
Predicting asthma control using patient attitudes toward medical care: the REACT Score

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Background: The association between patients' degree of asthma control and their attitudes toward medical professionals and asthma therapy is unknown.

Objective: To develop a tool, the REACT Score, that can be used by physicians to compute the risk of having uncontrolled asthma based on patient attitudes toward medical professionals and asthma treatment.

Methods: A nationally representative sample of adult patients (≥ 18 years old) with moderate to severe asthma completed the Asthma Control Test and were surveyed regarding their attitudes about relationships with medical professionals and asthma treatments. Competing predictive models were developed to determine the association between attitude questions and asthma control. Using the model with the highest c-index, a REACT Score was computed.

Results: The proportion of uncontrolled patients (Asthma Control Test score < 20) in the high-, medium-, and low-risk REACT Score categories was 75%, 50%, and 24%, respectively. Patients who believed that their physician recognized lifestyle compromises due to asthma, who were not satisfied with their treatment regimen, and who took asthma medication more frequently than prescribed had a higher risk of poor asthma control.

Conclusion: The REACT Score is a novel way to predict asthma control and to identify key attitudes and behaviors that need to be addressed to engage a patient in ongoing, effective care. This tool may also improve communication between asthmatic patients and their physicians by identifying patient concerns regarding their treatment and quality of life.

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INTRODUCTION

Despite increased awareness of daily preventive management, nationally promoted treatment standards, and improved therapeutic agents, asthma symptoms remain poorly controlled in many patients.¹ In a multinational study² of adult asthmatic patients conducted in 2006, 51% of asthmatic patients receiving regular physician care and maintenance therapy had uncontrolled symptoms; and even patients with asthma that their physicians considered to be well controlled reported frequent, bothersome, and physically limiting symptoms.

The reasons for recurrent asthma exacerbations and chronic symptoms are not completely understood. Symptom control is known to be affected by a patient's willingness to participate in asthma management activities and to discuss symptoms, activity limitations, and medication compliance with a health care provider.^{2–4} In fact, the recently revised National Asthma Education and Prevention Program Expert

Panel Guidelines for the Diagnosis and Management of Asthma⁴ recommends open and unrestricted communication between the physician and the patient to more thoroughly evaluate signs and symptoms, quality of life, history of exacerbations, and pharmacotherapy. However, despite its impact on asthma control, few tools are available to facilitate patient-provider communication.

Using data from the Real-world Evaluation of Asthma Control and Treatment (REACT) study, we examined the associations between patient attitudes toward medical professionals and asthma therapy and asthma control in a nationally representative sample of adult patients (≥ 18 years old) with moderate to severe asthma who were using a short-acting β -agonist and at least 2 standard asthma medications.³ To our knowledge, the REACT study is the first study to examine attitudes and patient-provider communication to predict asthma control in a large cohort of treated patients with asthma. We derived a REACT Score, a tool that treating physicians can use to easily compute asthmatic patients' risk of having uncontrolled asthma based on their attitudes toward medical professionals and asthma treatment.

METHODS

Study Design

The methods and baseline population characteristics of the REACT study have been described previously.³ In brief, the REACT study surveyed a nationally representative sample of patients with asthma in the United States who were receiving a short-acting β -agonist and at least 2 standard asthma med-

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ications. Participants in the survey were members of the Greenfield Online Panel, a diverse Web-based cohort of millions of individuals.⁵ A total of 1,118 adults met the enrollment criteria and were included in the analysis along with 694 supplemental panelists who were known to have asthma. These 2 groups were combined to create a cohort of 1,812 adults with asthma. The study methods and a flowchart depicting the sampling process are provided in Figure 1.

Respondents completed the 5-item Asthma Control Test (ACT)⁶ and an observational, cross-sectional questionnaire on demographics, comorbidities, and health care utilization as well as attitudes and behaviors toward asthma. The survey included 41 attitude questions grouped into the following 2 question categories: attitudes about relationship with medical professional (15 questions) and attitudes about treatments for asthma (26 questions) (Table 1). Responses to each question were categorized as agree, neutral, or disagree. Examples of selected survey questions are provided in Table 2.

