
Comparison of patterns of allergen sensitization among inner-city Hispanic and African American children with asthma

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Background: Among Hispanics, the largest minority ethnic group in the United States, asthma prevalence is increasing, particularly in inner-city neighborhoods. Although allergen sensitization among asthmatic African Americans has been extensively studied, similar details are not available for Hispanic children.

Objectives: To examine patterns of allergen sensitization, including the association with illness severity, in asthmatic children overall and in Hispanic and African American children living in a socioeconomically disadvantaged area of New York City.

Methods: A retrospective medical record review of asthmatic children attending a community hospital in the South Bronx area of New York City was performed. Information abstracted included demographics, asthma severity classification, reported exposures to indoor allergens, and results of allergy testing.

Results: Among 384 children in the analysis, 270 (70.3%) were Hispanic and 114 (29.7%) were African American. Sensitization to indoor and outdoor allergens, respectively, did not differ between Hispanic (58.5% and 27.0%) and African American (58.8% and 32.6%) children. Allergen sensitization exhibited a direct, significant association with asthma severity for indoor allergens for the 2 ethnic groups combined and for Hispanics separately but not between asthma severity and outdoor allergens ($P < .01$). No correlation was found between self-reported allergen exposure and sensitization.

Conclusions: Patterns of allergen sensitization among inner-city Hispanic asthmatic children resemble those among African American children, a finding that is likely explained by the similarity in levels of environmental exposures. With the increasing prevalence of asthma among inner-city Hispanic children, skin testing should be used frequently for objective evaluation of asthma in this ethnic group.

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INTRODUCTION

The prevalence of childhood asthma is reaching epidemic proportions and is now believed to be the most common chronic disease of childhood in the United States.¹ The current prevalence is disproportionately higher among inner-city children, particularly those of African American and Hispanic ethnicity.^{1–3} Hispanics are the fastest growing ethnic community in the United States, increasing at a rate 3 times that of other ethnic groups,⁴ with the greatest increase in inner-city neighborhoods.⁵ During the past decade and a half, asthma prevalence and correlates have been extensively studied among inner-city African American children.^{6–9} That allergen sensitization, particularly to indoor allergens, is associated with asthma development and severity^{7,10–14} is an especially well-established finding among inner-city African American pediatric populations.^{15,16} In contrast, studies of

inner-city asthmatic Hispanic children are scarce.^{17,18} Consequently, our knowledge of patterns of allergen sensitization in this population and of potentially contrasting patterns between African Americans and Hispanics is limited.

Recently, Celedon et al¹⁹ reported on skin test reactivity to indoor and outdoor allergens among asthmatic children residing in urban and suburban areas in Connecticut, with a focus on those of Puerto Rican origin. They reported a higher prevalence of indoor and outdoor allergen sensitization among Puerto Rican and African American children compared with white children. However, their population sample included children residing in urban and suburban neighborhoods, and the above-mentioned results were those of the entire group. Hence, the comparison of African American and Puerto Rican children with white children does not clarify the relative contribution of ethnicity as contrasted with modifiable socioeconomic and environmental differences to allergen sensitization. For example, in at least one study²⁰ the difference in prevalence of asthma between whites and African Americans was not sustained after adjustment for socioeconomic status and urban residence. To avoid this type of potential confounding in the present study, we compared the pattern of allergen sensitization among Hispanic children with that among African American children, with both residing in the same inner-city neighborhoods. Given that Hispanics compose a growing proportion of minorities residing in

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US cities, research and improved understanding of the role of allergen sensitization in asthma incidence, prevalence, and severity among Hispanics is likely to become increasingly important from a clinical and public health perspective.

The South Bronx is an urban area comprising extremely socioeconomically impoverished neighborhoods. The asthma prevalence among children residing in the South Bronx (16.7%) is one of the highest in the New York metropolitan area (9.1%) and also one of the highest in the United States (10.8%).²¹ The population is 62% Hispanic and 38% African American. The present study was undertaken to examine the association of sensitization to indoor and outdoor allergens with asthma severity among inner-city Hispanic and African American asthmatic children, all of whom reside in the South Bronx.

