



Associations of patient outcomes with level of asthma control

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ABSTRACT

Background: Despite effective medications, asthma remains a significant burden to the US health care system.

Objective: To determine whether partly and uncontrolled asthma in respondents to the Asthma Insights and Management (AIM) survey was associated with adverse outcomes (such as visits to health care professionals and medication use) compared with well-controlled asthma.

Methods: The AIM survey, conducted in 2009, included 2,500 patients with asthma who were 12 years or older. We classified patients into levels of control and compared use of health care services and limitations of activities in patients whose asthma was well controlled vs those with partly and uncontrolled asthma.

Results: Patients who reported lower income and educational status and lacked health insurance were less likely to have had well-controlled asthma. Respondents with uncontrolled asthma were more likely to report ever use of oral steroids (odds ratio [OR], 2.5; 95% confidence interval [CI], 1.9–3.2) and over-the-counter medicine (OR, 2.7; 95% CI, 2.0–3.7) compared with patients whose asthma was well controlled. Respondents with partly and uncontrolled asthma were also significantly more likely to report ever visiting physicians, specialists, or the emergency department or being hospitalized for asthma compared with those whose asthma was well controlled (ORs ranging from 2.1 to 5.6). Finally, respondents whose asthma was uncontrolled had increased odds (ORs ranging from 14 to 34) of reporting that asthma limited their activities compared with respondents whose asthma was well controlled.

Conclusion: Patients with partly and uncontrolled asthma defined by international guidelines reported use of significantly more health care resources and greater limitations of their daily activities compared with patients whose asthma was well controlled.

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Introduction

Asthma is a significant burden to the US health care system. Although hospitalization and mortality rates have been decreasing since 1980,¹ the prevalence of this disease increased nationally by approximately 1.4% per year between 2001 and 2009 and, by 2009, affected 8.2% of the US population.¹ By 2010, costs of direct medical expenses for asthma were estimated to be \$50.1 billion in the United States.² Furthermore, although several novel medications and drug combinations that were shown to be highly effective at managing asthma, such as more potent inhaled corticosteroids, long-acting β -adrenergic agonists, leukotriene modifiers, and combination therapy with inhaled corticosteroids and long-acting β -adrenergic agonists, were introduced in the 1990s,¹ well-controlled asthma remains elusive for a large proportion of patients. A

recent survey indicated that only about one-third of asthma patients in the U.S. used long-term control medications, which have consistently been shown to prevent flare-ups and asthma attacks.^{2,3} By the late 2000s, several studies reported that only approximately one-third of asthma patients were characterized as having well-controlled asthma.^{4–6}

During the past decade, researchers have advocated for composite metrics of asthma control rather than measures of lung function, such as forced expiratory volume in 1 second, to characterize the morbidity of asthma patients because objective physiologic measures have been found to have little correlation with health-related quality of life.^{7,8} Instead, the Global Initiative for Asthma (GINA) and the National Asthma Education Prevention Program (NAEPP) have issued guidelines that focus on regulating asthma symptoms to maintain normal daily activity levels.^{3,9} Several recent studies have examined factors associated with uncontrolled asthma by GINA or NAEPP guidelines.^{6,10,11} However, it has not yet been determined whether asthma that is defined as not well controlled by these guidelines is associated with increased rates of adverse outcomes compared with asthma that is defined as well controlled.

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The purpose of this study was to investigate whether partly and uncontrolled asthma are associated with sequela, such as increased medication use, visits to health care professionals, hospital admissions, and limitations of activities, compared with patients whose asthma is well controlled. Previous studies have demonstrated that these health care outcomes cause significant decreases in quality of life for both pediatric and adult asthma patients.^{10,12,13} In addition, these consequences of asthma, especially hospitalizations and increased use of medications, lead to substantially increased direct costs of asthma, whereas factors such as absenteeism and reduced productivity at work and school lead to greater indirect costs of asthma.¹⁴ Determining whether uncontrolled asthma is associated with negative health outcomes is a critical step toward lessening the overall burden of this disease.

