

ASTHMA IN THE ELDERLY

Perennial Allergen-Specific Immunoglobulin E Levels Among Inner-City Elderly Asthmatics

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Background. The role of allergen sensitization has been well established among children and young adults with asthma. Some studies have suggested that allergens play a less important role among older patients with asthma. However, whether older asthmatics have a lower prevalence of allergen sensitization than younger adults remains controversial. The aim of this study was to access the prevalence of sensitization to indoor allergens in older compared to younger inner-city adults with persistent asthma. **Methods.** The authors used data collected as part of a cohort study of inner-city adults with persistent asthma. Sensitization to indoor allergens (specifically *Dermatophagoides pteronyssinus*, *D. farinae*, cat, mouse, *Aspergillus fumigatus*, *Alternaria*, German and American cockroaches) was evaluated by specific immunoglobulin E (IgE) antibodies measured from peripheral blood. Univariate and multiple regression analyses were used to compare ratios of sensitization according to age (≤ 35 , 36–59, ≥ 60 years of age). **Results.** Of the 245 patients in the study, 19% were over the age of 60 years. Overall 73%, 61%, and 41% of patients ≤ 35 , 36–59, and ≥ 60 years old, respectively were sensitized to at least one indoor allergen ($p = .01$). Multivariate analysis showed that patients ≥ 60 years of age were significantly less likely to be sensitized (odds ratio 0.32, 95% confidence interval 0.11 to 0.89) compared to younger adults after controlling for potential confounders. **Conclusions.** Allergen sensitization is less common in older patients with persistent asthma. However, sensitization to any indoor allergen is relatively frequent in the elderly. Physicians should consider routinely accessing exposure and sensitization to these allergens as part of the evaluation of older inner-city patients with persistent asthma.

Keywords allergen, asthma, elderly, inner city, sensitization

INTRODUCTION

Although frequently characterized as a childhood disorder, asthma is relatively common among the elderly. The prevalence of asthma in patients ≥ 60 years of age has been reported between 4% and 13% (1–5); however, this number may be low because asthma in the elderly is commonly underdiagnosed (2, 6, 7). Furthermore, as the population over the age of 60 grows, the number of older patients with asthma is expected to increase. Older patients with asthma have one of the highest rates of asthma morbidity, hospitalization, and mortality (8–10). Reasons for these trends in older asthmatic patients are probably multifactorial and include presence of other comorbid conditions (11, 12), coexisting lung disease (13), as well as undertreatment (2, 6). Despite these statistics, the pathogenesis of asthma in older patients is not well characterized.

Asthma in the elderly may result from persistence of childhood asthma, reactivation of quiescent childhood asthma, or asthma that has developed later in life. Allergen sensitization and environmental and genetic factors are important for the

development of childhood asthma, but their role in asthma persistence into later years or late-onset asthma is not well understood. It has been reported that approximately 80% of young children in the United States with asthma are allergen sensitized (14, 15). Although it is generally accepted that immunoglobulin E (IgE) sensitization decreases with age (16, 17), the actual rate of specific allergen sensitization in older patients with asthma is not clear. Additionally, several studies have documented that minority inner-city populations have disproportionately higher rates of asthma and increased morbidity and mortality (9, 18). These studies have demonstrated that a majority of these patients are sensitized to allergens typically classified as “indoor.” However, the prevalence of sensitization among older asthmatics has not been well described. Studies in nonminority populations suggest that 24% to 74% of older adults with asthma are antigen sensitized (1, 19, 20). One study looking at antigen sensitization rates in older asthmatics from an inner-city population reported that 60% of patients were sensitized to at least one antigen (21). However, no comparison has been performed to assess differences in sensitization among young versus older asthmatics. The purpose of this study was to investigate the frequency of allergen sensitization in older patients from an inner-city population with persistent asthma and to compare rates of sensitization among young versus older patients. We hypothesized

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that the rate of antigen sensitization in older inner-city asthmatics would be less than for younger individuals.

