

Caregiver-Reported Asthma Control Predicts Future Visits, Independent of Guideline-Based Control Measures



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What is already known about this topic? Caregiver perception of a child's asthma control and symptom-based asthma control is often discordant.

What does this article add to our knowledge? In these 2 study populations, caregiver-reported asthma control status predicted asthma-related future acute visits, independent of guideline-based assessment of control.

How does this study impact current management guidelines? Caregiver-reported asthma control may provide important complementary information to guideline-based control assessment in determining the risk of future acute visits.

BACKGROUND: It is unknown whether caregiver perception of a child's asthma control, independent of guideline-based asthma control assessment, is a predictor of future acute visits.

OBJECTIVE: To determine whether caregiver-reported asthma control is an indicator of future risk of acute visit.

METHODS: Two study populations of low-income, minority 5- to 17-year-old children with persistent asthma were included. Questionnaires administered at baseline and at 3, 6, 9, and 12 months captured symptoms, short-acting β -agonist use, acute visits in the previous 3 months, and caregiver-reported asthma control. Well-controlled, not well-controlled, and very poorly controlled asthma were defined using National Asthma Education and Prevention Program guideline-based assessment.

Relationships between caregiver-reported control and acute visits in the subsequent 3 months were examined.

RESULTS: At baseline, both populations were predominantly black/African American (91% and 79%) with public insurance (85% and 88%) and very poorly controlled asthma (47% and 50%). In both populations, most caregivers reported that their child's asthma was well controlled (73% and 69%). In both populations, participants whose caregivers reported that their child had uncontrolled asthma had greater odds of having an acute visit in the following 3 months as compared with participants whose caregivers reported that their child's asthma was well controlled, independent of guideline-based control, age, sex, race, controller medication, insurance, and atopy (odds ratio [95% CI], 2.4 [1.4-4.2] and 1.6 [1.1-2.4]).

CONCLUSIONS: Among predominantly low-income minority children with asthma, caregiver-reported asthma control may provide information about the risk of future acute visit for asthma that is complementary to guideline-based control assessment. © 2019 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2019;7:1516-21)

Key words: Childhood asthma; Asthma control; NAEPP guidelines

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INTRODUCTION

The National Asthma Education and Prevention Program (NAEPP) endorses assessing and classifying a child's asthma control as a means of identifying children at a higher risk of having an asthma exacerbation in the future.¹ These guidelines provide a framework for clinicians to use to increase the treatment step for patients with uncontrolled asthma, with the goal of reducing the risk of future exacerbations. This framework incorporates daytime and nighttime symptoms, activity limitation, and use of short-acting β -agonists (SABAs), as well as lung function and recent exacerbations to classify asthma control.

Abbreviations used

ATAQ- Asthma Therapy Assessment Questionnaire

ED- emergency department

FVC- forced vital capacity

IPM- integrated pest management

MAACS- Mouse Allergen Asthma Control Study

MAAIT- Mouse Allergen and Asthma Intervention Trial

NAEPP- National Asthma Education and Prevention Program

SABA- short-acting β -agonist

Children who are classified as having uncontrolled asthma according to the NAEPP guidelines are at a higher risk for exacerbation.²⁻⁴ However, asthma control status is a suboptimal predictor of future risk of exacerbation: some children who have controlled asthma go on to have an exacerbation and some children with uncontrolled asthma do not go on to have an exacerbation.^{5,6} This observation suggests that there are additional predictors of future risk aside from guideline-based control. We need to understand what these predictors are, especially for children at a higher risk of exacerbations, such as low-income, minority children.

One simple assessment that could help to better identify children at risk of a future exacerbation, and is not an explicitly emphasized component of current guideline-based control assessment, is caregiver perception of the child's asthma control. The caregiver's perspective may be an important factor to consider given that caregivers are in an ideal position to assess their child's health status because of their daily interactions with the child. We therefore sought to determine whether caregiver perception of asthma control is a predictor of future acute visits for asthma, independent of guideline symptom-based control status, by examining both caregiver perception of asthma control and NAEPP guideline-based asthma control and their associations with future asthma-related acute visits among predominantly low-income, minority children and adolescents with persistent asthma.