Methods

AIM survey

This study was a retrospective, cross-sectional analysis of the Asthma Insights and Management (AIM) survey conducted between July and September 2009. Details of this study have been described previously,^{15–17} but briefly, subjects of the AIM survey included in our analyses were 2,500 patients with asthma who were 12 years or older identified from a US sample of 60,682 households. Interviews were conducted by telephone and averaged 33 minutes in length. For patients 12 to 17 years of age, the survey was completed by a parent or guardian. The questions were designed to assess asthma burden (short- and long-term symptoms, functional impact, health care use (such as physician visits and use of asthma medications), and patient beliefs on appropriate use of medications for asthma control. In addition, variables that could be used to investigate confounding, such as sex, age, smoking status, and diagnosis of nasal allergies, were also queried.

Classification of asthma control

Patients were characterized based on GINA guidelines⁹ into 3 categories of level of asthma control: well controlled, partly controlled, and uncontrolled (eTable 1). The manifestations of asthma that were used for the categorizations include daytime symptoms, restriction of daily activities, nighttime symptoms, and need for reliever or rescue treatment. We used questions from the telephone survey that correlated with the GINA-defined asthma manifestations, with the exception of a lung function measurement less than 80% predicted, because 66% of our sample had not received lung function testing in the previous year.

Statistical analyses

Frequencies and χ^2 tests were calculated to determine whether demographic variables, such as age, sex, race, presence of asthma triggers in the household, and socioeconomic status, varied by level of asthma control. Next, differences by GINA-defined level of asthma control in rates of use of asthma-related medications, use of health care services, and effects of asthma on productivity and activity levels were examined. When available, outcome variables were analyzed in 3 ways: (1) ever use of medication and services or ever occurrence of activity limitations; (2) use in the past 12 months of medication and services or occurrence in the past 12 months of activity limitations; and (3) number of instances in the past 12 months of use of medication and services or number of instances in the past 12 months of occurrence of activity limitations. For analyses examining ever use or ever occurrence and use or occurrence in the past 12 months, χ^2 tests and logistic regression were used to determine odds ratios (ORs) and 95% confidence intervals (CIs). For analyses examining the number of instances of use or occurrence, Kruskal-Wallis tests were used to detect unadjusted differences of the means of the different levels of control and

negative binomial regression was used to calculate rate ratios (RRs) and 95% CIs.

We also examined the relationships of level of asthma control with several categorical (rated by the respondents on a scale of 1 to 4) measures of interference with the patients' lives that were caused by asthma, using Kruskal-Wallis tests for unadjusted analyses and proportional logistic regression for adjusted analyses. Finally, we examined associations between level of asthma control and productivity (rated on a scale of 0% to 100%) on a typical day and on a day when asthma was at its worst. We used analysis of variance for unadjusted analyses and negative binomial regression for adjusted analyses.

All regression analyses were adjusted for age, sex, whether anyone in the household smoked, educational level, and health insurance status of the asthma patient. The ORs and RRs for partly and uncontrolled asthma are presented with well-controlled asthma as the referent category. Analyses were conducted using SAS statistical software for Windows, version 9.2 (SAS Institute Inc, Cary, North Carolina).

This study was determined not to meet the federal regulatory definition of human subjects research and hence was exempt from human subjects review by the University of Washington Institutional Review Board.

Results

Characteristics of the study cohort, stratified by GINA-defined level of asthma control, are given in Table 1. Approximately one-quarter (26%) of the cohort had asthma that was defined as well controlled, and almost one-third (30%) had uncontrolled asthma as classified by GINA guideline definitions. Asthma patients who were 12 to 17 years of age were less likely to have been classified as having uncontrolled asthma compared with patients 40 to 64 years of age. Female patients and patients of races other than white (32% and 35%, respectively) were slightly more likely to have asthma classified as uncontrolled compared with male patients and white patients (26% and 29%, respectively). Patients (or their proxy respondents) who were not married or cohabiting were more likely than those (or children of those) who were married or cohabiting to be classified as having uncontrolled asthma (36% and 26%, respectively).

In terms of potential environmental triggers of asthma, respondents who reported a smoker lived in the household were more likely to have asthma classified as uncontrolled compared with those who did not report living with a smoker, but having a pet in the household was not associated with level of asthma control.

Regarding socioeconomic status, respondents in the highest income bracket and those who owned their homes (37% and 29%, respectively) were more likely to have asthma that was classified as well controlled compared with those in the lowest income bracket and those who did not own their homes (11% and 19%, respectively). Similarly, 35% of respondents who reported having a family member who had lost his/her job in the past year had asthma that was classified as uncontrolled compared with 29% of respondents in households in which no one had lost his/her job in the past year. Respondents in the lowest bracket of education were also more likely than those in the higher brackets to be classified as having uncontrolled asthma (for the lowest bracket, 40% were classified as having uncontrolled asthma vs 18% in the highest bracket). Of asthma patients without health insurance, 47% had asthma that was characterized as uncontrolled compared with 28% of those with health insurance.

