Multiple Urban and Asthma-Related Risks and Their Association with Asthma Morbidity in Children

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Objective To determine whether a multi-dimensional cumulative risk index (CRI) is a stronger predictor of asthma morbidity in urban, school-aged children with asthma, than poverty or severity alone. **Methods** A total of 163 children with asthma, ages 7–15 years (42% female; 69% ethnic minority) and their primary caregivers completed interview-based questionnaires, focusing on potential cultural, contextual, and asthma-specific risks that can impact asthma morbidity. **Results** Higher levels of cumulative risks were associated with more asthma morbidity, after controlling for poverty level or asthma severity. Analyses by ethnic group and subgroup also supported the relationship between the CRI and specific indices of asthma morbidity. **Conclusions** This study demonstrates the utility of multiple-dimensional risk models for predicting variations in asthma morbidity in urban children. Research efforts with urban families who have children with asthma need to consider the context of urban poverty as it relates to children's cultural backgrounds and specific asthma outcomes.

Key words asthma risks; urban.

Urban children face an increased risk for experiencing asthma morbidity, and asthma burden disproportionately affects urban children who are poor and from ethnic minority backgrounds. Examining factors that influence poor asthma management and morbidity among inner-city children is a growing focus of asthma health disparities research (e.g., Morgan et al., 2004). Inner-city children face conditions (e.g., low-quality housing, exposure to indoor and outdoor allergens) that are more prevalent in poor communities and may challenge families' abilities to control symptoms (Kattan et al., 2005). Such conditions are associated with higher levels of psychological distress and more frequent asthma exacerbations, which can complicate effective management behaviors (Wright et al., 2004). Addressing additional sociocultural and asthma-specific factors that contribute to variations in asthma management behaviors and morbidity among specific groups of children may be a critical step to understanding asthma health disparities.

The current study has two objectives: (a) to describe the utility of multiple-risk models for quantifying factors that urban children face that may have a cumulative impact on asthma morbidity, and (b) to test an example of a multi-dimensional risk index that includes cultural, sociocontextual, and asthma-specific risks associated with asthma morbidity in a sample of school-aged, urban children.

Understanding Asthma Morbidity within a Sociocultural Context

Effective asthma management involves taking asthma medications consistently (as needed and/or daily medications), avoiding environmental triggers, and monitoring the course and frequency of asthma symptoms (National Heart Lung and Blood Institute, 2002). Such efforts can help to maintain normal lung function and normal activity levels including exercise. Ethnic minority children from urban environments are

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less likely to conform to standard, recommended asthma medication guidelines, and more likely to use inadequate preventative care (e.g., emergency department [ED] use) than their white counterparts. An under-use of daily anti-inflammatory medications and a higher frequency of episodic and emergency care has been found among African-American and Hispanic (Puerto Rican) children living in urban environments (Celano, Geller, Phillips, & Ziman, 1998; Diaz et al., 2000; Rand et al., 2000). It is possible that factors that extend beyond illness status, such as social and urban environmental risk factors, may be associated with asthma morbidity in children with this demographic profile.

The intermittent and reversible nature of asthma, coupled with the unique stresses associated with urban residence, are important for pediatric psychologists to consider, as multiple risks may effect the health behaviors among urban poor children and families. In addition, how families/caregivers perceive stress related to urban living (e.g., discrimination, acculturation, violence, poverty) is an important process that has implications on children's psychological well-being and health outcomes (Garcia Coll & Magnuson, 1997). We define a risk factor (e.g., poverty) as statistically evidenced when this status or condition is significantly associated with a higher probability of an undesirable outcome (Masten, Best, & Garmezy, 1990).

Urban Children's Asthma Morbidity: The Multidimensional Cumulative Risk Index

The accumulation of exposure to multiple physical and psychosocial stressors at one point in time or over time, rather than exposure to a single stressor, is a key aspect of the environment of poverty (Evans & English, 2002; Lengua, 2002) and is strongly related to the rising risk for poor outcomes on multiple indicators of development, including psychosocial competence, psychopathology, and health (Evans & English, 2002; Rutter, 2002; Sameroff, Seifer, Baldwin, & Baldwin, 1993). It has been argued that there may be a threshold for families' coping with multiple risk factors beyond which the probability of impaired adjustment climbs rapidly (Barocas, Seifer, & A.J., 1985; Sameroff et al., 1993). Although all risk factors do not have equivalent meaning and may represent varying levels of experience, multiple-risk studies allow numerous risk factors to be considered jointly, and the nature of the association between the number of risks families face and specific outcomes can be examined (Evans & English, 2002).
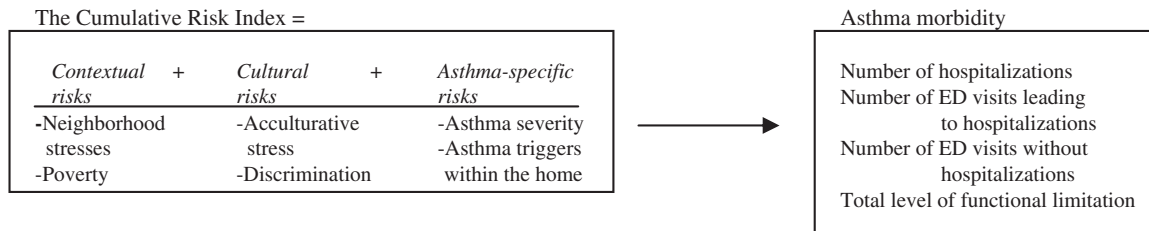
A growing body of asthma literature, including ethnic minority urban children, has begun to consider the range of stressors that urban children face that can impact asthma health outcomes (Miller, 2000). Much of this research, however, tends to conceptualize either asthma status, ethnic group membership, socioeconomic status (SES), or urban residence as a "risk factor". For example, Gillaspy, Hoff, Mullins, Van Pelt, and Chaney (2002) showed that low SES and asthma status are independent risk factors for depression and anxiety levels in children with asthma.