METHODS

Study population

Data from 2 studies addressing childhood asthma were analyzed for the present study. The first trial, The Mouse Allergen and Asthma Cohort Study (MAACS), included 150 Baltimore City children aged 5 to 17 years with persistent asthma. Participants were enrolled for 1 year, and the primary objective of the study was to evaluate relationships between mouse allergen exposure and clinical markers of asthma.⁷ The second study, The Mouse Allergen and Asthma Intervention Trial (MAAIT), was a 1-year, parallel group, randomized clinical trial conducted in Baltimore and Boston. This trial included mouse-sensitized and -exposed children and adolescents aged 5 to 17 years with asthma, who were randomized to receive integrated pest management (IPM) plus pest management education or pest management education alone. Three hundred sixty-one participants were randomized, and 350 participants received IPM plus education or IPM education alone. The primary objective of this study was to determine the effect of a professionally delivered IPM plus IPM education intervention on asthma morbidity as compared with IPM education alone.⁸

Clinical assessments

For MAACS, questionnaires that captured asthma symptoms within the last 2 weeks, medication use, and healthcare use were completed at baseline and at follow-up visits at 3, 6, 9, and 12 months. Spirometry was also performed at each visit and allergen skin prick testing at the baseline visit. For MAAIT, questionnaires about asthma symptoms, asthma-related healthcare use, and medication use were assessed at clinic visits at 6 and 12 months and by telephone calls at 3 and 9 months. Spirometry was performed at baseline and at 6 and 12 months. At each visit for MAACS and at each 3-month assessment for MAAIT, caregivers were asked the question "Do you believe your child's asthma was well controlled in the past 4 weeks?" The answer choices were "Yes," "No," or "Unsure" (question 3 of the pediatric Asthma Therapy Assessment Questionnaire [ATAQ]). *Acute visit* was defined as whether or not the participant had an emergency department (ED) visit, unscheduled doctor's visit, or hospitalization within the previous 3 months.

For MAACS and MAAIT, well-controlled, not well-controlled, and very poorly controlled asthma were defined using NAEPP guidelines on the basis of symptom days, activity limitation, albuterol use, nighttime awakenings in the past 2 weeks, FEV₁/forced vital capacity (FVC), and acute visits in the past 3 months. For both studies, *well-controlled asthma* was defined as less than or equal to 4 days of wheeze, cough, or chest tightness in the past 2 weeks, less than or equal to 1 nighttime awakening in the past 2 weeks, no interference with normal activity over the past 2 weeks, less than or equal to 4 days of SABA use in the past 2 weeks and FEV₁/FVC ratio of greater than or equal to 80%, and no exacerbations (defined as unscheduled doctor's visit, ED visit, or hospitalization) in the past 3 months. *Not well-controlled asthma* was defined as 1 or more of the following: greater than 4 but less than 14 days of wheeze, cough, or chest tightness in the past 2 weeks, greater than 1 but less than or equal to 4 nighttime awakenings in the past 2 weeks, interference with normal activity at least once but less than 10 times over the past 2 weeks, greater than 4 days but less than 14 days of SABA use in the past 2 weeks or FEV₁/FVC ratio of 75% to 79%, and 1 to 2 exacerbations in the past 3 months. *Very poorly controlled asthma* was defined as 1 or more of the following: 14 days of wheeze, cough, or chest tightness in the past 2 weeks, greater than 4 nighttime awakenings in the past 2 weeks, interference with normal activity 10 times or more over the past 2 weeks, 14 days of SABA use in the past 2 weeks, FEV₁/FVC ratio of less than 75%, and greater than 2 exacerbations in the past 3 months.

Statistical analyses

Relationships between caregiver-reported control and acute visits in the subsequent 3 months were examined using logistic regression for the dichotomous outcome variable (acute visit in the subsequent 3 months). Generalized estimating equations were used to account for repeated measures over the course of each study. Final models were adjusted for age, sex, race, health insurance type, controller medication, guideline-based control, and atopy. For MAACS, participants were considered atopic if they had at least 1 positive skin prick test result. For MAAIT, because all participants were sensitized to mouse, we defined atopy as the number of positive skin prick test results. We adjusted for guideline-based asthma control by including an ordinal variable indicating whether a participant's asthma was well controlled, not well controlled, or very poorly controlled. The variable of caregiver-reported control of asthma was converted to a dichotomous variable, by excluding those who answered "unsure" (5% of the MAAIT population and 6% of the MAACS population). Including

