Published in final edited form as:
J Allergy Clin Immunol. 2013 July ; 132(1): 55–62. doi:10.1016/j.jaci.2013.01.007.

The Pediatric Asthma Control and Communication Instrument asthma questionnaire: For use in diverse children of all ages

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Abstract

Background—National Institutes of Health asthma guidelines recommend questionnaires to assess asthma control, but these questionnaires are not useable across the entire pediatric age spectrum and have not been validated among significant numbers of minority or Spanish-speaking children.

Objective—We sought to evaluate a questionnaire designed to assess asthma control across a broad age range of minority and Spanish-speaking children cared for in an outpatient setting.

Methods—Between July 1, 2007, and September 30, 2010, we collected information using the Pediatric Asthma Control and Communication Instrument (PACCI), the Asthma Control Test (ACT; or the childhood ACT for children 4–11 years old), the Pediatric Asthma Caregiver Quality of Life Questionnaire, and lung function and clinicians' ratings of asthma status among a population of children presenting for routine asthma specialist care. The PACCI measure of asthma control was validated by evaluating accuracy, internal reliability, and concurrent, discriminative, and known-groups validity.

Results—We collected information on 265 English- and 52 Spanish-speaking children (mean age, 8.2 years; 58% male; 44% African American). Across all age groups and in both languages, PACCI control showed good internal reliability and strong concurrent, discriminative, and known-

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Disclosure of potential conflict of interest: The authors declare that they have no relevant conflicts of interest.

groups validity with ACT and Pediatric Asthma Caregiver Quality of Life Questionnaire scores and clinicians' ratings of asthma control. The accuracy of the PACCI in classifying children with uncontrolled asthma was good (area under the curve, 0.83; 95% CI, 0.79–0.88).

Conclusions—The PACCI accurately measures asthma control in English- and Spanish-speaking children. The PACCI should be useful to clinicians to assess and classify asthma according to National Institutes of Health asthma guidelines.

Keywords

Impairment; control; children; assessment; accuracy; survey; validation; Pediatric Asthma Control and Communication Instrument; Spanish

Underestimation of asthma control by parents, clinicians, or both can lead to inappropriate treatment and poorer outcomes.[1–8] The use of a validated asthma questionnaire might help to overcome this issue by standardizing and improving the accuracy of asthma evaluations by clinicians and parents.[9] Furthermore, use of validated asthma questionnaires has been encouraged in the most recent asthma guidelines from the National Institutes of Health (NIH).[10]

However, few published asthma questionnaires are available for use in children of all ages.[11,12] In addition, the publicly available questionnaires are limited by 1 or more of the following because they do not: (1) assess NIH guideline indicators of both impairment and risk; (2) measure disease activity across the full pediatric age spectrum; (3) have extensive validation data among racial/ethnic minority populations, those from low socioeconomic backgrounds, or both; (4) have evidence of validity in Spanish; or (5) incorporate the multidimensional measures of asthma morbidity outlined in the NIH asthma guidelines (eg, history of asthma exacerbations, pharmacotherapy, and patient-provider communication).[11–20]

We developed the Pediatric Asthma Control and Communication Instrument (PACCI) to facilitate the outpatient evaluation of childhood asthma, including control, risk, adherence, patient-provider communication, and a treatment algorithm to assist clinicians in asthma management. The purpose of this study was to evaluate the construct validity and reliability of the Control domain of the PACCI among a diverse pediatric population, including African American and Latino children, across the age spectrum.

METHODS

Questionnaire development and content

The PACCI was developed in conjunction with the adult Asthma Control Communication Instrument (ACCI).[21] Both asthma assessment tools are written at a fifth-grade reading level, were designed for use across diverse patient populations, and are intended to help clinicians better use patient/parent-reported information to guide asthma treatment.

The conceptual domains incorporated into the PACCI were derived from a variety of patient and physician focus groups,[21,22] including inner-city, African American, Latino, and

Spanish-speaking patients, as well as pediatricians, family practitioners, and pediatric asthma specialists. The PACCI was further evaluated through cognitive testing[22] and vignette-based surveys of pediatricians.[23,24] It is a 12-item parent-completed questionnaire (see Fig E1 in this article's Online Repository at www.jacionline.org) that assesses 5 conceptual domains of asthma status:

1. *Direction*—perceived changes in asthma status;
2. *Bother*—perceived disease burden;
3. *Risk*—reports of emergency department visits, hospitalizations, and oral steroid use;
4. *Adherence* to daily controller medications; and
5. *Control*—frequency of daytime symptoms, short-acting β_2-agonist use, asthma attacks, activity limitation, and nocturnal symptoms (ie, guideline-based measures of impairment).[10]

