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Neighborhoods, caregiver stress, and children's asthma symptoms

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Abstract

BACKGROUND: Neighborhood and caregiver characteristics have each been linked to children's asthma outcomes, but less is known about how caregiver psychosocial functioning may explain the link between neighborhood characteristics and asthma outcomes.

OBJECTIVE: To examine associations between neighborhood safety, caregiver stress and depressive symptoms, and children's asthma outcomes, and to evaluate whether caregiver stress and depressive symptoms mediate the relationship between neighborhood safety and asthma outcomes.

METHODS: We analyzed baseline data from a prospective cohort study of the effects of a housing mobility program on children's asthma-related outcomes. Age- and gender-adjusted models evaluated associations of neighborhood safety, and caregiver stress and depressive symptoms, with children's asthma symptoms and exacerbations.

RESULTS: Participants were 140 low-income children with persistent asthma (98% Black; 53% male; mean age = 9.0) with an average of 7.1 (SD=5.3) maximum symptom days per 2 weeks. Lower neighborhood safety, and higher caregiver stress and depressive symptoms, were associated with higher asthma symptoms, but not exacerbations, in adjusted models (e.g., for neighborhood safety, OR [95% CI] maximum symptom days: 1.41 [1.07-1.88]; for caregiver stress, maximum symptom days: 1.08 [1.01-1.15]; for depressive symptoms, maximum symptom days: 1.05 [1.00-1.11]). Exploratory analyses suggested that caregiver stress partially mediated associations between neighborhood safety and asthma symptoms for children in unsafe neighborhoods.

CONCLUSIONS: Neighborhood safety was associated with children's asthma symptoms independent from caregiver stress and depressive symptoms, although for children in unsafe

neighborhoods, caregiver stress may partially mediate this association. Findings suggest the importance of targeting multiple systems to improve children's asthma outcomes.

Abstract Word Count: 250

Text Word Count: 3,338

Highlight Box:

1. What is already known about this topic?

- Neighborhood characteristics and caregivers' psychosocial functioning are each associated with children's asthma outcomes.

2. What does this article add to our knowledge?

- Neighborhood safety was associated with children's asthma symptoms independent from caregiver stress and depressive symptoms. However, for children in unsafe neighborhoods, caregiver stress may partially explain the link between neighborhood safety and asthma symptoms.

3. How does this study impact current management guidelines?

- Findings suggest that children with asthma may benefit most from interventions at multiple levels, including the family and the neighborhood systems.

Key Words: asthma; child; neighborhood; stress; depression; urban

Abbreviations: Odds Ratio (OR); Mobility Asthma Project (MAP); Patient Health Questionnaire (PHQ-8); Maximum symptom days (MSD); Confidence Interval (CI); Oral corticosteroid (OCS); Emergency Department (ED).

Introduction

Low-income urban youth are at elevated risk for poorly controlled asthma¹. Many low-income urban youth live in neighborhoods with high levels of crime and exposure to violence, which are associated with asthma morbidity^{2,3}. Caregivers of children with asthma in low-income urban environments also experience a variety of challenges, ranging from poor housing quality⁴ to risk for mental health problems such as depressive symptoms⁵. Caregiver stress and depression have been linked to more negative asthma outcomes in youth, such as poorer disease control⁶, higher levels of inflammatory markers⁷, lower rates of medication adherence⁸, and increased hospitalizations⁹.

One proposed mechanism for the link between neighborhood characteristics and children's asthma outcomes is through caregiver psychosocial functioning. Specifically, caregivers may experience stress and depression due to ongoing concerns about the safety of their environment and the heightened need for vigilance¹⁰. Caregivers' stress and depression may then impede their ability to manage their child's asthma^{8,11}, as well as impact the child's own stress and immune response, leading to more negative asthma outcomes¹². Understanding pathways of risk has clinical relevance for identifying and intervening with high-risk patients, but existing research has not examined the role of caregiver stress or depressive symptoms in the association between neighborhood safety and asthma outcomes. Therefore, the purpose of the current investigation was to examine associations between caregiver perceptions of neighborhood safety, caregiver stress and depressive symptoms, and children's asthma outcomes among low-income urban families of children with persistent asthma, and to evaluate whether caregiver stress and depressive symptoms mediated relationships between neighborhood safety and children's asthma outcomes. We hypothesized that 1) neighborhood safety, caregiver stress

109 and depressive symptoms would be associated with child asthma outcomes, and 2) caregiver
110 stress and depressive symptoms would mediate associations between neighborhood safety and
111 children's asthma outcomes.

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Methods

MAP Study Design

The Mobility Asthma Project (MAP) is a prospective cohort study of the effects of an urban housing mobility program on children's asthma-related outcomes, including symptoms, exacerbations, and medication use. Children whose families participated in the Baltimore Regional Housing Partnership and with persistent asthma were invited to participate in MAP. The Baltimore Regional Housing Partnership assists families living in high-poverty neighborhoods with moving to low-poverty neighborhoods through pre- and post-move counseling in workshops and individualized sessions and by issuing a housing voucher which helps subsidize the costs of rent and utilities. MAP conducted baseline and follow up visits to assess asthma outcomes, home environmental exposures, neighborhood characteristics, and caregiver stress. We used cross-sectional baseline data from MAP to conduct a secondary analysis to understand the associations of neighborhood safety and caregiver stress and depressive symptoms with asthma morbidity. In the current analyses, asthma symptoms and exacerbations were examined as outcomes, while neighborhood safety, caregiver stress and depressive symptoms were examined as predictors (and stress and depressive symptoms were also examined as hypothesized mediators of the association between neighborhood safety and asthma outcomes), while child age and gender were included as co-variates.

Study Participants

Participants were 140 low-income children with persistent asthma. At baseline, 14 participants had already moved as a result of their participation in the Baltimore Regional Housing Partnership; the remainder had not yet moved. They were eligible to participate if (1) the child was between 5-17 years of age; and (2) the child had persistent asthma or a recent

exacerbation. Persistent asthma was defined as having been prescribed a controller medication or meeting National Asthma Education and Prevention Program symptom frequency criteria for persistent asthma, or having had an exacerbation, defined as an oral or parenteral corticosteroid burst, in the past 12 months¹³. Caregivers gave informed consent and youth provided assent to participate in the study. The study was approved by the Institutional Review Boards of Johns Hopkins Medicine and the University of Texas at Austin.