Other pediatric asthma research has examined whether ethnicity/race and/or SES may contribute to poor asthma outcomes. Miller (2000) found that the frequency of emergency room visits was strongly associated with both lifetime income and race/ethnicity, in a population-based sample of 3-year old children. Across the income range, Black children with asthma had 5–7 times a greater rate of ED use for asthma than non-poor, non-Black children. Among Black children, poor children with asthma were 1.76 times more likely to be hospitalized for asthma than their non-poor counterparts. Other findings indicated that disparities in asthma status between Black and Latino children and White children persisted even after adjusting for SES (Lieu et al., 2002). These results suggest that low-income status and race are independently associated with asthma morbidity.

Other studies have focused on urban residence as a risk factor for developing asthma in children. Aligne and colleagues (Aligne, Auinger, Byrd, & Weitzman, 2002) examined the separate effects of race, urban status, and income on asthma prevalence, using a representative sample of 17,000 children (ages 1–17 years). All urban children had a heightened risk of asthma, regardless of race or family income. With respect to asthma risk, Black race was shown to be a confounder for urban residence, rather than an independent risk factor. Their results contradict other reports referred to above, which have found race to be a significant correlate of asthma prevalence after controlling for SES and environmental variables (e.g., Grant, Lyttle, & Weiss, 2000). Taken together, this research has yielded conflicting results, which may be partly due to the fact that asthma risk factors for minority youth have not been examined in depth, such as specific aspects of urban residence.

Since ethnic minority families are disproportionately present in urban environments, and many urban families are living at or below the poverty threshold, it is difficult to tease apart which specific "risk factor" may most strongly predict asthma prevalence or morbidity since

(*Variables examined in the current study*)

The Cumulative Risk Index =			Asthma morbidity

Contextual risks +	*Cultural risks* +	*Asthma-specific risks*	Number of hospitalizations
			Number of ED visits leading
			      to hospitalizations
			Number of ED visits without
			      hospitalizations
			Total level of functional limitation

-Neighborhood
  stresses
-Poverty
	-Acculturative
	  stress
	-Discrimination
		-Asthma severity
		-Asthma triggers
		  within the home	

Figure 1. Multiple-risk model of asthma morbidity in urban children; *variables examined in the current study.*

these factors are interrelated. In addition, racial and ethnic categories may be too broad to be meaningful and may mask important differences within racial and ethnic groups (Aligne et al., 2002). Further, distinctions between ethnicity and race are unclear. For example, categorizing all Mexicans, Puerto Ricans, and Dominicans as ''Hispanic'' is imprecise and does not speak to the potential differences in acculturation experiences, values, beliefs, and practices among these groups (Hunninghake, Weiss, & Celedon, 2005). It has been argued that associating disease with racial or ethnic status, when these are imprecise markers, may lead to spurious biological connections (Hunninghake et al., 2005).

The current study tests a multi-dimensional, cumulative risk index (CRI) with a sample of urban children who have asthma (Fig. 1). The CRI reflects the assumption that asthma health outcomes for urban children are better predicted by combinations of experiences/processes which function as risks, rather than by individual factors alone. The CRI includes three dimensions of risk: a *cultural*, a *socio-contextual*, and an *asthma-specific* dimension. The significance of considering specific risks along these three dimensions with regard to urban children's asthma morbidity has been well-documented (e.g., Wallace et al., 2003).

Cultural Risks and Asthma Morbidity

For this study, families' *discrimination experiences* and *levels of acculturative stress* are the cultural risk variables of focus. Perceived discrimination can interact with aspects of the environment, such as family and community poverty, to threaten optimal health-related behaviors, and negatively impact health outcomes for children (Ren, Amick, & Williams, 1999; Szalacha et al., 2003). Further, the process of acculturation and its relation to health behaviors is likely to vary, depending on language differences; whether an individual migrated to a bicultural, ethnic, or mainstream community; the rate at which families acculturate; conditions surrounding migration; and the country from which each group migrated (Phinney & Landin, 1998). An association between acculturation and poor health care utilization in adults based on ethnic background has been shown (Solis, Marks, Garcia, & Shelton, 1990). Experiences related to discrimination (e.g., within the health care system) and acculturation (adopting the language, norms, and values of the mainstream culture) may affect stress levels and challenge optimal asthma management.

Socio-Contextual Risks and Asthma Morbidity

Poverty and the *level of neighborhood disadvantage* are the sociocontextual risk variables of focus. The rise in morbidity rates among urban poor children has been linked with the repeated exposure of immunologically sensitive individuals to airborne allergens heavily concentrated in urban areas (Eggleston, 1999). Other factors related to inner-city environments, such as neighborhood stressors (e.g., high crime rates, crowding in housing, substandard housing conditions, reduced access to community resources) place children at risk for poor health and development (e.g., Kwong, Das, Proctor, Whyte, & Primhak, 2002). Increased exposure to violence (by parent report) and more asthma daytime symptoms in children have been found, even after controlling for SES (Wright et al., 2004). SES indicators employed in asthma research tend to not consider the number of individuals that reside in the same household and the additional stressors that impact how asthma is managed. Hence we propose to include an income-to-needs ratio and caregiver's perceptions of neighborhood stresses as important contextual risks that may impact morbidity.

