Elevated Asthma and Indoor Environmental Exposures Among Puerto Rican Children of East Harlem

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ABSTRACT

Objective. East Harlem in New York City, a community with a large Puerto Rican population, has among the highest rates of asthma hospitalizations and mortality in the United States, but it is not known if the high rates are related to the ethnic composition, environmental or community factors, or if the higher rates reflect differentials in access to appropriate asthma care. A survey was conducted to: (a) estimate the prevalence of current asthma by ethnicity among school-age children, (b) assess indoor environmental risk factors for childhood asthma, and (c) assess health care utilization and school absences associated with childhood asthma. Design. A cross-sectional survey of parents of elementary school children, using a self-administered questionnaire with a 12-month recall on asthma symptoms based on the International Study of Asthma and Allergies in Childhood. Setting. Two public elementary schools in East Harlem (n = 1615 students 5–12 years of age). Results. Among the 1319 respondents (response rate 82%), the prevalence for current asthma (doctor or nurse diagnosis at any time plus wheezing in the past 12 months) was 23%. Puerto Rican children had a prevalence of 35%. Puerto Rican children reported both higher symptomatic frequencies and higher rates of physician diagnosis. Living in a home where cockroaches, rats, or mice had been seen in the past month and with a dust-enhancing heating system also

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was associated with having asthma, regardless of ethnicity. Compared with other children with asthma, Puerto Rican children with asthma were more likely to live in homes where rats or mice had been seen in the past month. Regardless of ethnicity, children with more frequent, more severe asthma symptoms and incomplete asthma action plans were more likely to have visited the emergency department in the past year. Puerto Rican children were more likely to have missed school because of their asthma in the past year. Conclusion. The prevalence of current asthma was significantly higher among Puerto Ricans, who had higher symptomatic frequency and greater diagnosis rates. Although all children with asthma in the East Harlem study appear to be sensitive to selected indoor environmental risk factors, only Puerto Rican children with asthma appear to be sensitive to the presence of rodents in their buildings. However, their higher school absence rate suggests problems with routine asthma management that could be addressed by improved medical management, programs to help parents manage their children’s asthma, or school staff assistance with medications.

Key Words: Asthma; Inner city; School absences.

INTRODUCTION

During the past 20 years, the prevalence of asthma among both children and adults in the United States and around the world has been rising, particularly in densely populated urban areas. In 1999 the self-reported annual incidence of an asthma episode among children ages 5–14 in the United States was 5.6%. This increased prevalence was associated with a near doubling of office visits since 1990 for asthma for this age group, and an increase in hospitalizations and emergency department visits for asthma (1). New York City is one of the cities with the highest asthma hospitalization rate for children 0–14 years of age, 8.6 per thousand in 1999, almost three times the US rate of age in the United States—3.3 per thousand (1,2). New York City’s highest rates for pediatric asthma hospitalizations were found in East Harlem, where the rate was 25.7 per thousand in 1999 (2).

High rates of asthma hospitalizations or visits to the emergency department typically result from the confluence of several factors in disadvantaged communities: poverty, poor access to health care, inadequate medical management of asthma, high levels of environmental exposures, or underlying genetic or allergic preconditions associated with asthma (3–8).

East Harlem is a community with a large concentration of Puerto Ricans, and several studies have shown very high asthma rates among Puerto Rican children, as compared with other Latino groups (9–12). The high rate of asthma among Puerto Rican children could be due to genetic factors (11,13,14), environmental exposures associated with their community or housing (11), or inadequate access to appropriate asthma management (15,16).

Recent studies conducted in similar urban environments have linked cockroach and dust mite allergens in the home with asthma, first by increasing the likelihood of sensitization to these allergens and then through the asthma exacerbations triggered by exposure to these allergens (7,17–25). The National Cooperative Inner-City Asthma Study included East Harlem and documented higher levels of asthma exacerbations among children sensitized to cockroach allergen who also had a high level of cockroach allergen present in their bedrooms (18), but this study did not report results separately for Puerto Ricans or for East Harlem.