TABLE I. Study population characteristics

Characteristic	MAACS (N = 150)	MAAIT (N = 350)
Age (y), mean, $\pm$ SD	11 $\pm$ 4	10 $\pm$ 3
Sex: female, n (%)	65 (43)	132 (38)
Race, n (%)		
Black/African American	137 (91)	278 (79)
White	6 (4)	36 (10)
Other/don't know	7 (5)	4 (1)
Multi	—	9 (9)
Hispanic ethnicity, n (%)	6 (4)	75 (21)
Insurance, n (%)		
Public	128 (85)	303 (88)
Nonpublic	22 (15)	38 (11)
Unsure/self-pay	—	4 (1)
Household income per year, n (%)	N = 136	
<30,000	87 (64)	232 (66)
$\geq$ 30,000	40 (29)	88 (25)
Refused/don't know	9 (6)	30 (9)
NAEPP Asthma control status (at baseline), n (%)		
Well controlled	14 (9)	30 (9)
Not well controlled	66 (44)	144 (41)
Very poorly controlled	70 (47)	176 (50)
Caregiver-reported control at baseline visit, n (%)		
Well controlled	109 (73)	243 (69)
Not well controlled	30 (20)	86 (25)
Unsure	11 (7)	21 (6)
Allergic sensitization	N = 149	N = 297
$\geq$ 1 positive SPT result, n (%)	135 (90)	316 (90)
No. of positive SPT results, median (IQR)	6 (4-9)	7 (4-10)
Specific sensitization, n (%)		
Cat	97 (65)	159 (53)
Cockroach	92 (62)	162 (54)
Dust mite	85 (57)	132 (44)
Mouse	78 (52)	256 (86)
Dog	26 (17)	67 (22)
Acute visit within the past 3 mo at baseline, n (%)	94 (63)	234 (67)
ED visit	69 (46)	169 (49)
Doctor's office	36 (24)	52 (16)
Hospitalization	14 (9)	44 (13)
Oral corticosteroid use in the past 3 mo at baseline, n (%)	66 (44)	165 (47)
Pulmonary physiology		
FEV ₁ (% predicted) at baseline, mean $\pm$ SD	90 $\pm$ 17*	87 $\pm$ 17†
FEV ₁ /FVC ratio ($\times$ 100) at baseline, mean $\pm$ SD	81 $\pm$ 10	80 $\pm$ 9
Controller medication at baseline, n (%)	98 (65)	309 (88)

IQR, Interquartile range; SPT, skin prick test.

*Age $\geq$ 8 y, N = 106.†Age $\geq$ 8 y, N = 211.

those who answered “unsure” in the analyses did not change the overall results (data not shown). Analyses were performed using Stata version 14.0 (StataCorp, College Station, Texas). A 2-tailed *P* value of less than .05 was considered statistically significant.

RESULTS

Mouse Allergen and Asthma Cohort Study

Study population characteristics. In MAACS, the mean age of participants was 11 $\pm$ 4 years, 43% were female, 91% were black/African American, and 4% were Hispanic. Eighty-five percent of participants had public insurance, and 64% reported an annual income of less than \$30,000.00 (Table I). Using NAEPP guideline-based measures of control, at baseline, 9% of participants had asthma that was well controlled, 44% had asthma that was not well controlled, and 47% had asthma that was very poorly controlled. At baseline, 73% of caregivers reported that their child's asthma was well controlled and 20% reported that their child's asthma was not well controlled. Among the 66 children who met NAEPP criteria for not well-controlled asthma, 11% had caregivers who reported that their child's asthma was uncontrolled and 82% had caregivers who reported that their child's asthma was well controlled (7% were unsure). Among the 70 children who met NAEPP criteria for poorly controlled asthma, 31% of caregivers reported that their child's asthma was not well controlled and 60% reported that their child's asthma was well controlled (9% were unsure). Among the 14 children (9%) who met criteria for well-controlled asthma, 7% had caregivers who reported that their child's asthma was uncontrolled and 93% had caregivers who reported that their child's asthma was well controlled (Table I).

Caregiver perception of asthma control and future acute healthcare use.

There were 150 participants at the baseline visit, 138 at the first visit, 138 at the second, 132 at the third, and 128 participants at the fourth visit. Among the 142 participants with at least 1 follow-up visit, there were 246 acute visits, 122 ED visits, 105 unscheduled doctor's visits, and 7 hospitalizations during the study.