Respondents

Respondents were eligible for the study if they (1) had not participated in an asthma-related survey in the past 3 months, (2) were diagnosed as having asthma for at least 1 year, (3)

did not have emphysema or chronic bronchitis, (4) were currently taking prescription medication for asthma, and (5) were receiving multiple controller medications, suggesting moderate to severe persistent asthma (as defined by the 2004 Global Initiative for Asthma⁷ guidelines). Specifically, respondents were included if they were taking an oral corticosteroid (minimum of 2 courses in the past 12 months) or a short-acting β_2 -agonist and at least 2 additional long-term controllers.

Model Development

A respondent's level of asthma control was based on the 5-item ACT as follows: a score of 5 to 19 indicated that the respondent had uncontrolled asthma, and a score of 20 to 25 indicated that the respondent had controlled asthma.⁶ Multivariable logistic regression was used to evaluate the association between the attitude questions and asthma control. Every possible combination of 3 attitude variables of the 41 variables considered was used to predict the binary outcome measure of asthma control (controlled/uncontrolled). All possible remaining 2-attitude variable combinations of the remaining 38 variables were added to the best 3-variable models to determine the best 5-variable model. The c-index, a descriptive statistic that describes the relative predictive power of a model, was used to determine which model best discriminated between patients with controlled and uncontrolled asthma. The c-index produces a value between 0 and 1; the closer the c-index is to 1, the greater the predictive ability of the model.

REACT Score Computation

Competing predictive models, to be used as candidate REACT Scores, were calculated using the best 3- and 5-question models. The 2 best 3-question models are summarized in Table 3. Odds ratios, 95% confidence intervals, and *P* values for the 2 competing models were computed to examine the association of patient responses with each of the attitude questions and their asthma control status. Model A, which had the highest c-index of all 3-question models considered (c-index = 0.760), was used as the basis for the first step of the REACT Score.

The goal of the 3-question model was to have a simple classification procedure that did not require any formal scoring. Nonetheless, the 3-question model was expected to leave many patients in an indeterminate medium-risk category. As a second stage, those in the medium-risk category were asked the 2 additional questions from the best 5-question model to shift a sizable percentage of these patients into either the low- or high-risk group. This 2-stage approach allowed the simplicity of the 3-question model to stay intact for most patients while providing options for further evaluation of patients who were not effectively categorized by the simple 3-question model.

Sensitivity analyses were conducted to evaluate the following: the effect of including or excluding demographics in the model, the effect of using an agree/neutral/disagree scale vs a

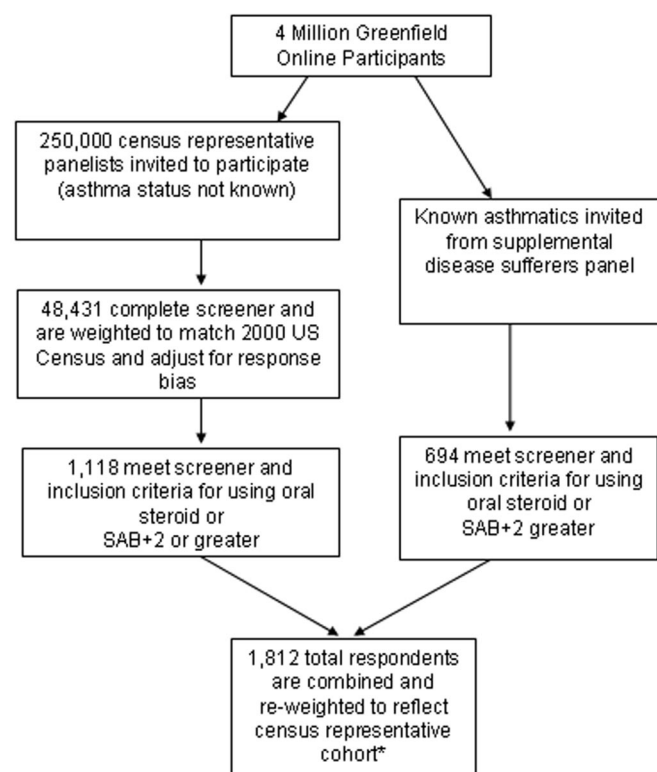


Figure 1. Patient recruitment scheme for the Real-world Evaluation of Asthma Control and Treatment (REACT) study. *Weights applied are adjusted for age, sex, race/ethnicity, region, and household income. SAB + 2 or greater indicates short-acting β_2 -agonist and at least 2 additional long-term controllers.

