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Asthma and Behavior in Homeless 4- to 7-Year-Olds

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KEY WORDS
homeless, asthma, disparity, academic function, conduct problems, ADHD, executive function

ABBREVIATIONS
ADHD—attention-deficit/hyperactivity disorder
ED—emergency department
EF—executive function
HBQ—Health and Behavior Questionnaire
NS—not significant
ANCOVA—analysis of covariance
CI—confidence interval

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WHAT'S KNOWN ON THIS SUBJECT: Asthma is more prevalent, more severe, less well managed, and linked to negative developmental and worse health outcomes among low-income children who live in urban areas. This is also the case for children who experience homelessness.

WHAT THIS STUDY ADDS: Asthma was reported for 27.9% of homeless children in this sample, ~3 times the national average. Children with asthma had been hospitalized more often, showed higher levels of inattention/hyperactivity and behavior problems, and evidenced lower academic functioning.

abstract

OBJECTIVE: Low-income, urban, ethnic minority children have higher rates of asthma, more severe symptoms, and more management issues, as well as high risk for academic and behavior problems. This study focused on asthma reported in young children who resided in a family emergency homeless shelter. Asthma rates were considered along with their relation to hospitalization and emergency department use and behavior that is important for school success, including cognitive function, conduct, and academic functioning.

METHODS: A total of 104 children (age 4.0–7.5 years) and parents were recruited while residing in an urban emergency homeless shelter for families. Children had no previously identified developmental delays and spoke English proficiently. Parents reported whether the child experienced asthma, as well as emergency department use and hospitalization. Parents and teachers completed measures of child inattention/hyperactivity and behavior problems. Cognitive function of children was directly assessed.

RESULTS: Asthma was reported for 27.9% of children, ~3 times the national average. Children with asthma had been hospitalized more often, showed higher levels of inattention/hyperactivity and behavior problems, and evidenced lower academic functioning.

CONCLUSIONS: Young children in homeless family emergency shelters have high rates of asthma and related problems that could lead to higher hospitalization rates, more behavioral problems, and lower academic functioning at school. Screening and treatment of children who stay in emergency family shelters may be particularly important for reducing risks associated with asthma in highly mobile, low-income families. *Pediatrics* 2010;125:145–151

Asthma is the most common chronic childhood illness in the United States, with a prevalence of 8.9% nationwide and 7.8% in Minnesota.[1] There are disparities in childhood asthma diagnoses, with higher rates among minority children, especially those of low socioeconomic status in urban areas.[1–8] National Center for Health Statistics[9] data show wide and increasing ethnic/racial disparities in asthma. In 1980–1981, the 12-month asthma prevalence was 15% higher for black than for white children, and by 1995–1996, the gap had increased to 26% higher. In 2004–2005, national data indicated prevalence for black children at 12.8% compared with 7.9% for white children.[1]

There are also differences in asthma severity, management/types of service use, and mortality by racial group. In 2003–2004, national data showed that, compared with white children, black children had >3.5 times the number of emergency department (ED) visits for asthma, >3.5 times the number of hospital stays, and 6 times as many asthma-related deaths.[1] High rates of asthma-related problems are reported for urban minority children. Among children who were younger than 12 years in the Harlem section of New York City, 30.3% of this primarily black sample had asthma-like symptoms, and 28.5% had been told by a doctor or a nurse that they had asthma.[10] A total of 34.9% of children with asthma had sought asthma-related treatment in an ED or other unscheduled setting in the preceding 3 months, and 8.3% were hospitalized overnight. High asthma prevalence (15%) was also found in a predominantly black sample of kindergarten-aged children in inner-city Rochester, New York.[11]

Asthma prevalence is high among urban homeless children, a group in which ethnic minorities are overrepresented. McLean et al[12] estimated the true asthma prevalence to be 39.8% on the basis of symptoms among homeless children at 3 New York City shelters in 1998–1999, with 26.9% of the sample receiving a diagnosis from a physician. A study from 1999 to 2002[13] found an overall prevalence of 33%, with 17% previously receiving a physician's diagnosis.

