

# Community Violence and Asthma Morbidity: The Inner-City Asthma Study

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In the United States, recent trends of increasing childhood asthma morbidity disproportionately affect urban children who are poor and non-White. Known risk factors (e.g., air pollutants, environmental and in utero tobacco smoke, viral infections, indoor allergens) do not fully explain these trends.<sup>1</sup>

Geographic variation in asthma outcomes among large cities<sup>2</sup> and among neighborhoods within cities<sup>3–5</sup> has been observed. Variation in asthma morbidity across urban neighborhoods cannot be explained by socioeconomic factors alone. Many New York City communities do not have elevated asthma morbidity in spite of the fact that they are comparably low on many socioeconomic indicators and have physical environmental exposures seemingly similar to other high-risk neighborhoods. These findings indicate that other factors may mediate the effects of living in low-socioeconomic status (SES) neighborhoods.

Health disparities research points to the influence of specific community characteristics, conceptualized as neighborhood disadvantages, on residents' health and well-being.<sup>6</sup> Neighborhood disadvantage—characterized by the presence of a number of community-level stressors, including poverty, underemployment, limited social capital, substandard housing, and high crime and violence rates<sup>7–8</sup> is prevalent in many US urban communities.<sup>8</sup>

Studies of minority and low-income populations have shown a high prevalence of children who experience<sup>9</sup> and witness violence in the inner city.<sup>10–12</sup> A prevalence study in a Boston, Mass, pediatric primary care clinic found that 10% of children younger than 6 years had witnessed a knifing or a shooting and that 47% had heard gunshots in their neighborhoods.<sup>11</sup> In Chicago, Ill, investigators found that 42% of children between the ages of 7 and 13 years had witnessed a shooting.<sup>13</sup>

**Objectives.** We examined the association between exposure to violence and asthma among urban children.

**Methods.** We obtained reports from caretakers (n=851) of violence, negative life events, unwanted memories (rumination), caretaker-perceived stress, and caretaker behaviors (keeping children indoors, smoking, and medication adherence). Outcomes included caretaker-reported wheezing, sleep disruption, interference with play because of asthma, and effects on the caretaker (nights caretaker lost sleep because of child's asthma).

**Results.** Increased exposure to violence predicted higher number of symptom days ( $P=.0008$ ) and more nights that caretakers lost sleep ( $P=.02$ ) in a graded fashion after control for socioeconomic status, housing deterioration, and negative life events. Control for stress and behaviors partially attenuated this gradient, although these variables had little effect on the association between the highest level of exposure to morbidity, which suggests there are other mechanisms.

**Conclusions.** Mechanisms linking violence and asthma morbidity need to be further explored. (*Am J Public Health.* 2004;94:625–632)

Exposure to violence may affect asthma through many pathways.<sup>14</sup> It may be related to psychological stress experienced by those who witness or are victims of violence,<sup>15</sup> which may have an impact on asthma.<sup>16</sup> Evolving research is exploring adverse psychological consequences among children who grow up in violent neighborhoods.<sup>17,18</sup> Health behaviors may be influenced by environmental factors, including high levels of stress, violence, and unpredictable daily life experiences. Exposure to violence (and other determinants of neighborhood disadvantage) may influence impulse control and risk-taking behavior, resulting in the adoption of coping behaviors (e.g., smoking) and leading to increased exposure to a known environmental trigger of asthma, (tobacco smoke).<sup>19</sup> Families who live in a violent environment may develop a fatalistic outlook that undermines their ability to invest in the future by complying with prescribed asthma treatment.<sup>20</sup>

High crime rates are correlated with other indicators of social disadvantage, including poor-quality housing. Deteriorated housing has been linked to high household cockroach allergen levels,<sup>21</sup> which in turn may increase

asthma morbidity.<sup>22</sup> Exposure to community violence may influence behaviors that could result in increased exposure to other known environmental risk factors. Parents who live in high-violence communities may restrict their children's outdoor activities, causing increased indoor-allergen exposure and higher asthma morbidity. Individuals who live in low-SES neighborhoods with high violence rates also may experience other adverse life events more frequently than their higher-SES counterparts.<sup>23,24</sup>

We examined the association between exposure to community violence and caretaker-reported asthma symptoms and behaviors in the Inner-City Asthma Study (ICAS). We hypothesized that families with children who lived with higher levels of violence would have increased asthma morbidity. We examined factors that might be correlated with violence (SES and other adverse life events) and hypothesized mediating pathways, including measures of the psychological experience of stress (perceived stress and intrusive memories), poor compliance with medication regimens, and other caretaker behaviors (keeping children indoors and smoking).