Table 1. The 41 Attitude and Behavior Questions Included in the Survey Completed by the Respondents

Attitudes about relationship with medical professional (15 questions)

- My doctor and I debate the best treatments for my asthma
- I am afraid to switch doctors because my doctor knows my health history
- Most doctors do not listen
- I believe that a specialist provides a much higher standard of care than a general/family practitioner
- I hate going to the doctor
- I feel much better after going to the doctor
- I have to be proactive to be sure I get the best care from my doctor
- I have requested specific asthma medications from my doctor for my asthma
- Even if I follow a physician's treatment plan, I do not think anything will completely eliminate my asthma symptoms
- I often ask my doctor about new treatments
- My pharmacist tells me how and when to take each asthma medication
- The nurse in my doctor's office is knowledgeable about the latest asthma treatments
- The nurse is more accessible than my doctor
- My physician and I are equal partners in managing my asthma
- My physician knows that I have made compromises to my lifestyle because of my asthma

Attitudes about treatments for asthma (26 questions)

- Asthma medications just mask the asthma
- Asthma medications treat the causes of asthma
- I will take any type of medication if it cures my asthma
- I am extremely satisfied with my current treatment regimen
- I am constantly looking for new treatments to improve my condition
- You can build up a tolerance for asthma medications that makes them less effective
- I worry that I could have long-term lung damage because I do not comply with my treatment
- I sometimes need to take my asthma medication more frequently than prescribed
- It would not bother me if I had to take medication for the rest of my life
- I rely on my asthma medication to get me through the day
- I do not care what is in my asthma medication, just that it works
- The medications I am taking do not completely relieve my asthma symptoms
- Asthma medications are only effective temporarily because they do not treat the cause of the asthma
- I would sacrifice how well the asthma medication works in order to have a safer medication
- Stronger asthma medications have worse side effects
- I worry about the interaction of asthma medications with other medications I take
- I am worried about the long-term side effects of asthma medications
- I am willing to take an asthma medication for as long as I need to before experiencing results
- Most asthma medications do not work fast enough for me
- Occasionally, I do not use asthma medications when I want to because of the cost
- I will always ask for a generic brand if it is available
- I would be willing to pay more (eg, a higher copay) for a drug that would reduce the number of asthma attacks
- I would be willing to pay more (eg, a higher copay) for a drug that would reduce my asthma symptoms
- I am concerned about using oral steroids too frequently
- I am worried about using my fast-acting inhaler too frequently
- I am afraid of not having my rescue medication available for me at all times

7-point Likert scale, and the effect of the data source on the REACT Score. Odds ratios, 95% confidence intervals, and P values based on the Wald χ^2 test were computed to examine the association of patient responses with each of the attitude questions and their asthma control status. Using the best model, a REACT Score was computed for each patient. No adjustments were made for multiple comparisons. All analyses were conducted using a software program (SAS version 9.1; SAS Institute Inc, Cary, North Carolina).

RESULTS

More than half of the 1,812 respondents (55%) had uncontrolled asthma. Controlled ($n = 809$) and uncontrolled ($n =$

1,003) asthmatic patients were similar regarding age and race/ethnicity. The mean (SD) age of the study population was 43 (16) years, and 66% of the patients were white, 10% were black, and 17% were Hispanic. Overall, there were more females (60%) than males, but within males, a higher proportion was in the uncontrolled group (44% vs 37%, $P = .04$). Although uncontrolled asthma patients were less educated than controlled asthma patients (62% vs 51% less than college, $P = .003$) and had somewhat lower household incomes (77% vs 70% less than \$75,000, $P = .02$), most patients in both groups had health insurance coverage (86% vs 88%, $P = .39$). A complete description of patient demographics is available elsewhere.³

Table 2. Survey Questions Used to Determine Patient Attitudes Toward Health Care Professionals and Asthma Treatment

