 26.6%), dogs (n = 674, 15.7%), and cats in the house (n = 680, 16.8%). Family history of atopy was collected from 896 patients. All family members shared a common family history of allergic disease, with AR being the most prevalent among them (Table 1).

According to the 6-year trend of aeroallergen sensitization among children with respiratory allergy (Fig. 1), the incidence of both species of house dust mites was consistently the highest every year, followed by both species of cockroaches. While both species of house dust mites showed an increase as of 2020, both species of cockroaches and Johnson gradually decreased as of 2017. The incidences of other aeroallergens remained relatively stable.

Among children with a respiratory allergy, *Dp* was the most common sensitized allergen in all diagnoses throughout all 6 years (63% in asthma with AR, 52.7% in AR alone, and 43.5%

Table 1.
Demographic data (N = 1,393)

Variables	N (%)
Gender	
Male	877 (63)
Female	516 (37)
Age (mean ± standard deviation) (y)	7.4 (3.3)
Diagnosis	
Allergic rhinitis	773 (55.5)
Asthma and allergic rhinitis	440 (31.6)
Asthma	180 (12.9)
Underlying atopy	
Allergic dermatitis (N = 1,157)	161 (13.9)
Food allergy (N = 1,253)	155 (12.4)
Drug allergy (N = 1,387)	103 (7.4)
Other comorbidities	
Obesity (N = 1,383)	140 (10.1)
Chronic rhinosinusitis (N = 75)	41 (54.7)
Snoring (N = 788)	509 (64.6)
Environment exposure	
Indoor smoking (N = 696)	185 (26.6)
Dog in the house (N = 674)	106 (15.7)
Cat in the house (N = 680)	114 (16.8)
Pollen (N = 20)	6 (30)
Family history of atopy (N = 896)	
Father's history	
Asthma	45 (5)
Allergic rhinitis	182 (20.2)
Atopic dermatitis	5 (0.6)
Food allergy	7 (0.8)
Mother's history	
Asthma	52 (5.8)
Allergic rhinitis	194 (21.6)
Atopic dermatitis	12 (1.3)
Food allergy	11 (1.2)
Siblings history	
Asthma	52 (5.8)
Allergic rhinitis	68 (7.6)
Atopic dermatitis	10 (1.1)
Food allergy	13 (1.4)

in asthma alone), and the asthma with AR patients significantly had the highest percentage of *Dp* and *Df* (63% both). Additionally, sensitization to both species of cockroaches, Johnson grass, acacia, *Candida albicans*, and cat pelts also had the significantly highest prevalence in children with both asthma and AR. Allergen sensitizations had the significantly highest prevalence in asthma within the AR group, except for Johnson and *Candida albicans*, which had the same trend of prevalence in each group. The highest sensitization was observed within the asthma with AR group, followed by AR alone and asthma alone. Alternaria and Aspergillus sensitization had the lowest prevalence across all respiratory allergic groups (Table 2).

Patients were categorized into 2 age groups: <5 years and ≥5 years. In each diagnostic group, patients aged ≥5 years exhibited a significantly higher prevalence of sensitization to both species of house dust mites and cockroaches compared with the younger patients across all diagnoses. Additionally, some aeroallergens showed a significantly higher prevalence of sensitization in the ≥5-year-old patients, although this was observed only in certain diagnostic groups (Table 3).

4. Discussion

Our retrospective study showed house dust mites as the most common aeroallergen sensitization over all 6 years. *Dp* had the highest allergen sensitization in all diagnoses, and the asthma with AR patients had the highest percentage for both species of house dust mites. These results are similar to the previous decade study of Yuenyongviwat et al. [11] in Songklanagarind Hospital, which also found house dust mites as the most common aeroallergen sensitization in asthma children. In the previous study, it constituted approximately half of the enrolled patients, a proportion that surpassed what we observed in the current study (*Dp*, 48.5%–50.5% in 2004–2009 of the previous study vs 43.5% in 2016–2021 of this study; and *Df*, 48.5%–52.5% in 2004–2009 of the previous study vs 39.8% in 2016–2021 of this study). Other studies, conducted in other regions of Thailand, also found similar results; in that, the most common aeroallergen sensitization was *Dp* [18-20]. Comparing this study with the study of Visitsunthorn et al. [18] in central Thailand and the study of Waithayawongsakul and Lao-Araya [20] in northern Thailand, the prevalence of *Dp* and *Df* sensitization in this study was less than these previous studies. Furthermore, studies in other countries, such as the USA, Turkey, and Qatar [10, 12, 21, 25], demonstrated that house dust mite sensitization was the most common sensitization, which is similar to this study. In Iran, tree mix was the most common sensitization [8]. In Beijing, the most sensitizations are grass and fungi allergen as: Japanese Hop (36.2%), Alternaria (34.6%), Artemisia (31.5%), and Fraxinus (30.64%); with house dust mites being the fifth most common sensitization [22]. These results suggest