## METHODS

The ICAS was conducted from August 1998 to July 2001. This study enrolled 937 children with asthma (aged 5 to 12 years) and their caretakers to an intervention study to reduce symptoms. Families were recruited from 7 cities: Boston; Chicago; New York City (Manhattan and the Bronx); Dallas, Tex; Seattle, Wash; and Tucson, Ariz. The study design has been detailed elsewhere.<sup>25</sup> Eligibility required that the child had at least 1 hospitalization or 2 emergency department visits for asthma during the 6 months before screening. Census tracts with 20% to 40% of households below federal poverty guidelines were targeted. Many census tracts also were racially segregated (i.e., Black–White): Boston (39.4% vs 39%), Chicago (65.2% vs 18.5%), Manhattan (47.9% vs 22.1%), the Bronx (38.7% vs 19.3%), Dallas (44.5% vs 30.1%), Seattle (8.6% vs 69.4%), and Tucson (3.5% vs 59.1%).

After informed consent was obtained, trained bilingual interviewers administered a baseline survey to the child's primary caretaker that included questions about demographics, asthma morbidity, home environmental characteristics, exposure to tobacco smoke, the child's medication regimen and any problems with adherence, and psychosocial well-being measures described elsewhere.<sup>26</sup>

### Assessment of Exposure to Violence

A community violence survey<sup>27</sup> was administered to caretakers. Caretakers were asked whether any of the following events had occurred in their neighborhoods during the past 6 months: (1) a fight in which a weapon was used, (2) a violent argument between neighbors, (3) a gang fight, (4) a sexual assault or rape, and (5) a robbery or mugging. Answers to these 5 items were summed to produce the Adult Violence Score. Additionally, caretakers were asked (1) whether the caretaker was afraid that the child would be hurt by violence in the neighborhood, and (2) whether the caretaker did not let the child play outside because of fear of violence in the neighborhood.

### Additional Measures of Stress

The Negative Life Events (NLE) instrument is a modified version of the List of Recent Experiences<sup>28,29</sup> that has been shown to have good test–retest reliability for the scale (0.89 to 0.94) and for specific items (0.70).<sup>30</sup> Participants indicated whether they had undergone any of the enumerated experiences during the past 12 months and whether the experience in question had a positive or a negative impact. A few items (e.g., death of a family member) were assumed to be consensually negative. Total NLE score was derived by adding the number of negative experiences (either consensually rated or participant-rated).

The experience of unwanted thoughts and memories (rumination) was ascertained for each reported negative life event with this follow-up question: "In the last month, how often did you experience unwanted thoughts, memories, or images about this event?" Each item was scored on a 5-point frequency scale of "never" (0) through "very often" (4). A maximum score was based on the highest frequency of unwanted thoughts and memories reported for any experience (other than violence). Thus, if an individual reported 2 negative life events but experienced unwanted thoughts and memories only in connection with 1 of the events, the participant was classified on the basis of the higher frequency.

The 4-item Perceived Stress Scale (PSS4)<sup>31</sup> measured the degree to which respondents had felt that their lives were unpredictable, uncontrollable, and overwhelming in the preceding month (reliability=0.85). Each item was scored on a 5-point frequency scale of "never" (0) through "very often" (4), and an overall/total score was obtained by summing the items (maximum=16). Higher scores indicated greater stress.

### Sociodemographic Indicators

Socioeconomic indicators included household income, the presence of at least 1 employed adult in the household, and caretaker level of education. Housing deterioration was assessed by summing a number of problems including water damage on walls or ceilings; other evidence of leaks; damaged or rotting windows; cracks or holes in floors; and chipped, cracked, or peeling paint on walls or

windows. Race/ethnicity was categorized as Hispanic, Black, or White/other.

