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Modifiable Risk Factors for Asthma Morbidity in Bronx Versus Other Inner-City Children

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Abstract

Background—Bronx children have higher asthma prevalence and asthma morbidity than other US children.

Objective—To compare risk factors for asthma morbidity present in Bronx children with those of children from other US inner-city areas.

Methods—Cross-sectional, multi-state study of 1772 children ages 5–11 yrs. old with persistent asthma. Parental responses to the Child Asthma Risk Assessment Tool for 265 Bronx children are compared with those of 1507 children from 7 other sites (1 Northeast, 2 South, 2 Midwest, 2 West).

Results—Bronx children were significantly more likely to be sensitized to reported aeroallergens in their homes than were children from the other sites (86% vs. 58%; $p < .001$). More Bronx parents reported household cockroaches (65% v 20%; $p < .001$), mice (42% v 11%; $p < .001$), and rats (7% v 3%; $p < .001$); using a gas stove to heat the home (20% v 9%; $p < .001$); and visible mold (48% v 25%; $p < .001$). Bronx parents were more likely to report pessimistic beliefs about controlling asthma (63% v 26%; $p < .001$) and high parental stress (48% v 37%; $p < .01$).

Conclusions—Compared with other inner-city children with asthma, Bronx children are more likely to be exposed to household aeroallergens to which they are sensitized and have poor housing conditions. Their parents are more likely to report low expectations for asthma control and high levels of psychological stress. Interventions that address these identified needs may help to reduce the disproportionate burden of asthma morbidity experienced by Bronx children.

Keywords

inner-city asthma; risk factors; housing conditions; pediatric asthma morbidity

INTRODUCTION

In the Bronx, New York, one of the poorest counties in the US, asthma is the leading cause of hospitalization and of school absence for children. Pediatric asthma prevalence rates in Bronx children far exceed national pediatric asthma rates. In a school-based sample, 15.5% of 4–5-year-old Bronx children were identified as having asthma compared with 9.2% of New York City students overall (1) and 8.9% of US children 2 to 17 years of age (2). Asthma morbidity

rates are also much higher for Bronx children than for other US children. Bronx children are twice as likely to be hospitalized for asthma and are more likely to die of asthma than other US children (1). Although higher morbidity may be due in part to higher asthma prevalence, it may also result from higher levels of modifiable risk factors among children with asthma.

Reasons for the high rates of asthma morbidity experienced by Bronx children are not fully understood. Poverty and minority status, both prevalent in the Bronx, have both been independently linked to asthma morbidity (3,4). In 2004, according to US Census, 28.2% of Bronx residents were living below the poverty level and the majority of the Bronx's 1.3 million residents were minorities: 43% African American and 51% Latino, predominantly of Puerto Rican ethnicity (5). In the US, asthma morbidity is highest among non-Hispanic Blacks and Puerto Ricans (6).

Asthma is a chronic inflammatory lung disorder that requires long-term management (7). Modifiable risk factors that contribute to asthma morbidity include environmental exposures to aeroallergens and airway irritants, delays in medical treatment, and inadequate adoption of preventive strategies. Investigators from The National Cooperative Inner-City Asthma Study (NCICAS) developed the Asthma Risk Assessment Tool (ARAT) (8), a comprehensive assessment designed to identify modifiable risk factors for asthma morbidity in inner-city children. Each family participating in the NCICAS intervention completed this intake survey. Based on the survey results, a trained asthma counselor provided a tailored, individualized intervention to the parent and child. In a randomized, controlled clinical trial the NCICAS intervention was shown to significantly reduce asthma symptom days in children with poorly controlled asthma (9).

In 2001, the Centers for Disease Control (CDC) funded 23 sites nation-wide to replicate the NCICAS intervention in low-income inner-city children. In this replication project, the asthma counselors administered an abbreviated intake form, The Child Asthma Risk Assessment Tool (CARAT) (10), to identify risks for asthma morbidity and then tailored their interventions to meet the specific needs of parental caretakers and their children. We examined the intake questionnaires for 9 of the 23 participating sites, representing four different US regions.

In this study, we compared modifiable risk factors for asthma morbidity reported by Bronx participants with those reported by parents of children from seven other inner-city sites. We hypothesized that the needs of Bronx families with a child with poorly controlled asthma would differ from those of other inner-city families. Furthermore, by identifying these risk factors, we may be able to better understand the factors that contribute to the high rates of asthma morbidity in Bronx children and develop a population-based approach to reduce morbidity.