Frequencies, ORs, and 95% CIs depicting the relationship between use or occurrence in the past 12 months of asthma medications, health care system use, and interference with work or school are given in Table 2. Survey respondents with partly controlled and uncontrolled asthma were more likely to report use in the past 12

Table 1
Frequencies and χ^2 results of descriptive variables of AIM survey respondents

Variable	No. (%) of respondents			Pearson χ^2 P value
	Well controlled asthma	Partly controlled asthma	Uncontrolled asthma	
Total	638 (26)	1093 (44)	762 (30)	
Age, y				<.001
12-17	123 (39)	143 (46)	48 (15)	
18-39	152 (29)	223 (43)	144 (28)	
40-64	250 (22)	475 (41)	429 (37)	
≥ 65	113 (22)	252 (49)	141 (28)	
Sex				.002
Male	223 (29)	341 (45)	200 (26)	
Female	415 (24)	751 (43)	561 (32)	
Race				.01
White	503 (26)	851 (45)	549 (29)	
Other than white	122 (23)	227 (42)	190 (35)	
Asthma patient had diagnosis of rhinitis				.28
Yes	368 (25)	674 (45)	452 (30)	
No	256 (27)	401 (42)	297 (31)	
Family member outside household with asthma				<.001
No	253 (30)	372 (44)	225 (26)	
Yes	334 (23)	644 (44)	470 (32)	
Patients or parent married or cohabitating				<.001
Yes	427 (29)	652 (44)	387 (26)	
No	198 (20)	427 (43)	357 (36)	
Smoker in household				<.001
No	525 (29)	833 (45)	476 (26)	
Yes	103 (17)	249 (40)	268 (43)	
Pets in household				.42
No	259 (24)	478 (44)	329 (31)	
Yes	369 (27)	603 (44)	414 (30)	
Yearly income				<.001
<\$15,000	50 (11)	178 (40)	216 (49)	
\$15,001-\$75,000	228 (23)	468 (46)	317 (31)	
>\$75,000	203 (37)	250 (46)	95 (17)	
Patient/parent owned home				<.001
Yes	480 (29)	763 (45)	440 (26)	
No	143 (19)	313 (42)	293 (39)	
Household member lost job in past year				.01
Yes	98 (21)	203 (44)	165 (35)	
No	530 (27)	882 (44)	578 (29)	
Education level				<.001
Completed high school or less	186 (19)	390 (41)	387 (40)	
Some/completed college	302 (27)	517 (47)	288 (26)	
Some/completed graduate school	141 (37)	176 (46)	68 (18)	
Asthma patient had health insurance				<.001
Yes	593 (27)	979 (45)	621 (28)	
No	40 (15)	105 (38)	129 (47)	

Abbreviation: AIM, Asthma Insights and Management.

months of oral steroids for uncontrolled asthma (OR, 4.9; 95% CI, 3.8-6.3) and over-the-counter medicine (most common responses were decongestants, such as ephedrine, and expectorants, such as guaifenesin) for uncontrolled asthma OR, 5.1; 95% CI, 3.9-6.6) but

not long-term maintenance medicine compared with patients whose asthma was well controlled; in fact, respondents who were classified as having uncontrolled asthma were significantly less likely to have reported using long-term maintenance medicines in

Table 2
ORs (95% CIs) associated with use of asthma medications or health care services and absence or interference with work or school in the past 12 months by level of control of asthma symptoms^a

Variable	No. (%) of patients			OR (95% CI)		χ^2 P value
	Well controlled asthma	Partly controlled asthma	Uncontrolled asthma	Partly Controlled asthma ^b	Uncontrolled asthma ^b	
Oral steroid	132 (15)	358 (40)	400 (45)	2.0 (1.6-2.5)	4.9 (3.8-6.3)	<.001
Extra doses of inhaler for quick relief or rescue medicine	124 (14)	338 (39)	401 (46)	2.0 (1.6-2.5)	5.1 (3.9-6.6)	<.001
Long-term maintenance medicine	75 (32)	102 (44)	56 (24)	0.82 (0.59-1.1)	0.63 (0.42-0.93)	.02
Visits to emergency department	25 (6.6)	132 (35)	220 (58)	3.4 (2.2-5.4)	9.0 (5.7-14)	<.001
Hospitalization	6 (3.9)	49 (30)	108 (66)	4.3 (1.8-10)	13 (5.5-30)	<.001
Urgent care ^c	76 (12)	264 (41)	305 (47)	2.5 (1.9-3.3)	5.6 (4.1-7.6)	<.001
Missed work or school	62 (12)	201 (39)	246 (48)	2.6 (1.8-3.5)	6.7 (4.7-9.4)	<.001
Interfered with work or school	31 (7.3)	150 (35)	244 (57)	3.4 (2.3-5.2)	11.5 (7.6-18)	<.001