Some studies also stress the role of exposures to animal dander, urine, or feces, namely exposure and sensitivity to pets with fur or rodents living in the building (7,17,19,22,25,26). In the inner city environment, there is some evidence that exposure and sensitivity are higher to rodents (rats and mice) than to cats or dogs (21). Thus, the higher asthma rate among Puerto Rican children might be due to greater sensitization and exposure to rodents in the home. The higher rate of asthma among Puerto Rican children also might be due to higher exposure to environmental tobacco smoke (ETS) (27–29), but one study of ETS and asthma among Puerto Ricans failed to find this relation (14).

The higher rate of asthma among Puerto Rican children in East Harlem might also be due to ethnic differences in access to appropriate asthma care (16). Several studies have documented a relation between high rates of hospitalization or emergency department visits and inadequate asthma care (e.g., inappropriate medications, no asthma management plan, no access to asthma providers at night) (8,30), but there are no studies
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which examine this relation specifically for Puerto Ricans.

Therefore, we undertook a population-based survey to examine the interplay of these factors among Puerto Ricans in East Harlem. As an alternative to the high cost of an in-person interview survey and the potential selection bias of a survey limited to households reachable in a telephone survey, we employed a take-home, self-administered survey of parents and guardians of children. In this neighborhood, the majority of the children attend public schools; therefore, the study was conducted in the two public schools that have the majority of all elementary school age children in East Harlem.

The objective of the school-based survey in East Harlem was to (a) estimate the prevalence of current asthma by ethnicity among school-age children, (b) assess sociodemographic and indoor environmental risk factors for childhood asthma, and (c) assess health care utilization and school absences associated with childhood asthma.

METHODS

Study Sites

The prevalence survey was conducted in two public elementary schools (grades K-6) in East Harlem. The survey was a collaborative effort of The New York State and City Departments of Health, The Center for Urban Epidemiologic Studies, the Mount Sinai Pediatric School Health Program, Columbia University, and New York City School District Four. These two schools were selected on the basis of their demographic similarity to the surrounding community, lack of specific asthma intervention programs, and their concern for asthma and interest in the survey. One school had no school-based health program, whereas the other had a school-based health program planning to launch an asthma program, for which the survey was needed to establish prevalence and determine program strategy.

Survey Instrument

To promote comparability with other studies, the International Study of Asthma and Allergies in Children (ISAAC) survey of parents of 6- and 7-year-olds was used for the asthma symptom questions (31). This survey has been conducted in 36 countries, including several Latin and Central American locations (32). It has been validated against lung function tests in several settings, and a high correlation has been demonstrated between bronchial hyperresponsiveness and parental or adolescent reports of symptoms in the last 12 months (33,34). In addition to a question regarding a doctor’s diagnosis of asthma, the parents were asked about the presence and frequency in the past 12 months of the main asthma symptoms: wheezing or whistling in the chest, sleep disturbed by wheezing, exercise-induced wheezing, speech limited by wheezing, and a dry cough at night without a cold or flu. If a child had asthma, the parent was asked about the child’s health care utilization for asthma (visits to the doctor, emergency department visits, hospitalizations in the past 12 months), and asthma management practices (medications taken and how often, use of a nebulizer, inhaler and spacer, use of a peak flow diary, and five written asthma management plan elements, per National Heart, Lung, and Blood Institute [NHLBI] recommendations) (35). Parents were asked to report on the monthly variability of asthma symptoms and to identify any of 17 common “triggers” that made their child’s asthma worse. Indoor environmental risk factors included pets in the home, use of an air conditioner, method of heating, presence and types of rugs, type of stove, ETS, and the sighting of cockroaches, rats, and mice in the home during the past month. Impact of asthma on participation in school was assessed with questions about asthma-related absences or loss of participation in sports or vigorous activities in the past month. The presence of a telephone in the home was used to assess poverty status and to determine if a subsequent telephone survey could lead to biased results (36–38). Socioeconomic risk factors for asthma were assessed with questions on sociodemographic information: child’s race/ethnicity, sex, and age; family income level; and respondent’s educational level. The bilingual (English/Spanish) questionnaire had one page of instructions and four pages of questions and had been pretested with a small group of parents at one school. The Institutional Review Boards of the collaborating organizations approved the survey.