In unadjusted models, children whose caregivers reported that their child had uncontrolled asthma had 2.4-fold greater odds (95% CI, 1.4-4.1) of having an acute visit in the following 3 months as compared with children whose caregivers reported that their child's asthma was controlled (Table II and Figure 1). The odds ratio (OR) remained similar after adjusting for NAEPP-based asthma control, age, sex, race, controller medication, insurance type, and atopy. The findings were similar for unscheduled doctor's visits. For ED visit and hospitalizations, the association was less strong but was consistent with the pattern for acute visits overall (Table II).

Mouse Allergen and Asthma Intervention Trial

Study population characteristics. MAAIT enrolled a population of mouse-sensitized and -exposed 5- to 17-year-old children with persistent asthma from Baltimore and Boston. Their mean age was 10 $\pm$ 3 years, 38% were female, 79% were black/African American, and 21% were Hispanic. Eighty-eight percent had public insurance, and 66% reported annual income of less than \$30,000.00 (Table I). Nine percent of the participants had well-controlled asthma, 41% had asthma that

TABLE II. Caregiver report of uncontrolled asthma and future acute visit

Acute Visit Outcome	Crude OR (95% CI)	Adjusted* OR (95% CI)	Adjusted† OR (95% CI)
MAACS			
Acute visit	2.4 (1.4-4.1)	2.3 (1.3-3.9)	2.4 (1.4-4.2)
ED visit	1.6 (0.9-3.0)	1.6 (0.9-2.9)	1.6 (0.8-3.0)
Hospitalization	2.3 (0.2-25.3)	1.3 (0.1-14.4)	‡
Unscheduled doctor's visit	2.6 (1.4-4.7)	2.5 (1.4-4.7)	2.7 (1.4-5.0)
MAAIT			
Acute visit	1.7 (1.2-2.3)	1.5 (1.1-2.1)	1.6 (1.1-2.4)
ED visit	1.2 (0.8-1.8)	1.1 (0.8-1.7)	1.3 (0.8-2.0)
Hospitalization	1.7 (0.9-3.5)	1.6 (0.8-3.4)	1.9 (0.8-4.4)
Unscheduled doctor's visit	1.7 (1.1-2.6)	1.5 (1.0-2.3)	1.4 (0.8-2.2)

Bold indicates statistical significance ($P < .05$).

*Adjusted for NAEPP guidelines asthma control.

†Adjusted for NAEPP guidelines asthma control, controller medication, age, sex, race, insurance, and atopy.

‡Insufficient data to report hospitalization when adjusted.