METHODS

Design

This is a cross-sectional study of 1,772 inner-city children, 5 to 11 years of age, with persistent asthma who enrolled in the CDC – sponsored multi-site Inner City Asthma Intervention implementation project between April 2001 to March 2004. Nine of the 22 sites (representing 42% of all children enrolled in the implementation project) supplied data for this study. De-identified data were entered at individual sites or at Montefiore Medical Center (MMC), which served as the data processing and analysis site. Results from 2 Bronx sites (MMC and Bronx Lebanon Hospital) are compared with those of 7 other inner-city sites: (Bay State Medical Center [Springfield, MA]; El Rio Health Center [Tucson, AZ]; Rainbow Babies & Children's Hospital [Cleveland, OH]; St. Joseph's Hospital & Medical Center [Phoenix, AZ]; University of Texas Health Science Center–San Antonio [San Antonio, TX]; WakeMed [Raleigh, NC]; and Washington U. [St. Louis]. As stipulated in the program requirements, all sites were located

in urban areas and served low-income populations. This protocol was reviewed by the Institutional Review Boards of the University of Texas Health Science Center-San Antonio and by Montefiore Medical Center and determined “exempt.”

Data Sources

A data set was created by compiling the baseline intake interviews of children participating in the NCICAS replication project. The 36-item intake interview, the Child Asthma Risk Assessment Tool (CARAT) (10), was created by the original NCICAS researchers based on the comprehensive Asthma Risk Assessment Tool (ARAT) used in the NCICAS clinical trial. Each site’s program manager reported the percent of enrollees who either received government-subsidized insurance or were uninsured, a proxy for low-income status.

The implementation project was designed as a community-based replication of the NCICAS Intervention. Trained asthma counselors administered the CARAT in English or Spanish based on the interviewee’s preference. Additional data were collected by chart review or records kept by the asthma counselor regarding timing and results of allergy testing. The asthma counselor requested allergy testing results from the child’s physician and recorded the results and type of testing (prick skin testing or in-vitro) when available. In keeping with the original NCICAS study, the six allergens assessed were limited to cockroach, dust mite, cat, dog, rat, and mold. Because the implementation project was not a research study, not all participants completed allergy testing and participant-specific data on race, ethnicity, and socioeconomic status are not available.

CARAT Domains of Risk

Scoring—Nine domains of risk were assessed by the CARAT. The original purpose of the measure was to identify individualized domains of risk for each family so the asthma counselor could tailor her intervention. The individual items contributing to each domain received a weighted score, which was determined by the CARAT authors based on expert opinion and empirical data. Individual item scores were summed into a domain score. The number of items and weighted scores of the included items differed by domain, thus the potential maximum score also varied by domain. Based on CARAT scoring procedures, domains scores greater than or equal to 7 points were considered to indicate “high risk.”

The components for each of the 9 domains are outlined below.

1. **Child sensitized to aeroallergens present in the home (6 items; maximum points 60):** Positive tests for allergy to dust mite or cockroach antigen and/or testing indicates rat, cat, dog, or mold sensitivity and the respective potential allergen is present in the home.
2. **Environmental exposures (7 items; maximum points 18):** Humidifier or vaporizer in child’s bedroom; carpeting in bedroom or family room; gas stove used to help heat the home; moisture or mildew on the ceiling, walls, or windows; or pests (cockroaches, mice, or rats).
3. **Pessimistic asthma attitudes (5 items; maximum points 20):** Caretaker feels asthma control cannot be achieved so that child can play like other children; child cannot be symptom free; medications will cause problems; caretaker has little control over her child’s asthma and/or feels helpless in dealing with her child’s asthma.
4. **Psychological well-being of caretaker (parental stress) (2 items; maximum points 20):** The caretaker is concerned about how well she has been coping “pretty much” or “all of the time.” She is feeling unusually stressed lately “pretty much” or “all of the time.”

5. **Medication adherence (3 items; maximum points 22):** Not having medications on hand for acute exacerbations; problems ensuring that child takes medication and/or that he receives medicines on schedule.
6. **Environmental tobacco smoke (3 items; maximum points 23):** Parental caretaker, child, household residents, or other child caretaker smokes
7. **Psychological well-being of child (concerns about child behavior) (1 item; maximum points 10):** Caretaker reports that she is concerned about her child's behavior or emotions "pretty much" or "all of the time."
8. **Adult and child asthma responsibility (1 item; maximum points 10):** Caretaker reports that child takes asthma medication on his/her own most or all of the time.
9. **Sub-optimal medical care (6 items; maximum points 18):** Child usually receives asthma care in an emergency room; no regular doctor; medication for acute symptoms only; no written plan; problems taking medications at school; and problems making and/or keeping doctor's appointments.

