
Initial test of the Seattle Asthma Severity and Control Questionnaire: a multidimensional assessment of asthma severity and control

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Background: The Seattle Asthma Severity and Control Questionnaire (SASCQ) was designed as a short, sensitive, and quantitative measure of asthma severity, impairment, and risk.

Objectives: To evaluate the distribution of responses to the SASCQ in a diverse asthma population and to determine whether the questionnaire is associated with other measures of asthma severity and control.

Methods: A cross-sectional study of 188 asthmatic patients was conducted in a large academic primary care network. Asthma severity was confirmed in a subgroup of 44 patients by means of an in-person interview and lung function measurement.

Results: The SASCQ score had a nearly normal distribution across the heterogeneous population and less of a floor effect than the number of asthma-free days. The SASCQ score showed a higher symptom burden in the mildest asthmatic patients compared with nonasthmatic controls. Asthma severity evaluated using the questionnaire was correlated with asthma severity evaluated by means of in-person interview and with controller medication class. The SASCQ score was associated with primary care visits for asthma, emergency department treatment for asthma, days missed from work, and confidence to control asthma symptoms; the associations between these measures of impairment and risk were all stronger for the SASCQ score than for asthma-free days.

Conclusions: The SASCQ is a quantitative measure of asthma that accurately discriminates between established levels of asthma severity and that is associated with other measures of asthma control and risk.

Ann Allergy Asthma Immunol. 2009;103:225–232.

INTRODUCTION

Persistent asthma is responsible for substantial morbidity, mortality, and economic cost.¹ Preventive therapy can reduce the morbidity,² mortality,³ and economic costs⁴ of asthma. The National Asthma Education and Prevention Program (NAEPP) guidelines^{5,6} provide a framework for asthma therapy based on severity and for reevaluation of control in response to treatment. Despite introduction of these guidelines, asthma control is not achieved in many patients.⁷ A barrier to effective application of the NAEPP guidelines is that primary care and subspecialty physicians frequently do not classify asthma severity correctly.⁸ Once therapy is applied, asthma control should be reassessed in

response to therapy. We were motivated to develop a new questionnaire that would measure asthma severity and control during a quality improvement project in a primary care network. Although several questionnaires have been developed to evaluate asthma control,^{9–11} a short valid questionnaire evaluating asthma severity based on the NAEPP guidelines as well as asthma control has not been developed.

The Seattle Asthma Severity and Control Questionnaire (SASCQ) was designed to provide an estimate of asthma severity based on the NAEPP guidelines and quantitative measurements of each domain of asthma control (ie, nocturnal symptoms, daytime symptoms, activity limitation, exacerbation frequency, and reliever medication use). The questionnaire was also designed to lack floor or ceiling effects and to be sensitive to small differences among asthmatic patients with different levels of asthma severity and control. In this initial test of the SASCQ, we conducted a cross-sectional study in a large primary care network composed of 10 clinics affiliated with the University of Washington. We sought to (1) characterize the distribution of responses on the SASCQ in individuals with and without asthma, (2) determine the accuracy of the questionnaire to evaluate asthma severity, and (3) determine whether the SASCQ summary score is associated with other measures of asthma severity, control, and health care utilization.

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Disclosures: Dr Hallstrand has received grants from the National Institutes of Health, the American Lung Association, and the Firland Foundation; has served on the speaker's bureau for Merck and Schering-Plough; and has served as a consultant to Glaxo and Merck. Dr Martin has received grants from the Centers for Disease Control and Prevention and the Agency for Healthcare Research and Quality. Dr LoGerfo has received grants from the Centers for Disease Control and Prevention and the National Institutes of Health.

Funding Sources: This study was supported by National Institutes of Health grant K23 HL04231 (Dr Hallstrand) and by a grant from the Merck Foundation (Dr LoGerfo).

Received for publication January 24, 2009; Received in revised form March 2, 2009; Accepted for publication March 22, 2009.

METHODS

Design and Content Validation of the SASCQ

The questionnaire is designed to measure 2 constructs, asthma severity and control, in a manner that is quantitative, is sensitive to small differences in asthma control, and can be used to classify asthma severity according to the NAEPP II classification system (Appendix 1). The SASCQ domains are nocturnal symptoms, daytime symptoms, activity limitation, exacerbation frequency, and bronchodilator use. Each of the 5 questions has a quantitative scale from 0 to 5 in which the range of possible answers was calibrated to provide a distribution of responses that differentiates patients with different levels of control and severity. The SASCQ summary score is the sum of the responses to the 5 individual questions (range, 0–25), with a higher score indicating better asthma control. The SASCQ asthma severity score is based on an algorithm that uses cutoff points on each SASCQ question to categorize patients into steps 1 to 4 of the NAEPP guidelines (Appendix 2). The severity algorithm includes peak expiratory flow rate (PEFR) and PEFR variability, if available. Overall asthma severity is defined by the highest step of asthma severity that is manifest on any individual question of the SASCQ.