Asthma-Specific Risks and Asthma Morbidity

Asthma severity level and a common trigger within the home environment, *environmental tobacco smoke* (ETS), are the asthma-related risk variables of focus. Children with the highest levels of severity remain at the most risk

for experiencing asthma morbidity, and severity increases according to the level of socioeconomic deprivation (Kwong et al., 2002). Associations among more home trigger exposure, more hospitalizations, and asthma severity in urban children have been found (Kwong et al., 2002). Several factors associated with urban living (e.g., environmental triggers) and families' beliefs about controller medications (e.g., Conn et al., 2005) may complicate the measurement of severity. For example, the frequency of daytime and nighttime symptoms, an important criteria for severity level, may be a function of a lack of adherence to daily asthma medications, the higher presence of environmental allergens and irritants in urban areas, or the difficulty in controlling or avoiding such environmental triggers. Nonetheless, children living in urban areas are at an increased risk for experiencing more persistent levels of severity (e.g., Kattan et al., 1997) and as a consequence, higher levels of morbidity.

Inner-city children with asthma are also commonly exposed to multiple indoor allergens and irritants, one of which is ETS (Crain et al., 2002; Morgan et al., 2004). An increased frequency of nocturnal symptoms was correlated with higher exposure to ETS, among inner-city school children (Morkjaroenpong et al., 2002). Due to its increased presence in urban homes, ETS plays a critical role in increasing the risk for experiencing a higher frequency of asthma exacerbations and therefore is considered an important risk factor for study.

Clearly, low-income urban children are disproportionately exposed to several risk factors (e.g., cockroach antigen, pollution) that appear to be intricately related; however, it is beyond the scope of this study to capture all the risks that may have a bearing on asthma management for urban children. Instead, we propose to test how certain key risks may function together to impact asthma morbidity for specific groups of inner-city families.

The Current Study

For this study, asthma morbidity in children is represented by the level of functional limitation imposed by asthma and the number of asthma-related emergency room visits and hospitalizations over the past year. The first question addressed examined the association between the total or ''cumulative'' level of risk and several indices of asthma morbidity in urban children. Second, we tested whether for urban children, asthma morbidity may be better explained by multiple risk factors, including those associated with context, asthma,

and culture, instead of one single risk factor (e.g., poverty). It is expected that a higher cumulative level of culturally related, contextual, and asthma-specific risks will be associated with more morbidity (e.g., an increased number of ED visits, hospitalizations, and more functional limitation). It is anticipated that the CRI will be a stronger predictor of asthma morbidity than poverty alone for urban children. A variant of this hypothesis involves testing whether the CRI is predictive of more variability in asthma morbidity than severity alone in this sample. This question is important since severity has been documented as a key predictor of asthma morbidity and health care utilization in children (Kwong et al., 2002). Exploratory analyses were also conducted to examine whether the relationship between the CRI and asthma morbidity may operate differently by ethnic group.

Method
Participants

One hundred and sixty-three children between the ages of 7 and 15 years, and their primary caregivers (PCG), most of whom were biological mothers, were interviewed for this study. Demographic characteristics of the study sample are presented in Table I. Children were recruited from three ethnic groups: Latino, African-American, and Anglo children.

Design and Procedures

Data for the Latino and Anglo children were collected as part of a larger project assessing factors that contribute to asthma health disparities between children from Anglo and Latino backgrounds. Further data for the African-American group were collected and added to the sample to form this substudy by the first author. Data collection occurred in parallel, and all participating families received the same measures.

Eligibility criteria for the respective studies consisted of the following: (a) volunteering PCG was the child's legal guardian; (b) child was between 7 and 15 years old; (c) child had been diagnosed with asthma by a physician and was currently obtaining asthma treatment; (d) child had lived in the same household as the PCG for at least 6 months; (e) child and PCG live in an urban environment (verified by zip code); and (f) PCG's ethnic identity is either non-Hispanic white, African-American, or Latino (Puerto Rican or Dominican, specifically). Five interested families did not meet inclusion criteria. Exclusion criteria included

Table I. Demographic Characteristics of Participants

Variable	% of sample	Mean	SD	Range
Child characteristics				
Child's age		10.5 years	2.0 years	7.9–15.0 years
Child's gender				
Female	42%			
Male	58%			
Primary caregiver's characteristics				
Primary caregiver's race[a]	40% Black; 51% Anglo; 8% multiracial; 1% other			
Primary caregiver's ethnicity[a]	34% Black; 18% Puerto Rican; 17% Dominican; 31% Anglo			
Spanish language preference	11% of the sample elected to hear the questions in Spanish			
Marital status	45% married; 9% separated; 14% divorced; 1% widowed			
	31% never married			
Number of years of education		13.04 years	2.8	5–17 years
Occupational status of PCG	55% not employed; 45% not employed			
Family characteristics				
Family's annual income[b]		$32,382		$500–$100,000
# of people living in home		4.4	1.5	2–10

[a]Primary caregivers were asked an open-ended question regarding the ethnic and racial group(s) with which they primarily identified themselves.
[b]Family's total annual income from all sources. The median income level for this sample was $22.500. Eight Anglo families' annual income was $\geq$100,000. Eighty-seven participants' incomes fell at or below the poverty threshold (Centers for Disease Control, 2005).

moderate to severe cognitive delay in the child as evidenced by school placement.