METHODS

Patient Population

Our study population comprised a cohort of adult asthmatics cared for at a hospital-based primary care clinic located in East Harlem, New York City, and have been previously described (22). Study participants were enrolled over a 19-month period, from July 2004 to January 2006. In order to identify potential participants, we screened the primary care's computerized registration system daily to identify all adults with a physician diagnosis of asthma. Patients were eligible if they were ≥ 18 years of age, spoke English or Spanish, and had mild, moderate, or severe persistent asthma, defined according to the National Heart, Lung and Blood Institute's Expert Panel on Asthma (23). Individuals with a smoking history of ≥ 10 pack-years, a diagnosis of chronic obstructive lung disease or emphysema, restrictive lung disease, or other chronic respiratory illness were excluded from the study. Of these subjects, we restricted our analysis to a subgroup of 245 consecutively enrolled participants who underwent blood testing and quantification of IgE levels to indoor allergens. The study protocol was approved by the Institutional Review Board and written informed consent was obtained from the study participants.

Data Collection and Measurements

Standardized questionnaires were used to obtain information on sociodemographic characteristics, access to care, asthma history, asthma medications, comorbidities, as well as smoking habits. Trained research staff conducted interviewer-administered surveys in English or Spanish.

Patients were classified into three groups based upon their age: ≤ 35 years, 36 to 59 years, and ≥ 60 years of age. Comorbid conditions were reported by patients as present or absent, including chronic sinusitis, gastroesophageal reflux disease, allergic rhinitis, and eczema. We also collected information regarding chronic use of systemic corticosteroids, frequency of hospitalizations during the 12 months prior to the index admission, and history of endotracheal intubation.

Data on home environmental conditions that may influence allergic sensitization was ascertained using validated instruments (24). Questions included type of dwelling, presence of visible mold, cockroaches, rodents, leaks or water damage, furry pets, indoor tobacco exposure, and flooring surface in various rooms (25). In addition, study subjects reported whether they have wall-to-wall carpeting, humidifiers, air conditioning in their bedroom, or anti-dust mite covers on bedding.

Allergic Sensitization Assessment

After completion of the questionnaire, a sample of peripheral blood was obtained on study subjects for quantification of IgE levels to house dust mites (*Dermatophagoides farinae* and *D. pteronyssinus*), cockroaches (*Blattella germanica* and *B. Americanus*, Bla g 1), molds (*Alternaria* and *Aspergillus*), cats (Fel d 1), and mice (Mus 1). Serum IgE levels were determined with the UniCap System (Pharmacia Diagnostics; Uppsala, Sweden). Allergen-specific levels

>0.35 kUA/L for *D. farinae*, *D. pteronyssinus*, *Alternaria*, *Aspergillus*, Fel d 1, Mus 1 were considered as indicative of sensitization (26–29). An IgE level >0.6 kUA/L was used to assess cockroach sensitization (*B. Germanica* and *B. Americanus* Bla g 1) (22, 30, 31).

Statistical Analysis

We used the chi-square test to examine the demographic and clinical characteristics of study subjects according to age group. Similarly, the association between sensitization to specific indoor allergens and age was assessed using the chi-square statistic. Logistic regression analysis was used to evaluate the relationship between age and sensitization to specific allergens after adjusting for potential confounders, including gender, race and ethnicity, income, and environmental exposure to dampness and molds, cockroach, rodents, and cats. Odds ratios are presented with 95% confidence intervals. All analyses used two-tailed significance levels of $p < .05$ and were conducted with SAS statistical software (SAS Institute, Cary, NC).

RESULTS

Baseline demographic and clinical characteristics of the study cohort are shown in Table 1. Overall, 19% were ≥ 60 years old. Consistent with the epidemiology of inner-city asthma, the cohort consisted predominantly of women (85%) of racial/ethnic minority groups (61% Hispanic and 30% African Americans). Most patients were insured by Medicaid; however, 50% of patients ≥ 60 years of age had Medicare coverage ($p < .001$). Almost 68% of patients reported an annual income $< \$15,000$ per year.