We evaluated the content validity of the SASCQ based on a literature review, our experience interviewing patients in the clinic, and medical provider feedback on a draft of the questionnaire. We also convened an expert panel to review the content and concepts measured in each domain. The design focus of the SASCQ was on calibrating the range of possible responses to provide a normal distribution of answers to the individual questions across a broad population and on providing appropriate cutoff points in the responses to each question to enable the questionnaire to evaluate guideline-based asthma severity.

Study Populations

We conducted a cross-sectional study of asthmatic patients enrolled in a network of 10 primary care clinics affiliated with the University of Washington. The University of Washington institutional review board approved the study procedures. Patients with asthma were identified through electronic medical records if they had 2 or more physician visits with asthma on the problem list in the previous year and were prescribed at least 1 asthma-related medication (eg, β -agonist, inhaled corticosteroid [ICS], leukotriene modifier, or theophylline) (Fig 1). We constructed a questionnaire that included the SASCQ, questions about the number of asthma-free days in the previous 30 days, and the Asthma Care and Control questionnaire (Appendix 3). The latter includes questions about use of health services for asthma care, rating of care received, smoking behavior, confidence in ability to control asthma symptoms, and number of days that asthma kept them from their usual activity. Asthmatic patients received a single mailing of the questionnaire.

To confirm asthma severity, a subgroup of the respondents with asthma was recruited for in-person interviews of the SASCQ with measurement of PEFR by a clinic nurse. To

determine whether the SASCQ specifically distinguishes between asthmatic and nonasthmatic individuals, a comparison group of persons with no history of asthma and no history of other lung disorders was recruited from 1 of the primary care clinics. Prescribed asthma medications, demographic data, and the numbers of total primary care and asthma-related primary care visits were obtained from electronic medical records.

Criterion and Construct Validation of the SASCQ

The criterion validity of the SASCQ to assess asthma control was evaluated by determining the correlation of the SASCQ score with the number of asthma-free days and the rating of confidence to control asthma symptoms. The number of asthma-free days was used as a comparator because it has been used as a preferred measure of asthma control in several well-designed asthma studies in adults and children.^{13,14} Construct validity of asthma control was evaluated by the correlation between the SASCQ score and the number of days missed from work, emergency department (ED) visits, and primary care visits for asthma.

Criterion validity of the SASCQ to measure asthma severity was determined by comparing asthma severity evaluated by the questionnaire alone with asthma severity evaluated via an in-person interview and PEFR measurement in the asthma subgroup. Construct validity of severity was evaluated in the whole population by examining the relationship between the severity evaluated using the questionnaire and the class of prescribed asthma medications by dividing participants into 3 groups: those who did not use controllers, those who used 1 controller, and those who used multiple daily controllers. The ability of the SASCQ score to discriminate between asthmatic and nonasthmatic individuals was evaluated by comparing the SASCQ score in mild intermittent asthmatic patients vs a group without asthma or allergies.

Statistical Analysis

Differences between patients who completed the SASCQ and the remaining asthmatic patients in the primary care network were evaluated using unpaired *t* tests for continuous variables and χ^2 tests for categorical variables. Correlations were evaluated using the Pearson correlation coefficient. Differences between the SASCQ and asthma-free days with measures of asthma severity and control were evaluated by means of analysis of variance (ANOVA) with the Tukey post hoc test to compare differences between individual levels of asthma severity and control. Differences in the distribution of variables across levels of severity were evaluated using the χ^2 test.

RESULTS

Participant Characteristics

Of the 43,203 patients registered in the University of Washington Physician Network primary care clinics, 888 had asthma based on the inclusion criteria. One hundred eighty-eight asthmatic patients (21.2%) completed the SASCQ (Fig