Data Analysis

Analyses were conducted using SPSS versions 13 and 15. For categorical variables, such as high or low risk for each domain, Chi-square analysis was conducted to examine differences between Bronx children and children from the other inner-city sites. We applied Bonferroni corrections for family-wise errors. We calculated a criterion p value of 0.00263 by dividing alpha (0.05) by the number of comparisons (19). For each domain of risk, we also calculated odds ratios and 95% confidence intervals to examine differences in the likelihood of high risk for Bronx children compared with children from the other sites.

RESULTS

Participants

Questionnaire responses were obtained for 1,772 children (265 Bronx children and 1,507 other). Results from two Bronx sites were compared with that of 7 other sites. The regional distribution of the 7 other sites was Northeast (1); South (2); Midwest (2); and West (2). All sites reported that the majority of children enrolled at their site received publicly funded health insurance (Medicaid or State Children's Health Insurance Program) or did not have health insurance (mean 84%, range 52–96%). For the Bronx sites, 88% to 96% of children met this criterion. For the other sites, the range was from 52% to 95% with five of the seven sites having more than 80% of children enrolled in government-subsidized insurance or uninsured.

All children were between 5 to 11 years of age (median age = 7). Of the 1,339 children for whom gender was recorded, 39.5% were girls and 60.4% were boys. Questionnaires were completed in English for 76.2%, Spanish 15%, other less than 1%; and the interview language was not recorded for 8.7%.

Bronx Domains of Risk Compared with Other Sites

Table 1 compares the presence of risk factors for asthma morbidity in Bronx versus other sites' participants. More Bronx participants reported high risk for asthma morbidity related to their child being sensitized and exposed to aeroallergens in their home; household exposure to cockroaches, rodents, and mold; parent's pessimistic asthma attitudes; and parent's psychological stress. The item responses within these four domains are highlighted below.

Child Sensitized to Aeroallergens Present in the Home

Allergy testing was completed for 40.4% of the children. Equal proportions of Bronx and other children completed testing. Of the 716 allergy tested children, most (65%) had at least 1 positive test. Specific sensitizations were compared with home exposures based on a self-reported household inventory. The Bronx children were significantly more likely to be both sensitized and exposed to allergens present in their homes than children from the other sites (86% vs. 58%; $p < 0.001$).

For Bronx children, the reported method of allergy testing was prick skin test (42.3%), radio allergosorbent test (RAST) (1.9%), or not specified (55.8%). Allergy test results suggested the following sensitizations: dust mite (39.2%), cat (26.3%), mold (21.5%), cockroach (25.4%), rodent (22.5%), and dog (18.7%).

Home Environmental Exposures

The home environmental exposures reported by Bronx respondents differed significantly from those reported by respondents from the other sites (Table 1). Bronx parents were more likely to report household cockroaches (65% vs. 20%; $p < 0.001$), mice (42% vs. 11%; $p < 0.001$), and rats (7% vs. 3%; $p < 0.001$); using a gas stove to heat the home, a source of the airway irritant nitrogen dioxide (20% vs. 9%; $p < 0.001$); and the presence of visible mold on walls, ceilings, or windows in their homes (48% vs. 25%; $p < 0.001$). Fewer Bronx parents reported risk for dust mite exposures related to having rugs in the child's bedroom (14% vs. 64%; $p < 0.001$) or in the living room (17% vs. 67%; $p < 0.001$). The low rate of rug use reported by the Bronx respondents led the Bronx sites to be less likely to exceed the environmental domain threshold for high risk than the other sites (39% vs. 50%, $p < 0.001$). However, as shown, the Bronx sites were more likely to report household exposure to cockroaches, mice, mold, and nitrogen dioxide.

Pessimistic Asthma Attitudes

Bronx parents were more likely than other inner-city parents to report pessimistic beliefs about the potential to safely control their child's asthma (63% vs. 26%; $p < 0.001$). Items that contributed to high pessimistic asthma belief scores in Bronx families included that families felt that they had little control over their child's asthma (45.1%) and felt helpless in dealing with asthma (41.7%). In addition, they thought that the asthma medications could harm their child (40.5%); their child could not be free of symptoms (38.5%); and it was not possible to control their child's asthma so he or she could play like other children (25.2%).

High Parental Stress

Bronx parents were more likely to report high levels of psychological stress than parents from the other sites (48% vs. 37%; $p < 0.01$). Bronx families' responses for the items comprising this domain included the caretakers reporting having been concerned regarding their coping "quite a bit" (20.8%) or "all of the time" (5.7%) and feeling unusually stressed "quite a bit" (28.3%) or "all of the time" (9.4%).