Demographic Characteristics

Caregivers reported their child's age, gender, race, and ethnicity as well as their annual household income and their relation to the child (e.g., biological mother) on a demographic questionnaire.

Neighborhood Safety

Caregivers reported their perception of their neighborhood's daytime safety ("How safe do you feel on the street near your home during the day?") on a 4-point Likert scale with options of very safe, safe, unsafe, or very unsafe, with lower numbers representing higher levels of safety.

Caregiver Urban Stress

Caregivers completed a modified 5-item version of the Urban Stress Scale¹⁴. This scale is designed to assess stress levels associated with living in a low-income urban neighborhood. The number of items on the original scale was reduced from twenty-two to five to limit response burden. The five items selected assessed stress about raising a child, the neighborhood environment, physical health, housing, and relations between racial groups. These items were selected because they were most relevant to the study. Participants rated each item on a 5-point

Likert scale, from “no stress” to “extreme stress;” total scores are out of 25, with higher scores indicating greater levels of stress.

Depression

Caregivers completed the 8-item version of the Patient Health Questionnaire (PHQ-8)¹⁵. The PHQ-8 is a brief, validated screener of depression risk in the general population. It assesses level of depressive symptoms (e.g., feeling down, insomnia, trouble concentrating) over the past two weeks. Scores are out of a total of 24, with higher scores indicating more depressive symptoms; a cutoff score of 10 or greater indicates elevated risk for depression.

Asthma Outcomes

We use the term “outcomes” as an efficient way to refer to the range of asthma control and exacerbation variables we studied, but we note that the study is cross-sectional and the term “outcomes” does not represent longitudinal outcomes or indicate causality. Caregivers reported their child’s asthma symptoms and medication use as the number of days the symptom or medication use was present in the past 2 weeks. Questions assessed days of coughing, wheezing, or chest tightness, nocturnal awakening due to asthma, symptoms while running, inability to speak in full sentences due to asthma, slowed activity due to asthma, cough without a cold, and short term beta-agonist use. Additionally, we calculated maximum symptom days (MSD), defined as the largest value out of the following three outcomes: (1) coughing, wheezing, or chest tightness, (2) nocturnal awakening, and (3) slowed activity. The MSD outcome has been validated as a clinically relevant asthma outcome for low-income ethnic minority youth¹⁶.

Caregivers also reported the number of asthma exacerbations, including oral corticosteroid bursts (defined as prednisone taken each day for 3 consecutive days or 1 dose of

dexamethasone as oral or IM injection) in the past 3 months, and the number of ED/urgent care visits, unscheduled doctor's visits, and hospitalizations in the last 12 months.

Statistical Analyses

We conducted a secondary analysis of the MAP baseline data to examine associations between neighborhood safety, caregiver stress and depressive symptoms, and asthma outcomes, and to examine evidence for mediation by caregiver stress and depressive symptoms in the association between neighborhood safety and asthma outcomes. The purpose of the mediation analyses was to examine whether co-variance between neighborhood safety and asthma outcomes would be explained by variance in the proposed mediators, which would suggest possible psychosocial mechanisms of the effects of neighborhood safety that could be targeted through behavioral intervention.

We first conducted descriptive analyses of study variables and sample characteristics. We then computed Spearman correlations between neighborhood safety and caregiver stress and depressive symptoms and reported significance at $p < .05$. Next, we used separate regression models to examine the associations of (1) neighborhood safety, (2) caregiver stress, and (3) depressive symptoms with asthma outcomes. Asthma symptom days and short term beta-agonist use were reported as the number of days they occurred per two weeks; therefore, those outcomes were modeled with a binomial distribution. To capture possible overdispersion we employed a quasibinomial regression. Event outcomes (oral corticosteroid bursts in the past 3 months, and number of ED/urgent care visits, unscheduled doctor's visits, and hospitalizations in the past 12 months) were modeled with a Poisson regression. Models controlled for child gender and age. We report odds ratios (ORs) to indicate the odds of experiencing an asthma outcome (e.g.,

general symptoms) given a 1-point increase in the predictor variable (e.g., neighborhood safety, caregiver stress, depressive symptoms).

We tested for mediation by comparing models that included neighborhood safety alone with those that included (1) neighborhood safety together with caregiver stress and (2) neighborhood safety together with caregiver depressive symptoms on asthma outcomes. We also conducted a sensitivity analysis for these mediational analyses that excluded the 14 participants who had already moved at baseline due to participating in the Baltimore Regional Housing Partnership. Finally, we conducted exploratory mediation analyses within each of the four categories of neighborhood safety (very safe, safe, unsafe, and very unsafe) to examine if there was evidence for mediation within each level of neighborhood safety. We did this because neighborhood safety may not vary continuously on one dimension (i.e., unsafe neighborhoods may be qualitatively different from safe neighborhoods in a multitude of ways that may be best captured categorically with the current data^{17, 18}). Using “very safe” as the reference group, we compared models examining associations between asthma outcomes and neighborhood safety for safe, unsafe, and very unsafe neighborhoods. We reported results as statistically significant if $p < .05$ (for ORs, when the 95% CI of the OR did not cross zero); although we did not correct for multiple comparisons, we reduced Type I error by interpreting patterns of results across multiple asthma outcomes, rather than singular significant results. Analyses were performed in R version 4.0¹⁹.