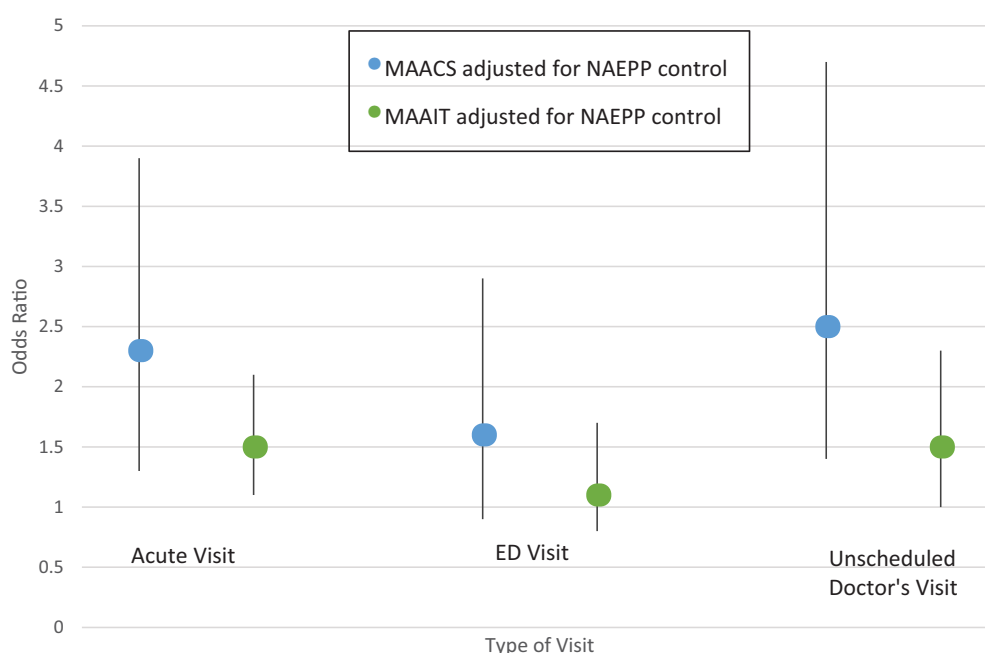


FIGURE 1. Associations between caregiver report of uncontrolled asthma and future asthma-related acute healthcare use. ORs and 95% CIs are displayed for each outcome and by study population and are adjusted for guideline-based control.

was categorized as not well controlled, and 50% had asthma that was very poorly controlled according to NAEPP-based control assessment. Sixty-nine percent of caregivers reported that their child's asthma was well controlled, and 25% reported that their child's asthma was not well controlled. Of the 144 children who met NAEPP criteria for not well-controlled asthma, 19% of caregivers reported that their child's asthma was not well controlled and 75% reported that their child's asthma was well controlled (6% were unsure). Of the 176 children with very poorly controlled asthma, 32% of caregivers reported that their child's asthma was not well controlled and 62% reported that their child's asthma was well controlled (6% were unsure). Of the 30 children who met NAEPP-based criteria for well-controlled asthma, 7% of caregivers reported that their child's

asthma was not well controlled and 87% reported that their child's asthma was well controlled (6% were unsure) (Table I).

Caregiver perception of asthma control and future acute healthcare use. There were 361 participants at the baseline visit, 11 never received education or IPM, and therefore 350 are included in the analysis. There were 347 participants at the first follow-up visit, 333 at the second, 328 at the third, and 320 participants at the fourth visit. Among the 347 patients with at least 1 follow-up visit, there were 548 total acute visits, 284 ED visits, 193 unscheduled doctor's visits, and 51 hospitalizations.

In this population, on average, children whose caregivers reported uncontrolled asthma had 1.7-fold greater odds of having an acute visit in the subsequent 3 months as compared with

TABLE III. Caregiver report of uncontrolled asthma and future acute visit by site for MAAIT

Acute Visit Outcome	Crude OR (95% CI)	Adjusted* OR (95% CI)	Adjusted† OR (95% CI)
<i>Baltimore</i>			
Acute visit	1.6 (1.1-2.3)	1.5 (1.0-2.2)	1.6 (1.1-2.5)
ED visit	1.2 (0.8-1.9)	1.2 (0.8-1.8)	1.4 (0.9-2.2)
Hospitalization	2.0 (0.9-4.3)	1.8 (0.8-4.1)	1.9 (0.7-5.0)
Unscheduled doctor's visit	1.4 (0.8-2.4)	1.1 (0.7-2.0)	1.0 (0.6-1.9)
<i>Boston</i>			
Acute visit	1.9 (1.0-3.4)	1.6 (0.8-3.0)	1.9 (0.9-3.9)
ED visit	1.3 (0.6-3.0)	1.0 (0.4-2.4)	1.1 (0.4-2.9)
Hospitalization	1.1 (0.2-5.1)	1.2 (0.2-6.5)	2.4 (0.4-14.7)
Unscheduled doctor's visit	2.7 (1.3-5.5)	2.4 (1.1-5.2)	2.8 (1.1-6.8)

Bold indicates statistical significance ($P < .05$).

*Adjusted for NAEPP guidelines asthma control.

†Adjusted for NAEPP guidelines asthma control, controller medication, age, sex, race, insurance, and atopy.

children whose caregivers reported that their child's asthma was controlled (95% CI, 1.2-2.3) (Table II and Figure 1). The OR remained similar after adjusting for NAEPP-based asthma control and for age, sex, race, controller medication, insurance type, and atopy. The association was similar for unscheduled doctor's visits. For ED visit and hospitalizations, the association was less strong but was consistent with the pattern for acute visits overall (Table II). These results were similar when stratified by study site: Baltimore (OR, 1.6; 95% CI, 1.1-2.3) and Boston (OR, 1.9; 95% CI, 1.0-3.4) (Table III). Associations between NAEPP-based asthma control and acute visits are presented in Table E1 in this article's Online Repository at www.jaci-inpractice.org.

