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# Association of recurrent wheezing with sensitivity to cockroach allergen in inner-city children

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**Background:** There are numerous data that show a strong relationship between early exposure and sensitization to indoor allergens and the development of asthma and persistent wheezing in children. Most studies, however, have only examined the prevalence of allergy in children who have been identified as having asthma.

**Objective:** To assess the prevalence of positive skin test results to common inhaled allergens and possible association with wheezing in inner-city children being seen in a general pediatric clinic.

**Methods:** Skin testing to common aeroallergens was performed by the prick-puncture method. Demographic and clinical data were collected.

**Results:** Seventy-five children aged 2 months to 10 years were evaluated. A total of 37% of the children had a positive skin test result to at least one allergen; 29% of the children were sensitive to dust mite, 15% to cockroach, 9% to cat, 7% to mold, 4% to grass, 3% to ragweed, and 1% to dog. Seven (64%) of 11 children with positive skin test results to cockroach had a history of wheezing compared with 21 (33%) of 64 with negative skin test results to cockroach ( $P = .05$ ).

**Conclusions:** Our results indicate that in a population of inner-city children not previously identified as atopic, more than a third showed sensitivity to at least one allergen. Although dust mite was the most common allergen to which the children were sensitized, cockroach sensitivity was the only allergen that correlated significantly with previous episodes of wheezing.

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## INTRODUCTION

Asthma and related allergic disorders in childhood have increased considerably in prevalence during the last few decades. It is estimated that approximately 4.8 million children in the United States have asthma.<sup>1</sup> Sensitivity to allergens is the hallmark of childhood asthma.<sup>2</sup> There is evidence showing high prevalence of atopy in children with asthma and a link between skin test sensitivity and severity of asthma.<sup>3–8</sup> Allergens associated with increased asthma morbidity include those derived from house dust mites, cockroach, cat, and dog.<sup>9–13</sup> Most studies, however, have examined the prevalence of allergy in children who have been identified as being symptomatic or have been diagnosed beforehand as having asthma or hyperreactive airways.<sup>14–18</sup> For some children, though, the acquisition of sensitivity to inhalant allergens may predate the manifestations of allergic rhinitis and asthma. Yet, to date, there has been a paucity of studies that examine the incidence of sensitization in asymptomatic children<sup>19–21</sup> and even fewer studies in inner-city populations. Therefore, this study was designed to examine the incidence of skin test sensitivity and possible association with recurrent wheezing among inner-city children seen in a general pediatric clinic.

## METHODS

### *Study Design*

Convenience sampling of pediatric patients was performed at a teaching hospital's general pediatric clinic that provides service for well and acutely ill children. A single investigator (M.J.D.) collected demographic and clinical data, as well as performed and interpreted skin tests to common aeroallergens. Informed consent was obtained from the parents or legal guardians of the subjects. The study was approved by the institutional review board of the hospital.

### *Subjects*

The study group consisted of children who were seen for well visits and follow-up visits in the general pediatric clinic. We selected children who were not previously diagnosed as having asthma or other atopic diseases as documented in their medical records. For the children who were being seen for follow-up, we failed to collect information regarding the disease they were being seen for. In addition to demographic data, a questionnaire was administered regarding episodes of wheezing within the previous year and the presence of other allergic symptoms, family history, exposure to smoking and pets, and presence of cockroaches in the home (Table 1). Suburban vs urban residence was determined by ZIP code. If the home was in one of the ZIP codes within the boundaries of Chicago, IL, the participant was considered to be an urban dweller. Children were excluded who had severe skin conditions precluding skin testing, used any antihistamine 72 hours

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Table 1. Demographic and Clinical Characteristics

| Characteristic          | No. (%) of patients |
|-------------------------|---------------------|
| Mean age, y*            |                     |
| ≤3                      | 35 (47)             |
| >3                      | 40 (53)             |
| Sex                     |                     |
| Male                    | 41 (55)             |
| Female                  | 34 (45)             |
| Race                    |                     |
| African American        | 51 (68)             |
| Hispanic                | 14 (19)             |
| White                   | 4 (5)               |
| Asian                   | 2 (3)               |
| Family history of atopy | 30 (40)             |
| Wheezing episodes       |                     |
| >1 episode              | 28 (37)             |
| ≤1 episode              | 47 (63)             |
| Rhinitis symptoms       | 23 (31)             |
| Conjunctivitis symptoms | 15 (20)             |
| Eczema                  | 3 (4)               |
| Smokers at home         | 31 (41)             |

\* The mean age of patients was 3.8 years.

before testing, a history of anaphylaxis to previous skin testing, and other coexisting severe respiratory or cardiac disease (eg, severe bronchopulmonary disease or cyanotic heart disease). None of the children were excluded using these criteria.