Homeless children had high rates of more severe diagnoses and were more likely to manage their condition poorly. Approximately 43% of the children with asthma symptoms displayed moderate or severe persistent symptom severity in 1998–1999.[12] Only 12% to 15% of children were taking an appropriate asthma controller medication. In addition, between 56% and 59% of the children with asthma had visited an ED in the preceding 12 months.

In recent years, growing attention has been directed toward the impact of asthma on child development across domains of functioning. Generally, more severe asthma diagnoses are associated with more and greater impairments in other domains.[14–17] In the Rochester study, more severe asthma diagnoses were related to behavior problems across a number of areas.[11] Calam et al[18] found that 3-year-olds with asthma were at risk for behavior problems. In national data from the United Kingdom, children with asthma were more likely to have externalizing behavior problems such as hyperkinetic and/or conduct diagnoses,[19] but this difference seemed to be a function of overall physical health. An exception, however, was found for attention-deficit/hyperactivity disorder (ADHD) symptoms in the school context, which were elevated for children with asthma, even in good health.

Results are mixed with respect to academic achievement and asthma. Overall, asthma seems to impart a small risk for poor school outcomes,[20,21] although the preponderance of this evidence is based on samples of older children and children with less severe forms of asthma. Consequently, such findings may underrepresent the risk for other groups. A study of inner-city preschoolers found that those with asthma scored lower on a measure of school readiness and needed additional help when learning.[16] There has been a call for additional research on younger children and the impact of more severe asthma.[15,21] These findings contrast with data indicating that children with asthma are not overrepresented among those with problems of conduct, attention, neurocognitive development, or academic functioning[22–25]; however, most of the relevant evidence to date is based on samples of children who are older, are white, and/or have less severe forms of asthma.

There is a need for additional research on asthma and its significance for adaptive functioning, particularly among young, disadvantaged, urban minority children, who tend to have high rates and more severe forms of asthma. This study was designed to begin filling this gap by examining asthma and its links to adjustment in young children who resided in a homeless shelter. Asthma status was expected to relate to more ED visits and hospitalizations, consistent with asthma that is more severe and/or less well managed. Children with asthma were expected to show higher levels of inattention/hyperactivity symptoms and other behavior problems and lower school success. Finally, differences in general cognitive function were explored, given their importance to school success and competence in other domains.

METHODS

Participants

Families who were staying in a Minneapolis emergency shelter were re-

TABLE 1 Characteristics of the Asthma and Nonasthma Groups

Characteristic	Asthma	No Asthma	Total
Total	29	75	104
Gender			
Female	10	33	43
Male	19	42	61
Age, mean ± SD, yr	6.01 ± 0.75	5.98 ± 0.70	5.99 ± 0.71
Minority status, *n* (%)	29 (100)	72 (96)	101 (97)
Race/ethnicity			
Black	23	61	84
Multiracial	6	9	15
White	0	3	3
Native American	0	2	2

cruited to participate in 2 waves. The first wave occurred in the summer/fall of 2006, and the second occurred in the summer of 2007. Caregivers provided informed consent, and all procedures were approved by the University of Minnesota institutional review board. Families included a child who was aged between 4.0 and 7.5 years, did not have an identified developmental delay, and spoke English proficiently. One family had a child participate in wave 1 and a sibling in wave 2. All other children were from different families. Approximately 85% of all eligible families agreed to participate in the study. This resulted in a total sample of 104 children (wave 1: $n = 66$; wave 2: $n = 38$). Demographic characteristics are provided in Table 1.

Measures

Cognitive Measures

Children completed developmentally appropriate tests of general cognitive function by using standardized measures of intellectual function and a battery of executive function (EF) tasks with strong predictive validity for school success.

General Intellectual Function (IQ Estimate)

In wave 1, 3 subtests of the Wechsler Intelligence Scales were used to estimate general intellectual function, including block design, matrix reasoning, and vocabulary. These subtests have acceptable reliability, including good psychometric properties for low-income and minority children, and together compose an acceptable estimate of overall intellectual function as measured by traditional IQ measures.[26] For wave 1, a composite score on these measures showed good coherence and predictive significance for school outcomes. Nonetheless, the vocabulary test proved challenging for many children and a considerable time burden; therefore, in wave 2, the Peabody Picture Vocabulary Test, Fourth Edition[27] was substituted for the Wechsler vocabulary subtest. The Peabody Picture Vocabulary Test, Fourth Edition has shown greater appeal for disadvantaged children; predictive validity for school performance; and moderate to high correspondence to other standardized, well-validated assessments of verbal abilities, such as the Wechsler verbal scales.[28–30] For each wave, scaled scores for each test were converted to *z* scores and averaged to produce an estimate of general intellectual function, or IQ, for each child. All children completed the age-appropriate version of the Wechsler scales: The Wechsler Preschool and Primary Scale of Intelligence, Third Edition[31] for children aged ≤7 years 3 months of age and the Wechsler Intelligence Scale for Children, Fourth Edition[32] for children ≥7 years 4 months of age.