Domains for which the Bronx did not Differ

The Bronx sites did not differ from the other sites in the percent of respondents who scored high risk for asthma morbidity owing to: medication non-adherence (35% vs. 39%); exposure to household environmental tobacco smoke (28% vs. 24%); parental concerns regarding their child's behavior (26% vs. 22%); assignment of the responsibility for medication administration to the child (21%); or sub-optimal medical care (23% vs. 20%).

Variability Across Sites

As shown in Table 1, there was some modest variability in domain scores across the non-Bronx sites. However, in the instances where we found Bronx versus non-Bronx differences, there tended to be few if any non-Bronx sites with percentages of families at high risk that were in the same range as found for the Bronx. For example, none of the other sites had as high rates as the Bronx in the domain of pessimistic attitudes or in their reported household exposures to cockroaches, mold, or mice. Only one site reported rates of gas stove use for heating as high as in the Bronx (20%) and only one site reported higher exposure to sensitized aeroallergens (95%).

Three sites (2 Bronx sites and 1 other site) were in the North East Region. These North East (NE) participants reported poorer housing conditions than participants from the other regions. More NE participants than participants from other regions reported the presence of visible household mold, either on the walls, ceilings, or windows (44% vs 24%), mice (33% vs 10%), rats (7% vs 3%), cockroaches (54% vs 18%), and use of a gas stove to heat their home (14% vs 10%); all $p < 0.05$. The Bronx site participants were significantly more likely than the other NE site participants to report household cockroaches (65% vs 36%), mice (42% vs 18%), and using the gas stove to heat the home (20% vs. 4%); all $p < 0.01$. There were no significant differences between the Bronx sites and the other NE site in reports of rats (7% vs 8%) or visible mold (48% vs 39%).

DISCUSSION

This study reveals that the risk factors for asthma morbidity present in Bronx children participating in the Inner-City Asthma Intervention differed in several respects from those of the other inner-city children. In particular, the Bronx children were more likely to be exposed to aeroallergens in their homes to which they were sensitized, to reside in poor housing conditions, to have low parental expectations for asthma control, and parents who reported high psychological stress.

Rates of allergen sensitization with exposure were higher for Bronx children than for the other inner-city children (86% vs. 58%; $p < 0.001$). In the NCICAS, high rates of allergen sensitization were also found: 77% of the children were sensitized to at least one aeroallergen and more than half were sensitized to three or more allergens (11). In the Inner-City Asthma Study (ICAS), which only included children with moderate to severe asthma, almost all of the screened children (94%) were sensitized to at least one indoor allergen (12). In that study, the prevalence of cockroach sensitization and exposure was highest in Bronx children with 81% sensitized to cockroaches and 54% exposed (13). As cockroaches have a greater effect on asthma morbidity than dust mites or pet allergens in sensitized children (13), efforts are needed to address cockroach allergy in Bronx children.

The Bronx participants reported poorer housing conditions than the other participants. These included the presence of cockroaches, mice, rats, visible mold, and use of the gas stove to heat the home, a source of the airway irritant nitrogen dioxide. Exposure to these aeroallergens and airway irritants contributes to asthma morbidity (7,14,15). Hospitalization rates for asthma are three times higher for sensitized children with high versus low levels of cockroach allergens in their homes (16). Asthma symptoms are more common in children with household exposures to mice allergen (17), mold (18), and nitrogen dioxide (19). In our study, Bronx families were seven times more likely to report household cockroaches, six times more likely to have mice, twice as likely to report rats, seven times more likely to use gas stoves to heat the home, a source of the airway irritant nitrogen dioxide, and three times more likely to report visible mold. For Bronx families, addressing these environmental exposures may be an essential step to improving asthma outcomes.

Home-based environmental interventions that teach families how to reduce household environmental exposures significantly reduce asthma morbidity (20,21). In the landmark ICAS, atopic children exposed to aeroallergens in their homes had significant reductions in asthma morbidity after a home-based environmental intervention that provided education on allergen remediation, pest extermination, HEPA vacuums, air purifiers, and dust mite encasings (21). The ICAS participants had 34 fewer days with wheezing compared with controls over the 2-year follow-up period. ICAS has been specifically highlighted by the 2007 Healthy Homes Expert Panel Peer Review of Interventions to have sufficient evidence to recommend immediate implementation. Most of the Bronx children in our study (86%) were exposed to aeroallergens in their home to which they are sensitized. Efforts are needed to translate evidence-based allergen remediation strategies into practice for atopic children with persistent asthma.