Abbreviations: CI, confidence interval; OR, odds ratio.

^aLogistic regression used. Adjusted for age, sex, whether anyone in the household smoked, race, educational level, and insurance status.

^bReferent category is well-controlled asthma.

^cBesides emergency department visits.

Table 3Means (SDs) and ORs (95% CIs) for categories of asthma interference with activities by level of control of asthma symptoms^a

Variable	Mean (SD)			OR (95% CI)		Kruskal-Wallis test <i>P</i> value
	Well-controlled asthma	Partly controlled asthma	Uncontrolled asthma	Partly controlled asthma ^b	Uncontrolled asthma ^b	
Sports or recreation ^c	1.59 (0.80)	2.37 (1.15)	3.21 (1.01)	3.6 (2.9-4.3)	15 (12-19)	<.001
Normal physical exertion ^c	1.35 (0.67)	2.15 (1.03)	3.04 (0.96)	5.4 (4.3-6.7)	23 (18-30)	<.001
Social activities ^c	1.12 (0.43)	1.66 (0.90)	2.60 (1.08)	6.7 (4.9-9.1)	33 (24-46)	<.001
Sleeping ^c	1.20 (0.52)	1.69 (0.87)	2.70 (1.05)	4.7 (3.6-6.1)	28 (21-37)	<.001

Abbreviations: CI, confidence interval; OR, odds ratio.

^aProportional logistic regression used. Adjusted for age, sex, whether anyone in the household smoked, race, educational level, and insurance status.^bReferent category is well-controlled asthma.^cEach measure quantified on scale of 1 (asthma did not interfere at all) to 4 (asthma interfered a lot).

the past 12 months for uncontrolled asthma (OR, 0.63; 95% CI, 0.42-0.93). Respondents with partly and uncontrolled asthma were more likely to have visited an emergency department for uncontrolled asthma (OR, 9.0; 95% CI, 5.7-14), been hospitalized for uncontrolled asthma (OR, 13; 95% CI, 5.5-30), and had a non-emergency department urgent care visit for uncontrolled asthma (OR, 5.6; 95% CI, 4.1-7.6) in the past 12 months compared with patients whose asthma was well controlled. Finally, respondents whose asthma was uncontrolled demonstrated a higher likelihood of reporting that their asthma caused them to miss school or work and interfered with school or work compared with respondents whose asthma was well controlled (ORs, 6.7-11.5; *P* < .001).

Similar results were found for the analyses of ever use or occurrence and the number of instances of uses of asthma medications and health services, as well as the number of days of school or work that were missed (eTable 2 and eTable 3).

Respondents whose asthma was characterized as uncontrolled were also more likely to report that asthma interfered with sports/recreation, physical exertion, social activities, and sleeping (Table 3; ORs for uncontrolled asthma, 15-33; *P* < .001). Respondents whose asthma was characterized as partly or uncontrolled also reported that asthma decreased their productivity on both a typical day (for uncontrolled asthma: RR, 0.75; 95% CI, 0.72-0.78) and at its worst (for uncontrolled asthma: RR, 0.71; 95% CI, 0.65-0.78) at a greater rate compared with respondents with well-controlled asthma (Table 4).

Discussion

This study found that patients whose asthma was classified as well controlled according to the 2010 GINA guidelines⁹ were less likely to experience adverse outcomes related to their asthma compared with patients whose asthma was classified as partly or uncontrolled. We also determined that asthma that was characterized as partly or uncontrolled was associated, usually with statistical significance, with increased use of asthma-related medications, physician or hospital visits, and limitations of activities. These results were consistent when we examined associations with adverse outcomes that ever occurred, adverse outcomes that occurred in the past year, and the number of times the outcomes occurred in the past year.