Elderly asthmatics were more likely to be women ($p = .01$) and to have an annual income $< \$15,000$ per year ($p < .01$). Older patients were less likely to report asthma onset before 18 years of age ($p < .001$). However, there were no significant differences according to age in the proportion of patients who had a history of more severe asthma, including a history of intubation ($p = .58$), hospitalization ($p = .59$), or use of oral corticosteroids in the prior year ($p = .80$).

Although physician-diagnosed eczema ($p = .009$) was more common among younger individuals with asthma, there were no significant differences in the frequency of allergic rhinitis ($p = .06$) or chronic sinusitis ($p = .09$) according to age. Older patients with asthma tended to have increased incidence of gastroesophageal reflux ($p = .03$). Age was not related to most home environmental characteristics, such as presence of wall-to-wall carpeting ($p = .83$), presence of air conditioning in the patient's bedroom ($p = .29$), or anti-dust mite covers on bedding ($p = .57$). However, humidifiers were less common in the homes of elderly asthmatics ($p = .03$) and older patients were less likely to be exposed to second hand smoking ($p = .02$). Exposure to dampness/molds ($p = .41$), rodents ($p = .87$), cats ($p = .10$), or cockroaches ($p = .07$) were not statistically significant.

The most common antigen to which the older patients were sensitized was *D. farinae* (28%), followed by *D. pteronyssinus* (22%), German cockroach (20%), and cat (15%; Table 2). The prevalence of sensitization to at least one allergen was 73% among patients ≤ 35 years, compared to 61% for patients 36 to 59 years, and 41% for patients ≥ 60 years of

TABLE 1.—Baseline patient characteristics according to age group.

Characteristic	Age group			p value
	≤35 years (n = 33)	36–59 years (n = 166)	≥60 years (n = 46)	
Female (%)	76	83	97	.01
Race/ethnicity (%)				
Hispanic	58	57	76	.23
African American	27	32	20	
White	6	5	4	
Other	9	5	0	
Income <\$15,000 (%)	49	67	85	.003
Insured by Medicaid (%)	64	73	46	<.001
No insurance during the last year (%)	12	14	7	.41
Asthma history				
Age of asthma onset <18 years (%)	79	49	15	<.001
Ever intubated (%)	6	13	11	.58
Required steroids in the past year (%)	55	48	49	.80
Hospitalized in past year (%)	30	22	26	.59
On inhaled corticosteroids or leukotriene inhibitor (%)	82	87	87	.69
Comorbid conditions				
Eczema (%)	30	20	4	.009
Allergic rhinitis (%)	12	31	20	.06
Chronic sinusitis (%)	6	23	19	.09
Gastroesophageal reflux disease (%)	21	36	50	.03
Current smoker (%)	24	17	0	.004
Home environment characteristics				
Wall-to-wall carpets (%)	15	14	11	.83
Room air conditioning (%)	70	73	61	.29
Humidifier (%)	30	36	15	.03
Anti-dust mite covers (%)	27	22	17	.57
Home environment exposure				
Second hand smoking (%)	42	32	15	.02
Dampness/mold exposure (%)	61	69	61	.41
Rodent exposure (%)	36	35	39	.87
Cockroach exposure (%)	33	51	59	.07
Cat exposure (%)	30	20	11	.10

age ($p = .01$; Table 2). Similarly, the prevalence of sensitization to individual indoor allergens such as *D. farinae* ($p = .01$), *D. pteronyssinus* ($p = .002$), cat ($p < .001$), and mouse ($p < .001$) was significantly lower among elderly asthmatics. Sensitization to *Alternaria* and German cockroach was somewhat less common among elderly patients, although the difference did not reach statistical significance ($p = .06$ and $.07$, respectively).

In multivariate analyses, we found that sensitization to any allergen (odds ratio [OR]: 0.32; 95% confidence interval [CI]

TABLE 2.—Prevalence of allergic sensitization according to age group.