Approval for this study was obtained from the Institutional Review Board of a children's hospital in Providence, Rhode Island. Families were recruited from hospital-based primary care clinics and two nearby primary care clinics in the community. There were no differences on study variables for families who were recruited by each method. A screening questionnaire including eligibility criteria was administered to caregivers. Informed consent and child assent were obtained. Questionnaires were administered separately to each child and parent in interview format in the lab or the participants' home. A release of information form that allowed a review of the medical record (for determining asthma severity level) was also administered. Families were paid for participation. Interviews were offered in Spanish or English, depending on participants' preference. All measures were translated to Spanish and then reviewed by a bilingual committee using a process to insure linguistic equivalence of measures (e.g., Canino & Bravo, 1994).

Measures

Table II presents the mean, standard deviation, range, and internal consistency for each measure.

Demographic Questionnaire

A Demographic Interview was administered to each parent to assess the following variables: yearly income, number of family members in the home, primary caregiver's employment status, marital status, education, and age, as well as the child's age and gender. Primary caregivers' report of ethnicity served as the index for the family.

Indices of Morbidity

Three variables were used to assess morbidity: number of asthma-related hospitalizations, number of asthma-related emergency room treatments, and children's level of functional limitation due to asthma.

Number of ED Visits and Hospitalizations

The number of ED visits and hospitalizations due to asthma by parent report were totaled over the past year (since the date of interview). It was necessary to include an overall 12-month assessment because asthma morbidity may vary by season, hence resulting in differential effects depending upon when data were collected.

Functional Limitation due to Asthma

Parents completed the Asthma Functional Severity Scale (AFSS), which assesses the degree of functional impairment that asthma imposes on children's daily functioning over the past 4 weeks and past year (Rosier et al., 1994). The scale examines four components of children's asthma: morbidity, including frequency of episodes, frequency of symptoms between episodes, intensity of impairment during an episode, and intensity of impairment during the intervals between episodes. The functional morbidity

Table II. Descriptive Data for Study Variables

Variable	Mean (SD)	Range in Sample	Sample Chronbach's α	% families qualifying for risk status per factor	% families qualifying for number of risks
Cumulative Risk Index: contextual dimension					
Poverty (income to needs ratio)	.68 (4.1)	0–1	N/A	53%	0 risks = 10%
Neighborhood disadvantage	8.0 (4.9)	0–18	.87	31%	1 risk = 24%
Cultural dimension					2 risks = 33%
Perceived discrimination	33.8 (9.5)	9–45	.87	40%	3 risks = 19%
Cultural stress	12.9 (9.2)	0–46	.89	30%[b]	4 risks = 11%
Asthma specific					5 risks = 3%
Asthma severity	6% mild intermittent; 20% mild persistent; 39% moderate persistent; 35% severe persistent			35%	6 risks = 0
ETS	N/A	0–1	N/A	42%	
Functional morbidity due to asthma	1.69 (0.78)	0–3.50	.72	N/A	
Hospitalizations due to asthma[a]	10% of children had one or more hospitalization			N/A	
ED visits due to asthma[a]	40% of children had one or more ED visits			N/A	

[a]Children who experienced ≥1 ED visits or hospitalizations in the last year were given a 1 on these asthma morbidity outcomes.

[b]Thirty percent of the sample who received this instrument (N = 113 African-American and Latino families) qualified for risk status on this factor.

index score is calculated by computing a mean across all completed items for the past year.

The Multi-Dimensional Cumulative Risk Index: Contextual/Environmental Dimension

Poverty

Poverty was defined as households living at or below the federally defined poverty line. In 2005, the federal poverty line for a family of four was $19,350. An income-to-needs ratio was developed, which is an annually adjusted, per capita index comparing household income to federal estimates of minimally required expenditures for food and shelter (Duncan & Brooks-Gunn, 1997). Family income over the past year was calculated from PCGs' reports and included earnings of the mother, earnings of her resident husband or partner, and all other sources of household income, including public assistance. A ratio was calculated for each family by dividing the total yearly family income by the poverty threshold for that family size (US Department of Health and Human Services, 2005). Consistent with the US government definition of poverty, a family was considered at or below the poverty line if the income-to-needs ratio was ≥1.0 during that year in which they took part in the study. Dividing family income by poverty guideline for a family of a given size is more closely associated with hardship experiences than total family income (Mayer & Jencks, 1989).

Neighborhood Disadvantage

Levels of neighborhood disadvantage associated with children's neighborhood context were collected from the Neighborhood Unsafety Scale (Resnick et al., 1997), a 7-item measure of the parent's perception of neighborhood disadvantage over the previous year. Questions for this scale were modified from the National Longitudinal Study of Adolescent Health (Resnick et al., 1997). This scale has standardized Cronbach's αs of .76 for the English language interview and .71 for the Spanish language interview. The seven items were summed to form a total neighborhood disadvantage score. Scores on this scale range from 0 to 28. Response categories for the 4-item Likert scale ranged from "very true" (3) to "not at all true" (0).

Cultural Dimension: Perceived Discrimination

Experiences of perceived discrimination were collected through parent report of responses to nine items assessing daily experiences of discrimination faced over the past year (Jackson & Williams, 2002). Response categories range from "almost everyday" (5) to "never" (0). The minimum and maximum scores for the scale are 0 and 45, respectively. This measure has Cronbach's αs of .90 for the English language interview and .91 for the Spanish language interview and has been used with different ethnic groups (e.g., African-American and Latino families; Jackson & Williams, 2002). The measure was administered to the all families in this study to assess

potential discriminatory experiences that all families face, regardless of ethnic group membership.