### Outcome Measures

Measures of morbidity included caretaker-reported wheezing, sleep disruption, or interference with play activities caused by asthma during the preceding 2 weeks and the impact of the child's asthma on the caretaker (number of nights caretaker lost sleep because of child's asthma). A measure of maximum symptom days during the preceding 2 weeks was defined as the number of days that the child experienced wheezing, sleep disturbance, or disruption of play activities because of asthma.

### Analyses

A total of 851 children and their caregivers had complete data for all covariates. We used analysis of variance (ANOVA) to examine mean outcome measures ([1] maximum symptom days and [2] nights caretakers lost sleep) by level of community violence. All analyses were adjusted for study center (site adjusted). A test for linear trend that used orthogonal polynomial coefficients was used to determine the relationship between (1) the Adult Violence Score and the mean asthma morbidity score and (2) the Adult Violence Score and the mean caretaker impact score.<sup>32</sup> Control variables were added in a stepwise fashion. We first added standard control variables, including SES, race/ethnicity, and a composite measure of general condition of the home, to ascertain whether associations we found were spurious (i.e., is level of exposure to violence merely a marker of low SES, race/ethnicity, or substandard housing stock, each of which may increase exposure to physical environmental factors related to morbidity?). We then added total NLE score to test whether the influence of violence on asthma morbidity was in part caused by greater exposure to other adverse events. Next we added hypothesized mediating variables. We introduced covariates into the linear model—individually or in sets—to determine whether they modified the effect of violence on morbidity. As covariates were added, we examined the change in the ANOVA model sums of squares related to the violence indicator. A substantial decrease in the effect size of the association between violence and the asthma morbidity

measure (i.e., percentage decrease in the violence sums of squares) would support 1 or more of these mediating pathways. We identified 2 mediating pathways—caretaker behaviors and the psychological experience of stress. Behaviors included (1) presence of smokers in the household, (2) caretakers skipping medications, and (3) caretakers not allowing the child to play outside. The stress-related predictors included (1) PSS4 score, and (2) unwanted thoughts about stressful life

events (i.e., rumination over adverse events), which is another measure of coping. A final model was adjusted for site, SES, and all potential mediating variables. Mean outcome measures adjusted for other covariates were produced for each level of the violence score.

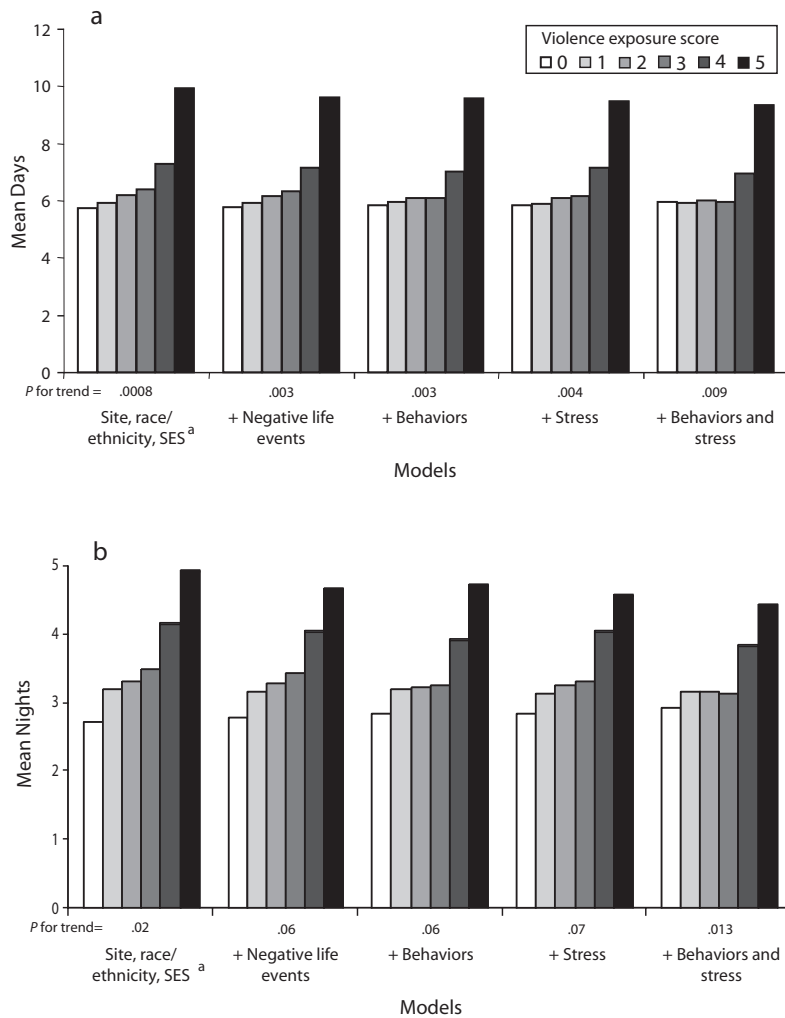
RESULTS

The frequency of caretaker-reported community violence varied across the sites: the