MATERIALS AND METHODS

Patients

Study material was drawn from the Pediatric Asthma Center at Bronx Lebanon Hospital Center (BLHC), where children are followed for multiple pulmonary and allergy problems, such as asthma, allergic rhinitis, bronchopulmonary dysplasia, and sickle cell disease. Of the 1,118 medical records reviewed of children attending the Pediatric Asthma Center between March 1, 1994, and September 30, 2004, 467 children with asthma were identified as having undergone allergy testing. Data on demographics, exposure to indoor allergens, and results of allergy testing were collected by means of retrospective medical record review. Asthma severity was classified at the first visit as per the National Heart, Lung, and Blood Institute guidelines²² into mild intermittent and mild, moderate, and severe persistent asthma. Children with frequency of daytime symptoms less than 2 times a week and nighttime symptoms less than 2 times a month were classified as having mild intermittent asthma. Those with daytime symptoms more than 2 times per week but less than once a day or nighttime symptoms more than 2 nights per month were classified as having mild persistent asthma, those with symptoms daily in the daytime or more than 1 night per week as having moderate persistent asthma, and those with symptoms continual in the daytime or frequent nighttime symptoms per week as having severe persistent asthma. Allergy testing was performed at subsequent visits. This study was approved by the institutional review board at BLHC.

Study Measures

Allergy skin testing. Percutaneous skin testing was performed by means of the prick-puncture method on the volar surface of the forearms. The multipricket applicator (Quick-Test from the Quanti-Test system; Panatrex Inc, Placentia, CA) allowed 8 antigen prick studies to be performed simultaneously to maintain reproducibility. Allergen extracts were obtained in glycerosaline (Greer Laboratories, Lenoir, NC).

The children were clinically stable at the time of allergy evaluation, and none were taking systemic corticosteroids. Antihistamines and other potential interfering agents were eliminated for at least 72 hours before skin testing to minimize false-negative results. Skin prick testing was performed for

indoor allergens (mite mix: *Dermatophagoides farinae* [5,000 AU/mL] + *Dermatophagoides ptereronysius* [5,000 AU/mL]; cockroach mix, 1:20 wt/vol; mixed-breed dog epithelium, 1:20 wt/vol; standardized cat hair, 10,000 BAU/mL; mouse epithelium, 1:20 wt/vol; mold mix I, 1:20 wt/vol; and mold mix II, 1:40 wt/vol) and outdoor allergens (grass mix, 100,000 BAU/mL; Eastern tree mix, 1:20 wt/vol; and ragweed mix: giant + short [1:20 wt/vol]). Reactions suggesting mast cell specific IgE directed against a test allergen were interpreted 15 to 20 minutes after application. A positive skin test reaction (PSTR) was classified as 1+ through 4+. A 1+ response was a wheal as large as or larger than the negative control and an area of erythema significantly larger than that at the negative control site; 2+, a wheal measuring 5 to 7 mm and an area of erythema larger than 10 mm; 3+, a wheal measuring 7 to 10 mm and an area of erythema larger than 20 mm; and 4+, any reaction with a wheal larger than 10 mm or pronounced pseudopodia; the area of erythema may be 20 mm or greater, as in the 3+ reaction. In the present analyses, an STR for any given allergen graded as 1+ or greater is classified as positive.

Tests with a positive response to histamine (positive control) and a negative response to saline (negative control) were included in the analysis. Skin tests that did not yield a wheal-and-flare reaction at the site of histamine application were deemed to be equivocal responses. Children with equivocal response ($n = 38$) were excluded from further analysis. In addition, 38 children who did not qualify for skin testing, such as those with severe eczema, underwent radioallergosorbent testing and were also excluded. Of the remaining 391 children, 7 who were neither African American nor Hispanic were excluded from further analysis. Skin tests results for 384 children are the subject of the present analyses.