Current Asthma Definition

Children were defined as having asthma if they had ever had a health care provider diagnosis of asthma and had experienced any wheezing or whistling in the chest or after exercise in the 12 months before the survey. Other studies have found a low
correlation with the single symptom of night cough, and clinical confirmation of asthma (17,33) and the dry night cough symptom has been excluded in the measurement of asthma prevalence in at least two other studies (39,40). For these reasons, night cough was not included among the criteria for current asthma.

Data Collection

The survey was implemented between May 19 and June 6, 1997. In the month before the survey, school administrators worked with community organizations, parent associations, and informal networks to inform parents about the survey and the importance of their participation. Flyers were sent home to parents 2 weeks before the survey. Teachers for all 68 classes at both schools distributed the bilingual survey and consent forms in envelopes to all students. Students were instructed to take the packet home and ask a parent or guardian to complete it for each of their children in the school, regardless of the asthma status of their children. Children put the completed surveys in the sealed envelopes in their classroom’s survey collection box. A numerical system was used to maintain confidentiality of the returned forms. Children who had not returned a survey after a week were reminded to bring in the survey. Incentives for participation were clearly described in the parent consent forms. Children who returned survey envelopes received a T-shirt, and classrooms with a return rate of at least 90% received $100 toward the purchase of educational materials.

Data Analysis

Bivariate associations were assessed using odds ratios (OR). Logistic regression was used to calculate adjusted OR with which to assess the significance of the risk factors, after controlling for other risk factors. Odds ratios are reported with their 95% confidence intervals (CI). Analysis was conducted with SPSS Version 7.0.

RESULTS

The return rates were comparable at both schools (85% and 84%). Of the 1615 total students in the two schools, 1319 (82%) returned usable questionnaires, 45 (3%) returned unusable questionnaires that were either blank or contained too many missing or illogical items to be usable, and 251 (15%) did not return the questionnaire. No information is available regarding the characteristics of the parents or children who did not return the questionnaire. Most (86%) parents completed the English version of the survey.

Study Population Characteristics

Children averaged 7.4 years of age. The children were split evenly by gender. The majority of the study population reported themselves as Hispanic, with 34% Puerto Rican and 16% other Hispanic groups. The remainder were African-American (37%) and other ethnic/racial groups (13%). Only nine children were identified as both African-American and Hispanic; therefore, we use African-American and Hispanic as exclusive categories in the analyses. Three-fourths of the parents had completed at least high school, with Puerto Rican parents less likely to complete high school than other parents (69% vs. 76%, t = 2.8). The income level for the families was low, with half of the families reporting incomes below $10,000. More than one-fifth (22%) of the families had no phone or had a disconnected phone. Comparison to the 1990 U.S. Census data for East Harlem indicates that this sample has an almost identical racial/ethnic and income distribution as the total population of East Harlem (41).

Assessment of Asthma

One-third (32%) of the parents reported that their child had an asthma diagnosis made by a doctor or nurse (Table 1). Twenty-five percent of the children had wheezing or whistling in the chest in the past 12 months. Almost one-fourth of all children (23%) had current asthma, symptoms in the past 12 months and an asthma diagnosis. An additional 5% had symptoms but had never been diagnosed, and 10% did not have current symptoms but had at one time been diagnosed with asthma. Asthma diagnosis and symptom rates were identical for the two schools.

The symptoms and diagnosis pattern varied by ethnicity (Fig. 1). Puerto Rican children were 1.6 times more likely to have current symptoms (95% CI = 1.3, 2.1), with and without a diagnosis and 1.99 times more likely to have current symptoms and a diagnosis (95% CI = 1.5, 2.6). Compared with all other children, Puerto Rican children were more likely to report daytime or nighttime wheezing (OR = 1.8, 95% CI = 1.4, 2.3). Puerto Rican children
were 1.6 times more likely to report exercise-induced wheezing (95% CI = 1.2, 2.2).