highest mean scores were reported in Chicago and Manhattan (1.3 and 1.4, respectively); Boston (0.9), the Bronx (1.2), and Dallas (0.89) were close behind; and the lowest mean scores were reported in Seattle (0.84) and Tucson (0.65). Caretaker reports of violent events occurring in their neighborhoods during the past 6 months were quite prevalent for certain categories of events: a fight in which a weapon was used (28%), a violent argument between neighbors (33%), a gang fight (15%), a sexual assault or rape (9%), or a robbery or mugging (21%). More than one-third of caretakers (38%) reported being afraid their child would be hurt by violence in the neighborhood and reported keeping their children indoors owing to fear of violence (34%). Table 1 shows the mean exposure-to-violence scores and the outcome measures stratified by sociodemographic factors and by control variables. Those caretakers who had higher exposure-to-violence scores were more likely to be minorities, were less likely to report at least 1 employed adult in the household, had more housing problems, had greater perceived stress, ruminated more about adverse life events, smoked more often, kept their children indoors more often, and skipped medications more often than caretakers who had lower scores.

Site-adjusted analyses showed a gradient increase in mean maximum symptom days with increasing exposure to violence ( $P=.0006$ ) (data not shown). Figure 1 shows the associations between violence exposure and mean (a) maximum symptom days or (b) nights caretaker lost sleep, adjusted for control and hypothesized mediator variables. We found no meaningful attenuation of the relationship between violence and caretaker-reported symptoms among children after we controlled for sociodemographic factors (we simultaneously adjusted for annual household income, presence of at least 1 employed adult in the home, caretaker education, housing deterioration score, and race/ethnicity) ( $P=.0008$ ). A similar graded relationship for exposure to violence and caretaker impact was seen in these adjusted analyses ( $P=.02$ ).

To assess whether level of exposure to violence was a marker for exposure to other adverse events, total NLE score was added to the model. The graded relationship between



Note. Behaviors = caretaker behaviors, including smoking, keeping children indoors, and skipping medications. Stress = Perceived Stress Scale and unwanted thoughts and memories. Each set of bars represents mean maximum symptom days (or nights caretaker lost sleep) adjusted for control variables. All models are adjusted for site, race/ethnicity, and socioeconomic status (SES) in addition to listed variates. Ps are for trends.  
<sup>a</sup>SES includes adjustment for household income, employment, caretaker education, and housing deterioration.

FIGURE 1—Mean (a) maximum symptom days and (b) nights caretaker lost sleep, by level of adult exposure to violence: adjusted analyses.

**TABLE 1—Mean Caretaker Violence Exposure Scores and Maximum Symptom Days, by Potential Control, Confounding, and Mediating Variables: Inner-City Asthma Study (n = 851, baseline assessment), August 1998–July 2001**