Results

Study population characteristics

Study population characteristics are summarized in Table I. Children were on average 9.0 years old ($SD = 3.3$; range 5-17 years), and 53% were male. The majority of the sample was Black/African-American (98%), with the remainder identifying as multiracial; 6% reported Latino ethnicity. Most caregivers were biological mothers (95%), with the remainder being biological fathers (1%), grandmothers (2%), legal guardians (1%), or not reported (1%). Most participants reported an annual household income of $< \$25,000$ (46%) or between $\$25,000$ - $49,000$ (26.5%); the remainder reported income $\geq \$50,000$ (1%) or did not know/refused to answer (26.5%). Sixty-four percent of children were sensitized to cockroach or mouse allergens, defined as a positive skin prick test or positive serum IgE test.

Children on average had 7.1 ($SD = 5.3$) maximum symptom days in a two week period. Twenty-eight percent reported taking a short course of oral corticosteroids in the past 3 months, and 75% reported at least one acute visit due to asthma in the past 12 months. The mean caregiver score on the PHQ-8 was 5.8 ($SD = 5.3$), with 29 caregivers (21%) scoring at heightened risk for depressive disorder (i.e., a PHQ-8 score ≥ 10). Most caregivers rated their neighborhood as safe (45%) or very safe (19%), with a smaller proportion rating it as unsafe (22%) or very unsafe (14%).

Associations Among Neighborhood Safety, Caregiver Stress and Depressive Symptoms

Bivariate correlations indicated that neighborhood safety was significantly correlated with caregiver urban stress ($r_s = .42, p < .001$), i.e., caregivers in neighborhoods perceived to be less safe reported higher stress. There was a nonsignificant correlation between neighborhood safety and caregiver depressive symptoms ($r_s = .10, p = .23$), and the difference between mean

neighborhood safety for participants at risk for depression (i.e., PHQ-8 $\geq$ 10) compared to those not at risk for depression was not statistically significant, $t(37) = 1.97$, $p = .056$.

Models Examining Associations Between Neighborhood Safety, Caregiver Stress and Depressive Symptoms, and Child Asthma Outcomes

In models examining associations between neighborhood safety and asthma outcomes that were adjusted for child age and gender (see Table II), neighborhood safety was significantly associated with maximum symptoms (Odds Ratio [OR] 1.41, 95% Confidence Interval [CI] 1.07-1.88), coughing, wheezing, or chest tightness (OR 1.38, CI [1.05-1.84]), and symptoms while running (OR 1.56, CI [1.15-2.15]). Neighborhood safety showed a pattern of positive associations with nocturnal awakening (OR 1.37, CI [0.99-1.90]), slowed activity (OR 1.37, CI [1.00-1.90]) and cough without a cold (OR 1.36, CI [0.99-1.87]), although this pattern was not statistically significant across all outcomes. Neighborhood safety was not associated with inability to speak in full sentences (OR 0.93, CI [0.51-1.62]), short-acting β -agonist use (OR 1.08, CI [0.80-1.45]), oral corticosteroid bursts (OR 1.41, CI [0.95-2.14]), ED/urgent care visits (OR 0.93, CI [0.75-1.14]), unscheduled doctors' visits (OR 1.14, CI [0.80, 1.61]), or hospitalizations (OR 0.57, CI [0.21-1.31]).

In models examining associations between urban stress and asthma outcomes that were adjusted for child age and gender (see Table II), caregiver urban stress was significantly associated with maximum symptoms (OR 1.08, CI [1.01-1.15]), coughing, wheezing, or chest tightness (OR 1.08, CI [1.01-1.15]), nocturnal awakening (OR 1.13, CI [1.05-1.22]), and symptoms while running (OR 1.08, CI [1.01-1.16]). Caregiver urban stress showed a pattern of positive associations with inability to speak in full sentences (OR 1.11, CI [0.98-1.25]), slowed activity (OR 1.07, CI [1.00-1.15]), and cough without a cold (1.06 [0.98-1.14]), but not with

short-acting b-agonist use (OR 1.00, CI [0.93-1.07]), oral corticosteroid bursts (OR 1.08, CI [0.99-1.19]) ED/urgent care visits (OR 1.03, CI [0.98-1.10]), unscheduled doctors' visits (OR 1.05, CI [0.97-1.13]), or hospitalizations (OR 0.98 CI [0.83-1.16]).

In models examining associations between caregiver depressive symptoms and asthma outcomes that were adjusted for child age and gender (see Table III), depressive symptoms were significantly associated with maximum symptoms (OR 1.05, CI [1.00-1.11]), nocturnal awakening (OR 1.08, CI [1.02-1.14]), symptoms while running (OR 1.06, CI [1.00-1.12]), inability to speak in full sentences (OR 1.10, CI [1.00-1.21]), and slowed activity (OR 1.06, CI [1.01-1.12]). Caregiver depressive symptoms showed a pattern of positive associations with coughing, wheezing, or chest tightness (OR 1.05, CI [1.00-1.10]) and cough without a cold (OR 1.05, CI [0.99-1.11]), but not short-acting b-agonist use (OR 1.00, CI [0.94-1.05]), oral corticosteroid bursts (OR 1.00, CI [0.93-1.07]), ED/urgent care visits (OR 1.01, CI [0.97-1.04]), unscheduled doctors' visits (OR 1.00, CI [0.94-1.06]), or hospitalizations (OR 0.94, CI [0.80-1.06]).

Mediation by Caregiver Stress and Depressive Symptoms

Mediation by caregiver urban stress. In adjusted models that included both neighborhood safety and caregiver urban stress, caregiver stress explained anywhere from 0% to 23% of the association between neighborhood safety and asthma symptoms or exacerbations (calculated as the percent change of the OR for neighborhood safety from before to after caregiver stress was added to the model; the change ranged from 0-23%). Neighborhood safety remained a significant predictor of symptoms while running (OR 1.44, CI [1.03-2.04]), but not any other asthma outcomes, after including caregiver stress in the models.

Mediation by caregiver depressive symptoms. In adjusted models that included both neighborhood safety and caregiver depressive symptoms, caregiver depressive symptoms explained anywhere from 0% to 5% of the association between neighborhood safety and asthma symptoms or exacerbations. Neighborhood safety remained a significant predictor of maximum symptom days (OR 1.42, CI [1.08-1.90]), coughing, wheezing, or chest tightness (OR 1.40, CI [1.05-1.87]), and symptoms while running (OR 1.53, CI [1.12-2.11]) after including depressive symptoms in the models.