**Asthma-Related Events**

Activity limitation and use of hospital care for asthma were common among children with current asthma (see Table 1). One-fourth (29%) had their sleep disturbed at least weekly or had asthma exacerbations so severe that they were not able to speak more than a few words (26%). More than two-thirds (70%) had an asthma-related visit to a hospital emergency department in the previous 12 months. In the previous month 38% had stopped participating in sports at least once because of their

### Table 1. Asthma history, symptoms, and events.

<table>
<thead>
<tr>
<th>History of symptoms</th>
<th>n</th>
<th>Total</th>
<th>Puerto Rican</th>
<th>Other</th>
<th>odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever been told by a doctor or nurse that your child has asthma</td>
<td>425</td>
<td>32.2</td>
<td>40.8</td>
<td>27.4</td>
<td>1.82 (1.44, 2.51)</td>
</tr>
<tr>
<td>In the last 12 months:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Had wheezing or whistling in the chest</td>
<td>323</td>
<td>24.5</td>
<td>31.7</td>
<td>20.4</td>
<td>1.81 (1.40, 2.33)</td>
</tr>
<tr>
<td>Sleep disturbed due to wheezing</td>
<td>199</td>
<td>61.6</td>
<td>22.0</td>
<td>13.1</td>
<td>1.87 (1.39, 2.51)</td>
</tr>
<tr>
<td>Wheezing severe enough to limit your child’s speech to only one or two words at time between breaths</td>
<td>81</td>
<td>25.1</td>
<td>8.0</td>
<td>5.4</td>
<td>1.52 (0.97, 2.37)</td>
</tr>
<tr>
<td>Chest sounded wheezy during or after exercise</td>
<td>204</td>
<td>15.5</td>
<td>19.7</td>
<td>13.1</td>
<td>1.62 (1.20, 2.19)</td>
</tr>
<tr>
<td>Dry cough at night, apart from cough with a cold or chest infection</td>
<td>278</td>
<td>33.1</td>
<td>38.9</td>
<td>29.9</td>
<td>1.49 (1.18, 1.89)</td>
</tr>
<tr>
<td>Current asthma</td>
<td>298</td>
<td>22.5</td>
<td>35.3</td>
<td>21.5</td>
<td>1.99 (1.52, 2.61)</td>
</tr>
<tr>
<td>Current asthma only:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep disturbance at least weekly in last 12 months</td>
<td>85</td>
<td>28.5</td>
<td>28.1</td>
<td>28.9</td>
<td>0.96 (0.58, 1.59)</td>
</tr>
<tr>
<td>Speech limited by asthma in last 12 months</td>
<td>76</td>
<td>25.5</td>
<td>25.9</td>
<td>25.2</td>
<td>1.04 (0.62, 1.75)</td>
</tr>
<tr>
<td>Stopped participating in sports activities during the last month</td>
<td>113</td>
<td>37.9</td>
<td>38.8</td>
<td>37.1</td>
<td>1.08 (0.67, 1.72)</td>
</tr>
<tr>
<td>Absent from school at least once due to asthma in last month</td>
<td>166</td>
<td>55.9</td>
<td>61.9</td>
<td>50.3</td>
<td>1.60 (1.01, 2.54)</td>
</tr>
<tr>
<td>Visited emergency room at least once in last 12 months</td>
<td>207</td>
<td>69.5</td>
<td>68.3</td>
<td>70.4</td>
<td>0.91 (0.55, 1.48)</td>
</tr>
<tr>
<td>Hospitalized overnight for asthma at least once in last 12 months</td>
<td>65</td>
<td>21.8</td>
<td>21.6</td>
<td>22.0</td>
<td>0.98 (0.56, 1.69)</td>
</tr>
<tr>
<td>Visited a doctor for asthma in the last 12 months</td>
<td>280</td>
<td>94.0</td>
<td>94.2</td>
<td>93.7</td>
<td>1.10 (0.42, 2.87)</td>
</tr>
<tr>
<td>Takes asthma medications</td>
<td>256</td>
<td>85.9</td>
<td>89.9</td>
<td>82.4</td>
<td>1.91 (0.96, 3.79)</td>
</tr>
<tr>
<td>Has an asthma management plan</td>
<td>253</td>
<td>84.9</td>
<td>86.3</td>
<td>83.6</td>
<td>1.24 (0.65, 2.34)</td>
</tr>
<tr>
<td>Has an incomplete asthma management plan</td>
<td>150</td>
<td>50.3</td>
<td>48.9</td>
<td>51.6</td>
<td>0.90 (0.57, 1.42)</td>
</tr>
</tbody>
</table>