Acculturative Stress

The Cultural Stress Scale was administered to African-American and Latino participants to assess the level of stress that parents experience while acculturating to the US (through migration experiences, language barriers, etc.) over the past year (Cervantes & Salgado de Snyder, 1990). This measure assesses the extent to which families experience cultural stress, so it is also applicable to families that are from ethnic minority backgrounds but have not immigrated to the US. It has been employed in studies with Mexican-American samples, and with island and mainland Puerto Ricans. Twenty-six items from the 73-item version of the Hispanic Stress Inventory were selected to evaluate stresses associated with acculturation: immigration stress, family/culture stress, and occupational/economic stress using a Likert scale. Scores can range from 0 to 52. Internal consistency estimates were estimated separately for both the English and Spanish version of the scale, and both exceeded .78 (Cervantes & Salgado de Snyder, 1990).

Asthma-Specific Dimension: Children's Asthma Severity

Standard criteria developed by NHLBI, such as parent report of asthma symptoms (over the past year) and children's current medication regimen were collected to classify children's asthma severity levels (National Institutes of Health, NIH, 2002). Medication reports were cross-verified with the medical chart review. Based on the results of the chart review and parent's self-report assessment, the study clinicians quantified the child's asthma severity as (a) mild intermittent, (b) mild persistent, (c) moderate persistent, or (d) severe persistent (NIH, 2002). For the Anglo and Latino families who participated in the larger study, children's pulmonary function test results were also available. Classification of asthma as severe persistent qualified for risk status on this variable.

Environmental Tobacco Smoke

Parents were asked questions regarding the presence of ETS in the home environment using questions from the Family Asthma Management System Scale (McQuaid, Walders, Kopel, Fritz, & Klinnert, 2005) a semi-structured interview to assess families' asthma knowledge and management practices. Households were considered to contain smokers if it was reported that either a parent, the asthmatic child, any other household member, or any regular visitor used tobacco. Families qualified for risk

status on this variable if they answer yes to any of the questions. Validity for the overall measure has been established (McQuaid et al., 2005) and it has been demonstrated to be internally consistent ($\alpha = 0.91$).

Results

Data were complete for asthma morbidity outcomes and potential risk factors included in the CRI. The means and standard deviations of the key predictor and outcome variables are presented in Table II.

Relations among Demographic Characteristics, Outcomes, Processes Qualifying as Risk Factors

Correlational analyses were conducted to examine significant associations among demographic characteristics (e.g., child's age) and morbidity in order to account for them in subsequent analyses. No significant associations emerged among these variables. Several demographic characteristics were considered as risk processes in the CRI and included in later analyses (e.g., severity, poverty). We did not include ethnic group status or racial group membership as a demographic factor, as we examined the relationship between the CRI and morbidity by ethnic group and ethnic subgroup. Results from correlational analyses were used to determine whether each variable qualified as a risk factor by its association with morbidity. Given that these analyses will be conducted with larger data sets in future, trends that approached significance were noted, as indicated in Table III.

Analyses Addressing the Hypotheses of the Current Study

In order to address the hypotheses of this study, the development and total score derived from the CRI was constructed.

Construction and Analysis of the CRI

A variable was created that reflected the total number of high risk factors present for each family. Although there may be differences among the six risk factors in their relation to each index of asthma morbidity, they were given equal weights in the composite variable because it has been noted that there is no practical difference in predictive power when weighted or unweighted measures are used (Sameroff et al., 1993). The definition of a high-risk group for each variable was defined according to the variable itself and a family qualified for risk status on that factor using a dichotomous score of 0 or 1. For example, families that were living at or below the poverty threshold were considered in the high-risk group and met the

Table III. Correlations of Potential Risk Processes and Asthma Morbidity Outcomes

|	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Income-to-needs	–	.32*	.11	.10	.11	.09	.20*	.22*	.18**
2. Neighborhood disadvantage		–	.31*	.20**	.10	.10	.30*	.22**	.10
3. Perceived discrimination			–	.52*	.10	.11	.15***	.10	.09
4. Cultural stress				–	.10	.11	.16***	.10	.11
5. Asthma severity					–	.11	.40*	.22*	.16**
6. ETS						–	.13***	.10	.11
7. Asthma functional limitation							–	.40**	.18**
8. # of annual of ED visits								–	.34*
9. # of annual hospitalizations									–

Pearson's product moment correlations were conducted for analyses examining associations between risk processes and functional limitation and Spearman's correlations were used for analyses including risks processes and ED and hospitalization outcomes. These analyses included the total number of ED visits and hospitalizations over the previous year. *$p < .001$, **$p < .05$, ***$p \leq .15$.

criteria of a score of 1 for the poverty risk factor. In the case of continuous variables where a categorical definition of risk is not possible (e.g., levels of neighborhood disadvantage), families in the top quartile of the sample were placed in the high-risk category for that variable (Sameroff et al., 1993). A CRI score represents a single, easily interpretable score that could group the families for comparison on the relationship between number of risks faced and mean indices of morbidity. Cumulative Risk Scores ranged from 0 to 6. A breakdown of percentage/number of families who qualified for a specific number of risks and the percentages of participants qualifying for each risk assignment is listed in Table II.