Sensitivity Analysis. Our sensitivity analysis indicated that overall point estimates were not meaningfully different in the sample that excluded 14 participants who had moved at baseline (see Tables E1 and E2 in supplemental materials).

Exploratory Analyses of Neighborhood Safety as a Categorical Variable

In adjusted models examining associations between neighborhood safety and asthma outcomes, we examined changes in ORs for neighborhood safety separately for safe, unsafe, and very unsafe neighborhoods, compared to very safe neighborhoods (see Table IV). We found decreases (i.e., $\geq 20\%$) in neighborhood safety ORs after including caregiver urban stress in several models (i.e., models for maximum symptom days, coughing, wheezing or chest tightness, nocturnal awakening, symptoms while running, inability to speak in full sentences, slowed activity, OCS bursts, ED/urgent care visits, and hospitalizations) but only for the unsafe or very unsafe groups. There were not comparable decreases in the neighborhood safety ORs for the safe group, with the exception of the model for inability to speak in full sentences. We did not find any evidence for mediation in the models that examined depressive symptoms as a mediator across all four neighborhood safety groups.

Discussion

This study examined associations among neighborhood safety, caregiver urban stress and depressive symptoms, and children's asthma outcomes in low-income urban families. We found that caregiver perceptions of greater neighborhood safety were linked to fewer asthma symptoms in children. Greater neighborhood safety was also associated with lower levels of caregiver urban stress and depressive symptoms, which were in turn also associated with fewer asthma symptoms. When we examined evidence for mediation of the association between neighborhood safety and asthma outcomes, we did not find consistent evidence that caregiver urban stress or depressive symptoms mediated this association in models adjusted for child age and gender. However, exploratory analyses suggested that caregiver urban stress may decrease the association between neighborhood safety and asthma symptoms for those families living in unsafe or very unsafe neighborhoods. This finding contributes to our understanding of how neighborhood- and family-level factors intersect in high-risk contexts, suggesting that caregiver psychosocial functioning could be part of a "risk pathway" from neighborhood safety to children's asthma outcomes.

The current results support previous findings that asthma symptom outcomes are associated with neighborhood safety² and caregiver psychosocial stress^{3,6}. Further, our results suggest that caregivers who perceive their neighborhoods as more unsafe also experience heightened stress around their living conditions, which may create a doubly risky context for children's asthma. Ultimately, if neighborhood- and family-level factors are each causally related to asthma symptoms, our results suggest that low-income urban children with asthma may benefit from a multi-level intervention approach that addresses both the family and neighborhood systems to reduce asthma risk.

Finally, it is worth noting that neighborhood safety and caregiver psychosocial stress were only associated with asthma symptoms and not asthma exacerbations such as OCS bursts, urgent care/ED and physician visits, and hospitalizations. This finding is consistent with previous research showing different etiology and predictors of symptomatology versus exacerbations for children with asthma^{20,21}. It is possible that neighborhood safety and caregiver stress exert a greater influence on day to day symptomatology (and caregiver attention to those symptoms) than on larger disruptions to asthma control. This may be because exacerbations involve a greater interplay between environmental, psychosocial, and biological factors, and neighborhood or caregiver factors alone are not always sufficient to trigger an exacerbation. Future research should explore the interaction of contextual and individual-level factors to understand risk for exacerbations.

The current findings are limited by a cross-sectional design, which did not allow us to examine potential mediational processes over time. It is possible that neighborhood safety may have long-term effects on asthma symptoms, but that this effect does not occur in a snapshot in time. Additionally, the study was based solely on caregiver-report data and it is possible that associations observed between neighborhood safety and asthma symptoms were due to shared method variance (i.e., using caregiver perception to measure exposure and outcome variables). Nevertheless, the measures we used are well-validated and clinically meaningful. For example, caregiver perceptions of neighborhood safety are not only linked to more objective measures of safety²², but may be just as likely to impact the actions that caregivers take to protect their families²³. Importantly, the mediational analyses were exploratory and hypothesis-generating, so should be evaluated in future studies. Finally, our study sample was from a single urban site in

the Northeast and primarily Black and low-income; therefore, our findings may not generalize to children of other backgrounds or in other contexts.

Conclusions

Consistent with prior research, the current study identified associations between caregiver perceptions of neighborhood safety, caregiver stress and depressive symptoms, and children's asthma symptoms. We did not find strong evidence that caregivers' stress or depressive symptoms explained the relation between neighborhood safety and children's asthma outcomes, although we found some indication that this mediational pathway may be specifically relevant for children living in unsafe neighborhoods. Overall, our results show that neighborhood safety and caregiver psychosocial functioning operate relatively independently in relation to children's asthma outcomes, which suggests that it may be necessary for interventions to target change at multiple levels of the child's ecological system to have the greatest impact on asthma outcomes.

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Table I. *Participant Demographic Characteristics and Descriptive Statistics of Asthma Outcomes, Days/2 weeks.*

<i>Demographic Characteristics</i>	N (%) or M (SD)
Age	9.0 (3.3)
Male	74 (53%)
Race	
Black	137 (98%)
Multiracial	3 (2%)
Ethnicity	
Hispanic/Latino	8 (6%)
Household Income	
< \$25,000	64 (46%)
\$25,000-\$50,000	37 (26.5%)
> \$50,000	2 (1%)
Don't know/refused to answer	37 (26.5%)
Cockroach or mouse sensitized*	90 (64%)
<i>Asthma symptoms and medication use, Days/2 weeks</i>	
Maximum symptom days	7.1 (5.3)
Coughing, wheezing, or chest tightness	6.5 (5.4)
Nocturnal awakening	3.2 (4.5)
Symptoms while running	3.4 (4.6)
Inability to speak in full sentences	0.3 (0.8)
Slowed activity	2.9 (4.2)
Cough without a cold	3.7 (5.1)
Short term B-agonist use	4.1 (4.8)
<i>Asthma exacerbations</i>	
OCS bursts ^a	0.4 (1.0)
ED/Urgent care visits ^b	0.7 (0.8)
Hospitalizations ^b	0.1 (0.3)
Unscheduled MD visits ^b	0.4 (0.9)

*Defined as a positive skin prick test or positive serum IgE test.

