

Indoor allergen sensitization and the risk of asthma and eczema in children in Pittsburgh

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ABSTRACT

Several studies have shown that sensitization to cockroach and mouse allergens is correlated with presence and severity of asthma, especially among children living in inner cities. This study evaluated the prevalence of positive skin testing to indoor allergens in the Pittsburgh area and the association with asthma and eczema. A retrospective analysis was performed of 540 children from the Pittsburgh area who underwent skin testing to indoor allergens. Presence of asthma and eczema were determined by parent and/or physician report. Asthma and eczema are not significantly more frequent among children who had positive skin testing to cockroaches or mice. However, asthma was more common among children who had positive skin testing to dogs (odds ratio [OR], 1.4; 95% CI, 1.23–1.65), cats (OR, 1.4; 95% CI, 1.21–1.58), and dust mites (OR, 1.2; 95% CI, 1.03–1.37). Eczema was more common in children who had positive skin testing to cats (OR, 1.5; 95% CI, 1.14–2.02). Both asthma (OR, 1.4; 95% CI, 1.18–1.58) and eczema (OR, 1.4; 95% CI, 1.07–1.92) were more prevalent among children with any positive skin test. We did not find that sensitization to cockroaches or mice was correlated with the diagnosis of asthma or eczema in the Pittsburgh area. However, sensitization to any allergen, and to cats and/or dogs specifically, was associated with diagnosis of both asthma and eczema. Our result suggests that allergic sensitization is associated with these diseases, but the implicated allergens may vary.

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Asthma and eczema are prevalent disorders of childhood.^{1,2} Sensitization to indoor allergens is a major risk factor for the development and persistence of both of these disorders.³ Several previous studies have shown that sensitization to cockroach and mouse allergens, in particular, are correlated with presence and severity of asthma, especially among children living in inner cities.^{4–6} These studies showed high levels of sensitization to mice and cockroaches in Chicago, New York, Baltimore, and Boston, with between 9 and 10% sensitized to mice and 11–37% to cockroaches. In addition, several studies have shown that exposure to mouse antigen is a risk factor for asthma.^{7,8}

Based on the clinical experience of observing few positive skin tests to mice and cockroaches in our population, we hypothesized that mouse and cockroach allergens were less likely to drive development of atopic diseases including asthma and eczema in the Pittsburgh area. The purpose of this study, therefore, was to evaluate the prevalence of positive skin testing

to indoor allergens in the Pittsburgh area and the association of sensitization with asthma and eczema.

Indoor allergen sensitization rates increase throughout childhood, and prevalence of allergen sensitization changes with age.⁹ We therefore, also evaluated the prevalence of positive skin testing to indoor allergens by age group.

METHODS

This study was a retrospective chart review of children 2–18 years of age who were skin tested to indoor allergens over a 12-month period (from July 2005 to June 2006) in the Allergy/Immunology Clinic at Children's Hospital of Pittsburgh of UPMC main clinic, located in the Oakland section of Pittsburgh. This study was approved by the Institutional Review Board of Children's Hospital of Pittsburgh of University of Pittsburgh Medical Center. Age, gender, race, zip code, and presence of asthma and eczema were recorded. Presence of asthma and eczema were determined by parent and/or physician report as documented in the medical record. Skin-prick tests to commercially available extracts using the Greer Pick individual test device was performed on the volar surface of the forearm or back using standard methods.^{10,11} Indoor allergens included dust mites (*Dermatophagoides farinae* and *Dermatophagoides pteronyssinus*), cockroach, dog, cat, and mouse. Negative saline control and positive histamine controls were used in all cases. A test result was considered positive if it produced a wheal 3 mm greater

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Table 1 Demographic and clinical characteristics	
Characteristic	No. (%) of Patients
Sex	
Male	317 (58.7)
Female	223 (41.3)
Race	
White	306 (56.7)
Black	115 (21.3)
Unknown	112 (20.7)
Asian	6 (1.1)
Hispanic	1 (0.2)
Asthma	316 (58.5)
Eczema	140 (25.9)

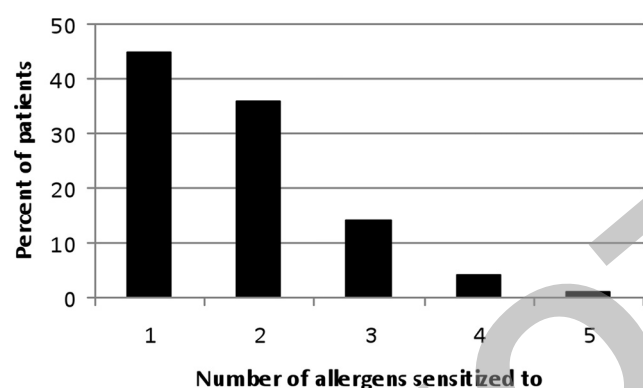


Figure 1. Percent of individuals sensitized to a given number of allergens.

than the negative control. Patients were excluded from the study if their histamine control was negative.