Executive Functioning

Four EF tasks were administered to each child as an additional measure of cognitive skills predictive of school adjustment,[33] such as controlling attention, inhibiting impulses, and cognitive flexibility in following rules. The first task, Simon Says,[34] requires the child to imitate the experimenter's behavior during activation trials (preceded by, "Simon says") and inhibit responses after commands that were not prefaced with, "Simon says." The Peg Tapping Task[35] requires the children to inhibit the prepotent response of mimicking the behavior of the experimenter across 16 counterbalanced trials. In the third task, the Computerized Pointing Stroop, the child is presented with 16 congruent trials followed by 16 incongruent trials in which he or she must inhibit the prepotent response of selecting the congruent stimulus.[36] The final task is a version of the Dimensional Change Card Sort,[37,38] whereby children must first sort 6 cards on the basis of color and then must shift and maintain a new rule set to sort 6 cards on the basis of shape. Scores on the 4 tasks were standardized with a *z* transformation, then composited as a single mean score (Cronbach's $\alpha = 0.74$).

Primary caregivers provided demographic information and completed the MacArthur Health and Behavior Questionnaire (HBQ).[39] Relevant to our study, the HBQ provides caregiver-report scores on externalizing and ADHD symptoms. Symptom scores are continuous variables that reflect the level of symptoms for each child. Caregivers also responded to the item, "Has your child ever had asthma?" to denote asthma status. Caregivers provided information regarding ED use and hospitalizations, as well as current medications.

During the subsequent school year, 1 of each child's teachers completed the

teacher version of the HBQ.[39] This produced scores that reflected ADHD symptom levels, externalizing symptom levels, and the child's overall level of academic functioning.

Missing Data

Parent report of asthma status was completed for all children, and IQ estimates were complete for all but 1 child. Seventeen (14.3%) participants were missing valid scores on at least 1 EF task, and 1 participant was missing all EF scores. Twenty-two (21.2%) participants did not have teacher data, primarily because the child could not be located after the family left the shelter.

Data were missing at random and addressed through multiple imputation using SAS/Stat PROC MI.[40] Twenty data sets were created, and then values were averaged to create a single data set for analyses. Analyses were rerun using nonimputed data, and the pattern of findings did not meaningfully change. Results that used imputed data are presented.

RESULTS

Twenty-nine (27.9%) caregivers indicated that their children had asthma. The asthma and nonasthma groups did not differ by age ($t_{102} = -0.22$; not significant [NS]) or gender ($\chi^2 = 0.78$; not significant). Ten children (34% of the asthma group) were receiving asthma-related medication: 9 were receiving an albuterol inhaler, and 1 was receiving a low-dose inhaled corticosteroid. Unfortunately, no information was collected about whether the family actively saw a physician to manage the child's treatment. Children with asthma were more likely to have been hospitalized overnight ($\chi^2 = 7.59$; $P < .01$). Among children with asthma, 41.4% had at least 1 overnight hospitalization, and nearly one quarter (24.1%) of these children had been hospitalized overnight at least once because of asthma.