#### Skin Testing

Each subject underwent standard allergy skin testing performed by the puncture method using the Quintest Skin Test Device (lancet device; Hollister-Stier, Spokane, WA). Standard, commercially available *Dermatophagoides pteronyssinus* (30,000 AU/mL), *Dermatophagoides farinae* (30,000 AU/mL), cockroach mix (1:10 wt/vol), cat hair (10,000 BAU/mL), dog (1:10 wt/vol), mold mix (1:10 wt/vol), grass mix (10,000 BAU/mL), and ragweed (1:20 wt/vol) allergens in 50% glycerin diluent (all from Hollister-Stier) were used in all subjects. Saline-phenol and histamine served as negative and positive controls, respectively. Tests were administered on the back, and results were read after 20 minutes. A test result was considered positive if it produced a wheal with a mean diameter 3 mm greater than the diameter of the negative control.

Subjects were clinically monitored for 30 minutes following reading of the skin test result for possible systemic reactions.

#### Statistical Analysis

Data were analyzed using the Statview statistical software program (Abacus Concepts Inc, Cary, NC) on a Macintosh computer (Apple Computer Inc, Cupertino, CA). A bivariate test of significance was analyzed by the  $\chi^2$  method.  $P \leq .05$  was considered statistically significant.

#### RESULTS

Seventy-five children were evaluated. Another 22 subjects and their parents were approached to participate in the study but refused for a variety of reasons. Table 1 shows the subjects' demographic and clinical characteristics. The mean age of the subjects was 3.8 years (age range, 2 months to 10 years). There were more boys than girls, and most subjects were African Americans. All subjects resided in urban areas. A family history of atopy was elicited from 30 subjects (40%). Twenty-eight (37%) of the subjects had more than one episode of wheezing within the previous year. Report of wheezing episodes was dependent on recollection of the parents or caregivers. We did not collect information on whether they were seen by a physician or given a diagnosis at the time of the wheezing episodes. Thirty-one children (41%) were exposed to cigarette smoke at home.

Overall, 28 subjects (37%) had a positive skin test result to at least 1 of the 8 allergens. The youngest subject to have a positive skin test result was 4 months old, and this was to dust mite and cockroach. Table 2 shows the results of skin testing and the age of the children reactive to the specific allergen. Single-allergen sensitization was uncommon. Eight children were monosensitized to dust mite and 2 to cockroach. None of the children were monosensitized to pollens, animal dander, or mold.

There was no correlation between cockroach and animal dander sensitization with presence of pets or cockroaches at home as per response to the questionnaire. However, it must be emphasized that few of the families had a cat or dog. Twenty families reported that they had pets at home. Five of the 7 children who tested positive to cat allergen had cats at home, and the only child who was positive to dog did not have any pets. We did not ask about exposure to animals outside the home. All the responders denied seeing cock-

Table 2. Results of Aeroallergen Skin Testing and Association with Wheezing\*

| Antigen      | No. (%) of positive test results | Mean age (range)  | >1 Wheezing episode | P value |
|--------------|----------------------------------|-------------------|---------------------|---------|
| Df and/or Dp | 22 (29)                          | 4.8 y (4 mo–10 y) | 8                   | .90     |
| Cockroach    | 11 (15)                          | 4.4 y (4 mo–10 y) | 7                   | .05     |
| Cat          | 7 (9)                            | 6.1 y (3 y–9 y)   | 4                   | .20     |
| Dog          | 1 (1)                            | 6 y               | 0                   | .40     |
| Mold mix     | 5 (7)                            | 6.2 y (7 mo–6 y)  | 2                   | .90     |
| Ragweed      | 2 (3)                            | 5.6 y (1 y–10 y)  | 1                   | .70     |
| Grass mix    | 3 (4)                            | 4.2 y (5 mo–7 y)  | 1                   | .90     |

\* The table shows the number of positive skin test results and the age range of the subjects who were reactive to each specific allergen. The P value refers to the relationship of a positive skin test result to a particular allergen and repeated wheezing episodes.

roaches in their homes. Responses to questions about cockroach, however, may not be reliable. There was also no significant correlation between symptoms of rhinitis, conjunctivitis, and eczema with a positive skin test result (data not shown).

We evaluated the relation between exposure to cigarette smoke at home and any history of wheezing (Table 3). There was no significant correlation, with 42% of the subjects exposed to smokers at home having previous episodes of wheezing and 34% who, although not exposed to cigarette smoke, had a similar history. Tables 2 and 3 also show the association of wheezing and a positive skin test result. Forty-three percent of subjects who had a positive skin test result to at least one of the allergens also had a previous history of wheezing. This was not statistically different to the 34% who were skin test negative and yet had a history of wheezing as well (Table 3). Taking into account each allergen separately also did not show significant correlation to previous wheezing episodes (Table 2), except for cockroach. When we analyzed those subjects who tested positive to cockroach, 7 (64%) of the 11 had a history of more than one episode of wheezing and 4 (36%) had a history of 1 or fewer wheezing episodes. For those patients who tested negative for cockroach, 21 (33%) had a history of more than 1 wheezing episode and 43 (67%) had a history of 1 or fewer wheezing episodes. This finding was statistically significant ( $\chi^2 P = .05$ ; odds ratio, 3.6; 95% confidence interval, 0.81–16.72).