The AIM survey was similar in design to the Asthma in America (AIA) survey, conducted in 1998.^{18,19} A recent study by Nathan et al¹⁷ compared differences in the burden of asthma between respondents to the AIA survey and the AIM survey and found that, although the prevalence of asthma was lower in the AIM group, the effect of asthma generally did not improve during the 11-year period. For example, hospitalization rates were 7% in both surveys, and rates of unscheduled emergency health care visits were slightly higher in the 2009 AIM survey (25% vs 22%). These results were somewhat surprising in light of clinical guidelines and other practice-based changes that took place between 1998 and 2009, including the release of updated NAEPP and GINA guidelines for asthma management and the availability of new medications.

To make our results more generalizable to asthma patients in international settings, we chose to use the GINA rather than the NAEPP guidelines to define each level of asthma control. Several studies have used the Asthma Control Test to examine the relationship between level of asthma control and outcomes,²⁰⁻²³ but few studies have used the recently defined guideline-based characterizations of asthma control to analyze associations between asthma severity and health outcomes. Lai et al²² used the 2006 GINA guidelines, which differed slightly from the guidelines we used in that they included asthma exacerbations as a symptom that defined level of asthma control.²² Similar to our findings, these authors found that patients with partly and uncontrolled asthma were at significantly greater risk of using urgent health care services. Other research that used NAEPP guidelines to classify level of asthma control also found that patients whose asthma was classified as "very poorly controlled" reported higher rates of adverse health outcomes, such as being admitted to an intensive care unit, compared with patients whose asthma was classified as well controlled.¹⁶ Nguyen et al⁶ in 2011 found patients with "very poorly controlled" asthma (defined using the NAEPP guidelines) had statistically significantly increased odds of visits to the emergency department, urgent care, or being hospitalized in the previous year compared with patients whose asthma was well controlled (OR, 3.9; 95% CI, 2.1-7.3). However, in contrast to our findings, the authors reported statistically significant greater adjusted odds of use of long-term controller medications in the previous 3 months for patients with not well-controlled (OR, 1.7; 95% CI, 1.1-2.5) and

Table 4Means (SDs) RRs (95% CIs) for categories of asthma interference with productivity by level of control of asthma symptoms^a

Productivity	Mean (SD)			RR (95% CI)		F test <i>P</i> value
	Well-controlled asthma	Partly controlled asthma	Uncontrolled asthma	Partly controlled asthma ^b	Uncontrolled asthma ^b	
Typical day ^c	91.9 (15.4)	81.4 (22.7)	65.9 (27.1)	0.90 (0.87-0.94)	0.75 (0.72-0.78)	<.001
Asthma at its worst ^c	64.0 (27.8)	54.1 (29.1)	42.9 (29.7)	0.87 (0.80-0.95)	0.71 (0.65-0.78)	<.001

Abbreviations: CI, confidence interval; RR, rate ratio.

^aNegative binomial regression used. Adjusted for age, sex, whether anyone in the household smoked, race, educational level, and insurance status.^bReferent category is well-controlled asthma.^cProductivity measured on scale of 0% to 100% (higher indicates more productive).

very poorly controlled (OR, 2.6; 95% CI, 1.6–4.2) asthma compared with those with well-controlled asthma. We found the opposite; patients with partly controlled and uncontrolled asthma were less likely to have used long-term maintenance medications in the past 12 months (for partly controlled asthma: OR, 0.82; 95% CI, 0.59–1.1; for uncontrolled asthma: OR, 0.63; 95% CI, 0.42–0.93). Findings regarding long-term maintenance medications in other studies have also been mixed. For example, in a survey of pediatric asthma patients, Bloomberg et al¹⁰ found that only 6% of patients whose asthma was classified as poorly controlled had used oral corticosteroids in the past 3 months, but, in a random sample of adult asthma patients, Schatz et al²⁴ found a significant relationship between patients with lower scores on the Asthma Control Test (indicating more poorly controlled asthma) and use of oral corticosteroids in the past 4 weeks. Similarly, in a random sample of adult asthma patients in Sweden, Stallberg et al²⁵ also found that 49% of patients with uncontrolled asthma were taking long-term maintenance medications compared with only 29% of patients with controlled asthma. Further research using longitudinal data that are better suited to determining cause and effect is necessary to elucidate the relationship between long-term maintenance medications and level of asthma control.