Question	Respondents	
	Total No.	Uncontrolled asthma, %
Patient relationships with medical professionals		
My doctor and I debate the best treatments		
Agree	446	57
Neither agree nor disagree	232	58
Disagree	326	52
I hate going to see the doctor		
Agree	513	65
Neither agree nor disagree	194	47
Disagree	296	49
I have requested specific asthma medications from my doctor for my asthma		
Agree	483	65
Neither agree nor disagree	174	59
Disagree	346	45
Even if I follow a physician's treatment plan, I don't think asthma symptoms will be eliminated		
Agree	628	64
Neither agree nor disagree	196	54
Disagree	179	39
My pharmacist tells me how and when to take each asthma medication		
Agree	597	61
Neither agree nor disagree	125	44
Disagree	281	51
My physician and I are equal partners in managing my asthma		
Agree	662	54
Neither agree nor disagree	203	57
Disagree	138	59
My doctor knows that I have made compromises to my lifestyle because of my asthma		
Agree	613	66
Neither agree nor disagree	224	49
Disagree	166	39
Patient attitudes about their asthma treatment		
I will take any type of medication if it cures my asthma		
Agree	577	56
Neither agree nor disagree	214	58
Disagree	213	51
I am extremely satisfied with my current treatment regimen		
Agree	494	45
Neither agree nor disagree	259	68
Disagree	251	77
I am constantly looking for new treatments to improve my condition		
Agree	550	68
Neither agree nor disagree	236	50
Disagree	217	41
I sometimes need to take my asthma medications more frequently than prescribed		
Agree	568	70
Neither agree nor disagree	152	56
Disagree	283	39
I rely on my asthma medication to get me through the day		
Agree	574	69
Neither agree nor disagree	222	55
Disagree	207	36
The medications I'm taking don't completely relieve my asthma symptoms		
Agree	562	72
Neither agree nor disagree	187	57
Disagree	254	36
Most asthma medications don't work fast enough for me		
Agree	439	74
Neither agree nor disagree	255	53
Disagree	309	42
I'm afraid of not having my rescue medication available for me at all times		
Agree	682	66
Neither agree nor disagree	129	41
Disagree	192	41

Table 3. Odds Ratios and *P* Values for the 2 Best Competing 3-Question Models Assessing Risk of Poor Asthma Control Based on Patients' Responses to Attitude Questions^a

Question	Model A (c-index = 0.760)		Model B (c-index = 0.757)	
	Odds ratio	<i>P</i> value	Odds ratio	<i>P</i> value
I am extremely satisfied with my current treatment regimen				
Agree (vs neutral)	0.44	<.001	0.39	<.001
Disagree (vs neutral)	1.69	<.001	1.41	<.001
I sometimes need to take my asthma medication more frequently than prescribed				
Agree (vs neutral)	1.67	<.001	1.68	<.001
Disagree (vs neutral)	0.59	<.001	0.65	<.001
My physician knows I have made compromises to my lifestyle because of my asthma				
Agree (vs neutral)	1.96	<.001	NA	NA
Disagree (vs neutral)	0.69	<.001		
I rely on my asthma medication to get me through the day				
Agree (vs neutral)	NA	NA	1.84	<.001
Disagree (vs neutral)			0.58	<.001

Abbreviation: NA, not applicable.

^a Best 3 questions is defined as the 3-question combination that maximized the logistic regression c-index.

Relationship Between Patient Attitudes and Asthma Control

Initial 3-question predictive models evaluating the associations between patient attitudes and asthma control and used to determine candidate REACT Scores are given in Table 3. The 3 questions included in model A constituted what was considered the best model with the highest predictive value (c-index = 0.760). This model included questions regarding patient satisfaction with current treatment, the patient believing that the physician recognizes lifestyle compromises necessitated by asthma, and the need for taking asthma medications more frequently than prescribed. The c-index for model B was only slightly lower than that for model A (c-index = 0.757) and included a question about relying on asthma medications to get through the day instead of the question about physician-recognized lifestyle compromises.

The REACT Score

Using model A, the REACT Score was developed by assigning patients to the following 3 risk categories based on the predicted values from the model: high ($\geq 65\%$), medium (≥ 35 to $< 65\%$), and low ($< 35\%$). Figure 2 illustrates how the 3 survey questions were used to predict the degree of risk of uncontrolled asthma. However, step 1 alone placed many patients in the medium-risk category. Step 2 of the REACT Score used responses to 2 additional questions to further classify many of these patients into the low- or high-risk group (Fig 3).

The predicted vs the actual percentage of patients with uncontrolled asthma, as determined by the REACT Score risk category, demonstrated reasonable "goodness of fit." Generally, this model fit well regardless of physician specialty. Of the patients treated by pulmonologists and those determined to be in the high-risk REACT Score category, 89% had

uncontrolled asthma compared with the average 75% expected for that group (Table 4).