Sensitivity to a particular allergen was defined by a positive skin test. Prevalence rates of sensitization to each allergen were calculated. Odds ratios (ORs) of asthma and eczema were also calculated. ORs between groups were compared by performing a Pearson χ^2 -analysis.

RESULTS

Five hundred forty children met the criteria for inclusion in the study. Each patient was tested for the entire panel of indoor inhalants. The demographic and clinical characteristics of the patients are shown in Table 1; race was not recorded for a substantial fraction of patients.

Overall, 264 children (49%) had a positive skin test result to at least one of the five allergens tested, and three (1%) individuals were sensitized to all five allergens (Fig. 1). Table 2 shows the results of skin testing to each allergen. Sensitization to dust mites was most prevalent, followed by cats. Mouse sensitization was the least prevalent. There were no significant differ-

Table 2 Prevalence of sensitization	
Allergen	No. (%) of Patients
Dust mite	182 (33.7)
Cat	148 (27.4)
Dog	67 (12.4)
Cockroach	61 (11.3)
Mouse	22 (4.1)

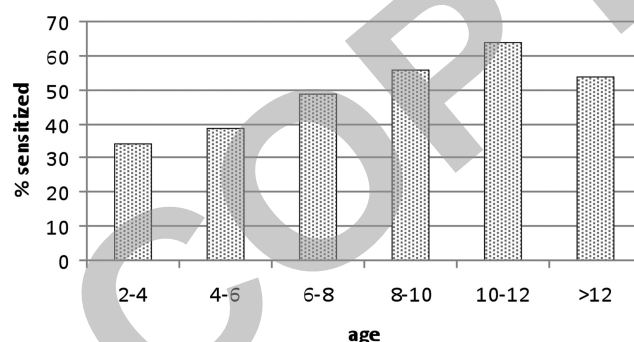


Figure 2. Overall sensitization by age.

Table 3 Prevalence of positive skin prick test for any indoor allergen for all ages			
Age Group (yr)	No. Tested	Percentage Sensitized	OR (95% CI)
2-4	77	33.8	reference
4-6	107	39.3	Not significant
6-8	99	49.5	1.92 (1.04-3.56)
8-10	100	56.0	2.50 (1.35-4.62)
10-12	61	63.9	3.48 (1.72-7.03)
>12	96	54.2	2.62 (1.23-4.31)
Total	540	48.9	

OR = odds ratio.

ences in sensitization by race or gender (data not shown).

Age-specific sensitization rates ranged from 33.8% in the youngest age group (2-4 years) to a peak of 64% in the 10- to 12-year-old age group (Fig. 2). There was increasing sensitization to at least one indoor allergen throughout childhood ($p = 0.001$), until the age of 12 years when there was a slight decline. Compared with the 2- to 4-year-old group, ORs of sensitization were significantly increased for each group >6 years of age (Table 3). Age-specific sensitization rates to each individual indoor allergen are presented in Fig. 3. In the youngest age group, cats were the most common sensitizers. In ages 4-6 years and 6-8 years, both cats and dust mites were almost equally common. In children >8 years old, dust mites were the most common sensitizers. Cockroach and dust mite sensitization in-