Another interesting finding of our research was the relationship of uncontrolled asthma with socioeconomic status indicators, such as lower levels of income and education, which has been reported previously.^{26–28} In addition, we found that patients who reported that they had no health insurance were more likely to have asthma that was classified as uncontrolled compared with patients who had health insurance, which has also been reported in previous research.^{27,29}

Several practices that could be implemented to improve degree of asthma control have been described. Research has found that patients and physicians often do not use the same terms when describing asthma symptoms, which could lead to confusion and misunderstandings.³⁰ Improving communication between patients and health care professionals has been reported to raise medication adherence rates.^{31,32} In addition, guidelines emphasize educating patients on managing comorbidities and environmental exposures that might exacerbate their asthma.^{3,9,33} Still, an estimated 50% of asthma patients do not adhere to their medical therapy, putting them at greater risk for exacerbations, hospitalizations, and death.³⁴ In the United States, one barrier to treatment adherence is increasing out-of-pocket payments for asthma medications, which have been reported to reduce patient access to affordable asthma therapy.³⁵ In addition, reimbursement policies by insurance companies generally do not account for the substantial amounts of time that health care professionals require to educate asthma patients on proper disease management.³³

Although our study included a large population of asthma patients that was randomly selected from the US population, it also had several limitations. We did not have data on nonrespondents, so the participants who agreed to take part in the survey may not have been representative of the US population of asthma patients, and therefore the results of this analysis might not be generalizable. Responses might have been subject to recall bias, especially for participants 12 to 17 years old, because parents served as surrogate responders. Although efforts were made to standardize the survey questions, the terms used to query study participants might have been subject to interpretation and responses might not be comparable among patients. In addition, although the wording of the survey questions that we used to divide our population into those with well-controlled, partly controlled, and uncontrolled asthma was similar to that used in the GINA guidelines (eTable 1), it did not correlate perfectly, and most of our study population did not provide information on forced expiratory volume in 1 second, so we were not able to use that information in our classifications. In addition, our

analyses are based on self-reported asthma diagnosis and health care use information, which may have been biased, although studies have found that self-reported use of medications and health care services is more likely to be underreported than overreported^{36, 37} and asthma diagnoses are fairly accurately reported compared with medical records in surveys.³⁸ Finally, although this article reports associations between poorly controlled asthma and health outcomes, the data were cross-sectional; thus, we cannot address issues of cause and effect in this study.

The results of this population-based analysis suggest that 74% of asthma patients in the United States do not have well-controlled asthma. Furthermore, patients with partly and uncontrolled asthma consume more resources and are more limited in their daily activities when compared with patients whose asthma was characterized as well controlled. The relationships observed suggest that continued emphasis on improving asthma control and thereby reducing asthma burden could benefit not only patients but also employers and the US health care system as a whole because reductions in the cost of asthma care and increases in productivity could be realized.

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eTable 1

Survey questions used to categorize level of asthma control as defined by GINA guidelines

GINA characteristic	US AIM survey question(s)	Response		
		Controlled	Partly controlled	Not controlled
Daytime symptoms	"In the past 4 weeks have you (your child) had cough, wheezing, shortness of breath, chest tightness during the day?"	Twice or less per week	More than twice per week	Three or more features of partly controlled asthma
Limitation of activities	"Do you feel your (your child's) asthma restricts you (your child) a lot, some, only a little or not at all in daily activities?"	Not at all	Any	
Nocturnal symptoms or awakening	"In the past 4 weeks, have you (your child) been awakened by a cough, or wheezing, or shortness of breath, or chest tightness during the night?"	No	Yes	
Need for reliever or rescue treatment	"In the past 4 weeks, have you (your child) used any over-the-counter medicine to give you (your child) quick relief from asthma symptoms?" "How often do you (does your child) use an inhaler for quick relief or rescue from asthma symptoms?"	Twice or less per week	More than twice per week	

Abbreviations: AIM, Asthma Insights and Management; GINA, Global Initiative for Asthma.

eTable 2Sample sizes and ORs (95% CIs) associated with ever use of asthma medications and health care services and limitations of activities by level of control of asthma symptoms^a