## DISCUSSION

There are numerous convincing data that show a strong relationship between early exposure and sensitization to indoor allergens and the development of asthma and persistent wheezing in children.<sup>3,9,11,22–24</sup> Allergens involved include those derived from house dust mites, cockroach, cat, and dog.<sup>9,10,25</sup> In contrast, sensitization to outdoor pollens, with the conspicuous exception of the mold *Alternaria*, appear to be of much less importance to the risk of developing asthma.<sup>26–30</sup> In this study of incidence of skin test sensitivity, our results show that in a population of children who have not been previously diagnosed as having asthma or other atopic diseases, approximately one third showed sensitization to at least one allergen. Certainly, this rate of occurrence is much less than those cited in the literature for known asthmatic patients. However, it was interesting to see that the pattern of

skin test sensitivity in our subjects was comparable to those reported in asthmatic subjects, with sensitivity to dust mite being the most frequent.<sup>26,27,30–34</sup> The literature shows that sensitivity to house dust mites is in fact the most consistent risk factor for the development of asthma in most parts of the world.<sup>12,27,32,35</sup> Sporik et al<sup>11</sup> have even shown that individuals with a positive skin test response were at a higher risk for the development of asthma than those with a negative response. However, despite the preponderance of dust mite–sensitive subjects in our population, we did not find a significant association with recurrent wheezing.

In contrast to most parts of the world, sensitization and exposure to cockroach allergen are predominantly linked with increased asthma morbidity in children living in the inner cities of the United States.<sup>3,9,36–39</sup> The prevalence of cockroach allergy ranges from 17% to 41% in various studies involving both children and adults.<sup>3,9,31,36–38,40,41</sup> It is noteworthy then that in our population of nonasthmatic patients, those who were reactive to cockroach allergen were found to have repeated episodes of wheezing. This is in keeping with various reports demonstrating that exposure and sensitization to cockroach allergen correlate with recurrent wheezing.<sup>39,42,43</sup> This begs the question of whether our patients who are sensitized to cockroach and are currently labeled as having recurrent nonasthmatic wheeze will eventually be diagnosed as having asthma. It would be helpful to follow up this cohort over time.

In as much as there are a multitude of data showing that the development of allergic disorders may be related to early exposure to allergens,<sup>2,11,26,35</sup> there is no clear consensus defining the age at which this response occurs. Previous studies suggest that IgE antibody to inhalant allergens (specifically Der p) is rarely detected in the first year of life<sup>44</sup> and that skin testing responses to inhalant allergens in that period are often negative.<sup>45</sup> In our study, however, we found skin test positivity to allergens (cockroach and dust mite) in a child as young as 4 months old. In light of the fact that cockroach sensitization may be related to recurrent wheezing, this finding may be crucial, since the age we detect sensitization can dictate the timing at which avoidance measures or other interventions would have to be performed to be of any influence.

As part of the questionnaire given to the parents and caretakers, a question on presence of smokers in the home was included. It was not surprising that 41% of the children were exposed to environmental tobacco smoke at home, since it is estimated that in the United States 43% of children 2 months to 11 years of age live in a home with at least 1 smoker.<sup>46</sup> However, there was no relation between exposure to smokers and skin test positivity in our population despite earlier studies showing increased atopy in children of smoking parents.<sup>47–49</sup> Likewise, when we investigated how smoking exposure related to previous episodes of wheezing, we found no difference between those who reported the presence of smokers at home to those who did not. This was surprising, since several studies provide a large body of data from around the

Table 3. Association of Wheezing and Cigarette Smoke Exposure and Skin Test Results

|                           | No. (%) of patients  |                     |
|---------------------------|----------------------|---------------------|
|                           | >1 Wheezing episodes | ≤1 Wheezing episode |
| Positive skin test result | 12 (43)              | 16 (57)             |
| Negative skin test result | 16 (34)              | 31 (66)             |
| Smoke exposure            | 13 (42)              | 18 (58)             |
| No smoke exposure         | 15 (34)              | 29 (66)             |

world showing that postnatal exposure to environmental tobacco smoke is associated with cough, wheeze, shortness of breath with wheeze, respiratory illness in children, and increased emergency department visits for wheeze.<sup>41,50–56</sup> Unfortunately, we did not elicit from the history which parent smoked at home, if the child spent a significant amount of time in another household where smokers were present, or the presence of frequent visitors who smoked. These factors coupled with our small sample size and the wide age range of the subjects probably contributed to the negative association observed.

Our study demonstrates that in children who have not been previously diagnosed as having atopic diseases, there is a significant number with skin test reactivity to inhalant allergens. Although it has not been proved that sensitization alone leads to asthma, there is convincing evidence on the strength of its association. Of further note is the association of cockroach sensitization and recurrent wheezing in this targeted population of nonasthmatic children. Our small sample size, however, affects the strength of this correlation. Therefore, in our case, longitudinal data and a larger sample size may better elucidate the importance of this association. Our study would likewise be strengthened by comparing our cohort with known asthmatic and atopic individuals in terms of skin test positivity. These aspects would make a stronger argument for the development and adoption of better methods to reduce cockroach allergen exposure among children.

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