

Mouse allergen skin sensitization in asthmatic children of suburban, rural, and inner-city populations

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ABSTRACT

Mouse allergen (MA) exposure is a well-known risk factor for allergic sensitization and is implicated in the pathogenesis of pediatric asthma. Although previous studies report high prevalence of MA sensitization in inner-city asthmatic children, no data exist on its comparison with either suburban or rural children with asthma. We did a retrospective cohort study by chart review of all children (≤ 18 years of age) who underwent allergy testing during a 6-month period in a tertiary care referral center. Patients were divided geographically into suburban, rural, and inner-city groups based on their zip codes. MA was tested using the standard allergy test panel by skin prick/puncture. Positive skin test reactivity was defined as wheal diameter ≥ 3 mm and erythema ≥ 5 mm. A total of 989 patients underwent allergy testing and 349 children were tested for MA with the overall positivity rate of 18.6% (65/349). In children with asthma (mean age, 12.8 years; $SD \pm 3.19$) who had MA testing ($n = 166$), the rate of positive skin test reactivity was 18% ($n = 30$). Inner-city asthmatic children had significantly greater MA sensitization compared with either suburban or rural children. MA sensitization is highly prevalent among children with asthma, especially in inner-city populations but also among suburban and rural children. Although most allergists do not routinely test for MA sensitization during the initial evaluation, it may be useful to include it in the allergy testing for children with asthma.

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There is no place safe from allergies in North America, and some cities are more problematic than others.¹ The Ohio River Valley, including the Commonwealth of Kentucky, is among the top areas in the United States with very high prevalence of environmental allergens. Mouse allergen (MA) exposure is an established risk factor for allergic sensitization and has been extensively studied for its role in pathogenesis of asthma in children as well as adults.^{2–4} Most studies, to date, have reported on its prevalence in the inner-city population. A recently published survey of a nationally representative sample of U.S. households reported a prevalence of 82% of detectable levels of mouse urinary protein (MUP) among surveyed homes.⁵ Among all of the households, 35% of them had MUP concentration of $>1.6 \mu\text{g/g}$, a level associated with increased MA sensitization rates. The National Cooperative Inner-City Asthma Study showed that MA is prevalent in inner-city households and that increasing levels of exposure are associated with sensitization.^{6,7} Generally, allergists do not routinely test for MA sensitization

during initial evaluation and MA sensitization is best assessed by using skin-prick testing. Very limited data exist on prevalence of MA sensitization in children with asthma who reside in suburban and rural areas. We planned to study the prevalence of MA skin sensitization in asthmatic children residing in inner-city, suburban, and rural areas and we hypothesized that it may be useful to include it in routine allergy testing for children with asthma.

METHODS

This is a retrospective cohort study by chart review of all new patients (aged ≤ 18 years of age) referred for either asthma or allergy testing over a 6-month period (July 2009–December 2009) to a university-based tertiary care referral center. The Institutional Review Board of the University of Louisville approved this study. Patients were geographically divided into suburban, rural, and inner-city groups based on their zip codes.⁸ MA sensitization was tested using the standard allergy test panel by skin prick/puncture. Skin-prick testing was performed using a Duotip-Test device (Lincoln Diagnostics, Decatur, IL).⁹ Per the practice parameters set forth by the American Academy of Allergy, Asthma, and Immunology, a prick/puncture test with a response of at least a 3-mm diameter (with equivalent erythema) more than diluent control performed at the same time was considered as proof of the presence of cutaneous allergen-specific IgE.¹⁰ Positive skin test reactivity was defined as wheal diameter ≥ 3 mm and

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Table 1 Demographics of patients and their MA skin test reactivity

Characteristics	Suburban	Rural	Inner City
Age, yr (mean $\pm$ SD)	4.5 $\pm$ 1.2	5 $\pm$ 1.9	3 $\pm$ 0.9
Gender (male/female)	209:229	218:239	43:51
Total patients who underwent MA testing, <i>n</i> (%; <i>n</i> = 989)	438 (44.3%)	457 (46.2%)	94 (9.5%)
Asthma patients, <i>n</i> (%; <i>n</i> = 448)	192 (42.8%)	206 (46%)	50 (11.2%)
Asthma patients who underwent MA testing, <i>n</i> (%; <i>n</i> = 166)	68 (41%)	76 (45.8%)	22 (13.2%)
Asthma patients with positive MA skin test reactivity, <i>n</i> (%; <i>n</i> = 30)	12 (17.6%)	12 (15.8%)	6 (27.2%)

MA = mouse allergen.

erythema ≥ 5 mm. Decision to include MA in the panel of allergy testing was based on individual discretion of the allergists and their practice preference at the time of study. Statistical analysis was performed using SPSS software Version 16.0 (SPSS, Chicago, IL). Descriptive analysis was performed on demographic and clinical variables such as age, gender, ethnicity, socioeconomic status, and reason for allergy testing. Pearson chi-square test was used to compare the MA reactivity between inner-city children with pooled data of suburban and rural children. All statistical tests were two tailed with significance set at 0.05.

RESULTS

A total of 989 patients referred for either asthma or allergy underwent allergy testing during the study period (Table 1). Of these patients, 448 had diagnosis of asthma (including previously diagnosed and new cases). Among all patients who underwent allergy testing, 349 patients were tested for MA sensitization and the overall positivity rate was 18.6% (65/349). Mean age of patients with MA testing was 13.5 years (SD $\pm$ 3.04). In children with asthma (mean age, 12.8 years; SD $\pm$ 3.19) who had MA testing (*n* = 166), the rate of positive skin test reactivity was 18% (*n* = 30). Inner-city children had significantly higher MA skin reactivity when compared with children from suburban and rural areas (*p* = 0.02). However, inner-city asthmatic children had similar MA sensitization compared with either suburban or rural children that was not statistically significant (*p* = 0.239).