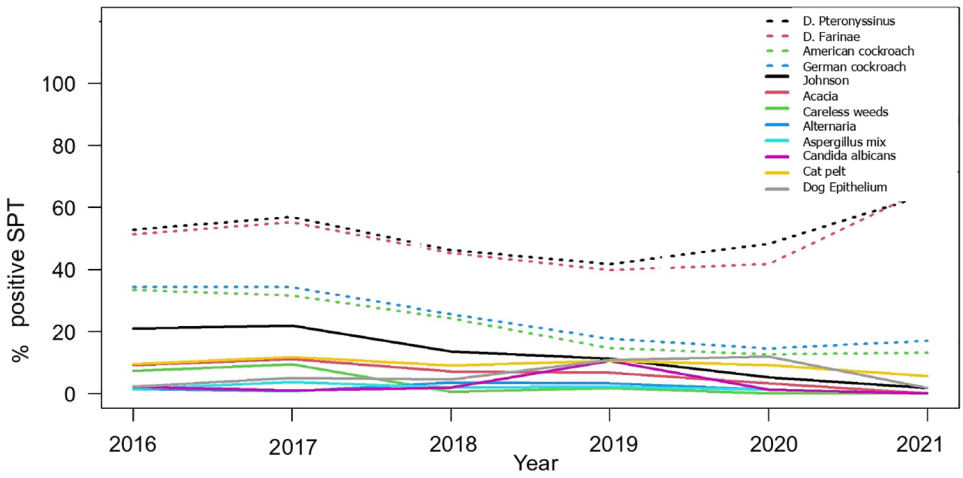

Figure 1. Trends of aeroallergen sensitization among the children with respiratory allergy, from January 2016 to December 2021.

Table 2.

Prevalence of aeroallergen sensitization among the children with respiratory allergy over 6 years, divided by patient diagnosis

Aeroallergen	Asthma (%)	AR (%)	Asthma and AR (%)	*P* value
Johnson	24 (14.9)	90 (12.7)	98 (24.5)	<0.001
Acacia	10 (6.2)	48 (6.8)	49 (12.2)	0.004
Careless weeds	5 (3.1)	29 (4.1)	24 (6)	0.217
Alternaria	3 (1.9)	15 (2.1)	11 (2.8)	0.737
Aspergillus mix	3 (1.9)	13 (1.8)	14 (3.5)	0.193
Candida albicans	5 (3.1)	17 (2.4)	24 (6)	0.008
Cat pelt	9 (5.6)	64 (9)	65 (16.2)	<0.001
Dog epithelium	5 (3.1)	46 (6.5)	33 (8.2)	0.083
Dermatophagoides pteronyssinus	70 (43.5)	374 (52.7)	252 (63)	<0.001
Dermatophagoides farinae	64 (39.8)	353 (49.7)	252 (63)	<0.001
American cockroach	38 (23.6)	169 (23.8)	132 (33)	0.003
German cockroach	37 (23)	185 (26.1)	145 (36.2)	<0.001
Total*	161	710	410	

AR, allergic rhinitis.

*Total number of children diagnosed with asthma, allergic rhinitis or both, excluding false positive and false negative SPT.

Table 3.

Prevalence of aeroallergen sensitization among children with respiratory allergy over 6 years