Allergen	Age group			p value
	≤35 years (n = 33)	36–59 years (n = 166)	≥60 years (n = 46)	
Any allergen (%)	73	61	41	.01
<i>D. pteronyssinus</i> (%)	61	42	22	.002
<i>D. farinae</i> (%)	61	42	28	.01
Cat (Fel d 1) (%)	68	42	15	<.001
Mouse (Mus 1) (%)	33	13	4	<.001
<i>Aspergillus fumigatus</i> (%)	15	15	4	.15
<i>Alternaria</i> (%)	15	21	7	.06
German cockroach (%)	39	20	20	.07
American cockroach (%)	6	3	2	.41

TABLE 3.—Adjusted association of allergic sensitization and age.

Allergen	Age group			
	36–59 years		≥60 years	
	Odds ratio ^a	95% CI ^b	Odds ratio	95% CI
Any allergen	0.64	0.27–1.50	0.32	0.11–0.89
<i>D. pteronyssinus</i>	0.51	0.23–1.12	0.23	0.08–0.64
<i>D. farinae</i>	0.50	0.23–1.11	0.31	0.11–0.83
Cat (Fel d 1)	0.39	0.16–0.92	0.12	0.04–0.37
Mouse (Mus 1)	0.31	0.13–0.75	0.09	0.02–0.48
<i>Aspergillus fumigatus</i>	1.08	0.35–3.31	0.44	0.07–2.71
<i>Alternaria</i>	1.87	0.61–5.68	0.78	0.16–3.97
German cockroach	0.38	0.16–0.95	0.45	0.14–1.40
American cockroach	0.34	0.06–2.11	0.21	0.02–2.77

^aOdds ratio for allergic sensitization compared to individuals ≤35 years of age. All models were adjusted for age, gender, race and ethnicity, income, and environmental exposure to dampness and molds, cockroach, rodents, and cats.

^bCI = confidence interval.

0.11–0.89], *D. pteronyssinus* (OR: 0.23; 95% CI 0.08–0.64), *D. farinae* (OR: 0.31; 95% CI 0.11–0.83), cat (OR: 0.12; 95% CI 0.04–0.37), and mice (OR: 0.09; 95% CI 0.02–0.48) were less common among individuals ≥60 years compared to those ≤35 years of age after adjusting for gender, race and ethnicity, income, and environmental exposures (Table 3). However, sensitization rates were not significantly different among older asthmatics for *Aspergillus* (OR: 0.44, 95% CI 0.07–2.71), *Alternaria* (OR: 0.78, 95% CI 0.16–3.97), German cockroach (OR: 0.45, 95% CI 0.14–1.40), and American cockroach (OR: 0.21, 95% CI 0.02–2.77) compared to those ≤35 years of age. Overall, there were no significant differences in the probability of sensitization for any indoor allergen among patients 36 to 59 years of age versus those ≤35 years, except for cat (OR: 0.39, 95% CI 0.16–0.92), mouse (OR: 0.31, 95% CI 0.13–0.75), and German cockroach (OR: 0.38, 95% CI 0.16–0.95).

DISCUSSION

Although it is well established that between 60% and 80% (32, 33) of children and young adults with asthma are sensitized to at least one environmental allergen, the incidence of allergen sensitization in older asthmatics is not well characterized. In this cohort of inner-city adult patients with persistent asthma, we found that elderly asthmatic patients were less likely to be sensitized to indoor allergens. However, >40% of older asthmatics were sensitized to at least one indoor allergen, most commonly to dust mites (*D. pteronyssinus* or *D. farinae*). These results suggest that it may be important to evaluate allergen sensitization as well as to discuss environmental control practices with older patients with poorly controlled asthma.

The potential importance of allergen sensitization in older patients is not well understood. For many years, asthma in older patients was characterized as nonatopic (34). Although it is reported that allergen sensitization by either skin prick testing or serum antigen-specific IgE decreases with increasing age (35), the prevalence of older patients with asthma who are allergen sensitized is not well described. Most prior studies have focused on white non-inner-city populations, demonstrating sensitization rates between 23.9% and 36.6% (1, 36). Conversely, a more recent study has found a higher

rate of sensitization among older patients. In a group of 80 asthmatics with a mean age of 73.5 years, allergy testing was positive to at least one allergen in 74% of the patients, most commonly cat (19). Similarly, Rogers et al. demonstrated in a study of 45 patients >65 years of age recruited from an asthma clinic in New York City that 60% had an elevated allergen-specific IgE (including outdoor allergens) and 47% were sensitized to cockroach (21). Among these patients, cockroach sensitization was associated with more severe asthma as measured by airflow limitation and hyperinflation. However, this study did not compare rates of sensitization of elderly versus younger asthmatics. Consistent with these studies, our results suggest that although less common than in younger adults, sensitization remains quite frequent among older patients with asthma.