TABLE 2 Means for Asthma and Nonasthma Groups

Variable	Asthma	No Asthma	Entire Sample
Any ED visit in past year, *n* (%)	14 (48)	24 (32)	38 (37)
Ever hospitalized, *n* (%)[a]	12 (41)	12 (16)	24 (23)
Cognitive abilities, mean ± SD			
EF tasks	−0.11 ± 0.77	0.05 ± 0.74	0.00 ± 0.75
Intelligence estimate	−0.20 ± 0.82	0.08 ± 0.87	0.00 ± 0.86
ADHD symptoms, mean ± SD			
Parent report[b]	0.98 ± 0.48	0.74 ± 0.51	0.80 ± 0.51
Teacher report	0.95 ± 0.53	0.75 ± 0.48	0.81 ± 0.50
Externalizing symptoms, mean ± SD			
Parent report[c]	0.53 ± 0.44	0.39 ± 0.35	0.43 ± 0.38
Teacher report[c]	0.53 ± 0.37	0.37 ± 0.36	0.41 ± 0.36
Academic functioning[a]	2.90 ± 0.62	3.31 ± 0.67	3.19 ± 0.68

[a] $P < .01$.
[b] $P < .05$.
[c] $P < .1$.

No group differences emerged regarding ED use in the past year ($\chi^2 = 2.39$; NS). Overall, ED use was high in the sample (36.5%). Nearly half (48.3%) of all children in the asthma group visited an ED in the past year, and 27.6% of children in the asthma group used the ED at least once because of asthma. Asthma was the most common reason for all ED visits among these children (64.7%).

Three multivariate analysis of covariance (ANCOVA) tests were conducted to evaluate differences in cognitive skills, ADHD symptoms, and externalizing symptoms. All of the models controlled for the effects of age and gender on the dependent variables. For models that involved ADHD and externalizing symptoms, teacher-report and parent-report scores were included as separate dependent variables to test for group differences across contexts. Effects in the multivariate models below a P value $< .10$ were examined for each outcome separately by using univariate models (ANCOVAs), given constraints of power related to sample size and unbalanced groups. Univariate models were considered significant at a P value $< .05$. Standardized effect sizes are provided in the form of Cohen's d statistics on the basis of univariate models. Variables are summarized in Table 2.

First, we tested a model whereby asthma status predicted performance on EF tasks and IQ estimate. Asthma status was not related to current cognitive function ($F_{2,99} = 2.20$; NS).

The second model tested the relationship between asthma status and ADHD symptoms. Children with asthma had higher levels of ADHD symptoms in the multivariate model ($F_{2,99} = 2.88$; $P = .06$). Follow-up ANCOVAs revealed that children with asthma had higher symptom levels but only for parent-reported ADHD symptoms ($F_{1,100} = 4.72$; $P < .05$; Cohen's d = 0.47; [95% confidence interval (CI): 0.041–0.90]), with no difference on teacher-reported ADHD symptoms ($F_{1,100} = 2.55$; NS; d = 0.23 [95% CI: −0.08 to 0.74]).

The third multiple ANCOVA investigated differences in externalizing symptoms. Parent-report and teacher-report scores both violated normality assumptions, so corrective square-root transformations were applied. Untransformed means and SDs are presented in Table 2. The multivariate model suggested that children with asthma were higher in externalizing symptoms ($F_{2,99} = 2.68$; $P = .07$). Univariate models revealed that children

with asthma were marginally higher in externalizing symptoms for both parent-report ($F_{1,100} = 3.11$; $P = .08$; d = 0.38 [95% CI: −0.05 to 0.81]) and teacher-report measures ($F_{1,100} = 3.74$; $P = .06$; d = 0.42 [95% CI: −0.01 to 0.86]).

Finally, an ANCOVA tested for differences in teacher-rated academic functioning. Children with asthma had lower levels of academic functioning ($F_{1,100} = 7.60$; $P < .01$; d = −0.58 [95% CI: −1.00 to 0.16]), controlling for gender and age.

DISCUSSION

In line with previous research, the asthma rate among homeless children exceeded national averages. According to parents, the asthma rate was 27.9% in this sample of 4- to 7-year-olds, 3 times the national and 3.5 times the state rates. This high rate may underestimate the true prevalence, because other studies have found many undiagnosed children with asthma but symptoms at screening, particularly for low-income minority children.[12,13] In this study, only 34% of children with asthma were receiving any medication for their condition, 48% had visited an ED in the preceding year, and these children were more likely to have been hospitalized overnight in their lifetime compared to peers without asthma. These findings are in line with other estimates of the prevalence of asthma among inner-city minority and homeless children.[10,12,13] This study further documents disparities in asthma among underprivileged urban minority children in general and homeless children in particular.