| Characteristic                              | n (%)      | Mean Violence Exposure Score | P      | Mean Maximum Symptom Days | P      | Mean Nights Caretaker Lost Sleep | P      |
|---------------------------------------------|------------|------------------------------|--------|---------------------------|--------|----------------------------------|--------|
| Caretaker race/ethnicity                    |            |                              |        |                           |        |                                  |        |
| Hispanic                                    | 364 (42.8) | 0.96                         |        | 5.93                      |        | 3.15                             |        |
| African American                            | 340 (40.0) | 1.16                         |        | 6.48                      |        | 3.19                             |        |
| White/mixed/other                           | 146 (17.2) | 1.05                         | .1238  | 5.52                      | .1181  | 2.74                             | .5238  |
| Household income, \$                        |            |                              |        |                           |        |                                  |        |
| < 15 000                                    | 512 (60.2) | 1.11                         |        | 6.40                      |        | 3.33                             |        |
| ≥ 15 000                                    | 339 (39.8) | 0.96                         | .0973  | 5.58                      | .0203  | 2.72                             | .0360  |
| At least 1 employed adult in household      |            |                              |        |                           |        |                                  |        |
| No                                          | 207 (24.3) | 1.33                         |        | 6.77                      |        | 3.81                             |        |
| Yes                                         | 644 (75.7) | 0.96                         | .0003  | 5.85                      | .0206  | 2.86                             | .0042  |
| Caretaker education                         |            |                              |        |                           |        |                                  |        |
| High school graduate                        | 600 (70.5) | 1.07                         |        | 6.12                      |        | 3.07                             |        |
| Not a high school graduate                  | 251 (29.5) | 1.02                         | .5746  | 5.96                      | .6821  | 3.14                             | .8096  |
| No. of housing problems                     |            |                              |        |                           |        |                                  |        |
| 0                                           | 355 (41.7) | 0.88                         |        | 5.86                      |        | 2.76                             |        |
| 1                                           | 267 (31.4) | 1.14                         |        | 5.94                      |        | 3.02                             |        |
| 2                                           | 82 (9.6)   | 1.35                         |        | 6.32                      |        | 4.04                             |        |
| 3                                           | 60 (7.0)   | 1.32                         |        | 6.55                      |        | 3.80                             |        |
| 4                                           | 38 (4.5)   | 1.18                         |        | 7.42                      |        | 3.50                             |        |
| 5                                           | 23 (2.7)   | 0.78                         |        | 6.30                      |        | 3.22                             |        |
| 6                                           | 26 (3.1)   | 1.08                         | .0106  | 6.35                      | .6134  | 3.00                             | .1964  |
| Smoking in household                        |            |                              |        |                           |        |                                  |        |
| No                                          | 432 (50.8) | 0.97                         |        | 5.66                      |        | 3.01                             |        |
| Yes                                         | 419 (49.2) | 1.14                         | .0583  | 6.50                      | .0133  | 3.17                             | .5745  |
| NLEs score (quartiles)                      |            |                              |        |                           |        |                                  |        |
| 1st                                         | 368 (43.2) | 0.79                         |        | 5.70                      |        | 2.77                             |        |
| 2nd                                         | 130 (15.3) | 0.85                         |        | 5.58                      |        | 2.58                             |        |
| 3rd                                         | 184 (21.6) | 1.32                         |        | 6.74                      |        | 3.69                             |        |
| 4th                                         | 169 (19.9) | 1.50                         | <.0001 | 6.54                      | .0435  | 3.51                             | .0218  |
| Unwanted thoughts about adverse life events |            |                              |        |                           |        |                                  |        |
| Never                                       | 296 (34.8) | 0.74                         |        | 5.55                      |        | 2.76                             |        |
| Almost never                                | 53 (6.2)   | 0.81                         |        | 5.74                      |        | 2.64                             |        |
| Sometimes                                   | 191 (22.4) | 1.07                         |        | 5.90                      |        | 2.80                             |        |
| Fairly often                                | 135 (15.9) | 1.04                         |        | 5.82                      |        | 2.79                             |        |
| Very often                                  | 176 (20.7) | 1.65                         | <.0001 | 7.44                      | .0017  | 4.33                             | .0006  |
| PSS4 score (quartiles)                      |            |                              |        |                           |        |                                  |        |
| 1st                                         | 229 (26.9) | 0.84                         |        | 5.43                      |        | 2.73                             |        |
| 2nd                                         | 262 (30.8) | 1.11                         |        | 6.11                      |        | 3.14                             |        |
| 3rd                                         | 194 (22.8) | 0.96                         |        | 6.12                      |        | 3.19                             |        |
| 4th                                         | 166 (19.5) | 1.37                         | .0004  | 6.85                      | .0493  | 3.41                             | .4241  |
| Ever skip medications                       |            |                              |        |                           |        |                                  |        |
| No                                          | 550 (64.6) | 0.97                         |        | 5.57                      |        | 2.83                             |        |
| Yes                                         | 301 (35.4) | 1.21                         | .0088  | 7.00                      | <.0001 | 3.56                             | .0146  |
| Afraid to let child play outside            |            |                              |        |                           |        |                                  |        |
| No                                          | 559 (65.7) | 0.82                         |        | 5.71                      |        | 2.66                             |        |
| Yes                                         | 292 (34.3) | 1.51                         | <.0001 | 6.76                      | .0037  | 3.90                             | <.0001 |

Note. NLE = Negative Life Events instrument; PSS4 = 4-item Perceived Stress Scale.

violence and morbidity markers remained significant.