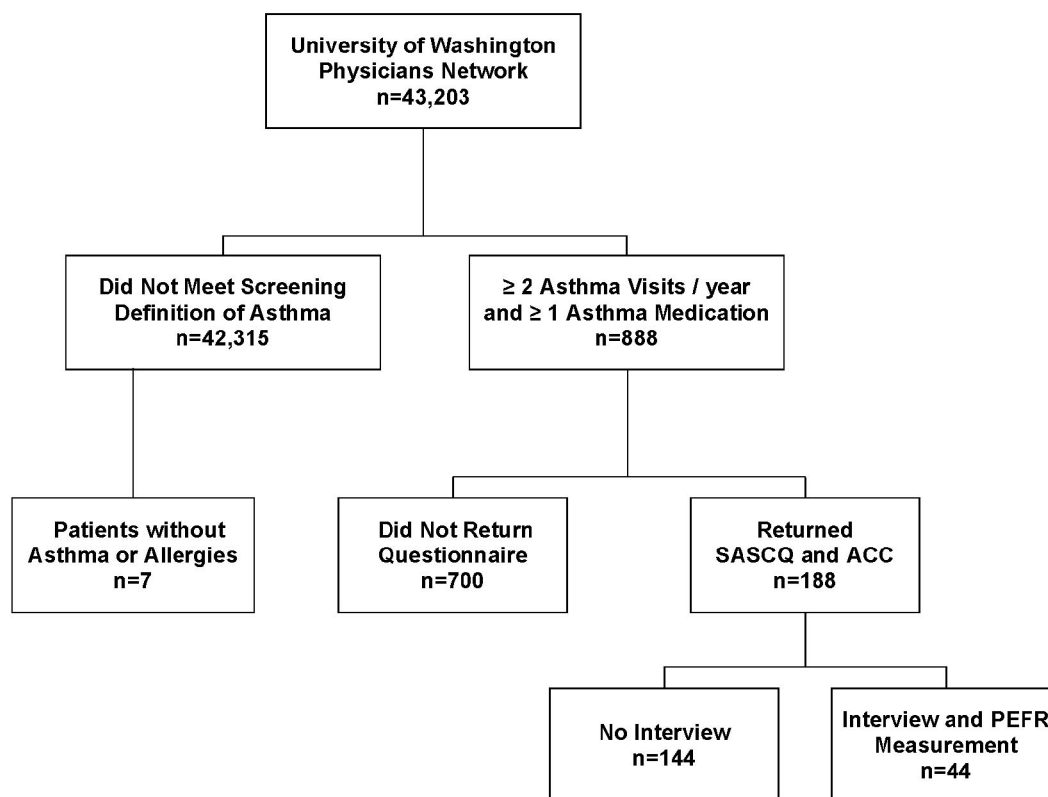


Figure 1. Identification and recruitment of the study groups from a large academic primary care network. Asthmatic patients were identified if they had 2 or more visits in a year with asthma on the problem list and had been prescribed at least 1 asthma medication. The questionnaire was returned along with information about health care utilization by 188 of the 888 patients with asthma. An in-person interview and measurement of peak expiratory flow rate (PEFR) were conducted in 44 of the 188 respondents. A comparison group without asthma or allergies was recruited from among the nonasthmatic patients in one clinic. ACC indicates Asthma Care and Control questionnaire; SASCQ, Seattle Asthma Severity and Control Questionnaire.

1). Compared with asthmatic patients who did not complete the SASCQ, respondents were older and were more likely to be prescribed controller therapy for asthma (ie, an ICS, leukotriene modifier, or methylxanthine with or without a long-acting β -agonist [LABA]) (Table 1). There were no significant differences between the groups regarding the percentage receiving a single controller (ie, ICS, leukotriene modifier, or methylxanthine without a LABA) or multiple controllers (ie, a combination of ≥ 2 agents, including an ICS, leukotriene modifier, methylxanthine, or LABA). Details of the SASCQ sample population are given in Table 2.

Characteristics of the SASCQ and the Summary Score

The questionnaire takes approximately 5 minutes to complete and is easy to use; however, none of the respondents self-reported PEFR or PEFR variability. The distribution of responses to each SASCQ question is given in Table 3. When the questions are combined into the SASCQ summary score, the distribution across the possible range of responses reasonably approximates a normal distribution (mean, 16.6; median, 17.0) (Fig 2A). The summary score has some ceiling effect, with 5.3% of the respondents scoring 25 and 20.7%

Table 1. Comparison of SASCQ Respondents and Nonrespondents

	Respondents (n = 188)	Nonrespondents (n = 700)	P value
Age, mean, y	44.0	39.7	.001
Asthma visits per year, mean, No.	3.3	3.0	.06
Controller therapy, % ^a	87.2	78.7	.01
Single controller, % ^b	36.9	33.7	.42
Multiple controllers, % ^c	50.3	45.0	.20
Inhaled corticosteroid, %	78.6	74.3	.22
Leukotriene modifier, %	34.8	22.6	.001
Methylxanthine %	3.7	2.0	.29
LABA, % ^d	44.9	40.7	.24

Abbreviations: LABA, long-acting β -agonist; SASCQ, Seattle Asthma Severity and Control Questionnaire.

^a An inhaled corticosteroid, a leukotriene modifier, or methylxanthine with or without a LABA.

^b An inhaled corticosteroid, a leukotriene modifier, or methylxanthine without a LABA.

^c A combination of 2 or more agents, including an inhaled corticosteroid, a leukotriene modifier, or a LABA.

^d A LABA alone or combined with another controller medication, including an inhaled corticosteroid (ie, Advair).

Table 2. SASCQ Respondent Characteristics and SASCQ Scores

Characteristic	Value	SASCQ score
Respondents, No.	188	16.6
Sex, %		
Female	80	16.5
Male	20	16.9
Race, % ^a		
White	92.3	16.6
African American	4.4	13.5
Hispanic	1.1	25.0
Asian	2.2	19.0
Age, %		
12–18 y	7.0	18.2
19–40 y	36.4	16.4
41–60 y	42.3	16.4
61–90 y	14.4	16.4
Asthma severity class (NAEPP II guidelines), %		
Mild intermittent (step 1)	41.5	21.8
Mild persistent (step 2)	12.1	16.6
Moderate persistent (step 3)	28.2	14.3
Severe persistent (step 4)	18.1	7.2
Health care utilization (previous year)		
Hospitalized for asthma, %	5.9	14.2
ED visit for asthma, %	21.9	13.0
Total primary care visits, mean (SD), No.	7.1 (4.6)	NA
Primary care asthma visits, mean (SD), No.	3.3 (2.3)	NA
Asthma-free days per month, mean (SD) ^b	14.2 (11.5)	NA
Missed workdays for asthma per month, mean (SD), No. ^b	2.4 (5.7)	NA
Smoker, %	12.9	14.6
Nonsmoker, %	87.1	16.8

Abbreviations: ED, emergency department; NA, not applicable; NAEPP, National Asthma Education and Prevention Program; SASCQ, Seattle Asthma Severity and Control Questionnaire.