OCS = Oral corticosteroid. ED = Emergency department.

^aNumber of events in the past 3 months. ^bNumber of events in the past 12 months.

450 Table II. *Unadjusted and adjusted (for child age and gender) models examining associations between asthma outcomes and*
 451 *neighborhood safety, parental stress, and both.*

Asthma Outcome		Unadjusted ORs		Adjusted ORs	
		Neighborhood Safety OR [95% CI]	Caregiver Stress OR [95% CI]	Neighborhood Safety OR [95% CI]	Caregiver Stress OR [95% CI]
Maximum symptom days		1.40 [1.07-1.86]		1.41 [1.07-1.88]	
			1.08 [1.02-1.15]		1.08 [1.01-1.15]
	<i>Mediation model</i>	1.27 [0.94-1.72]	1.06 [0.99-1.13]	1.28 [0.94-1.75]	1.05 [0.98-1.13]
Coughing-wheezing-or chest tightness		1.38 [1.04-1.83]		1.38 [1.05-1.84]	
			1.08 [1.01-1.15]		1.08 [1.01-1.15]
	<i>Mediation model</i>	1.24 [0.91-1.69]	1.06 [0.99-1.13]	1.26 [0.92-1.72]	1.05 [0.98-1.13]
Nocturnal awakening		1.37 [0.99-1.89]		1.37 [0.99-1.90]	
			1.12 [1.04-1.21]		1.13 [1.05-1.22]
	<i>Mediation model</i>	1.14 [0.79-1.62]	1.11 [1.02-1.20]	1.12 [0.78-1.61]	1.11 [1.03-1.21]
Symptoms while running		1.54 [1.13-2.12]		1.56 [1.15-2.15]	
			1.08 [1.01-1.16]		1.08 [1.01-1.16]
	<i>Mediation model</i>	1.41 [1.00-1.99]	1.05 [0.97-1.13]	1.44 [1.03-2.04]	1.04 [0.97-1.13]
Inability to speak in full sentences		0.93 [0.52-1.61]		0.93 [0.51-1.62]	
			1.10 [0.98-1.24]		1.11 [0.98-1.25]
	<i>Mediation model</i>	0.73 [0.39-1.33]	1.13 [0.99-1.28]	0.72 [0.38-1.31]	1.14 [1.00-1.31]
Slowed activity		1.38 [1.00-1.90]		1.37 [1.00-1.90]	
			1.07 [1.00-1.15]		1.07 [1.00-1.15]
	<i>Mediation model</i>	1.27 [0.89-1.80]	1.05 [0.97-1.13]	1.26 [0.88-1.79]	1.05 [0.97-1.14]
Cough without a cold		1.35 [0.99-1.86]		1.36 [0.99-1.87]	
			1.05 [0.98-1.13]		1.06 [0.98-1.14]
	<i>Mediation model</i>	1.28 [0.91-1.82]	1.03 [0.95-1.11]	1.28 [0.90-1.83]	1.03 [0.95-1.12]
Short term B-agonist use		1.07 [0.80-1.44]		1.08 [0.80-1.45]	
			1.00 [0.94-1.07]		1.00 [0.93-1.07]
	<i>Mediation model</i>	1.08 [0.78-1.50]	0.99 [0.92-1.07]	1.10 [0.79-1.53]	0.99 [0.92-1.07]
OCS bursts/3 months		1.40 [0.94-2.10]		1.41 [0.95-2.14]	
			1.08 [0.99-1.19]		1.08 [0.99-1.19]
	<i>Mediation model</i>	1.26 [0.81-1.96]	1.06 [0.96-1.17]	1.28 [0.82-2.01]	1.06 [0.95-1.17]
ED/Urgent care visits/12 months		0.93 [0.75-1.14]		0.93 [0.75-1.14]	
			1.03 [0.98-1.07]		1.03 [0.98-1.10]

	<i>Mediation model</i>	0.86 [0.68-1.07]	1.04 [0.99-1.09]	0.85 [0.68-1.06]	1.05 [0.99-1.10]
Unscheduled visits/12 months MD		1.14 [0.81-1.59]		1.14 [0.80-1.61]	
			1.05 [0.97-1.13]		1.05 [0.97-1.13]
	<i>Mediation model</i>	1.05 [0.72-1.51]	1.04 [0.96-1.13]	1.05 [0.72-1.54]	1.04 [0.96-1.14]
Hospitalizations/12 months		0.56 [0.24-1.16]		0.57 [0.21-1.31]	
			0.98 [0.84-1.14]		0.98 [0.83-1.16]
	<i>Mediation model</i>	0.52 [0.21-1.16]	1.04 [0.87-1.23]	0.52 [0.17-1.34]	1.05 [0.84-1.31]

Note. N=140. OCS = Oral corticosteroid. ED = Emergency department. ORs indicate the odds of experiencing an asthma outcome given a 1-point increase in the predictor variable (i.e., neighborhood safety or caregiver stress). Bold indicates statistically significant ORs ($p < .05$). The first row for each outcome reports the OR for neighborhood safety, the second row reports the OR for caregiver stress, and the third row reports the ORs for neighborhood safety and the hypothesized mediator, i.e., caregiver urban stress, when both are included in the model. Variations in the ORs for neighborhood safety in Tables II and III are due to slight differences in the N's used for analyses (N=140 for Table II; N=139 for Table III).