Caretaker behaviors as mediating variables were then considered. Adjustments for smoking, keeping the child indoors, and skipping medications attenuated the gradient relationship between violence and morbidity markers. A significant trend remained for symptoms ( $P=.003$ ), although the association was borderline significant for caretaker impact ( $P=.06$ ). The decrease in impact of violence was not uniform across the gradient. The greatest absolute attenuation occurred in groups with lower levels of exposure to violence (i.e., violence exposure score  $\leq 3$ ).

When we adjusted for measures of psychological stress, including the PSS4 score and the frequency of unwanted thoughts and memories, exposure to violence remained an independent predictor of mean maximum symptom days ( $P=.004$ ). We found attenuation of the graded relationship between violence and morbidity markers after we added these other measures of stress. Again, the greatest attenuation occurred in the groups with the lowest levels of exposure to violence. Notably, when frequency of other negative life events and the unwanted thoughts and memories were added together in models predicting asthma morbidity, negative life events were no longer significant ( $P=.5$ ), sug-

gesting that chronic reexperiencing of adverse life events may have a greater impact than discrete events.

In a final model adjusted for SES, other negative life events, perceived stress, unwanted thoughts and memories, and caretaker behaviors, increased exposure to violence was still associated with greater mean maximum symptom days ( $P=.009$ ) and caretaker's losing sleep ( $P=.13$ ), with more attenuation of the gradient in the groups with the lowest levels of exposure to violence.

To determine the relative contribution of the standard control variables and the purported mediators in explaining the effect of exposure to violence on morbidity, we examined the differences in the sums of squares associated with the violence exposure score alone in site-adjusted models and the sums of squares related to violence, and we adjusted for each covariate as it was added. The percentage decrease in the violence exposure sums of squares when each control variable was added is shown in Table 2. Socioeconomic indicators and smoking in the home explained relatively little of the effect of violence. Conversely, experiencing other negative life events and the occurrence of unwanted thoughts and memories of adverse events individually explained the greatest proportion of change in the violence exposure

sums of squares. An intermediate proportion of change in the violence exposure sums of squares was explained by caretaker-perceived stress, skipping medications, and keeping the child indoors more often.

In subsequent models that adjusted for multiple variables, we again assessed by determining the percentage decrease in the violence exposure sums of squares in the respective multivariate models the relative contribution of the combined covariates in explaining the effect of exposure to violence. After we controlled for site, socioeconomic indicators, and race/ethnicity, 6% of the violence exposure effect was explained for symptoms and 11% for caretaker impact (i.e., on the basis of a 6% and 11% decrease in the violence exposure sums of squares in the respective models). After all behaviors were added with standard control variables (site, SES, race/ethnicity), 34% of the effect of exposure to violence was explained for symptoms and 50% for caretaker impact. After the other measures of stress were added with standard controls, 36% of the violence exposure effect was explained for symptoms and 51% for caretaker impact. A fully adjusted model including standard control variables, other negative life events, stress measures (perceived stress, unwanted thoughts and memories), and the behavior variables accounted for 46% of violence exposure effect for mean maximum symptom days and 70% for nights caretaker lost sleep.

DISCUSSION

As in previous studies,<sup>10-13</sup> a high prevalence of exposure to violence among the inner-city families was found. Greater exposure to violence was independently associated with asthma morbidity after simultaneous adjustment for income, employment status, caretaker education, housing problems, and other adverse life events, which suggests that exposure to violence was not merely a marker for these other factors. Psychological stress and caretaker behaviors (keeping children indoors, smoking, and skipping medications) partially explained the association between higher exposure to violence and increased asthma morbidity, although the greatest attenuation occurred among caretakers who re-