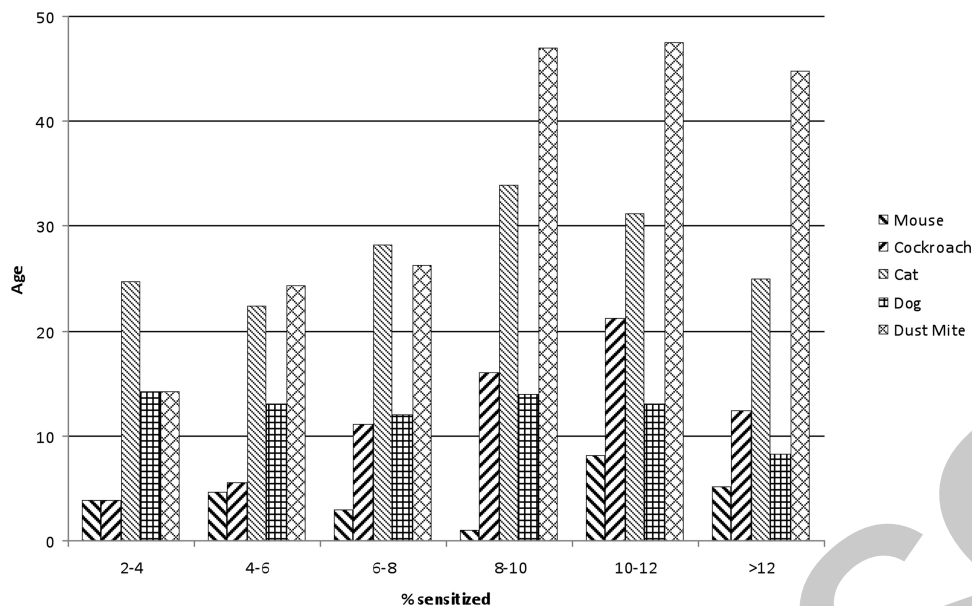


Figure 3. Sensitization to individual allergens by age.

Table 4 Results of indoor allergen testing and the association with asthma and eczema

Antigen	Asthma			Eczema		
	Odds Ratio	CI	p Value	Odds Ratio	CI	p Value
Dust mite	1.5	1.07–2.23	0.02	1.3	0.86–1.91	0.23
Cat	2.4	1.60–3.65	<0.0001	1.8	1.18–2.71	0.005
Dog	3.0	1.63–5.60	0.0003	1.7	1.00–2.95	0.05
Cockroach	1.5	0.86–2.67	0.14	1.3	0.75–2.39	0.32
Mouse	1.6	0.62–3.88	0.34	2.05	0.85–4.89	0.10
≥1 Positive	2.1	1.51–3.03	<0.0001	1.6	1.10–2.40	0.01

OR = odds ratio.

creased with increasing age, and cat and dog sensitizations were similar across age groups; likewise, mouse allergy, although variable, did not show a consistent increase with age.

We evaluated the relationship between sensitization to indoor allergens and the presence of asthma or eczema. Table 4 shows the results of indoor allergen testing and the association with asthma and eczema. Asthma and eczema are not significantly more frequent among children who had positive skin testing to cockroaches or mice. However, asthma was significantly more common among children who had positive skin testing to dogs (OR, 3.0; 95% CI, 1.63–5.60), cats (OR, 2.4; 95% CI, 1.60–3.65), and dust mites (OR, 1.5; 95% CI, 1.07–2.23). Eczema was more common in children who had positive skin testing to cats (OR, 1.8; 95% CI, 1.18–2.71). Both asthma (OR, 2.1; 95% CI, 1.51–3.03) and eczema (OR, 1.6; 95% CI, 1.10–2.40) were more prevalent among children with any positive skin test. Age, gender, or race did not affect the rela-

tionship between sensitization to indoor allergens and the presence of asthma or eczema.

DISCUSSION

Sensitization to allergens, particularly indoor allergens, increases the risk of persistent asthma. Several studies have shown high rates of sensitization to cockroaches and mice, particularly in inner city populations (see table 5).^{4–7,9,12,13} In contrast, we found that 11.3% of children in the Pittsburgh area had a positive skin test to cockroaches, and only 4.3% had a positive skin test to mice, rates significantly below those seen in other studies (see Table 5).

Multiple studies have shown that exposure to pest allergens in the inner city has clinical effects on atopic disease.^{5,14} An inner-city population from New York was followed prospectively, and it was determined that the odds of early wheeze and atopic dermatitis were significantly higher among children who had

Table 5 Summary of previous studies of prevalence of cockroach and mouse sensitization

Reference	Location	Type of Testing	Cockroach (%)	Mouse (%)
Current study	Pittsburgh	Skin Test	11	4
Sheehan <i>et al.</i> ⁹	Boston	Skin Test	13	9
De Vera <i>et al.</i> ⁴	Chicago	Skin Test	15	N/A
Donohue <i>et al.</i> ⁵	New York	RAST Test	11	10
Rosenstreich <i>et al.</i> ⁶	Various US Cities	Skin Test	37	N/A
Matsui <i>et al.</i> ⁷	Baltimore	Skin Test	41	9
Rastogi <i>et al.</i> ¹²	New York	Skin Test	31	22
Sarpong and Karrison ¹³	Chicago	Skin Test	49	N/A

positive IgE to cockroaches and mice.⁵ Another study conducted in Chicago found that cockroach sensitivity was significantly associated with wheezing.⁴ Interestingly, no other allergen was associated with persistent wheezing. An additional study showed that children with sensitivity to cockroaches who were exposed to the allergen had more wheezing, missed more school, lost more nights of sleep, and had more hospitalizations related to asthma.⁶ Similar patterns were not found for sensitization to dust mites or cats.