^a Race data were available for only 91 patients.

^b Asthma-free days and missed workdays for asthma refer to the number of days in the month before the survey.

Table 3. Distribution of Responses on the Individual Items of the SASCQ

Item	Mean	SD	Interquartile range
Nocturnal symptoms (0–5)	3.84	1.50	3–5
Daytime symptoms (0–5)	2.78	1.66	1.75–4
Activity limitation (0–5)	3.75	1.58	3–5
Exacerbations (0–5)	3.86	1.44	3–5
Bronchodilator use (0–5)	2.25	1.86	0–4

Abbreviation: SASCQ, Seattle Asthma Severity and Control Questionnaire.

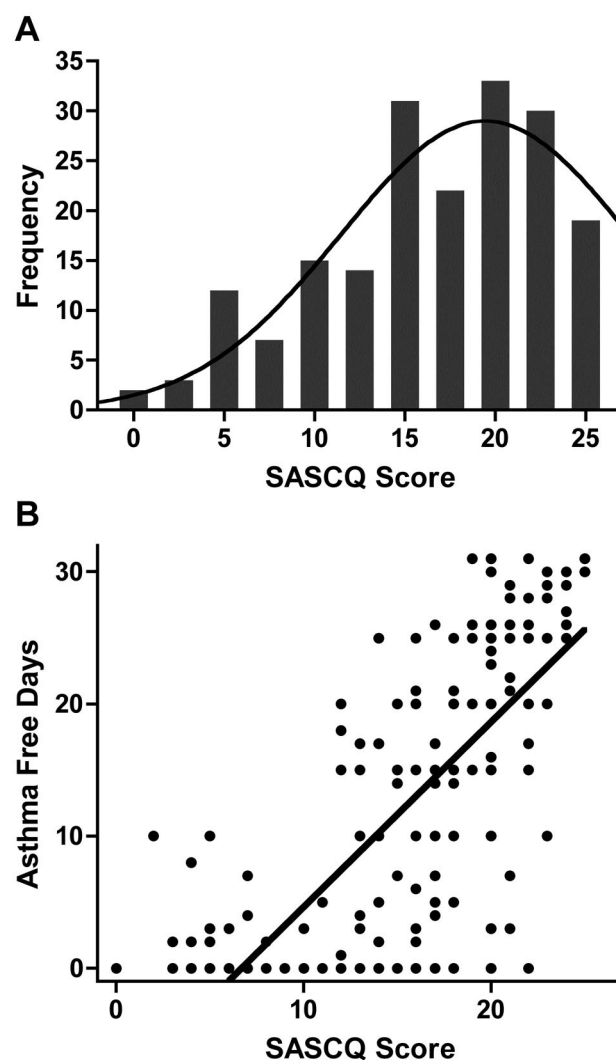


Figure 2. Distribution of Seattle Asthma Severity and Control Questionnaire (SASCQ) summary scores in a heterogeneous population of patients with asthma (A) and a scatterplot comparing the SASCQ summary score with the number of asthma-free days in the previous month (B).

with scores of 22 to 24. To further characterize the ceiling of the questionnaire, we compared the response on the questionnaire in 7 controls without asthma or allergies with that of patients with mild intermittent asthma defined by symptoms and PEFR and found that the SASCQ summary score was significantly higher (better) in nonasthmatic patients than in the mildest asthma group in the present study (mean, 25.0 vs 22.7; $P = .001$). The SASCQ score was strongly correlated with the number of asthma-free days ($r = 0.77$, $P < .001$); however, there is less of a floor effect with the SASCQ score compared with the number of asthma-free days (Fig 2B).

Evaluation of Asthma Severity Using the SASCQ

Asthma severity classified using the SASCQ questionnaire alone without PEFR was strongly correlated with severity

classified by an in-person interview using the questionnaire and measurement of PEFR ($n = 44$) ($r = 0.91$, $P < .001$); however, severity classification increased by 1 step in 9.8% of patients classified by the in-person interview due entirely to the addition of PEFR data. Asthma severity classification based on the questionnaire was also correlated with medication class ($r = 0.20$, $P = .01$). The distribution of medication class also differed by asthma severity classified by the SASCQ, with a greater percentage of severe asthmatic patients as classified by the SASCQ requiring multiple controller therapy ($P = .04$) (Fig 3).