	Asthma			AR			Asthma and AR		
Aeroallergen	<5 y (%)	≥5 y (%)	*P* value	<5 y (%)	≥5 y (%)	*P* value	<5 y (%)	≥5 y (%)	*P* value
Total	85	76		185	525		89	311	
Johnson	12 (14.1)	12 (15.8)	0.94	16 (8.6)	74 (14.1)	0.074	14 (15.7)	84 (27)	0.041
Acacia	3 (3.5)	7 (9.2)	0.193	7 (3.8)	41 (7.8)	0.088	4 (4.5)	45 (14.5)	0.019
Weeds	3 (3.5)	2 (2.6)	1	4 (2.2)	25 (4.8)	0.187	1 (1.1)	23 (7.4)	0.052
Alternaria	1 (1.2)	2 (2.6)	0.603	3 (1.6)	12 (2.3)	0.77	1 (1.1)	10 (3.2)	0.468
Aspergillus	2 (2.4)	1 (1.3)	1	3 (1.6)	10 (1.9)	1	3 (3.4)	11 (3.5)	1
Candida	1 (1.2)	4 (5.3)	0.189	2 (1.1)	15 (2.9)	0.263	5 (5.6)	19 (6.1)	1
Cat	2 (2.4)	7 (9.2)	0.085	5 (2.7)	59 (11.2)	<0.001	5 (5.6)	60 (19.3)	0.003
Dog	1 (1.2)	4 (5.3)	0.189	5 (2.7)	41 (7.8)	0.024	3 (3.4)	30 (9.6)	0.093
Dp	28 (32.9)	42 (55.3)	0.007	78 (42.2)	296 (56.4)	0.001	42 (47.2)	210 (67.5)	<0.001
Df	24 (28.2)	40 (52.6)	0.003	65 (35.1)	288 (54.9)	<0.001	45 (50.6)	207 (66.6)	0.008
AC	14 (16.5)	24 (31.6)	0.039	19 (10.3)	150 (28.6)	<0.001	15 (16.9)	117 (37.6)	<0.001
GC	13 (15.3)	24 (31.6)	0.024	18 (9.7)	167 (31.8)	<0.001	14 (15.7)	131 (42.1)	<0.001

Patients divided by age of <5 years and ≥5 years in each group of diagnosis.

AC, American cockroach; AR, allergic rhinitis; *Df*, *Dermatophagoides farinae*; *Dp*, *Dermatophagoides pteronyssinus*; GC, German cockroach.

that aeroallergen sensitization may vary due to geographic factors within each region.

Despite the impact of the COVID-19 pandemic on the small sample size of patients during 2020–2021, the trends of allergen sensitization remained consistent with the previous years. The observed increase in house dust mite sensitization in the last 2 years of the study could be attributed to the environment. During the COVID-19 outbreaks, individuals sensitized to house dust mites likely spent more time at home, exposing them to higher risks of allergen exposure. This might have triggered respiratory allergic symptoms, prompting them to seek medical attention and undergo SPT. However, it is recommended to conduct further studies post-COVID-19 pandemic to investigate both the trend of aeroallergen sensitization and to compare the prevalence of sensitization before and after the outbreak.

In this study, approximately half of the patients were diagnosed with AR alone, followed by asthma with AR; accounting for about one third of patients. However, the major sensitization was found in the asthma with AR patients.

This result was similar to the previous studies in Bangkok and Qatar [18]. This showed that the greater number of aeroallergen sensitization was influenced by greater combined respiratory atopies.

The results also indicate that older children (≥5 years old) are significantly more likely to be sensitized compared with children under 5 years. This could be attributed to older children having a longer duration of exposure to aeroallergens. The same results were not only found in the retrospective study of Waithayawongsakul and Lao-Araya [20] in northern Thailand, in which an age ≥5 years was a significant factor to any aeroallergen sensitization, but also in the study in Beijing that showed significantly more sensitization to house dust mites in older children than in younger children [22].

One limitation of this study was its retrospective design. Additionally, there was a substantial amount of missing data, particularly concerning concomitant atopies, comorbidities, and environmental exposure. It was assumed that these factors might be associated with the symptoms of respiratory allergy and aeroallergen sensitization. Furthermore, this study could not establish a definitive association between aeroallergen sensitization and the severity of respiratory allergies, given the partial treatment of the patients. The limited sample size during the last 2 years of the study, attributed to the COVID-19 pandemic, also impacted the data of this study. Therefore, a prospective study post-COVID-19 should be considered to assess more accurate and updated data.

In conclusion, this study revealed that house dust mites and cockroaches are the 2 most prevalent aeroallergen sensitizations, exhibiting consistent trends over the past 6 years. Our findings align with similar studies in Thailand but differ from some

countries, showing that older children (≥5 years old) exhibit a higher rate of sensitization. The study suggests that these causative allergens, particularly house dust mites and cockroaches, should be a focus for effective environmental control in children with respiratory allergies.

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Conflicts of interest

The authors declare no conflicts of interest.

Author contributions

Study conception and design: Araya Yuenyongviwat, Pasuree Sangsupawanich, Vanlaya Koosakulchai. Acquisition of data: Taksaporn Sangchan, Bunrat Srisuk. Analysis and interpretation of data: Araya Yuenyongviwat, Pasuree Sangsupawanich, Taksaporn Sangchan. Writing of the manuscript: Araya Yuenyongviwat, Taksaporn Sangchan, Vanlaya Koosakulchai.

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