TABLE 2—Percentage Decrease in Violence Exposure Sums of Squares After Each Variable Is Added Individually to the Model With Violence

| Added Variable                            | Decrease in Violence Exposure Sums of Squares, %     |                                                             |
|-------------------------------------------|------------------------------------------------------|-------------------------------------------------------------|
|                                           | Exposure to Violence Predicting Maximum Symptom Days | Exposure to Violence Predicting Nights Caretaker Lost Sleep |
| Socioeconomic status indicators           |                                                      |                                                             |
| Income category                           | 3.0                                                  | 2.6                                                         |
| Household employment                      | 7.0                                                  | 10.6                                                        |
| Caretaker education                       | 0.37                                                 | -0.31                                                       |
| Housing problems                          | 1.2                                                  | 1.9                                                         |
| Caretaker behaviors                       |                                                      |                                                             |
| Smoking at home                           | 7.7                                                  | 1.7                                                         |
| Skipping medications                      | 14.0                                                 | 12.5                                                        |
| Caretaker will not let child play outside | 18.1                                                 | 37.3                                                        |
| Negative life events                      | 25.2                                                 | 30.6                                                        |
| Experience psychological stress           |                                                      |                                                             |
| Unwanted thoughts                         | 31.4                                                 | 40.7                                                        |
| Perceived stress                          | 18.1                                                 | 16.7                                                        |

ported lower levels of exposure to violence. These findings suggest that other mechanisms are operating between high-level exposure to violence and childhood asthma morbidity.

The impact of exposure to violence on asthma morbidity was, in part, attenuated through psychological experiences of stress (i.e., the degree to which participants felt that their lives were uncontrollable, unpredictable, or overwhelming and the occurrence of unwanted thoughts and memories in connection with other adverse events), supporting the notion that exposure to violence is a pervasive stressor that adds to environmental demands imposed on an already vulnerable population.<sup>33</sup> Living in a violent environment is associated with a chronic, pervasive atmosphere of fear and the perceived threat of violence.<sup>34,35</sup> Families who live with violence are more likely than those not exposed to violence to view their world and their lives as being out of their control.<sup>36</sup> Facing daily life experiences in an unpredictable or an uncontrollable environment may predispose these populations to suffer more deleterious effects from stress.<sup>37</sup>

Psychological stress has been associated with disturbed regulation of the hypothalamic-pituitary-adrenal (HPA) axis. An optimal level of mediators is needed to maintain a functional balance, and the absence of appropriate levels of glucocorticoids and catecholamines may allow immune mediators to overreact, thereby increasing the risk of inflammatory disorders, such as asthma.<sup>38,39</sup> In this framework, exposure to violence may be a psychosocial environmental factor that can “get into the body” and result in long-term biological changes that contribute to asthma morbidity.

Life events can have long-term effects on stress through lasting psychological, behavioral, and physiological responses maintained by recurrent unwanted thoughts about past events.<sup>40</sup> Caretakers who reported higher levels of exposure to violence were more likely to ruminate. Ongoing rumination may have an impact on problem-solving skills, may erode perceived control, and may decrease motivation to manage ongoing challenges, including management of a chronic illness such as asthma.<sup>41</sup> Caregivers who use ruminative coping strategies may experience greater

stress and psychological comorbidity<sup>42</sup> that may more directly influence a child. Growing evidence links caregiver stress to the stress responses of their offspring. Animal and human studies suggest that caregiver stress may influence the stress response of the child and may modify infant neuroendocrine function during early development.<sup>43–45</sup> It also is possible that caretaker exposure to violence resulting in posttraumatic stress symptoms (e.g., avoidance, rumination) may cue their children to adopt less effective coping strategies, so that the children themselves experience greater stress.<sup>46</sup> This area of study warrants further research.

Poor adherence to medication regimens partially explained the relationship between exposure to violence and asthma. Coping with a violent environment may have an impact on compliance with therapy and with medical follow-up. Living in a violent community has been conceptualized as a barrier to keeping appointments and to following prescribed exercise programs.<sup>47</sup> Fearing to make a trip to a pharmacy or a medical facility may lead to lapses in prophylactic medication use, delayed intervention, and higher morbidity. Ruminative coping may influence problem-solving behaviors, which may impede compliance. Other unmeasured barriers to medication adherence may exist; for example, pharmacies may be reluctant to remain open 24 hours a day in high-crime communities. Exposure to violence may have an impact on access to medical care by diverting limited funds away from primary care and asthma specialty clinics.<sup>48</sup> Future research exploring other potential mediating pathways may contribute to more effective intervention strategies targeting high-risk urban populations.