Variable	No. (%) of patients			OR (95% CI)		χ^2 P value
	Well-controlled asthma	Partly controlled asthma	Uncontrolled asthma	Partly controlled OR (95% CI) ^b	Uncontrolled OR (95% CI) ^b	
Oral steroid	356 (23)	658 (42)	546 (35)	1.3 (1.1-1.7)	2.5 (1.9-3.2)	<.001
Over-the-counter medicine	82 (16)	226 (44)	201 (39)	1.8 (1.4-2.4)	2.7 (2.0-3.7)	<.001
Long-term maintenance medicine	411 (26)	687 (44)	476 (30)	1.0 (0.8-1.2)	1.2 (0.9-1.5)	.78
Visits to physician	76 (12)	264 (41)	305 (47)	2.5 (1.9-3.3)	5.6 (4.1-7.6)	<.01
Visits to specialist	276 (21)	577 (44)	445 (34)	1.5 (1.3-1.9)	2.2 (1.7-2.8)	<.001
Visits to emergency department	273 (22)	511 (41)	477 (38)	1.2 (1.0-1.5)	2.1 (1.7-2.7)	<.001
Hospitalization	146 (19)	308 (39)	327 (42)	1.3 (1.0-1.6)	2.2 (1.7-2.9)	<.001
Admission to intensive care	37 (15)	84 (35)	118 (49)	1.3 (0.8-1.9)	2.5 (1.7-3.8)	<.001
Interfered with life besides work or school	310 (17)	842 (44)	724 (39)	3.7 (3.0-4.6)	25 (17-37)	<.001
Limited sports or recreation	260 (16)	720 (44)	653 (39)	3.3 (2.6-4.1)	14 (10-19)	<.001
Limited normal physical exertion	164 (10)	706 (45)	694 (44)	5.1 (4.1-6.4)	29 (21-41)	<.001
Limited social activities	55 (5.1)	442 (41)	590 (54)	6.7 (4.9-9.1)	34 (24-47)	<.001
Limited sleeping	93 (7.7)	488 (40)	626 (52)	4.8 (3.7-6.3)	29 (21-39)	<.001

Abbreviations: CI, confidence interval; OR, odds ratio.

^aLogistic regression used. Adjusted for age, sex, whether anyone in the household smoked, race, educational level, and insurance status.^bReferent category is well-controlled asthma.

eTable 3

RRs (95% CIs) associated with number of instances of use of asthma medications and health care services and absence or interference with work or school in the past 12 months by level of control of asthma symptoms

Variable	Mean (SD)			RR (95% CI)		Kruskal-Wallis test <i>P</i> value
	Well-controlled asthma	Partly controlled asthma	Uncontrolled asthma	Partly controlled asthma ^b	Uncontrolled asthma ^b	
Oral steroid, No. of times	0.81 (4.1)	1.8 (6.9)	4.0 (12.4)	2.2 (1.6-3.1)	4.9 (3.5-7.0)	<.001
Extra doses of inhaler for quick relief or rescue medicine, No. of days	0.91 (4.0)	1.4 (5.3)	3.6 (10.2)	1.7 (1.3-2.3)	4.6 (3.4-6.3)	<.001
Long-term maintenance medicine ^c	3.5 (3.7)	3.8 (3.7)	4.2 (3.8)	1.1 (0.9-1.3)	1.3 (1.1-1.6)	<.001
Visits to emergency department, No. of times	0.06 (0.31)	0.22 (0.93)	0.99 (2.9)	3.6 (2.3-5.7)	14 (8.7-22)	<.001
Hospitalization, No. of times	0.03 (0.38)	0.07 (0.39)	0.50 (3.5)	2.3 (1.2-4.4)	10 (5.4-20)	<.001
Urgent care, ^d No. of times	0.14 (0.64)	0.51 (1.3)	1.5 (3.8)	3.4 (2.5-4.7)	10 (7.3-14)	<.001
Missed work or school, No. of days	0.39 (1.8)	2.3 (19.9)	14 (58)	4.1 (2.6-6.4)	30 (18-50)	<.001
Interfered with work or school ^e	0.11 (0.52)	0.38 (1.00)	1.07 (1.63)	3.6 (2.5-5.2)	10 (7.0-15)	<.001

Abbreviations: CI, confidence interval; RR, rate ratio.

^aNegative binomial regression used. Adjusted for age, sex, whether anyone in the household smoked, race, educational level, and insurance status.

^bReferent group is well-controlled asthma.

^cRated on a scale of 1 (less than once per month) to 8 (at least twice per day).

^dBesides emergency department visits.

^eRated on a scale of 1 (asthma did not interfere with work or school at all) to 5 (asthma interfered all the time).