Second, to test whether a higher cumulative level of risks was associated with more morbidity (e.g., an increased number of hospitalizations), correlational analyses (Pearson's product moment and Spearman's rho) were conducted between the total number of cumulative risks and each index of morbidity. Results indicated that for this sample, a higher cumulative level of risks was positively and significantly correlated with more functional limitation ($r = .32$; $p < .001$), more hospitalizations ($r = .22$; $p < .05$); and more ED visits due to asthma ($r = .24$; $p < .05$). Figures 2–4 illustrate the mean levels of functional limitation, hospitalizations, and ED visits plotted against the number of risk factors present in each family. In this sample, families qualified for risk status on a range of 0–5 risks. No family qualified for six risks. In Fig. 2, the mean levels of asthma functional limitation appears to increase in a linear fashion for the first three number of risks, and then stabilizes for families who qualify for high-risk status on 4 or 5 risks. In Figs. 3 and 4, the mean number of ED visits and hospitalizations due to asthma increases with families who qualify for high-risk status on up to 3 risks, and then the number of visits decreases with more risks faced.
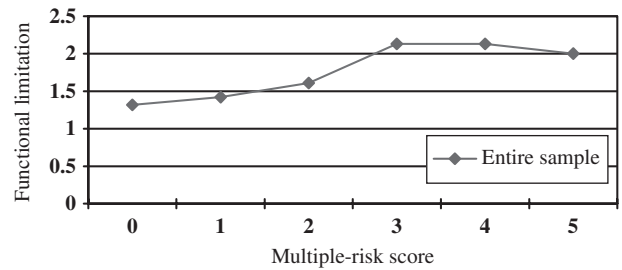
Figure 2. Mean levels of functional limitation scores within multiple risk groups.
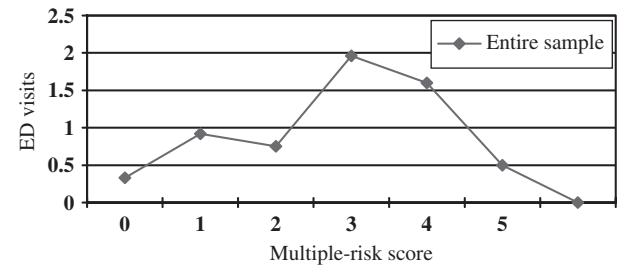
Figure 3. Mean levels of asthma ED visits within multiple –risk groups.
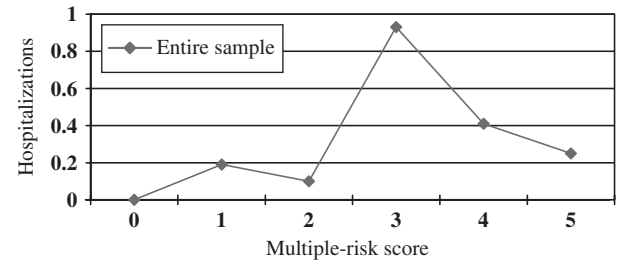
Figure 4. Mean levels of asthma hospitalizations within multiple-risk groups.

Third, to assess the relative contribution of the CRI on morbidity and whether or not these factors have differential consequences for morbidity than poverty or severity alone, hierarchical multiple regression analyses

were conducted with the functional limitation model and logistic regressions were used for the asthma-related ED and hospitalization models. Each regression model either included the income-to-needs ratio or asthma severity level in the first step and the total score of the CRI was entered as the final step. The CRI score accounted for an additional 7% of the variance in functional morbidity ($\beta = .32$; $p < .001$; $R^2 = .13$), even when poverty was taken into account. When severity was held constant, the CRI accounted for an additional 5% of the variance in children's functional morbidity ($\beta = .22$; $p < .001$; $R^2 = .17$).

When poverty was entered alone in the ED visits and hospitalizations models, children were 1.1 and 1.2 times more likely to experience an ED visit and hospitalization, respectively. When poverty was taken into account, families with higher cumulative risks were 1.4 times more likely to have a child experience an ED visit ($\beta = .32$; $SE = 0.17$; Wald $\chi^2 = 3.49$; $p < .05$) and 1.7 times more likely to experience a hospitalization ($\beta = .50$; $SE = 0.26$; Wald $\chi^2 = 3.72$; $p < .05$). With severity entered alone in each model, children were 1.3 times more likely to experience an ED visit and 1.4 times more likely to experience a hospitalization. When severity was held constant, families with higher cumulative risks were 1.4 times more likely to have a child experience an ED visit ($\beta = .28$; $SE = 0.16$; Wald $\chi^2 = 3.02$; $p < .001$) and 1.6 times more likely to experience a hospitalization ($\beta = .45$; $SE = 0.25$; Wald $\chi^2 = 3.15$; $p < .05$).

We then conducted similar regression analyses by ethnic group. For the Anglo families, the CRI accounted for an additional 17% of the variance in functional morbidity ($\beta = .54$; $p < .05$; $R^2 = .37$), beyond poverty. In addition, the CRI was significantly related to the risk for an ED visit ($\beta = .81$; $SE = 0.47$; Wald $\chi^2 = 3.04$; $p < .05$), as children were 2.24 versus 0.60 times more likely to visit the ED when the CRI was entered into this model, rather than poverty alone. A trend toward significance was shown in the model including hospitalizations ($\beta = 1.78$; $SE = 1.30$; Wald $\chi^2 = 1.87$; $p = .10$). Children were 5.8 versus 0.13 times more likely to experience a hospitalization when the CRI was entered into this model, rather than poverty alone.