Figure 1. Asthma symptoms by Puerto Rican ethnicity. Chi square = 30.1, p < .000.
asthma. In the previous month, more than half (56%) had been absent from school because of asthma (mean 5.3 days).

There were significant differences in asthma outcomes by ethnicity. Compared with the other ethnic groups, Puerto Rican children did not have more severe asthma symptoms (weekly sleep disturbance or speech limitation during an asthma exacerbation), but they were more likely to report higher frequency of asthma exacerbations and absences from school in the past month. Despite their higher rate of asthma symptom experience, there were no significant differences in the associations for Puerto Rican vs. other children in asthma-related health service utilization. Indeed, Puerto Rican children reported fewer emergency department visits than other ethnic groups (3.8 vs. 6.4 visits) (see Table 1). Need for hospital care was correlated with activity limitation. Children with a hospital admission for asthma were more than twice as likely to have asthma-related disturbances to their daily routine than were other children.

**Asthma Management**

More than three-fourths of the children with current asthma (78%) had been to the doctor about their asthma in the past 6 months. Most of the children with current asthma (86%) reported taking asthma medications. There were no significant differences by ethnicity in the proportions with a written asthma management plan, which was used by 85% of the children with current asthma. Specific plan elements, however, were often missing. Fewer than half reported having a plan for when to call the doctor (44%) or when to go to the emergency department (46%). Only 64% reported a plan for medicines to take in case of an exacerbation. Half the children’s asthma action plans lacked at least one of these three elements. There were no other significant ethnic differences in asthma management by ethnicity.

**Sociodemographic and Indoor Environmental Risk Factors**

Compared with Hispanics and other groups, Puerto Ricans were at greater relative risk of having current asthma (OR = 1.3, 95% CI 1.1–1.8). Males were significantly more likely to have asthma, compared with females (OR = 1.5, 95% CI 1.1–1.9). Socioeconomic status was not associated with an increased risk of asthma.

Some indoor environmental exposures were associated with asthma. Children living in homes where cockroaches (OR = 1.3, 95% CI 1.0–1.7) or rodents (OR = 1.6, 95% CI 1.2–2.2) had been seen in the past month were more likely than other children to have asthma. In addition, children living in houses with forced air heat or radiators, both of which may increase the level of dust in the home (either by blowing dust particles into the room or serving as a site where dust accumulates), were more likely to have current asthma (OR = 1.4, 95% CI 1.0–1.9). The children who have any pets with fur, air conditioning, wall-to-wall carpeting, or live with a cigarette smoker were not more likely than other children to have asthma.

**Risk Factors for Puerto Rican Children vs. Other Ethnic Groups**

Compared to other children with asthma in the survey, Puerto Rican children with asthma came from slightly (but not significantly) more disadvantaged families. More than two-thirds (38%) of their parents had not completed high school education, compared with (23%) of the other parents, and 36% of their families had incomes of $10,000 or below, compared with 24% of the other families.

Puerto Rican children reported asthma-related use of medical facilities similar to those of the other ethnic groups. There was no difference between Puerto Rican and other children in asthma medical visits, with 96% making a visit in the past 12 months. Similar proportions had been to the emergency department (68% vs. 71%) and hospitalized for asthma (22% vs. 22%) in the last 12 months. However, Puerto Rican children were 1.6 times more likely to have had an asthma-related absence from school in the past month.