DISCUSSION

Across 2 populations of predominantly low-income, minority children and adolescents with persistent asthma, caregiver perception of the child's asthma control was associated with an increased risk of future acute visits, independent of the child's guideline-based assessment of asthma control. Previous studies have demonstrated discordance between caregiver perception of asthma control and actual control,^{9,10} but this is the first study that we know of to examine the association between caregiver perception of asthma control and future acute visits. Currently, the NAEPP guidelines for assessing asthma control and adjusting therapy in children aged 5 to 11 years recommend assessing symptoms, lung function, exacerbations, lung growth, and treatment-related adverse effects and do not include assessment of caregiver- or patient-reported control status.¹ For adults and adolescents 12 years and older, assessment of control may include a validated questionnaire to assess impairment (ATAQ, Asthma Control Questionnaire, or Asthma Control Test).¹ These control assessment tools include questions pertaining to self- and caregiver-reported perception of control, but the guidelines do not explicitly include perception of asthma control as a criterion for assessing asthma control. International guidelines recommend assessing the goals and concerns of the caregiver and patient but do not explicitly recommend assessing perception of asthma control.¹¹ Our findings suggest that caregiver perception of asthma control may be important complementary information for predicting future acute visits for asthma and deserves further study.

Overall, the findings were consistent between the 2 study populations, supporting their generalizability to all low-income,

minority children with asthma in the United States. There was a suggestion that caregiver perception of asthma control may be a better predictor of acute visits in the MAACS study than in the MAAIT study because the association was stronger in the MAACS population than in the MAAIT population (ORs, 2.4 vs 1.6, respectively). However, there was substantial overlap in the 95% CIs, so the evidence that the associations differed between study populations is weak. In addition, study design may have accounted for any apparent differences because MAACS was a single-site observational study whereas MAAIT was a 2-site randomized clinical trial. Although there was no statistical evidence that there was a difference between the 2 study sites in MAAIT (Baltimore, Md and Boston, Mass), there was some suggestion that caregiver perception of asthma control was a better predictor of future unscheduled doctor's visits in Boston as compared with Baltimore. The reason for this difference is unclear. How caregiver perception performs in other populations deserves further study through larger population-based studies.

In both study populations, the main outcome of interest (acute visit) was a composite outcome, which was chosen *a priori* and defined as whether or not the participant reported an asthma-related unscheduled doctor's visit, ED visit, or hospitalization. However, we also analyzed associations between caregiver perception of asthma control and each component of the acute visit outcome. Although the study was not designed to determine whether caregiver perception of child's asthma control was a better predictor of any one type of outcome (urgent doctor visit, ED visit, hospitalization) compared with others, in MAACS, unscheduled doctor visits may contribute more to the association with acute visit than do ED visit or hospitalization. In MAAIT, unscheduled doctor visits, ED visits, and hospitalizations all appear to contribute to the association with acute visit. One caveat, however, is that hospitalization is much less common than ED visits or urgent doctor visits, limiting our ability to assess the relationship between parent perception of the child's asthma control and asthma-related hospitalization.

Although some asthma control assessment tools that are validated or adapted for use in children assess the child's perception of their own asthma control (Childhood Asthma Control Test for those <12 years and the Asthma Control Test for those ≥12 years), only 2 ascertain the caregiver's perception of the child's asthma control (adapted ATAQ and Lara Asthma Symptom Score).¹² ATAQ, which was developed for, and validated in,

adults, has been adapted and validated for use in children and includes the following question, which is asked of caregivers: "Do you believe that your child's asthma was well controlled in the past 4 weeks?"¹³ Although the ATAQ is 1 of 2 tools that capture caregiver perception of the child's control, it has not been validated in low-income, minority populations. Lara Asthma Symptom Score, designed for non-English-speaking populations, includes the following question for caregivers: "Overall, how would you rate the severity of your child's asthma?"¹⁴ There do not appear to have been any head-to-head comparisons of the ability of these tools to predict asthma-related outcomes. Therefore, it is unknown whether asthma control assessment tools that incorporate caregiver-reported asthma control perform any better than similar tools that do not incorporate caregiver-reported asthma control in predicting asthma-related outcomes.