459 Table III. *Unadjusted and adjusted (for child age and gender) models examining associations between asthma outcomes and*
 460 *neighborhood safety, caregiver depressive symptoms, and both.*

Asthma Outcome		Unadjusted ORs		Adjusted ORs	
		Neighborhood Safety OR [95% CI]	Depressive Symptoms OR [95% CI]	Neighborhood Safety OR [95% CI]	Depressive Symptoms OR [95% CI]
Maximum symptom days		1.44 [1.10-1.92]		1.45 [1.10-1.94]	
			1.05 [1.01-1.11]		1.05 [1.00-1.11]
	<i>Mediation model</i>	1.41 [1.07-1.88]	1.05 [1.00-1.10]	1.42 [1.08-1.90]	1.05 [1.00-1.10]
Coughing-wheezing-or chest tightness		1.42 [1.07-1.89]		1.43 [1.08-1.91]	
			1.05 [1.00-1.10]		1.05 [1.00-1.10]
	<i>Mediation model</i>	1.39 [1.05-1.85]	1.05 [1.00-1.10]	1.40 [1.05-1.87]	1.04 [0.99-1.10]
Nocturnal awakening		1.45 [1.05-2.01]		1.45 [1.05-2.02]	
			1.07 [1.02-1.13]		1.08 [1.02-1.14]
	<i>Mediation model</i>	1.39 [1.01-1.93]	1.07 [1.01-1.13]	1.39 [1.00-1.93]	1.07 [1.01-1.13]
Symptoms while running		1.55 [1.13-2.14]		1.58 [1.16-2.18]	
			1.06 [1.01-1.12]		1.06 [1.00-1.12]
	<i>Mediation model</i>	1.50 [1.09-2.07]	1.05 [1.00-1.11]	1.53 [1.12-2.11]	1.05 [1.00-1.11]
Inability to speak in full sentences		0.92 [0.51-1.60]		0.92 [0.51-1.60]	
			1.09 [1.00-1.19]		1.10 [1.00-1.21]
	<i>Mediation model</i>	0.86 [0.49-1.47]	1.10 [1.00-1.19]	0.87 [0.49-1.49]	1.10 [1.01-1.21]
Slowed activity		1.38 [1.00-1.92]		1.38 [1.00-1.92]	
			1.06 [1.00-1.12]		1.06 [1.01-1.12]
	<i>Mediation model</i>	1.34 [0.97-1.85]	1.05 [1.00-1.11]	1.33 [0.96-1.84]	1.06 [1.00-1.12]
Cough without a cold		1.34 [0.98-1.84]		1.34 [0.98-1.85]	
			1.05 [0.99-1.10]		1.05 [0.99-1.11]
	<i>Mediation model</i>	1.30 [0.95-1.79]	1.04 [0.99-1.10]	1.30 [0.95-1.79]	1.04 [0.99-1.10]
Short term B-agonist use		1.12 [0.83-1.50]		1.12 [0.83-1.51]	
			1.00 [0.95-1.05]		1.00 [0.94-1.05]
	<i>Mediation model</i>	1.12 [0.83-1.51]	1.00 [0.95-1.05]	1.13 [0.83-1.53]	0.99 [0.94-1.05]
OCS bursts/3 months		1.38 [0.93-2.08]		1.40 [0.93-2.11]	
			1.01 [0.94-1.08]		1.00 [0.93-1.07]
	<i>Mediation model</i>	1.38 [0.93-2.09]	1.00 [0.93-1.07]	1.40 [0.93-2.14]	0.99 [0.92-1.07]
ED/Urgent care visits/12 months		0.94 [0.76-1.16]		0.94 [0.76-1.16]	
			1.01 [0.97-1.04]		1.01 [0.97-1.04]

	<i>Mediation model</i>	0.94 [0.76-1.16]	1.01 [0.97-1.04]	0.94 [0.76-1.15]	1.01 [0.97-1.04]
Unscheduled MD visits/12 months		1.16 [0.81-1.63]		1.16 [0.81-1.65]	
			1.00 [0.94-1.06]		1.00 [0.94-1.06]
	<i>Mediation model</i>	1.15 [0.81-1.63]	1.00 [0.94-1.06]	1.16 [0.81-1.66]	1.00 [0.94-1.06]
Hospitalizations/12 months		0.55 [0.23-1.14]		0.55 [0.19-1.30]	
			0.94 [0.80-1.06]		0.94 [0.80-1.06]
	<i>Mediation model</i>	0.55 [0.24-1.14]	0.94 [0.80-1.06]	0.56 [0.20-1.32]	0.94 [0.78-1.09]

Note. N=139. OCS = Oral corticosteroid. ED = Emergency department. ORs indicate the odds of experiencing an asthma outcome given a 1-point increase in the predictor variable (i.e., neighborhood safety or caregiver stress). Bold indicates statistically significant ORs ($p < .05$). The first row for each outcome reports the OR for neighborhood safety, the second row reports the OR for caregiver depressive symptoms, and the third row reports the ORs for neighborhood safety and the hypothesized mediator, i.e., depressive symptoms, when both are included in the model. Variations in the ORs for neighborhood safety in Tables II and III are due to slight differences in the N's used for analyses (N=140 for Table II; N=139 for Table III).

467 Table IV. *Unadjusted and adjusted (for child age and gender) models exploring associations between asthma outcomes,*
 468 *neighborhood safety and caregiver stress at different levels of neighborhood safety.*