There were differences in the patterns of association between asthma and risk factors for asthma. The OR reported in the last column of Table 2 indicate whether there were significant differences in the risk factors for asthma when Puerto Rican children with asthma are contrasted with the other ethnic groups with asthma. Puerto Rican children with asthma were 1.9 times more likely to live in homes where cockroaches had been seen than other children with asthma, whereas they were 0.4 times less likely to live in homes with wall-to-wall carpeting than other children with asthma. Puerto Rican children with asthma were slightly more likely to live in homes
where mice or rats had been seen, but this difference was not statistically significant.

**Multivariate Analysis of Risk Factors for Asthma by Ethnicity**

Logistic regression analyses were used to test for these associations by ethnicity, while simultaneously controlling for the other risk factors. After controlling for the other risk factors, three remained statistically significant: male gender (OR = 1.5), being Puerto Rican (OR = 1.9), and presence of rodents in the home (OR = 1.5). The contrasting results shown in the second and third columns of Table 3 highlight the different risk factor associations for Puerto Ricans vs. other groups in East Harlem. Whereas male gender is a significant asthma predictor for all other ethnic groups (OR = 1.5), it is not for Puerto Ricans. Presence in the home of mice or rats is a significant predictor for Puerto Ricans (OR = 1.7), but not for other ethnic groups. In contrast, asthma among Puerto Rican children is not associated with living in a home with heaters, associated with higher dust levels, whereas it is for other children in the sample (OR = 1.6). After controlling for all the other risk factors, presence of cockroaches are not associated with asthma for either Puerto Ricans or the other ethnic groups.

**DISCUSSION**

We found a lifetime asthma prevalence of 32% and a current asthma prevalence of 23% among elementary school students participating in this East Harlem study. This current asthma prevalence is four times the national average of 5.6% for this age group (1), and still higher than the prevalence reported for selected inner city populations (42–46). The highest prevalence, 35%, was found among Puerto Rican children. These findings are consistent with other findings showing an exceptionally high rate of asthma among Puerto Rican children, whether they reside in the US mainland or in Puerto Rico (11,12,47). However, the rate observed in East Harlem was three times higher than the 11% prevalence found for Puerto Ricans in a 1982–1984 national survey of children 6 months to 11 years of age (9), and almost four times higher than the prevalence of 9% observed for children 0–17 years old in the Bronx, which also has a large Puerto Rican population (10).

Several limitations of our study might have influenced our asthma prevalence estimate. The prevalence might have been underestimated if parents were unaware of daytime symptoms experienced at school. Some of the children with an asthma diagnosis but no current symptoms may fall into this category, but it is more likely that many had asthma.
symptoms at a much earlier age and are no longer symptomatic. Additionally, we found a small proportion (5%) of children who had symptoms but were never diagnosed with asthma. These children could represent new cases that have not yet been diagnosed. Finally, the survey was conducted during the spring, when asthma symptoms may be less frequent than during the autumn and winter months (48,49). It is also possible that the prevalence rate could be overestimated if parents not responding to the survey were more likely to have children without asthma. If we assume that all nonrespondents’ children did not have asthma and include them in the denominator, the prevalence rate would have been 19.5%, still more than two times higher than the level found in other studies of asthma among children.

Our study shows that Puerto Rican children are more likely to have asthma, after controlling for socioeconomic status, neighborhood, and indoor living environment. This persistent Puerto Rican asthma correlation could reflect the presence of a gene associated with heightened inflammatory responses, as suggested by earlier studies (11). The higher prevalence could be due to localized residential locations in areas with higher air pollution levels. Although we did not assess outdoor air quality, other studies suggest that part of the basis for high asthma prevalence among minorities living in inner city neighborhoods is exposure to high levels of atmospheric pollutants and particulate matter, which triggers the inflammatory response (46,50). The higher prevalence among Puerto Ricans also may be associated with the greater likelihood of being born either prematurely or with a low birth-weight, both of which are associated with delays in lung development and a higher risk of asthma (23). Although not assessed in this sample, in New York City, Puerto Rican mothers are disproportionately more likely to have low birthweight babies (51).