Bronx respondents were almost five times as likely as other inner-city parents to report having pessimistic asthma attitudes regarding the potential for safe and effective asthma control. These low expectations for asthma control may contribute to asthma morbidity. Other studies show that children whose parents have low expectations for asthma control have more symptoms and are less likely to be taking medications (22). Raising parents' expectations may be essential to improve asthma outcomes and reduce asthma-related health care disparities.

Almost half of the Bronx parents reported high levels of psychological stress. Parental stress may increase children's susceptibility to asthma (23) and the frequency of asthma exacerbations (24). Psychological stress may also impede parental caretakers ability to prioritize preventive asthma care. Maternal depression is strongly associated with pediatric asthma morbidity (25). As children's well-being is strongly related to having a stable adult caretaker, efforts are needed to expand support for parents. In NCICAS, the asthma counselors were social workers who could offer social support to families and refer parents for mental health services. Social support and mental health services need to be available for families of children with poorly controlled asthma.

Participants from both Bronx and non-Bronx sites reported difficulties with medication adherence (35% vs 39%). Other studies have shown low rates of adherence to inhaled steroids (26). There is convincing evidence that long-term use of inhaled steroids in children is safe and effective (27). Efforts are needed to improve communication with families regarding the importance, effectiveness, and safety of these medications for children with persistent asthma symptoms. Physicians who receive training to improve their asthma communication skills are more likely to prescribe inhaled steroids (28,29). Additional work is needed to improve adherence to long-term control plans.

There were several limitations to this study. First, we relied exclusively on parent report to determine asthma risk status. However, there is little reason to believe respondent bias would explain the variations found by site. Second, the data set was based on clinical information collected as part of a community-based implementation project, not for research purposes. Although the CARAT is a brief, easy-to-use clinical tool, it is not a validated research questionnaire. Similarly, allergy testing was performed according to local clinical practice, not according to a standard protocol. Selection bias may have affected which children were allergy tested, so we cannot generalize our findings to all participants. We do not have data on asthma morbidity, severity, or socio-demographic variables. Despite these limitations, this study provides valuable information about asthma risk based on information obtained as part of a community-based replication of a proven asthma intervention.

CONCLUSIONS

This study suggests that Bronx children are more likely than other inner-city children with asthma to have household exposure to aeroallergens to which they are sensitized, poor housing conditions, and parents with low expectations for asthma control and high levels of psychological stress. These findings suggest reasons for poorer asthma outcomes in Bronx children and identify areas for intervention.

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DECLARATION OF INTEREST

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A comparison of Bronx vs. other sites' results for the 9 domains of risk for asthma morbidity and selected domain items.

TABLE 1

Domains of risk for asthma morbidity (and selected items)	Percentage of Bronx respondents with high risk (range)	Percentage of other sites' respondents with high risk (range)	p value	Odds ratio	95% confidence interval
1. Child sensitized to aero-allergens at home ^a	86 (86–87)	58 (22–95)	<0.001	4.63	2.62–8.18
2. Home environmental exposures	39 (36–41)	50 (30–79)	<0.001	.62	.49–.84
Household cockroaches	65 (60–72)	20 (14–36)	<0.001	7.57	5.70–10.04
Household mice	42 (34–50)	11 (4–18)	<0.001	5.78	4.32–7.75
Household rats	7 (7–7)	3 (0–8)	<0.001	2.32	1.32–4.06
Using gas stove to heat home	20 (20–21)	9 (4–20)	<0.001	7.08	4.83–10.39
Visible mold on walls	35 (34–36)	15 (8–25)	<0.001	3.26	2.38–4.45
Visible mold on walls, ceilings or windows	48 (46–49)	25 (21–39)	<0.001	2.66	2.04–3.48
Rugs in child's bedroom	14 (6–22)	64 (42–76)	<0.001	.09	.06–0.13
Rugs in living room	17 (9–26)	67 (46–86)	<0.001	.11	.08–0.15
3. Pessimistic asthma attitudes	63 (56–71)	26 (11–31)	<0.0026	4.86	3.69–6.40
4. High parental stress	48 (35–58)	37 (16–54)	<0.001	1.5	1.15–1.95
5. Medication non-adherence	35 (35–35)	39 (29–49)	NS	.83	.63–1.09
6. Environmental tobacco smoke	28 (24–31)	24 (15–34)	NS	1.22	.91–1.63
7. Concerns about child's behavior	26 (26–27)	22 (5–38)	NS	1.26	.03–1.69
8. Child responsible for medications	21 (15–27)	21 (4–41)	NS	.97	.70–1.36
9. Sub-optimal medical care	23 (23–24)	20 (7–34)	NS	1.20	.88–1.64

^a Analysis for this domain is limited to the 713 respondents who were tested for allergies.