Intake questionnaire. As part of the initial intake evaluation, the primary caregiver accompanying the child was questioned about the presence of the following allergens in the home: roaches, mice, and mold. Sociodemographic information, medical insurance carrier, and ZIP code of residence were also recorded for the child and the caregiver.

Data Analysis

All the children resided in the BLHC's catchment area: the Hunts Point-Mott Haven, Highbridge Morrisania, and Crotona-Tremont neighborhoods in the South Bronx. More than 35% of the families in the census tracts represented in the study sample were below the poverty level. The ethnicity of participating children was based on parental report.

Skin test reactions to all indoor allergens combined were dichotomized, with persons positive on 1 or more individual indoor allergens classified as positive. The same dichotomous classification was used for STRs to all outdoor allergens combined and for all indoor and outdoor allergens combined. Descriptive statistics were calculated for the sociodemographic, clinical, and exposure characteristics of the children composing the study sample. Bivariate relationships between categorical variables, eg, PSTRs for indoor allergens (0,1+) by ethnicity (African American vs Hispanic) and PSTRs for allergens with

asthma severity, were analyzed using maximum likelihood logistic regression. Logistic regression was used to estimate the strength of association, as indexed by the odds ratio, between a given predictor and outcome, overall and for the 2 ethnic groups considered separately. Potential confounding variables were retained in the final logistical model if their inclusion changed the criterion regression coefficient for the odds ratio by more than 10% (Table 1).²³ All statistical tests were 2-tailed, with significance set at $P < .05$. Odds ratios are reported together with their 95% confidence intervals. All the statistical analyses were performed using a software package (SPSS version 12; SPSS Inc, Chicago, IL).

RESULTS

Of the 384 children studied, 270 (70.3%) were Hispanic and 114 (29.7%) were African American (Table 1). The age range at testing was 1 to 18 years (mean age, 7.4 years), and 61% were boys. Ninety-seven percent of the sample was receiving Medicaid. Overall, approximately 8% of the sample had mild intermittent asthma, 18% had mild persistent asthma, 53% had moderate persistent asthma, and 21% had severe persistent asthma. Approximately 55% of the caregivers reported exposure to cockroach, 43% to mice, and 26% to mold. The distribution of the 2 ethnic groups did not differ significantly on any of these variables (Table 1).

Sensitization was substantially higher to indoor than to outdoor allergens overall among Hispanic (58.5% vs 27.0%) and African American (58.8% vs 31.6%) children, and this finding did not differ by ethnicity (Table 2). Among individual indoor and outdoor allergens, a higher percentage of African Americans reacted to cockroach, dust mite, mouse, and mold (indoor allergens) and to tree and grass (outdoor allergens) compared with Hispanics. However, none of these individual differences between the 2 ethnic groups were statistically significant, except for sensitization to tree (Table 2). If adjusted for the number of statistical tests performed, the finding is not significant.

The association of sensitization to indoor and outdoor allergens with asthma severity—overall and for Hispanics and African Americans separately—is examined in Table 3. For both ethnic groups combined, sensitization to indoor allergens directly correlated with asthma severity ($P < .01$). The adjusted odds ratio indexing this association rose in a monotonic manner with increasing asthma severity. The odds of indoor allergen sensitization relative to children with mild intermittent asthma was 1.29 among children with mild persistent asthma, 2.22 among children with moderate persistent asthma, and 3.43 among those with severe persistent asthma, a statistically significant association. The same direct linear statistically significant relationship between indoor allergen sensitization and asthma severity was obtained for Hispanics but not for African Americans. This apparent difference between Hispanics and African Americans in this regard was not statistically significant, indicating that the observed discrepancy between the 2 groups is likely an artifact of the small number of African Americans in the mild intermittent category. No association between sensitization to outdoor allergens with asthma severity was found for the entire cohort or for the 2 ethnic groups analyzed separately.