For the Latino families, the CRI score was not significantly related to functional morbidity and the risk for an ED visit; however, a trend toward significance was shown in the model including hospitalizations ($\beta = .44$; $SE = .41$; Wald $\chi^2 = 1.15$; $p = .10$). Children were 1.6 versus 1.4 times more likely to experience a hospitalization when the CRI was entered in this model, compared with poverty alone. Interestingly, when analyses were conducted by Latino ethnic subgroup (Puerto Rican versus Dominican), the CRI score accounted for an additional 12% of the variance in functional limitation for children from Puerto Rican backgrounds ($\beta = .34$; $p < .05$; $R^2 = .18$), over and above poverty. Significant relations did not emerge between the CRI score and risk for ED visits and hospitalizations in this group. For children from Dominican backgrounds, the CRI was not significantly related to asthma morbidity.

For the African-American families, the CRI was not significantly related to functional morbidity, or risk for an ED visit; however, a trend toward significance was shown in the model including hospitalizations ($\beta = .45$; $SE = .41$; Wald $\chi^2 = 1.21$; $p < .10$). Children were 1.6 versus 1.1 times more likely to experience a hospitalization when the CRI was entered in this model, compared with poverty alone.

Discussion

The primary aim of this study was to emphasize the need for multiple-risk models, which may more appropriately represent the social realities of urban families' lives and capture the combination of risks that are associated with specific indices of morbidity.

Summary of Findings and Implications

Results from our regression models showed that the CRI score accounted for more morbidity than either poverty or severity alone. Correlational analyses showed that higher levels of risks included in the CRI were related to more functional limitation imposed by asthma. In addition, results from these analyses indicated that families that faced a higher level of cumulative risk were more likely to have their child experience an asthma-related ED visit or hospitalization.

The graphical presentation of data (Figs. 2–4) illustrating the relationship between the mean levels of morbidity by number of risks for which families qualified for high-risk status, however, warrants closer examination. It appears that asthma morbidity increases for up to 3 risks faced, and then either stabilizes (as in the case with the functional limitation scores) or decreases for families who face more than 3 risks (as is the case with the ED visits and hospitalizations), suggesting a curvilinear relationship. One plausible explanation for these findings may be that children at the highest levels of risk have been identified and followed more closely by health care providers and

hospital insurance carriers, as providers tend to pay more attention to families who are in highest need. These families may be referred to asthma education programs, tracked, and provided more support by case management and managed care programs. Alternatively, it is possible that families who face a number of risks and have a child who has uncontrolled asthma for a long period of time, may be less sensitive to detecting changes in respiratory status. These families may use the ED less often for frequent symptoms. The clinical implications of the above findings deserve mention, as families who face a moderate level of risks may be an important group to target. It may be that the transition from 1, to 2 to 3 risks may matter the most in terms of asthma morbidity, and these families may be overlooked by the system. There may be a window of opportunity for earlier clinical intervention.

Analyses examining the relation between the CRI and asthma morbidity by ethnic group revealed interesting results. Statistical support emerged for associations between more cumulative risks and several aspects of morbidity for Anglo, Latino, and African-American children. Analyses by Latino ethnic subgroup indicated that the CRI was significantly associated with more functional limitation for children from Puerto Rican backgrounds; however, this association was not significant in the analysis that included all Latinos. These results underscore how the experience of urban risks and their impact on aspects of asthma morbidity may differ, depending upon a family's cultural background and the severity of risks faced.

The relation between functional limitation and the CRI was not supported in children from African-American backgrounds. This may have been due to the homogeneity of the African- American group in this sample and the similarity in the threshold to which families who face an increased number of risks may experience adversity in outcomes (Sameroff et al., 1993). The level of poverty was higher in the African-American group (e.g., the mean difference between the income-to-needs ratio of the Anglo and African-American group was significant; 0.60 for Anglo families and 1.3 for African-American families; $p < .001$), and this group also experienced a higher number of cumulative risks (compared with the Anglo and Latino groups in this sample). As cited in previous research including disadvantaged families, the limited range in poverty level and number of CRI risks qualifying a family for high-risk status, may yield a restricted range of variability in the scores of the study (e.g., Sameroff et al., 1993).

Although it does allow for the robust examination of the effects of multiple risk factors on specific outcomes depending on the numbers of risks faced, multiple-risk studies with high-risk groups do not allow us to contrast how families who face persistent poverty function versus families who face moderate levels of poverty. In future research, the CRI will be tested with larger groups of families from a variety of ethnic backgrounds, who may qualify for a full range of risks indices.

Taken together, the findings suggest limited utility in merely considering urban status or ethnic group status as a ''risk factor'', and examining whether such a risk factor may be more predictive of asthma morbidity in this population. For clinicians and researchers working with urban families, it is important to learn about the experiences related to having asthma while living in an urban residence, which, in combination, may function as stressful risk factors affecting asthma-related functioning. The specific pathways by which these urban socio-contextual stressors affect asthma management and asthma morbidity remain largely unexplored. Exposure to increased stresses related to urban living (e.g., violence) may have deleterious effects on caregivers' psychological well-being (increased distress levels), which can compromise their abilities to manage their child's asthma effectively (e.g., Koinis-Mitchell, Murdock, & McQuaid, 2004; Wright et al., 2004). It also may be that acculturative stress and stresses related to previous experiences of discrimination can impact comfort levels when seeking asthma treatment. Although it may be clinically useful to examine whether one risk factor (e.g., poverty) predicts an aspect of asthma morbidity for specific groups of children, the complexity of asthma in the context of urban poverty, which should take into consideration the cultural beliefs, practices, and experiences of ethnic groups, may be better suited to an approach that considers how these risks function together to represent the social world of these families.