Asthma Outcome	Model	Neighborhood Safety OR [95% CI]				Caregiver Stress OR [95% CI]
		Very Safe [N=26]	Safe [N=63]	Unsafe [N=31]	Very Unsafe [N=20]	
Maximum symptom days	Unadjusted	Reference	1.66 [0.82-3.44]	1.75 [0.78-3.97]	3.35 [1.34-8.77]	
		Reference	1.51 [0.74-3.15]	1.39 [0.59-3.29]	2.48 [0.93-6.88]	1.06 [0.99-1.14]
	Adjusted	Reference	1.65 [0.81-3.43]	1.72 [0.76-3.95]	3.39 [1.35-8.96]	
		Reference	1.52 [0.74-3.18]	1.40 [0.59-3.35]	2.58 [0.95-7.25]	1.05 [0.98-1.13]
Coughing, wheezing, or chest tightness	Unadjusted	Reference	1.55 [0.75-3.29]	1.43 [0.63-3.33]	3.38 [1.34-8.96]	
		Reference	1.41 [0.68-3.02]	1.13 [0.47-2.75]	2.50 [0.92-7.03]	1.06 [0.99-1.14]
	Adjusted	Reference	1.54 [0.74-3.28]	1.41 [0.61-3.3]	3.43 [1.34-9.18]	
		Reference	1.42 [0.68-3.04]	1.14 [0.47-2.80]	2.61 [0.95-7.43]	1.06 [0.98-1.13]
Nocturnal awakening	Unadjusted	Reference	1.04 [0.44-2.65]	1.38 [0.52-3.81]	2.45 [0.89-7.08]	
		Reference	0.86 [0.35-2.25]	0.90 [0.31-2.64]	1.43 [0.47-4.49]	1.11 [1.02-1.21]
	Adjusted	Reference	1.03 [0.43-2.67]	1.37 [0.51-3.82]	2.46 [0.88-7.17]	
		Reference	0.86 [0.35-2.27]	0.89 [0.31-2.64]	1.42 [0.46-4.50]	1.11 [1.02-1.21]
Symptoms while running	Unadjusted	Reference	1.82 [0.74-5.02]	1.73 [0.62-5.19]	4.70 [1.68-14.47]	
		Reference	1.66 [0.68-4.60]	1.39 [0.47-4.33]	3.56 [1.18-11.62]	1.06 [0.98-1.14]
	Adjusted	Reference	1.85 [0.77-4.96]	1.62 [0.60-4.73]	5.04 [1.83-15.16]	
		Reference	1.69 [0.70-4.59]	1.32 [0.46-4.04]	3.88 [1.30-12.53]	1.05 [0.97-1.13]
Inability to speak in full sentences	Unadjusted	Reference	0.49 [0.12-2.05]	1.01 [0.25-4.25]	0.51 [0.05-2.97]	
		Reference	0.39 [0.10-1.57]	0.59 [0.14-2.63]	0.27 [0.03-1.65]	1.13 [0.99-1.27]
	Adjusted	Reference	0.49 [0.12-2.12]	1.00 [0.24-4.34]	0.51 [0.05-3.04]	
		Reference	0.39 [0.10-1.59]	0.57 [0.13-2.57]	0.26 [0.03-1.61]	1.14 [1.00-1.31]
Slowed activity	Unadjusted	Reference	1.16 [0.48-3.06]	1.51 [0.56-4.27]	2.57 [0.92-7.58]	
		Reference	1.07 [0.44-2.83]	1.25 [0.44-3.66]	2.01 [0.67-6.32]	1.05 [0.97-1.13]
	Adjusted	Reference	1.17 [0.48-3.09]	1.51 [0.56-4.30]	2.57 [0.91-7.63]	
		Reference	1.07 [0.44-2.84]	1.23 [0.43-3.63]	1.96 [0.65-6.21]	1.05 [0.97-1.14]
Cough without a cold	Unadjusted	Reference	1.70 [0.71-4.48]	2.00 [0.75-5.72]	2.78 [0.96-8.50]	
		Reference	1.61 [0.67-4.31]	1.78 [0.63-5.32]	2.38 [0.76-7.82]	1.03 [0.95-1.11]

	Adjusted	Reference	1.69 [0.70-4.50]	2.03 [0.75-5.88]	2.79 [0.96-8.59]	
		Reference	1.61 [0.66-4.33]	1.82 [0.64-5.50]	2.40 [0.76-7.98]	1.03 [0.95-1.12]
Short term B-agonist use	Unadjusted	Reference	1.77 [0.83-4.05]	0.90 [0.35-2.35]	1.91 [0.73-5.11]	
		Reference	1.78 [0.82-4.10]	0.90 [0.33-2.47]	1.92 [0.68-5.55]	1.00 [0.93-1.07]
	Adjusted	Reference	1.77 [0.82-4.07]	0.89 [0.34-2.34]	1.93 [0.73-5.22]	
		Reference	1.79 [0.82-4.17]	0.91 [0.33-2.53]	2.00 [0.69-5.88]	0.99 [0.92-1.07]
OCS bursts/3 months	Unadjusted	Reference	1.59 [0.53-5.45]	1.46 [0.41-5.61]	3.44 [0.93-13.98]	
		Reference	1.43 [0.47-5.02]	1.14 [0.29-4.68]	2.51 [0.61-11.23]	1.06 [0.96-1.18]
	Adjusted	Reference	1.58 [0.53-5.50]	1.50 [0.42-5.88]	3.45 [0.93-14.28]	
		Reference	1.44 [0.47-5.09]	1.18 [0.30-4.94]	2.52 [0.60-11.49]	1.06 [0.96-1.18]
ED/Urgent care visits/12 months	Unadjusted	Reference	0.84 [0.51-1.43]	0.84 [0.46-1.51]	0.77 [0.38-1.50]	
		Reference	0.79 [0.48-1.32]	0.71 [0.38-1.31]	0.62 [0.30-1.25]	1.04 [0.99-1.09]
	Adjusted	Reference	0.85 [0.52-1.42]	0.86 [0.48-1.55]	0.76 [0.38-1.48]	
		Reference	0.79 [0.49-1.31]	0.71 [0.39-1.3]	0.60 [0.29-1.19]	1.05 [1.00-1.10]
Unscheduled MD visits/12 months	Unadjusted	Reference	1.19 [0.47-3.59]	1.68 [0.61-5.25]	1.30 [0.37-4.55]	
		Reference	1.11 [0.43-3.33]	1.42 [0.49-4.59]	1.05 [0.28-3.89]	1.04 [0.96-1.13]
	Adjusted	Reference	1.19 [0.45-3.69]	1.74 [0.61-5.64]	1.29 [0.36-4.69]	
		Reference	1.11 [0.43-3.40]	1.47 [0.49-4.88]	1.03 [0.27-3.94]	1.04 [0.96-1.14]
Hospitalizations/12 months	Unadjusted	Reference	0.47 [0.11-2.11]	0.18 [0.01-1.38]	0.29 [0.01-2.23]	
		Reference	0.44 [0.10-2.01]	0.15 [0.01-1.30]	0.23 [0.01-2.16]	1.04 [0.88-1.24]
	Adjusted	Reference	0.46 [0.09-2.48]	0.21 [0.01-1.99]	0.27 [0.01-2.65]	
		Reference	0.42 [0.08-2.40]	0.17 [0.00-1.90]	0.20 [0.00-2.62]	1.06 [0.85-1.31]