To clarify whether this was a sample of highly atopic children such that they had a propensity to react to any allergen, we examined whether a child who was allergic to a given indoor allergen had the same extent of reactivity to other indoor and outdoor allergens. Children allergic to 1 indoor allergen were significantly more likely to react to other indoor allergens than to outdoor allergens. For example, the correlation between a PSTR to cockroach and a PSTR to cat was $r = .52$ ($P < .0001$), whereas between PSTRs to cockroach and ragweed, $r = .15$ ($P = .02$). Similarly, the correlation between PSTRs to tree and grass was $r = .46$ ($P < .0001$) and to tree and dust mite was $r = .16$ ($P < .02$).

Table 1. Sociodemographic, Clinical, and Environmental Characteristics of the Study Sample

Characteristics	Hispanic children (n = 270)	African American children (n = 114)	Total (N = 384)
Sex, No. (%)			
M	162 (60.0)	72 (63.2)	234 (60.9)
F	108 (40.0)	42 (36.8)	150 (39.1)
Age, mean (SD), y	7.7 (4.2)	6.8 (4.2)	7.4 (4.2)
Type of health insurance, No. (%)			
Medicaid	262 (97.0)	109 (95.6)	371 (96.6)
Non-Medicaid	8 (3.0)	5 (4.4)	13 (3.4)
Asthma severity, No. (%)			
Mild intermittent	20 (7.4)	11 (9.6)	31 (8.1)
Mild persistent	50 (18.5)	18 (15.8)	68 (17.7)
Moderate persistent	149 (55.2)	55 (48.2)	204 (53.1)
Severe persistent	51 (18.9)	30 (26.3)	81 (21.1)
Self-reported frequency of allergen exposure, No. (%)			
Cockroach	138 (51.1)	75 (65.8)	213 (55.5)
Mice	117 (43.3)	51 (44.7)	168 (43.8)
Mold	69 (25.6)	30 (26.3)	99 (25.8)

Table 2. Pattern of Allergen Sensitization Among Hispanic and African American Children and Adolescents

Allergen sensitization	Patients with PSTRs, No. (%)			Odds ratio (95% CI)*	P value
	Hispanic children (n = 270)	African American children (n = 114)	Total (N = 384)		
Indoor†	158 (58.5)	67 (58.8)	225 (58.6)	0.99 (0.63–1.54)	<.96
Outdoor†	73 (27.0)	36 (31.6)	109 (28.4)	0.81 (0.50–1.30)	<.37
Individual allergens					
Cat	94 (34.8)	44 (38.6)	138 (35.9)	0.85 (0.54–1.34)	<.48
Dust mite	83 (30.7)	40 (35.1)	123 (32.0)	0.82 (0.52–1.31)	<.41
Cockroach	80 (29.6)	40 (35.1)	120 (31.3)	0.78 (0.49–1.24)	<.29
Mouse	53 (19.6)	30 (26.3)	83 (21.6)	0.68 (0.41–1.14)	<.15
Dog	50 (18.5)	27 (23.7)	77 (20.1)	0.73 (0.43–1.24)	<.25
Mold	14 (5.2)	11 (9.6)	25 (6.5)	0.51 (0.23–1.17)	<.11
Grass	42 (15.6)	24 (21.1)	66 (17.2)	0.70 (0.40–1.21)	<.19
Tree	33 (12.2)	23 (20.2)	56 (14.6)	0.55 (0.31–1.01)	<.05
Ragweed	43 (15.9)	19 (16.7)	62 (16.1)	0.95 (0.53–1.71)	<.86

Abbreviations: CI, confidence interval; PSTR, positive skin test reaction.

* African American children is the reference group.

† No adjustment for potential confounders was required.