In the full study population, SASCQ scores differed across the 4 steps of asthma severity based on the NAEPP II guidelines ($P < .01$, overall ANOVA) (Fig 4A). There were significant differences between mild intermittent and mild persistent ($P < .01$), mild persistent and moderate persistent ($P = .02$), and moderate persistent and severe persistent ($P < .01$) asthma. The results were similar in the 44 patients classified in-person along with PEFR, demonstrating differences in the SASCQ score across the 4 steps of asthma severity (22.7 vs 17.0 vs 14.4 vs 8.2; $P < .01$, ANOVA). The number of asthma-free days also differed across the 4 levels of asthma severity ($P < .01$) (Fig 4B); however, there was no difference in the number of asthma-free days between mild persistent and moderate persistent asthma ($P = .65$).

Compared with asthmatic patients who used no controller therapy, those treated with a single controller and those treated with multiple controllers had lower SASCQ scores ($P = .05$ and $P = .01$, respectively) (Fig 4C); however, there was no difference in SASCQ score between those treated with a single controller and those treated with multiple con-

trollers ($P = .66$). Similarly, the number of asthma-free days was higher in patients without controller therapy than in those treated with single and multiple controllers ($P = .01$ for both) (Fig 4D), but there was no difference in the number of asthma-free days between patients treated with single and multiple controllers ($P = .99$).

Relationship of the SASCQ Score to Asthma Control

The SASCQ score was strongly correlated with measures of asthma control, including days of absence from usual activity due to asthma, ED visits for asthma, primary care visits for asthma, and the confidence to control asthma symptoms (Table 4). The correlations between these asthma control measures were stronger with the SASCQ score than with the number of asthma-free days (Table 4). In contrast to the number of asthma-related visits, the total number of primary care visits in the previous year was not associated with the SASCQ score ($r = -0.06$, $P = .50$).

Compared with asthmatic patients who did not miss any work due to asthma, those who missed 1 to 3 days and 4 days or more of work due to asthma had lower SASCQ scores ($P < .01$ for both) (Fig 5A). The SASCQ score was lower for patients who missed at least 4 days of work than for those who missed 1 to 3 days ($P = .05$). Compared with asthmatic patients who were not treated in an ED in the previous year, those who were treated in the ED 1 time and those who were treated more than 1 time had lower SASCQ scores ($P < .01$ for both) (Fig 5B); however, there was no difference in SASCQ scores between patients with 1 ED visit and those treated at least 2 times in the ED ($P = .99$). Compared with asthmatic patients who had 2 asthma-related visits to their primary care physician, there was a trend toward lower SASCQ scores in patients with 3 to 5 visits and 6 or more visits ($P = .08$, overall ANOVA) (Fig 5C). Compared with asthmatic patients who felt very confident that they could control their asthma symptoms, those who felt moderately confident and those who felt somewhat to not at all confident had lower SASCQ scores ($P = .01$ and $P < .01$, respectively) (Fig 5D), but there was no difference in SASCQ scores between those who felt moderately confident and those who felt somewhat to not at all confident to control asthma symptoms ($P = .48$).

DISCUSSION

Asthma is a multidimensional disease that requires the health care provider to simultaneously evaluate several dimensions of severity, impairment, and risk. In the present study, we evaluated the effectiveness of a new asthma questionnaire designed to provide a sensitive and quantitative measure of asthma severity and control. The results indicate that the questionnaire differentiates among a clinically heterogeneous group of asthmatic patients in a large primary care network and provides an accurate estimate of asthma severity; also, the summary score is associated with measures of asthma impairment and risk.

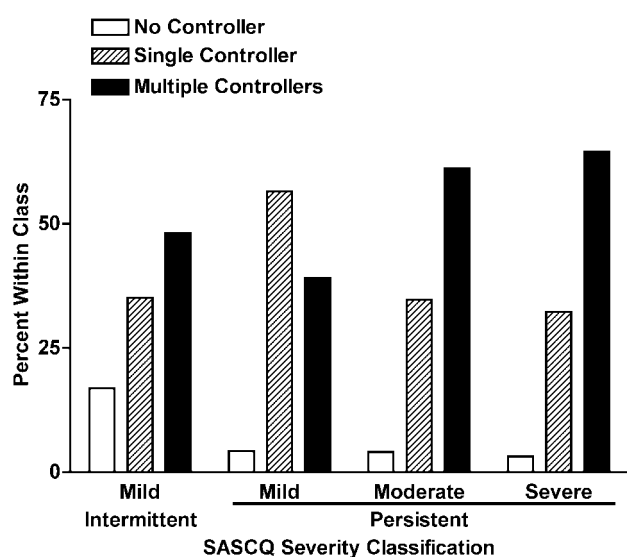


Figure 3. Categories of controller therapy according to classification of asthma severity using the Seattle Asthma Severity and Control Questionnaire (SASCQ) during ongoing treatment for asthma. The distribution of controller therapy differed across the 4 levels of severity ($P = .04$)