Of interest is our finding that gender selectivity does not operate for Puerto Ricans. This finding is consistent with another New York City study reporting no difference in asthma prevalence among Puerto Rican children younger than age 13, although a marked differential was found for other Hispanic groups (12). A study conducted in a predominantly Puerto Rican neighborhood of Buffalo also found males to be underrepresented among asthmatics, compared with nonasthmatics (52). These findings of the ethnic differentials in gender selectivity reinforce the need for asthma diagnosis and management to be particularly sensitive to likely gender differentials (or the lack of them) among children.

Although there is often a relation between poverty and asthma (10,53–55), we found no significant association between socioeconomic status and asthma for all children or for Puerto Rican children alone. This could be associated with the homogeneity of our sample, with half the families earning $10,000 or less. More Puerto Rican families had very low income, but this was not associated with their children’s asthma.

Perhaps the most surprising finding of our study was the absence of an association between current asthma and presence of cockroaches in the homes of the Puerto Rican children, which contrasted with the strong association found for the entire study group. The lack of association is not due to under-reporting of cockroaches by Puerto Rican parents, because Puerto Rican parents actually were more likely than other parents to report cockroaches (64% vs. 52%, OR = 1.6, 95% CI = 1.3–2.1). These differences could be real or perceived. Puerto Ricans might be concentrated in city blocks that differ significantly from others in cockroach

### Table 3. Adjusted odds ratios for risk factors associated with asthma by ethnicity.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Puerto Rican</th>
<th>Other ethnic groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male gender (reference female)</td>
<td>1.47 (1.12, 1.93)</td>
<td>1.38 (0.90, 2.10)</td>
<td>1.54 (1.08, 2.21)</td>
</tr>
<tr>
<td>Puerto Rican (reference other ethnic groups)</td>
<td>1.88 (1.42, 2.48)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mice or rats seen (reference not seen)</td>
<td>1.53 (1.14, 2.05)</td>
<td>1.65 (1.06, 2.58)</td>
<td>1.46 (0.98, 2.16)</td>
</tr>
<tr>
<td>Cockroaches seen (reference not seen)</td>
<td>1.11 (0.83, 1.49)</td>
<td>1.29 (0.81, 2.04)</td>
<td>1.02 (0.71, 1.49)</td>
</tr>
<tr>
<td>Dust emitting heating system (reference other heating)</td>
<td>1.34 (0.96, 1.86)</td>
<td>1.00 (0.59, 1.71)</td>
<td>1.56 (1.02, 2.39)</td>
</tr>
</tbody>
</table>
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population density, as in a Boston study showing the highest cockroach allergen levels among the lowest income areas of Boston (56). Or, there may be cultural differences in Puerto Rican reporting of cockroaches, leading them to believe there are cockroaches in the home when there are not. Note we did not actually measure cockroach allergens in the home; actual cockroach allergens may not match parental reports, as one recent study showed (57). In addition, it is possible that Puerto Rican children may be differentially sensitive to the cockroach allergen. Some studies have found much stronger evidence for an association between dust mite allergens and asthma than between cockroach and asthma (58–60), but there is no such evidence specifically for Puerto Ricans in contrast to other Hispanic groups.

We found a strong association between asthma and presence in the home of rats or mice for the entire study group and for Puerto Ricans, consistent with hypotheses that inner city exposure to rodents such as rats or mice may be associated with asthma (18,26). The NICAS study (61) documented the levels of exposure to rodents, but failed to find any significant association with asthma. Caution is needed in interpreting our finding, because the exposure is only measured indirectly, namely by parent report of having seen a rat or a mouse in the past month. As with the cockroaches, parental reports may not be valid or correlated with actual levels of rat or mouse urine or feces in the home. Assuming that the exposure measures are valid, our findings suggest that exposure and sensitization to rodents merits further consideration in our attempt to understand the high rates of asthma among certain ethnic groups and communities. This association between current asthma and exposures to rats or mice also underscores the need to find ways to eradicate or reduce rodent populations in homes in East Harlem.