Asthma was linked to higher levels of conduct and ADHD symptoms, although not to differences in cognitive function. Children with asthma had higher parent-reported ADHD scores, consistent with other studies,[17] and the differences were more robust than some other associated impairments.[19] It is interesting that asthma was not related to EF performance or ADHD problems in school. Asthma was related to conduct problems as rated by both parents and teachers and to parent report of ADHD symptoms, which may reflect a single cluster of disruptive behavior problems in these young children.[18,19] Asthma did not reflect a general problem in cognitive development.[22–25] The processes underlying the association of asthma to behavior need to be considered further.

Children with asthma had lower levels of academic success. Other studies that failed to find an effect of asthma on functional impairment or academic achievement were disproportionately focused on older, white children, who tend to have lower rates of severe asthma diagnoses.[20,21,23] Our finding is consonant with results by Haltermann et al[16] linking asthma with lower levels of school readiness and higher levels of learning difficulties among inner-city preschoolers. The association between asthma and reduced academic success may be stronger among younger, urban children who experience poverty.

This study relied on parent report of asthma status. In past studies, large numbers of homeless children expressed asthma symptoms but had never received a diagnosis.[3,12,13] For better estimation of the true asthma rate, future efforts need to include direct assessments or screening for asthma symptoms. A pediatric assessment would also inform the severity of asthma symptoms. Other research has found that a significant percentage of homeless children have a persistent level of asthma symptoms[12] and would benefit from controller medication. Only 1 child in this sample was receiving an inhaled corticosteroid, and few were receiving any medication. This might mean that children with a persistent level of symptoms are being poorly treated, and our findings may reflect associations between poorly controlled symptoms and not merely an asthma diagnosis.

Another limitation involves the type of data available. Although this study included prospective data on the significance of an asthma diagnosis for subsequent school adjustment, longitudinal data are needed to link ongoing assessments of health to repeated assessments of school attendance, health care, and behavior.

Asthma may be linked to adaptive behavior through various developmental pathways. These processes need to be examined at multiple levels of analysis, as called for by researchers of childhood asthma[15] and developmental psychopathology.[41,42] Processes that link asthma and outcomes likely involve interactions across the levels of genes; physiologic function; psychological functioning; and the external contexts of a child's life, such as the physical environment, family, school, and the broader macrosystem. Homeless children are affected by health and housing policies, as well as proximal influences related to parenting and health care access. This study was unable to account for many factors that may be key in the link between asthma and negative outcomes, including how well the child was adhering to prescribed medications or whether there was a disruption in care. The sources of the increased prevalence of asthma and its influence on the development of poor, inner-city, minority children most likely lies in the interaction of many factors across levels.

CONCLUSIONS

Homeless children showed elevated rates of asthma, ≥3 times the national and state prevalences. Their condi-

tions seemed to be severe and poorly managed, judging from the high number who had been to an ED or hospitalized as a result of asthma and the low number who were receiving medication. Asthma was also linked to higher levels of behavior problems and worse academic functioning. These findings underscore the importance of screening and treatment for asthma among children in shelters. Asthma in children from residentially unstable, low-income families seems to be a prevalent problem and may not be effectively managed because of disruptions in health care or high levels of family stress.

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The Buzz on Nanobees: *Bee venom appears to be the latest discovery in cancer chemotherapy. An article in* The Wall Street Journal *(Loftus P,* The Wall Street Journal*, September 29, 2009) describes the results of research done at Washington University in St. Louis where melittin, an ingredient in bee venom was shown to slow tumor growth in mice. This substance had been identified in earlier studies, but was not being tested because it appeared harmful to healthy red blood cells as well as tumor cells. The researchers in St. Louis, however, have found a way to shield healthy cells using nanotechnology: they attach the melittin to nanoparticles, ultra-tiny spheres made of perfluorocarbon, lipids, and lecithin, that have a ligand attached that is specific for a particular tumor cell. These nanoparticles, when combined with melittin, create nanobees that pinpoint a tumor cell and destroy it like a bee stinging only its target while avoiding other toxic side effects. Work with nanobees is currently only occurring in animal trials, but promising results like these mean clinical trials may not be too far behind.*

Noted by JFL, MD

Asthma and Behavior in Homeless 4- to 7-Year-Olds

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