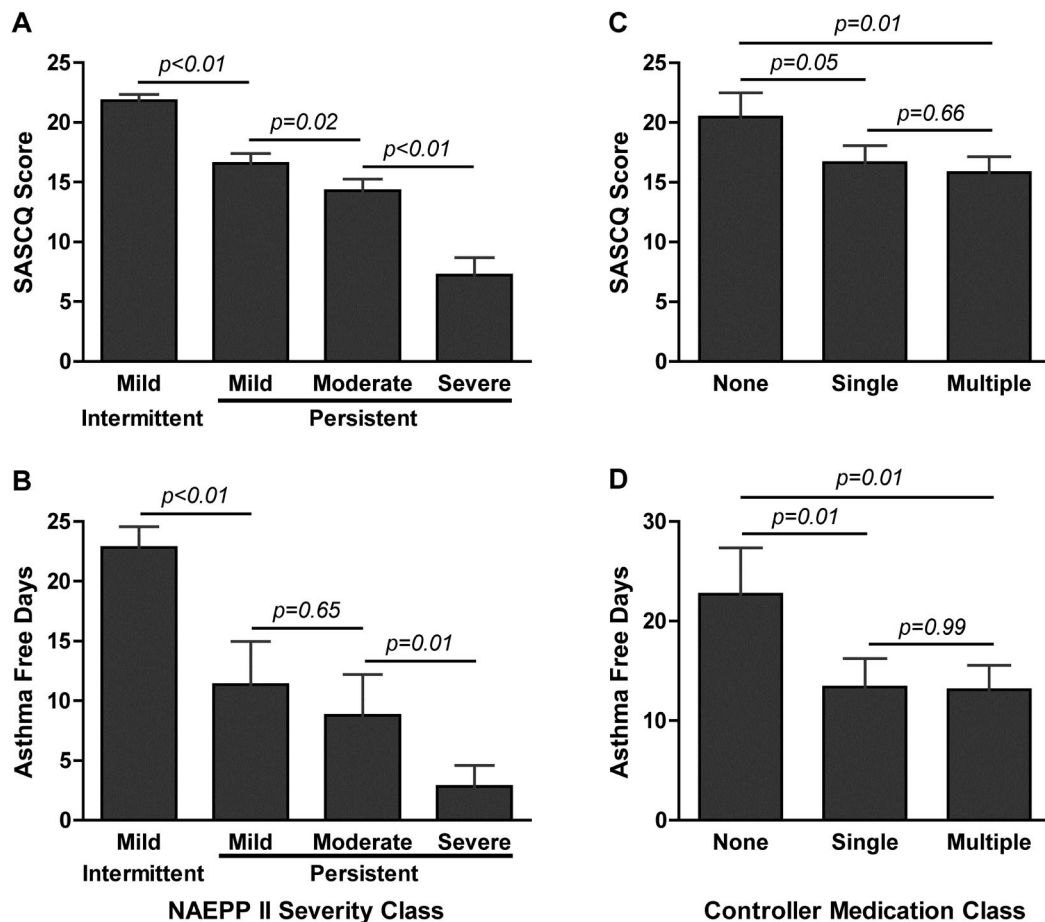


Figure 4. Mean differences in Seattle Asthma Severity and Control Questionnaire (SASCQ) scores and asthma-free days according to level of asthma severity evaluated by the National Asthma Education and Prevention Program (NAEPP) II guidelines (A and B) and by class of controller medication (C and D). The SASCQ score (A) and the number of asthma-free days (B) varied across the 4 steps of asthma severity. The SASCQ score (C) and the number of asthma-free days (D) also varied based on the type of controller therapy prescribed. Error bars represent upper 95% confidence intervals.

Table 4. Associations of the SASCQ Score and Asthma-Free Days With Measures of Asthma Control

	SASCQ score		Asthma-free days	
	r	P value	r	P value
Missed days of usual activity for asthma	−0.370	<.001	−0.269	<.001
Emergency department visits for asthma	−0.209	.004	−0.194	.01
Primary care visits for asthma	−0.178	.02	−0.117	.13
Confidence to control asthma symptoms	0.272	<.001	0.165	.03

Abbreviation: SASCQ, Seattle Asthma Severity and Control Questionnaire.

During content validation, the SASCQ was designed to be quantitative and was calibrated to detect small differences in each domain.¹⁵ The results of this study demonstrate that there was a broad distribution of responses to each of the questions, especially questions 2 and 5 on daytime symptoms and rescue medication use, respectively. The overall SASCQ summary score has a nearly normal distribution across the sample population that included patients of all levels of asthma severity and had less of a floor effect than the asthma-free days measurement that is commonly used in clinical trials.¹² The distribution of SASCQ scores has a modest ceiling effect; however, we demonstrated that the SASCQ score is significantly lower in the mildest group of asthmatic patients in the present study than in a nonasthmatic control group.