Most studies documenting an association between dust mites and asthma have focused on the role of floor coverings, upholstery, and bedding (7,17,54,62–64). We did not measure the level of dust mites in the homes, but our study found no association between floor coverings and asthma. However, we did consider another dust source, namely the type of heating. Although several studies have examined the role of forced hot air systems in relation to asthma (65–67), most have failed to find a direct association between asthma and forced air heating. In this study, we considered both forced air heating and radiators to be dust-producing, with forced air heating actively blowing in the dust and radiators serving as passive sources, repositories for dust, which may be circulated into the room when the heat is on. Viewed from this perspective, both heating systems could increase circulation of ultra-fine particles, which are associated with decreased peak expiratory flow (57). In our study, both types of heating were associated with asthma, specifically among African-American and non–Puerto Rican children, but not for Puerto Rican children. Puerto Rican children may not be as affected by heater-related dust circulation if their asthma is less likely to be linked to dust mite sensitization, as has been found by other studies of low-income Puerto Rican and other Hispanic populations (56,58–60). Our findings regarding the impact of different heating systems suggest the need to further develop interventions to reduce dust exposures related to heating systems, particularly for groups sensitized to dust mites.

In this study, there was no significant association between exposure to tobacco smoke and asthma for Puerto Ricans or the other ethnic groups. This finding contrasts with the strong evidence linking childhood asthma to maternal smoking, especially for children exposed in utero (9,40,68). In general, Puerto Rican women have higher smoking rates than women of other ethnic groups (11), and this is usually hypothesized as a factor contributing to the high asthma rate among Puerto Rican children. However, in our study Puerto Rican parents of children with asthma had a lower smoking rate. We did not ask whether the parents had ever smoked, and it is possible that the parents had smoked previously. If so, this previous smoking behavior would be a confounder in observing the relation between current smoking and asthma among these families. Alternatively, Puerto Rican parents may be differentially less likely to identify themselves as smokers. Both possibilities should be investigated in future research.

Finally, there was no association between the presence of cats, dogs, or other pets with fur and asthma, among Puerto Ricans or any other group. The lack of this association is most likely related to the low prevalence of pets in this study population (only 2.4%). None of the Puerto Rican children with asthma had pets, and fewer than 25% of the other children with asthma had a pet with fur. These findings parallel another study of asthma in inner city, minority populations where there was only a weak association between exposure to pets and asthma (62).
Despite the differences in risk factors and asthma prevalence, Puerto Rican children did not differ from other children in their use of health care facilities for asthma. Despite the higher prevalence of symptoms, Puerto Rican children were no more likely to make asthma-related visits to the doctor, emergency department, or hospital. Puerto Rican children were slightly more likely to have plans lacking a key component, including what medications to use in case of an asthma attack, when to call the doctor or when to go to the emergency department. Compared with other children, however, Puerto Rican were more likely to have their school and normal activities disrupted by asthma. Puerto Rican children with asthma missed 6.0 days from school, 1.25 more than other children, indicating either greater difficulty in managing asthma or greater propensity to stay home when ill.

This study clarifies some of the unknowns regarding the high rates of asthma among Puerto Rican children, namely that they are linked to indoor environmental exposures to which Puerto Rican children appear to be uniquely responsive. Asthma among Puerto Rican children was shown to be associated with exposure to mice or rats, whereas for African-American and other Hispanic children dust associated with heating systems is a risk factor. After controlling for these risk factors neither exposure to smoke nor cockroaches is significantly associated with current asthma for any group. Future research should better distinguish the particular ways in which each ethnic group develops asthma and responds to asthma threats in the environment. Meanwhile, concerted efforts are needed, involving schools, parents, community groups, and providers serving the community in cooperative and complementary activities to improve the control of asthma among children already affected. Given the high prevalence of asthma and impact on school attendance, even a modest improvement in asthma management could yield substantial benefits for a large segment of the school population in this community.

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