Sensitivity analyses indicated that adjusting the model for patient demographics or the use of a 3-category scale (agree/neutral/disagree) vs the full 7-point Likert scale used in the survey questionnaire had minimal effects on the model's discriminatory abilities as measured by the c-index. An additional sensitivity analysis comparing the breakout of high, medium, and low risk by data source demonstrated that the REACT Score accurately predicted asthma control for all patients, including the cohort of individuals with known asthma (the "asthma sufferers panel"), which was used to supplement the study sample size. When comparing the average predictive values for controlled and uncontrolled asthma patients, those for the REACT Score and the full model fell within 2 percentage points, demonstrating that the REACT Score effectively captured the predictive information from the model with limited loss of information.

DISCUSSION

The REACT data indicate that patient attitudes toward asthma care and health care professionals are significant predictors of uncontrolled disease. Using a REACT Score to predict asthma control is a novel and easy-to-use approach to asthma management. Insights gained from the REACT Score may also improve physician-patient communications by identifying patient concerns about the effectiveness of controller therapy in the face of significant compromises in quality of life. Awareness of this deleterious impact of asthma should indicate to the physician an increased risk of uncontrolled asthma and provide the basis for further discussion.

STEP 1. Categorization of poor asthma control as high-, medium-, or low-risk based on the 3-question model.				
Question 1. My physician knows that I have made compromises to my lifestyle because of my asthma.	Question 2. I sometimes need to take my asthma medication more frequently than prescribed.	Question 3. I am extremely satisfied with my current treatment regimen.		
		Agree	Neutral	Disagree
Agree to both questions above		High	High	High
Agree to one, neutral to the other		Medium	High	High
Neutral to both or one agree and one disagree		Medium	Medium	High
Disagree to both or disagree to one and neutral to one		Low	Medium	Medium

Figure 2. Categorization of poor asthma control as high, medium, or low risk based on the 3-question Real-world Evaluation of Asthma Control and Treatment (REACT) model. Patients can be classified as having a high, medium, or low risk of being uncontrolled based on the responses to the 3 survey questions that compose step 1 of the REACT Score. The risk categorization is identified by assessing agreement with the first 2 questions and combining this response with the response to the third question.

STEP 2. Two additional questions for use in patients with medium control with the 3-question model.			
Additional Question 1. The medications I am taking do not completely relieve my asthma symptoms.	Additional Question 2. I am afraid of not having my rescue medication available for me at all times.		
	Agree	Neutral	Disagree
Agree	High	Medium	Medium
Neutral	Medium	Medium	Medium
Disagree	Medium	Low	Low

Figure 3. Categorization of poor asthma control after incorporating 2 additional questions into the Real-world Evaluation of Asthma Control and Treatment (REACT) model. Patients categorized as medium risk by the 3-question model were asked 2 additional questions to more completely classify their asthma control.

A simple, standardized method for globally assessing and quantifying asthma symptoms in a given patient or group of patients is needed.⁸ Historically, clinical and physiologic outcomes have been of most concern to practitioners.⁹ The ACT,⁶ the Asthma Therapy Evaluation Questionnaire,¹⁰ and the Asthma Control Questionnaire¹¹ were developed to facilitate and standardize evaluation of the impairment domain of asthma control. These instruments catalog historical events, such as symptoms, nighttime awakenings, lost productivity, and missed work or school as a result of asthma, but their

precision depends on the patient's ability to recall specific details of past asthma events, details that are often subject to recall bias or that are only vaguely remembered. A degree of awareness about symptom frequency, severity, and the extent to which asthma limits daily activities and quality of life is also required. Significantly, currently used evaluation tools catalog discrete events that happened in the past; consequently, they cannot be acted on in real time to improve treatment outcomes. In addition, many patients perceive their asthma to be better controlled than is indicated by standard

Table 4. Predicted vs Actual Asthma Control by Risk Category and Physician Specialty

Physician specialty	REACT Score category ^a		
	High (≥65%)	Medium (35%–<65%)	Low (<35%)
All physicians			
Respondents, No.	704	716	412
Actual % uncontrolled	75	50	24
Average predicted value ^b	75	49	25
General/family physicians/internists ^c			
Respondents, No.	475	522	299
Actual % uncontrolled	74	54	21
Average predicted value ^b	76	49	24
Allergists			
Respondents, No.	118	109	66
Actual % uncontrolled	68	40	22
Average predicted value ^b	74	49	25
Pulmonologists			
Respondents, No.	90	76	41
Actual % uncontrolled	89	38	32
Average predicted value ^b	75	49	25

Abbreviation: REACT, Real-world Evaluation of Asthma Control and Treatment.