Asthma in older patients may be either long-standing disease, diagnosed during childhood, or later-onset asthma. In our study, most of the elderly patients had received a diagnosis of asthma after the age of 18 years. Whether age of onset is related to the prevalence of allergen sensitization among older asthmatics is unclear. Some prior studies have suggested that sensitization may also play a role in later-onset asthma (20, 36). As part of the Normative Aging Study established by the Veterans Administration, men developing airway hyperresponsiveness after 49 years of age were more likely to be sensitized to cat (23.9% versus 4.4%) compared to age-matched controls (36). However, sensitization to other indoor allergens (dust mite, mouse) were not significantly different. In a study of 21 patients with asthma onset after 65 years of age, 81% demonstrated a positive skin prick test to at least one allergen compared to a group of 14 patients developing asthma <65 years in whom 57% were allergen sensitized (20). Given that most of the elderly patients in our study had adult-onset asthma, we were not able to further explore this issue.

The mechanisms of decreased antigen-specific IgE sensitization with aging are not entirely clear. Aging is associated with alterations of B- and T-cell functions, which affect antigen presentation, B-cell memory, and cytokine profiles (37). Furthermore, it is possible that, over time, the older patients have become more tolerant or desensitized to specific antigens. There are several environmental factors that may also play a role in the differences in sensitization seen in different age groups. For example, older patients were more likely to have exposure to cockroach or not have a humidifier (potentially decreasing dust mite exposure). Further research is necessary to unveil the mechanisms related to these different pathways of sensitization in the elderly.

Our study has several strengths and limitations that are worth acknowledging. The study population was from a single institution, thus limiting the generalization of our findings. However, our center is one of the largest providers of medical care to the East Harlem, New York, population, which has one of the highest rates of asthma in the United States (38, 39). Moreover, inner-city minority populations are at risk for increased morbidity and mortality from their asthma (40, 41). Our study is also strengthened by the use of standardized questions to collect data about sociodemographic factors, asthma history, and environmental exposure to allergens. Patients with asthma were limited to those with a history of physician diagnosed disease. As asthma is most

likely underdiagnosed in older patients, it is possible that our sample included patients with more severe disease, which in turn affected the sensitization rate. However, patients with a diagnosis of chronic obstructive pulmonary disease (COPD), a smoking history of >10 pack years, or any other chronic lung disease were excluded, decreasing the possibility of misclassification of asthma in our sample. We performed serum IgE evaluation because skin prick testing for aeroallergen sensitization in older individuals may not be as accurate as in younger patients due to an alteration in skin mast cells, photo damage, or other factors including medications (42). However, it is important to note that skin prick testing and serum antigen-specific IgE only agree between 85% to 95% when performed on the same individual (43, 44). We did not measure total serum IgE because the focus of the study was to measure specific antigen sensitization with age. Furthermore, results of the **National Health and Nutrition Examination Survey** (NHANES) 2005–2006 suggest that total IgE not be routinely determined as part of the asthma evaluation (16). However, because total IgE concentration may play a role in effector cell degranulation (45), this is an important question that should be addressed in the future. Finally, although we measured rates of allergen sensitization, we did not collect objective measures of indoor allergen exposure; however, our survey used several validated questions that addressed information on home environmental characteristics and self-reported indoor allergen exposure (24, 25, 46).

In summary, our study of inner-city adults with persistent asthma shows that allergen sensitization is less common among elderly asthmatics. However, it also suggests that allergen sensitization via specific IgE is still very prevalent among older inner-city patients with asthma. Physicians providing care for these patients should consider testing for sensitization and counseling about environmental control practices, particularly among elderly patients with poorly controlled asthma.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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