Note. N=140. OCS = Oral corticosteroid. ED = Emergency department. Bold indicates $\geq 20\%$ decrease in OR of the neighborhood safety variable (safe, unsafe or very unsafe) when caregiver urban stress is added to the model. The first row for each outcome reports the results of the unadjusted model with neighborhood safety, and the second row reports the results of the unadjusted model with neighborhood safety and caregiver urban stress. The third row for each outcome reports the results of the adjusted model with neighborhood safety, and the fourth row reports the results of the adjusted model with neighborhood safety and caregiver urban stress.

Table E1. Sensitivity analysis excluding participants who had moved at baseline of adjusted models examining associations between asthma outcomes and neighborhood safety, parental stress, and both, adjusted for child age and sex.

	Neighborhood Safety OR [95% CI]	Parental Stress OR [95% CI]
Maximum symptom days	1.34 [0.99-1.83]	
		1.07 [1.00-1.15]
	1.24 [0.90-1.72]	1.05 [0.98-1.13]
Coughing-wheezing-or chest tightness	1.35 [0.99-1.84]	
		1.07 [1.00-1.15]
	1.24 [0.89-1.73]	1.05 [0.98-1.14]
Nocturnal awakening	1.24 [0.87-1.76]	
		1.11 [1.02-1.20]
	1.06 [0.73-1.54]	1.10 [1.01-1.20]
Symptoms while running	1.51 [1.08-2.11]	
		1.08 [1.00-1.16]
	1.39 [0.98-2.00]	1.05 [0.97-1.13]
Inability to speak in full sentences	0.79 [0.43-1.40]	
		1.09 [0.96-1.24]
	0.66 [0.35-1.20]	1.12 [0.99-1.29]
Slowed activity	1.29 [0.91-1.83]	
		1.06 [0.98-1.15]
	1.20 [0.83-1.74]	1.05 [0.96-1.14]
Cough without a cold	1.36 [0.96-1.93]	
		1.05 [0.97-1.13]
	1.30 [0.90-1.90]	1.03 [0.94-1.12]
Short term B-agonist use	0.95 [0.69-1.30]	
		0.98 [0.92-1.05]
	0.97 [0.69-1.37]	0.99 [0.91-1.06]
OCS bursts/3 months	1.23 [0.80-1.89]	
		1.06 [0.97-1.18]
	1.13 [0.71-1.79]	1.05 [0.95-1.17]
ED/Urgent care visits/12 months	0.85 [0.68-1.05]	
		1.02 [0.97-1.07]
	0.80 [0.64-1.01]	1.04 [0.99-1.09]
Unscheduled MD visits/12 months	1.08 [0.74-1.56]	
		1.04 [0.96-1.13]
	1.01 [0.68-1.50]	1.04 [0.95-1.14]
Hospitalizations/12 months	0.55 [0.19-1.32]	
		0.98 [0.82-1.17]
	0.52 [0.17-1.36]	1.03 [0.82-1.29]

Note. N=126. OCS = Oral corticosteroid. ED = Emergency department. Bold indicates statistically significant ORs ($p < .05$).

Table E2. Sensitivity analysis excluding participants who had moved at baseline of adjusted models examining associations between asthma outcomes and neighborhood safety, depressive symptoms, and both, adjusted for child age and sex.

	Neighborhood Safety OR [95% CI]	Depressive Symptoms OR [95% CI]
Maximum symptom days	1.39 [1.03-1.90]	
		1.05 [0.99-1.10]
	1.36 [1.00-1.87]	1.04 [0.99-1.10]
Coughing, wheezing, or chest tightness	1.40 [1.03-1.92]	
		1.04 [0.99-1.10]
	1.37 [1.01-1.89]	1.04 [0.98-1.09]
Nocturnal awakening	1.32 [0.93-1.89]	
		1.07 [1.01-1.14]
	1.27 [0.89-1.81]	1.07 [1.01-1.13]
Symptoms while running	1.52 [1.09-2.15]	
		1.07 [1.01-1.13]
	1.47 [1.05-2.07]	1.06 [1.00-1.12]
Inability to speak in full sentences	0.78 [0.42-1.38]	
		1.10 [1.00-1.20]
	0.75 [0.41-1.31]	1.10 [1.00-1.20]
Slowed activity	1.29 [0.91-1.84]	
		1.06 [1.00-1.13]
	1.25 [0.88-1.78]	1.06 [1.00-1.12]
Cough without a cold	1.34 [0.95-1.9]	
		1.04 [0.98-1.10]
	1.31 [0.93-1.86]	1.03 [0.98-1.10]
Short term B-agonist use	0.99 [0.72-1.37]	
		1.00 [0.95-1.05]
	1.00 [0.72-1.38]	1.00 [0.95-1.05]
OCS bursts/3 months	1.20 [0.78-1.86]	
		1.00 [0.93-1.08]
	1.20 [0.78-1.87]	1.00 [0.93-1.08]
ED/Urgent care visits/12 months	0.86 [0.69-1.07]	
		1.00 [0.97-1.04]
	0.86 [0.68-1.07]	1.01 [0.97-1.04]
Unscheduled MD visits/12 months	1.10 [0.74-1.59]	
		1.00 [0.93-1.06]
	1.10 [0.74-1.61]	1.00 [0.93-1.06]
Hospitalizations/12 months	0.52 [0.17-1.31]	
		0.92 [0.78-1.05]
	0.52 [0.18-1.3]	0.93 [0.76-1.08]

Note. N=125. OCS = Oral corticosteroid. ED = Emergency department. Bold indicates statistically significant ORs ($p < .05$).