Table 3. Association of Asthma Severity With Patterns of Allergen Sensitization by Ethnicity

	Asthma severity, %				Odds ratio (95% CI)*	
	Mild intermittent	Mild persistent	Moderate persistent	Severe persistent	Unadjusted	Adjusted†
Indoor						
All	48.4	47.1	60.8	66.7	0.95 (0.41–2.22)	1.29 (0.52–3.22)
					1.65 (0.77–3.53)	2.22 (0.98–5.05)
					2.13 (0.92–4.95)	3.43 (1.37–8.60)
African American children	72.7	33.3	56.4	73.3	0.19 (0.04–0.98)	0.30 (0.05–1.70)
					0.48 (0.12–2.02)	0.67 (0.15–3.07)
					1.03 (0.22–4.88)	1.70 (0.31–9.34)
Hispanic children	35.0	52.0	62.4	62.7	2.01 (0.69–5.89)	2.50 (0.78–8.00)
					3.08 (1.16–8.19)	4.00 (1.38–11.59)
					3.13 (1.06–9.21)	4.53 (1.40–14.67)
Outdoor						
All	25.8	23.5	29.9	29.6	0.89 (0.33–2.36)	1.24 (0.44–3.53)
					1.23 (0.52–2.89)	1.61 (0.65–4.04)
					1.21 (0.48–3.08)	1.76 (0.65–4.79)
African American children	36.4	27.8	30.9	33.3	0.67 (0.14–3.35)	2.11 (0.31–14.19)
					0.78 (0.20–3.04)	1.75 (0.34–9.00)
					0.88 (0.21–3.71)	2.06 (0.35–12.00)
Hispanic children	20.0	22.0	29.5	27.5	1.13 (0.31–4.07)	1.25 (0.33–4.75)
					1.68 (0.53–5.30)	1.86 (0.56–6.14)
					1.51 (0.43–5.32)	1.82 (0.49–6.23)

Abbreviation: CI, confidence interval.

* Mild intermittent asthma is the reference group. In each cell, the odds ratio in the top row corresponds to the odds of 1 or more positive skin test reactions among children with mild persistent asthma relative to children with mild intermittent asthma; the odds ratio in the middle row corresponds to the odds of 1 or more positive skin test reactions among children with moderate persistent asthma relative to children with mild intermittent asthma; and the odds ratio in the bottom row corresponds to the odds of 1 or more positive skin test reactions among children with severe persistent asthma relative to children with mild intermittent asthma.

† Adjusted for age and sex.

Although approximately half the families reported seeing roaches and mice in their homes, there was no significant relationship between self-report and sensitization to that particular allergen among either of the 2 ethnic groups. For

example, among children whose caregivers reported exposure to mice (n = 168), the STR was positive only for 21.4% of the children. Among children with PSTRs to mouse (n = 83), only 43% of the caregivers reported such exposure.

DISCUSSION

Greater understanding of the role of allergen sensitization in asthma prevalence and severity may lead to improved control of the current epidemic of inner-city childhood asthma. The allergic component of asthma has been extensively studied among predominantly African American inner-city children, a group with higher prevalence rates and greater asthma severity compared with white children.⁶⁻⁹ Reports also indicate increased sensitization to multiple indoor allergens among African Americans compared with whites.^{19,24-27} In the present study, comparing allergen sensitization among inner-city Hispanic children and African American children residing in the same neighborhoods, we found similar patterns of reactivity to indoor allergens in both ethnic groups irrespective of asthma severity. This finding is likely due to the similarity in the exposures to indoor allergens among the 2 ethnic groups.

Studies^{6,7} of inner-city African American children report an association between increased sensitization to indoor allergens and greater asthma severity. Further support for the role of indoor allergens in asthma severity derives from intervention studies. Individual allergen levels in the settled dust in houses²⁸ and schools²⁹ have been found to be elevated in inner-city neighborhoods, and remediation of these elevated levels in inner-city homes leads to a decreased frequency of asthma symptoms.³⁰ The increase in levels of indoor allergen sensitization with increasing levels of asthma severity was evident in the sample as a whole and separately among Hispanics to a larger extent compared with African Americans in the present study. These results underscore that indoor environmental exposures may play a major role in asthma severity among African Americans, as established in previous studies (absent herein because of limited sample size), and among Hispanic children. The housing stock of the South Bronx comprises buildings more than 50 years old, with many in structural disrepair. Home evaluations and environmental remediation strategies offer a plausible option for decreasing asthma morbidity among Hispanic and African American inner-city children.