Keeping children indoors also mediated the violence exposure and asthma relationship in our study. Children who are kept indoors will be more sedentary than those who go outside. This sedentariness may be linked to obesity, which has increased among US families who live in poverty<sup>49</sup> and has been linked to asthma.<sup>50,51</sup> Another reasonable hypothesis is that children who are restricted from going outside may have greater exposure to aeroallergens and increased likelihood of sensitization. Further research is needed to systematically examine this hypothesis.

Unexpectedly, smoking had little impact on the association between exposure to violence and asthma, perhaps because smoking is a strategy to cope with stress<sup>52</sup> that is related to violence.<sup>19</sup> This finding may reflect the fact that smoking was considered a dichotomous predictor, and we did not account for dose (i.e., number of cigarettes per day) or misclassification of self-reported smoking.

Exposure to violence and asthma morbidity were related in a graded fashion, even after we adjusted for socioeconomic indicators. The greatest absolute attenuation of the gradient occurred at the lowest level of exposure to violence, after we controlled for potential mediators. The relationship between the highest level of exposure to violence and increased asthma morbidity was not influenced by caretaker behaviors, perceived stress, or recurrent memories. Other factors important in explaining the association at the highest level of exposure to violence (i.e., that covary with high rates of exposure to violence) may not have been measured or cannot be fully adjusted for when accounting for individual-level SES factors. Crime and violence (or their absence) can be thought of as indicators of collective well-being or social cohesion within a community,<sup>53,54</sup> constructs increasingly linked to health.<sup>55</sup>

Neighborhood disadvantage, including higher crime rates and community violence, is enhanced in more racially segregated communities.<sup>56</sup> Segregated minority group status may predispose individuals to other pervasive stressors (e.g., discrimination, institutionalized violence, police injustice), a lack of infrastructure of the sort facilitating healthy living (e.g., fewer facilities for healthy physical recreation or purchase of healthy foods), and other societal factors that link minorities with neighborhood disadvantage.<sup>57,58</sup> Thus, individuals in these communities may face multiple social challenges simultaneously. Whereas individual psychosocial stressors may have small effects, cumulative stressors (at the individual and ecological levels) can enormously increase the likelihood of adverse health outcomes.<sup>59</sup>

Marginalized groups are disadvantaged not only in their vulnerability to adverse events but also in their access to coping resources.<sup>60,61</sup> Parents who are worried about their children's safety may restrict their social

behavior; thus, the family's ability to develop support networks may be compromised (i.e., exposure to violence may lead to diminished stress-buffering factors). These additional supports are especially important to the well-being of populations faced with the cumulative effects of many ecological stressors.

## CONCLUSIONS

High crime rates and, thus, the real or perceived threat of violence are aspects of the inner-city environment that have an impact on the psychological and physiological functioning, as well as the health-promoting behaviors, of the inhabitants. Exposure to violence contributes to the environmental demands that tax both individuals and the communities in which they live. Systematic exploration of an association between exposure to violence (an urban stressor) and asthma may help us understand the rise in morbidity and further our understanding of the disproportionate asthma burden among poor urban children. ■

### About the Authors

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H. Mitchell, J. Stout, and R. Evans participated in the conceptualization of the study and the implementation of the Inner-City Asthma Study as principal investigators at their respective study sites. H. Mitchell, S. Cohen, D.R. Gold, and R.J. Wright guided the inclusion of stress measures in the parent study. H. Mitchell and C.M. Visness conducted the analyses and were guided by input from all of the authors. R.J. Wright synthesized the analyses and led the writing. All of the authors interpreted the findings and reviewed drafts of the article.

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### Human Participant Protection

This study was approved by the institutional review boards of all participating institutions.

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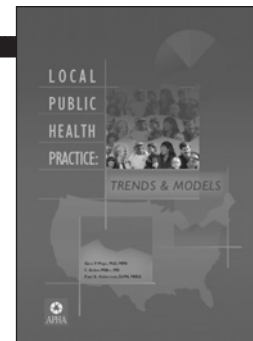
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