The goal of our study was to evaluate the prevalence of positive skin testing to indoor allergens in the Pittsburgh area and the effect of sensitization on asthma and eczema. Our study found that asthma and eczema are not significantly more frequent among children who had positive skin testing to cockroaches or mice. However, asthma was significantly more common among children who had positive skin testing to dogs, cats, and dust mites. Eczema was more common in children who had positive skin testing to cats, and both asthma and eczema were more prevalent among children with any positive skin test. Consistent with these results, a study conducted in Chicago evaluated children with asthma and showed that sensitization to cat allergen itself was a risk factor for more severe asthma.¹³ This study also showed that children with combined sensitivity to cat, dog, dust-mite, and cockroach allergens were at increased risk of having more severe asthma, but cockroach sensitivity alone did not correlate with more severe asthma. A second study from the same group of investigators also showed that sensitization to cockroach allergen was not an independent risk factor for asthma hospitalization.¹⁵ Our interpretation is that allergy to indoor antigens is an important driver of atopic disease, including asthma incidence and severity, but the specific antigen implicated varies by location.

Another important finding of our study was the increase in rates of sensitization to indoor aeroallergens throughout childhood. We found that 48.9% of children were sensitized to at least one indoor aeroallergen, increasing from 33.8% at age 2–4 years to a

maximum of 63.9% at age 10–12 years. A similar study from New York City examined 384 inner-city Hispanic and black children with asthma.¹² They found that a slightly higher percentage (58.6%) of children were sensitized to at least one indoor allergen. Our study also showed that at different ages, different aeroallergens are prominent. For example, in children <4 years of age, cats were the most common allergy; in children 4–8 years, cats and dust mites were approximately equal in level of sensitization; and in children >8 years, dust mites were the most prevalent allergy. Cockroach sensitization increased with age, and mouse sensitization was variable. Our findings are similar to a study performed in Boston among 1394 atopic children aged 0–21 years.⁹ They also found that there were increasing sensitization rates to at least one aeroallergen throughout childhood, and that 51.3% of patients were sensitized to at least one indoor aeroallergen. This study found that cats and dogs were the most likely sensitizers in children <4 years old, and dust mites were most prominent in children ≥4 years old. In this study, cockroach sensitization also increased with increasing age, and mouse sensitization was more variable. This study found higher prevalence of positive skin testing in their 10- to 12-year old age group; 81.2% were sensitized to at least one aeroallergen. We found that 63.9% of 10- to 12-year old children were sensitized to at least one aeroallergen. The most significant difference between our study and the one from Boston is that they also included outdoor allergens in their testing, which could account for their higher prevalence of sensitization for each age group. In addition, there may be a difference in the characteristics of children referred for allergy evaluation between the two institutions.

This study is limited by its retrospective design and reliance on parental report of asthma and eczema. Additionally, patients in our study are drawn from a wide geographic area, including inner-city, suburban, and rural areas, so patterns of exposure may vary. Our study might have shown an association between cockroach or mouse allergy and asthma or eczema if only

inner-city patients were studied. Studies have shown that rodent infestation and IgE antibody varies dramatically in different populations and areas of the United States.¹⁶ Our study was also very limited in Hispanic population (0.2%) because of the ethnic composition of the Pittsburgh area. Some evidence shows that Hispanic populations are particularly affected by indoor allergens, and indoor allergen sensitization correlates with an increasing severity of asthma.¹²

In summary, unlike studies of other locations, we did not find that sensitization to cockroaches or mice was correlated with the diagnosis of asthma or eczema in the Pittsburgh area. However, sensitization to any allergen, and to cat and/or dog specifically, was associated with diagnosis of both asthma and eczema. Our result suggests that allergic sensitization is associated with these diseases, but the implicated allergens may vary. Our results also show that sensitization rates by age differed for specific allergens.

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