The primary purpose of assessing asthma severity is to estimate the intensity of treatment that is likely to be needed to attain asthma control.¹⁶ Physicians frequently do not accurately evaluate severity based on the NAEPP guidelines.⁸ One

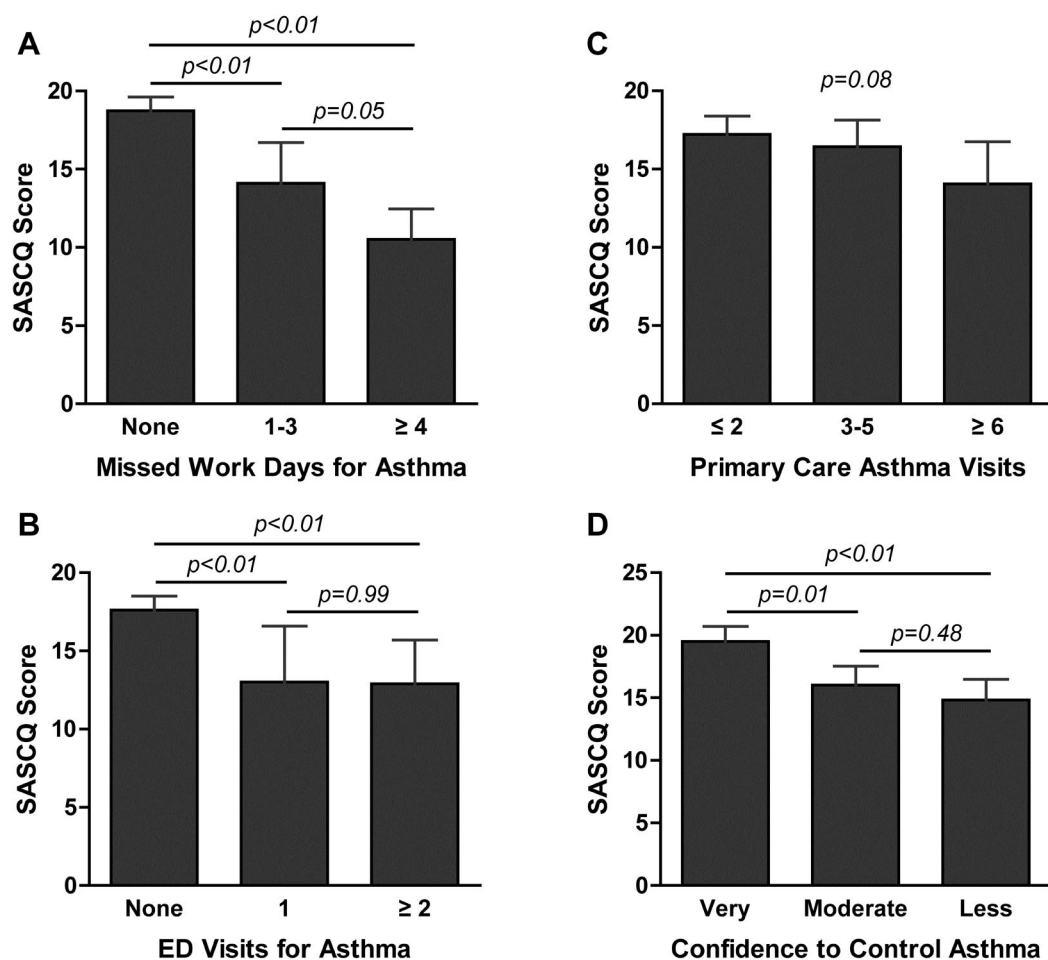


Figure 5. Mean differences in Seattle Asthma Severity and Control Questionnaire (SASCQ) scores according to levels of asthma impairment and risk. The SASCQ score is associated with the number of days missed from work (A) and the number of emergency department (ED) visits for asthma (B). The SASCQ score tended to be lower in patients with increased primary care visits for asthma (C). Confidence to control asthma symptoms was higher in patients who had higher SASCQ scores (D). Error bars represent upper 95% confidence intervals.

of the barriers to assessing asthma severity in the primary care setting is that lung function measurements are often not evaluated by primary care providers.¹⁷ In the present study, lung function data in the form of PEFR only changed the severity classification based on the SASCQ alone in approximately 10% of the study patients. Asthma severity evaluated before therapy may have been preferable; however, asthma severity remains fairly constant across time,¹⁸ highlighted in the present study by the ongoing use of multiple controller therapies by most patients who were classified as having severe persistent asthma.

Asthma control refers to the frequency and intensity of asthma-related events.¹⁶ Asthma control is further broken down into components of impairment (eg, symptoms and need for rescue therapy) and risk (eg, asthma exacerbations and acute care visits) in the most recent asthma guidelines.⁶ We found that the SASCQ summary score was associated with both of these asthma control dimensions. The SASCQ

score was directly associated with the number of ED visits, previously shown to measure asthma control in a prospective study.¹¹ In addition, the SASCQ score was associated with days missed from work. Compared with the number of asthma-free days, the SASCQ score was more strongly associated with all 4 aspects of impairment and risk in the present study. We found that the confidence to control symptoms in these patients was also strongly related to the SASCQ score, providing additional evidence that the SASCQ score accurately evaluates asthma control because patient perceptions of control are strongly associated with evaluation of control by a health care provider.¹⁰