DISCUSSION

The interplay of the genetics of atopy and asthma with various environmental exposures may manifest itself in the form of allergic phenotypes or paradoxically may actually suppress the allergic response.¹¹ Allergic triggers for airway disease in children include house-dust mites, domestic animal allergens (with dog, cat, and horse being the most common), household pests (mouse and cockroach), fungi spores, and pollen that can infiltrate into the indoor environment. Rodents have long been recognized as occupational aller-

gens in laboratory work, with MUP being the major allergen. It is recognized as a potential allergen in both home and schools and similar to cockroach, exposure is not limited to just inner-city housing. Homes and public buildings without pets may have significant allergen levels. In a recent study by Sheehan *et al.*,¹² although cat and dog allergens were detected in 96 and 78% of school rooms, respectively, MA was detectable in 89% of school samples with 68% having MUP levels of >0.5 $\mu\text{g/g}$. Classroom samples for mouse were higher than matched home samples. Pongracic *et al.*¹³ studied the effect of MA and rodent environmental intervention on asthma in inner-city children. They found that MA sensitization occurred at low levels of exposure and MA was an independent risk factor for asthma morbidity. Also, targeted environmental intervention reduced MA levels and asthma-related sleep and activity disturbance. Our study results on prevalence of MA sensitization are in concordance with published literature.^{2,3,6,7,14} MA sensitization is highly prevalent among children with asthma, especially in inner-city populations but also among suburban and rural children. The disproportionately higher number of suburban and rural area children in our study is largely because of the number of satellite clinics of our referral center catering to the majority of the state population. Because most allergists do not routinely test for MA sensitization during the initial evaluation, it may be useful to include it in the allergy testing for children with asthma. Although our study design gives a fairly accurate assessment of MA sensitivity prevalence, selection bias may affect the numerator because some overlap exists in zip code-based population analysis. Pongracic *et al.* found a relationship among MA sensitivity, exposure, and asthma morbidity, even after controlling for cockroach sensitivity and exposure because this was shown to have a significant impact on asthma morbidity in the National Cooperative Inner-City Asthma Study.¹³ However, we have not studied the correlation of MA sensitivity with other household environmental allergens that has implications in the pathogenesis of pediatric asthma. A larger percentage of inner-city children underwent mouse antigen testing

when compared with other patients (44% versus 36%). The overall assumption that there is a high prevalence of mouse antigen sensitivity in asthmatic patients may be based on the fact that a larger percentage of patients from the inner city population (a group at high risk for mouse antigen sensitivity) were tested for mouse antigen sensitivity. Thus, a prospective study whereby mouse antigen sensitivity is tested for in all patients might provide more generalizable data.

REFERENCES

1. Asthma and Allergy Foundation of America 2009 Report, rankings for the allergy capitals. Available online at www.aafa.org/display.cfm?id=9&sub=33; accessed August, 2010.
2. Matsui EC, Simons E, Rand C, et al. Airborne mouse allergen in the homes of inner-city children with asthma. *J Allergy Clin Immunol* 115:358–363, 2005.
3. Matsui EC, Eggleston PA, Buckley TJ, et al. Household mouse allergen exposure and asthma morbidity in inner-city preschool children. *Ann Allergy Asthma Immunol* 97:514–520, 2006.
4. Chong LK, Ong MJ, Curtin-Brosnan J, and Matsui EC. Skin test sensitivity to mouse predicts allergic symptoms to nasal challenge in urban adults. *Allergy Asthma Proc* 31:472–476, 2010.
5. Salo PM, Jaramillo R, Cohn RD, et al. Exposure to mouse allergen in U.S. homes associated with asthma symptoms. *Environ Health Perspect* 117:387–391, 2009.
6. Phipatanakul W, Eggleston PA, Wright EC, et al. Mouse allergen, I: The prevalence of mouse allergen in inner-city homes. *J Allergy Clin Immunol* 106:1070–1074, 2000.
7. Phipatanakul W, Eggleston PA, Wright EC, et al. Mouse allergen, II: The relationship of mouse allergen exposure to mouse sensitization and asthma morbidity in inner-city children with asthma. *J Allergy Clin Immunol* 106:1075–1080, 2000.
8. Kentucky State Data Center. Available online at www.ksdc.louisville.edu/census/blockdata/2010blocks.htm; accessed August, 2010.
9. Nelson HS, Lahr J, Buchmeier A, and McCormick D. Evaluation of devices for skin prick testing. *J Allergy Clin Immunol* 101:153–156, 1998.
10. Bernstein IL, Li JT, Bernstein DI, et al. Allergy diagnostic testing: an updated practice parameter. *Ann Allergy Asthma Immunol* 100:S1–S148, 2008.
11. Sublet JL. The environment and risk factors for atopy. *Curr Allergy Asthma Rep* 5:445–450, 2005.
12. Sheehan WJ, Rangsithienchai PA, Muilenberg ML, et al. Mouse allergens in urban elementary schools and homes of children with asthma. *Ann Allergy Asthma Immunol* 102:125–130, 2009.
13. Pongracic JA, Visness CM, Gruchalla RS, et al. Effect of mouse allergen and rodent environmental intervention on asthma in inner city children. *Ann Allergy Asthma Immunol* 101:35–41, 2008.
14. McHugh BM, and MacGinnitie AJ. Indoor allergen sensitization and the risk of asthma and eczema in children in Pittsburgh. *Allergy Asthma Proc* 32:372–376, 2011. □

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