Although one third of the patients in this study were sensitized to an outdoor allergen, no statistically significant association emerged between sensitization to outdoor allergens and asthma severity overall or in either ethnic group separately. These results differ markedly from those of Celedon et al,¹⁹ who found an association between Puerto Rican and African American ethnicity and increased sensitization to outdoor allergens. That our sample derived entirely from a highly impoverished inner-city area, whereas Celedon et al accrued children from suburban/urban areas, may explain the divergent findings. Inner-city asthmatic children are less physically active^{31,32} and spend more time indoors, thereby possibly limiting their exposure to outdoor allergens sufficiently as to preclude its contribution to asthma severity or to preclude the ability to detect such a contribution. The null finding for outdoor allergens in relation to asthma in both ethnic groups in the inner-city setting requires further study.

When evaluating an asthmatic child, physicians devote considerable time obtaining a history of exposure to common aeroallergens from the child and the child's primary caregiver. In the present study, no correlation emerged between self-reports of allergen exposure, eg, sighting of mice, roaches, and mold, and sensitization responses to that allergen overall or for the 2 ethnic groups considered separately. Several studies^{33,34} report the same finding, suggesting that exposure history alone is not a useful guide in determining which children with asthma should undergo skin testing. Because skin testing provides objective evidence of potential sensitization, it affords an opportunity for the physician to offer more specific advice on allergen avoidance and modification of the home environment.

The present study has several limitations. The high prevalence of allergen sensitization in this sample may raise concerns regarding a selection bias such that children who attended the BLHC asthma center and were tested for allergen sensitization were those who were highly atopic. Although not reflective of the general pediatric population, the frequency of allergen sensitization to indoor and outdoor allergens in the present sample was similar to that reported for the National Cooperative Inner-City Asthma Study cohort.⁶ Furthermore, there was significant correlation between the 3 outdoor allergens such that children with PSTRs to 1 outdoor allergen were more likely to react to other outdoor allergens than to indoor allergens. Although it has been reported that sensitization to outdoor allergens is not associated with increased risk of asthma,³⁵ longitudinal studies are needed to monitor the progression of atopic diseases in children sensitized to outdoor allergens and to evaluate whether they later develop sensitization to indoor allergens as well or vice versa.

The present cross-sectional study was performed on data collected by retrospective medical record review, and the sample included only asthmatic children. Therefore, the results may not reflect the allergen sensitization pattern of the general population sample residing in the inner-city area. Details on those born in the United States compared with those who were immigrants were also not available. Although longitudinal studies have demonstrated onset of asthma in children allergic to indoor allergens,¹¹ similar studies are needed to evaluate the role played by indoor and outdoor allergens in the inner-city environment, particularly in the ethnic groups of interest and in the immigrant population. Additional comparative studies evaluating sensitization patterns to indoor and outdoor allergens among urban inner-city children compared with those residing in suburban neighborhoods will further enhance the understanding of the role of allergen sensitization in the prevalence of inner-city asthma.

CONCLUSION

In summary, we found increased sensitization to indoor allergens with increasing severity of asthma overall and for Hispanic children separately. The patterns of allergen sensitization among inner-city Hispanic children with asthma

closely resemble those among African American children, a finding that is likely explained by the similarity in their levels of environmental exposures. These findings support the larger role of the environment in asthma, as 2 different ethnic groups have a similar presentation of atopic asthma.

Skin testing offers an objective evaluation tool and should be incorporated into the regular evaluation of asthmatic children to enable providers to give specific advice regarding environmental modifications. With the increasing number of Hispanics in the nation and the high rate of asthma in this population, the role of atopy needs to be emphasized and allergy testing be performed more regularly in inner-city Hispanic asthmatic children.

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