There are several limitations to consider when interpreting these findings. There was evidence that the subgroup of patients who completed the questionnaire had more severe asthma than the remainder of the population, although asthma severity in the present study was similar to that in other large patient populations studied.¹⁹ In addition, the group that com-

pleted the SASCQ was predominantly female and white. These differences could limit generalization of the findings to more diverse patient populations. We did not classify severity in this population when asthma was first diagnosed, and serial longitudinal assessments of control were not conducted to validate the cross-sectional associations with control demonstrated in the present study. Future prospective studies are needed to fully evaluate the performance of the SASCQ to evaluate asthma control in response to treatment across time. An additional component of the SASCQ questionnaire that was incorporated during the design was the measurement of PEFr and PEFr variability. Although PEFr was not self-reported by any patients in the present study, the addition of self-reported PEFr could provide additional useful information because PEFr variability can be used to differentiate asthma from other diagnoses²⁰ and is strongly related to the degree of airway hyperresponsiveness.²¹

We conclude that the SASCQ is short and easy to administer and provides a quantitative measure of asthma severity and control that will be useful to the primary care provider. This initial evaluation of the SASCQ supports further development of this instrument to guide the application of asthma therapy.

REFERENCES

1. Weiss KB, Sullivan SD. The health economics of asthma and rhinitis, I: assessing the economic impact. *J Allergy Clin Immunol.* 2001;107:3–8.
2. Bateman ED, Boushey HA, Bousquet J, et al. Can guideline-defined asthma control be achieved? the Gaining Optimal Asthma Control study. *Am J Respir Crit Care Med.* 2004;170:836–844.
3. Suissa S, Ernst P, Benayoun S, Baltzan M, Cai B. Low-dose inhaled corticosteroids and the prevention of death from asthma. *N Engl J Med.* 2000;343:332–336.
4. Sullivan SD, Buxton M, Andersson LF, et al. Cost-effectiveness analysis of early intervention with budesonide in mild persistent asthma. *J Allergy Clin Immunol.* 2003;112:1229–1236.
5. National Asthma Education and Prevention Program. *Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma.* Bethesda, MD: NIH/National Heart, Lung, and Blood Institute; 1997.
6. Expert Panel Report 3 (EPR-3): guidelines for the diagnosis and management of asthma—summary report 2007. *J Allergy Clin Immunol.* 2007;120:S94–S138.
7. Adams RJ, Fuhlbrigge A, Guilbert T, Lozano P, Martinez F. Inadequate use of asthma medication in the United States: results of the asthma in America national population survey. *J Allergy Clin Immunol.* 2002;110:58–64.
8. Doerschug KC, Peterson MW, Dayton CS, Kline JN. Asthma guidelines: an assessment of physician understanding and practice. *Am J Respir Crit Care Med.* 1999;159:1735–1741.
9. Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. *Eur Respir J.* 1999;14:902–907.
10. Nathan RA, Sorkness CA, Kosinski M, et al. Development of the asthma control test: a survey for assessing asthma control. *J Allergy Clin Immunol.* 2004;113:59–65.
11. Vollmer WM, Markson LE, O'Connor E, et al. Association of asthma control with health care utilization: a prospective evaluation. *Am J Respir Crit Care Med.* 2002;165:195–199.
12. Sullivan SD, Liljas B, Buxton M, et al. Design and analytic considerations in determining the cost-effectiveness of early intervention in asthma from a multinational clinical trial. *Control Clin Trials.* 2001;22:420–437.
13. Evans R III, Gergen PJ, Mitchell H, et al. A randomized clinical trial to reduce asthma morbidity among inner-city children: results of the National Cooperative Inner-City Asthma Study. *J Pediatr.* 1999;135:332–338.
14. Price DB, Hernandez D, Magyar P, et al. Randomised controlled trial of montelukast plus inhaled budesonide versus double dose inhaled budesonide in adult patients with asthma. *Thorax.* 2003;58:211–216.
15. Curtis JR, Martin DP, Martin TR. Patient-assessed health outcomes in chronic lung disease: what are they, how do they help us, and where do we go from here? *Am J Respir Crit Care Med.* 1997;156:1032–1039.
16. Stoloff SW, Boushey HA. Severity, control, and responsiveness in asthma. *J Allergy Clin Immunol.* 2006;117:544–548.
17. O'Dowd LC, Fife D, Tenhave T, Panettieri RA Jr. Attitudes of physicians toward objective measures of airway function in asthma. *Am J Med.* 2003;114:391–396.
18. Sears MR, Greene JM, Willan AR, et al. A longitudinal, population-based, cohort study of childhood asthma followed to adulthood. *N Engl J Med.* 2003;349:1414–1422.
19. Osborne ML, Vollmer WM, Linton KL, Buist AS. Characteristics of patients with asthma within a large HMO: a comparison by age and gender. *Am J Respir Crit Care Med.* 1998;157:123–128.
20. Parameswaran K, Belda J, Sears MR. Use of peak flow variability and methacholine responsiveness in predicting changes from pre-test diagnosis of asthma. *Eur Respir J.* 1999;14:1358–1362.
21. Douma WR, Kerstjens HA, Roos CM, Koeter GH, Postma DS; Dutch Chronic Non-Specific Lung Disease Study Group. Changes in peak expiratory flow indices as a proxy for changes in bronchial hyperresponsiveness. *Eur Respir J.* 2000;16:220–225.

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