A concept that we did not examine is whether a child's perception of their asthma control is a predictor of future acute visits, and some asthma control assessment tools ascertain child's self-perception, as stated above. It is possible that a child's self-perception also predicts future visits, independent of symptom-based control assessments, and perhaps is better than, or complementary to, caregiver perception. Both child and caregiver perception of control may prove to be important predictors and their relative and independent contributions to assessing asthma control and predicting future risk deserve further study. An additional consideration is that family- and patient-centered constructs including the patient experience and goals are emphasized as important in NAEPP and Global Initiative for Asthma guidelines,^{1,11} but they are not an integral component of assessment of asthma control in these guidelines. As we move toward greater recognition of the importance of patient-centered outcomes, it may be important to consider how to explicitly integrate caregiver and child perception of control into asthma management guidelines.

It is also important to note that although caregiver-reported asthma control offered information over and above what the NAEPP guidelines offered, caregiver's report of child's asthma control was often discordant with the child's actual control. Overall, about 70% of caregivers whose child's asthma was uncontrolled reported that their child's asthma was well controlled. This is consistent with previously reported findings.^{9,10} The disconnect between NAEPP-based asthma control and caregiver perception of control could suggest that caregivers' expectations for asthma control are too low because well-controlled asthma is achievable with guidelines-based care in similar populations.¹⁵

There are several strengths and limitations of this study. Strengths include the inclusion of 2 populations of subjects as well as the ability to control for many of the confounding variables associated with asthma control and outcomes. Other strengths include frequent assessments throughout a 1-year period as well as high retention rates. Weaknesses include the inability to measure severity of exacerbations, that hospitalizations were relatively uncommon, and that the findings may not be generalizable to other pediatric asthma populations. It is also important to note that the NAEPP guidelines are not designed to predict imminent risk of exacerbation but are designed to determine future risk and to be used for determination of controller therapy modifications. Developing and testing an asthma control assessment tool for this population that captures

caregiver perception of control may be an important next step. Testing could include validating this tool and comparing it to currently available screening tools to determine whether it helps better predict the risk of future exacerbation than do currently available tools and if so, whether managing asthma based on a tool that incorporates caregiver perception of control results in improved asthma outcomes.

For low-income, minority children with asthma, caregiver perception of a child's asthma control may be an important predictor of future asthma acute visits independent of guideline-based assessment of asthma control. These findings suggest that assessing caregiver perception of asthma control in addition to guideline-based assessment of control may more accurately estimate the risk of acute visits. Whether more accurate assessment of future risk would translate into more effective asthma management and reduced exacerbations is unclear and would need to be examined in future studies.

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TABLE E1. NAEPP guideline asthma control category and future acute visit

Acute Visit Outcome	OR for not well controlled vs well controlled (95% CI)	OR for very poorly controlled vs well controlled (95% CI)	Adjusted* OR for not well controlled vs well controlled (95% CI)	Adjusted* OR for very poorly controlled vs well controlled (95% CI)
<i>MAACS</i>				
Acute visit	2.1 (1.1-3.9)	2.6 (1.2-5.0)	2.2 (1.1-4.4)	2.7 (1.4-5.4)
ED visit	2.1 (1.0-4.6)	2.3 (1.0-5.1)	2.2 (0.9-5.1)	2.3 (1.0-5.4)
Hospitalization	†	2.2 (0.2-20.4)	†	2.7 (0.2-33.4)
Unscheduled doctor's visit	2.1 (0.9-4.8)	2.1 (0.9-4.9)	2.3 (0.9-5.4)	2.2 (0.9-5.2)
<i>MAAIT</i>				
Acute visit	1.4 (1.0-1.87)	1.8 (1.3-2.5)	1.4 (0.9-1.9)	1.9 (1.3-2.7)
ED visit	1.3 (0.9-1.9)	1.4 (0.9-2.1)	1.2 (0.8-1.9)	1.3 (0.9-2.1)
Hospitalization	1.2 (0.5-2.6)	1.6 (0.7-3.7)	1.3 (0.5-3.4)	1.9 (0.7-5.0)
Unscheduled doctor's visit	1.4 (0.9-2.4)	2.5 (1.5-4.1)	1.6 (0.9-2.8)	2.8 (1.6-4.9)

Bold indicates statistical significance ($P < .05$).

*Adjusted for controller medication, age, sex, race, insurance, and atopy.

†Insufficient data to report.

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