Limitations and Directions for Future Research

Several limitations of this study require consideration and should be addressed in future research. The study's sample was small and limits the ability to address important questions in further depth, such as providing more specificity on the threshold to which urban families are more likely to experience morbidity. Future research efforts will include other potential dimensions of risk factors to be incorporated in this model, such as processes associated with the health care system that may affect asthma management behaviors

(e.g., insurance status, cultural competence of providers; Lieu et al., 2002). Additional factors to be considered in future studies include parental and child beliefs about medications (Bearison, Minian, & Granowetter, 2002), language barriers (Apter, Reisine, Affleck, Barrows, & ZuWallack, 1998), other environmental triggers (e.g., pollution, cockroach; Morgan et al., 2004), and access to consistent asthma care (Crain, Kercsmar, Weiss, Mitchell, & Lynn, 1998), all of which have been shown to independently account for poor health management behaviors and health care utilization among urban children and their caregivers.

The degree to which specific dimensions of risk may differentially impact morbidity for specific ethnic sub/ groups (e.g., Puerto Rican families versus Dominican families) is another question to pursue, given the differing asthma prevalence and morbidity rates that exist. Further, regression analyses did not permit us to identify potential bidirectional associations that may exist among risk factors and morbidity outcomes. Longitudinal designs with more sophisticated modeling techniques and larger samples may uncover the directional pathways that link associations among specific risk factors, and between risk factors and specific indices of morbidity.

Our sample represented a wide age range. Developmental differences among children may have impacted the results of this study, although children's age was not related to any of our primary morbidity outcomes. As indicated in Table I, there was a higher proportion of Anglo families with annual income ranges that exceeded those of the ethnic minority families in this sample. Since one criterion for this study was that families needed to reside in an urban setting, we wanted to capture a representative group of families from each ethnic background. Thus, families were not excluded based on income level. Further, study clinicians had additional information (e.g., pulmonary function test results) for classifying the severity level of children from Latino and Anglo backgrounds. This assessment was not included in the substudy with African-American families; however, the other measures used to determine severity were the same (medical chart review, symptom report). There were no statistically significant differences in the severity levels of children from the groups depicted by each method.

Other limitations include the following. Severity level was not related to the contextual risks, which may have been due to the restricted range in variability of these data for our urban sample. Also, the specific item

assessing exposure to ETS does not have established validity—only the entire interview that contains it. Finally, our assessment of health care utilization data was limited to parent report only. Although we collected data on the number of ED visits and hospitalizations due to asthma over the past year through the primary care provider's medical chart review, these data were incomplete for a number of different reasons, namely, families did not have a consistent primary care provider or attend regular healthcare visits, and many families changed where they received health care over the course of the study, which was difficult to track.

A growing number of studies have identified several important risk factors associated with asthma morbidity in urban children. However, many of these studies are not guided by conceptual-based or theoretical models and tend to use the term ''risk factor'' loosely, without statistical evidence documenting each risk factor's association with a decrease in a specific asthma health outcome. ''Risk factors'' should not be generalized to various asthma health outcomes (e.g., across asthma morbidity outcomes), unless there is statistical evidence to support that such associations exist (e.g., acculturation is related to ER visits and/or functional limitation (Masten et al., 1990). No studies have attempted to understand the experiences related to urban living and ethnic minority status that may affect asthma management behaviors and asthma morbidity.

Although this study did not directly assess psychological outcomes (e.g., anxiety, depression) in the CRI model, its aim was to focus on validating the relationship between the constellation of risks related to urban living and asthma morbidity outcomes for urban children. A substantial literature documents the relationship between psychological correlates (mainly depressive symptoms and anxiety) and asthma morbidity in ethnic minority children (e.g., Ortega, McQuaid, Canino, Goodwin, & Fritz, 2004). The association between discrimination, acculturative stress, and poor psychological functioning in children has also been demonstrated (e.g., Garcia Coll & Magnuson, 1997). Perceptions of social stresses related to the experience of urban living and ethnic minority status such as discrimination, poverty, acculturative stress, and neighborhood disadvantage are psychological in nature, and can interact with children's and families' health management behaviors, mental health, and health outcomes (Garcia Coll & Magnuson, 1997). Future research examining direct and indirect relationships among risks associated with urban poverty, asthma morbidity, and children's psychological functioning is needed. Future work should specify

the pathways by which social stresses, asthma, and psychological outcomes affect one another and whether these relations are modified by different levels of stress over time.

Research employing cumulative risk models with inner city children may help to account for the multiple underlying mechanisms that explain the asthma health disparity. Important clinical implications from this research include uncovering information that can help structure asthma interventions to make them more culturally appropriate for urban families from specific ethnic groups. Results from this study also suggest that health care providers should consider risk factors along multiple dimensions that may impact asthma management and morbidity for urban children. The nature of the risks, index of morbidity, and families' adherence to asthma treatment should be taken into consideration, as the CRI is a cumulative risk index, but may not have a cumulative effect. This may demonstrate, however, a specific window of opportunity for clinical intervention for families who face a moderate number of risks with increasing morbidity, currently overlooked by the healthcare system. Cumulative risk models similar to the one employed in this study may also be applicable to research involving other medical illnesses (e.g., diabetes). A crucial next step for research is to determine whether the associations between multiple risk factors and specific asthma-related health outcomes differ depending upon the duration of exposure to risks, and level of severity and quantity of risks faced, across ethnic groups and subgroups. A challenge associated with this goal is to continue to develop culturally appropriate measurements that assess the similarities or differences in asthma-related experiences that urban families face.

Acknowledgements

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