^a The REACT Score category is based on patients with an uncontrolled asthma predicted value in the given range.

^b Uncontrolled asthma predicted values were computed based on the following logistic regression model: control = $q2.15 + q5.04 + q5.08$.

^c Listed physician specialty categories exclude “other,” which consisted of ear, nose, and throat specialist, emergency department physician, and other.

evaluation tools.¹² These patients seem to poorly perceive the symptoms of their asthma and frequently attribute them to aging, obesity, lack of fitness, or some other cause. Consequently, these symptoms are not reported to be asthma related on the commonly used questionnaires.¹³

An increasing number of treatment options provide the opportunity for better asthma control for more patients. However, more therapeutic choices also means an increased need for patient education.¹⁴ An open and unrestricted 2-way dialogue between the physician and the patient is essential to selecting the most appropriate treatment option, setting treatment expectations, identifying potential adverse events from treatment, and gathering details on patient satisfaction with asthma care. The updated guidelines of the Expert Panel Report recommend that every effort should be made to encourage open discussion of concerns and their expectation of therapy⁴ because a patient’s negative attitude toward medication or reluctance toward self-management are risk factors for severe exacerbations.¹⁵ Instruments that capture the effects of asthma on humanistic outcomes, such as attitudes, beliefs, and quality of life, can be used to facilitate patient-provider communication at the same time that they provide insight into the asthma control status.⁹

Patient attitudes toward their asthma treatment and the health care providers who deliver their care have a direct

effect on asthma control.¹⁶ Although the questions incorporated into the REACT model regarding attitudes do not provide a clear cutoff score for earmarking uncontrolled asthma, responses to questions about lifestyle compromises and feelings about treatment form the basis of a meaningful discussion about asthma-related impairment that can provide the physician with a gauge of the patient’s level of asthma control and risk of future exacerbation. In particular, the question about physician awareness of lifestyle compromises as a result of asthma is revealing and timely as the revised National Asthma Education and Prevention Program asthma treatment guidelines encourage the use of quality of life questions to evaluate asthma impairment and control.⁴ In other areas, this question is helpful for identifying asthma-related missed work or school, reduction in usual activities, and disturbances in sleep.

An advantage of the REACT Score is that it shifts the focus of asthma control from recalling discrete historical events to a global evaluation based on attitudes and beliefs, elements that may not be as vulnerable to the accuracy of patient recall. In addition, by encouraging discussion, the REACT Score brings to the forefront issues related to asthma care that are important to the patient. The issues highlighted by the REACT Score provide a basis for discussion and for modifying approaches to asthma care in a way that may help to engage patients in ongoing care. This discussion can increase patient understanding of asthma and its treatment, which can motivate patients to take greater responsibility for their own care and, thus, increase asthma control.

Attitudes of moderate to severe asthmatic patients toward their treatment and the professionals delivering their health care can affect the degree of asthma control. Thus, tools that incorporate patient attitudes and behaviors into the evaluation of asthma control are needed. The REACT Score provides an easy-to-use method to predict the degree of asthma control by using the responses to 3 questions that evaluate patient attitudes toward asthma treatment and their relationship with asthma care providers. This new instrument may provide an additional tool to evaluate the true degree of asthma-related impairment.

Using the ACT and the REACT Score simultaneously may provide the potential for a more accurate approach to tracking asthma control because each tool uses different variables. Whereas the ACT is based on disease activity, the REACT Score is based on attitudes and is supplementary in terms of evaluation and intervention. The REACT Score provides a basis for intervention based on self-management and behavior. However, because the ACT was used as the gold standard for the evaluation of the REACT Score, it is inherently not possible to determine from this study how these 2 instruments might be used together. This topic is important for future research, ideally in a prospective validation that the study group is currently considering, to allow the REACT Score to be implemented for widespread use.

We recognize the following limitations to the present study. It is unclear whether the attitudinal questions used to

create the REACT Score are directly predictive of asthma control or are a proxy for some other measure of asthma control, such as medication adherence. Also, cross-sectional data were used to develop the REACT Score. The level of computer expertise among respondents could also be a source of error or nonresponse, and participants willing to take the time to complete the survey may not represent the typical computer user in the general public.¹⁷

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