The time frame of recall for the Control domain items is 1 week, except for nocturnal awakening, which is 2 weeks. The 12th item is an open-ended question designed to enhance patient-centered communication with the clinician. As described previously for the adult ACCI,[21] the PACCI Control domain can be scored in 3 ways:

1. The *sum score*[25] is a summation of the score assigned to each response option (0–4 for questions 7, 8, 10, and 11 and 0–3 for question 9), ranging from 0 (best asthma control) to 19 (worst asthma control).
2. The *problem index*[26] dichotomously scores each of the 5 Control domain items as 0 (controlled) or 1 (not controlled), which are then summed, ranging from 0 (no control problems) to 5 (5 control problems).
3. *Categories* uses a classification scheme based on NIH asthma guideline assessments by categorizing patients into 4 severity/control categories (intermittent/controlled, mild persistent/partly controlled, moderate persistent/uncontrolled, and severe persistent/poorly controlled). In this study because we do not have data on patient medication use, the focus will be on assessment of the control categories only. The category chosen is based on responses to questions 7 to 11 of the PACCI. An instruction is provided for the clinician, stating "Assign patient's current level of asthma control by looking at the box checked farthest to the right on questions 7–11 and match the box color to the level of asthma control in this section." For simplicity, 2 control categories can be used instead ("controlled" and "not controlled").[10] "Intermittent" symptoms are considered "controlled," whereas "persistent" symptoms are considered "not controlled."

Spanish PACCI

The Spanish-language PACCI is shown in Fig E2 in this article's Online Repository at www.jacionline.org. The English-language PACCI was translated by a native Spanish-speaking clinician coinvestigator (JAL). This Spanish version was then back-translated by a clinician coinvestigator (DAT, a native English speaker fluent in Spanish) and another

clinician coinvestigator (CMP, a native Spanish speaker fluent in English). Differences in the Spanish and English versions were reconciled among the translators.

Procedures

This was a cross-sectional study that took place between July 2007 and September 2010. The study was approved by the Johns Hopkins University and University of California, San Francisco, Institutional Review Boards. Before seeing a clinician, parents completed the PACCI, established questionnaires measuring asthma morbidity (described below), and a demographic questionnaire. The University of California, San Francisco, site (San Francisco General Hospital [SFGH]) saw both English- and Spanish-speaking patients, and therefore either version of the PACCI was used based on the patient's language preference. All Spanish-speaking participants were recruited at SFGH. Clinicians at SFGH spoke Spanish with varying degrees of fluency. Interpreter services were available if needed. Spirometry was obtained at the discretion of the treating clinician.

Sample

A convenience sample of participants and their caregivers was recruited among patients presenting for outpatient asthma care at Johns Hopkins Children's Center (JHCC) or SFGH. Participants were eligible if they (1) had self-reported doctor-diagnosed asthma, (2) were accompanied by a caregiver who could provide consent, (3) spoke English or Spanish, and (4) were 21 years of age or younger. In their preferred language caregivers provided informed consent, whereas children older than 8 years of age provided assent.

Established asthma morbidity measures

The Asthma Control Test (ACT; for patients ≥12 years of age)[25] or the Childhood Asthma Control Test (C-ACT; for patients 4–11 years of age)[20] are 5- and 7-item questionnaires, respectively, that assess asthma control (eg, symptom frequency) over the prior month.[20,25] The scores for the ACT items are summed to yield a total score ranging from 5 (poor control of asthma) to 25 (complete control of asthma [or 0–27 for the C-ACT]). A score of greater than 19 indicates well-controlled asthma. For Spanish-speaking participants, the Spanish version of the ACT/C-ACT was completed.

The Pediatric Asthma Caregiver Quality of Life Questionnaire (PACQLQ)[27] consists of 13 questions that assess the effect of asthma on activity limitation and emotional function during the previous week. Each question is scored on a 7-point scale. The final PACQLQ score is a mean of the 13 scores, with higher scores indicating better quality of life. No validated Spanish-language PACQLQ was available.

Spirometry was obtained at the discretion of the clinician for the 118 children who were able to perform it.

Clinician's assessment

Patients were evaluated by pediatric clinicians (pulmonologists, pediatricians, and nurse practitioners) in established asthma specialty care clinics with practices modeled after NIH guidelines.[10] On the basis of history, medications, and physical examination and spirometric

results (FEV_1 and FEV_1/forced vital capacity [FVC] ratio), clinicians were asked to classify the patient's asthma disease status in one of 2 ways: (1) controlled or not controlled or (2) intermittent or persistent (mild, moderate, or severe). The clinician provided an assessment of asthma control based exclusively on the information obtained during the encounter while blind to the parent-completed measures.

Analysis

Means and proportions were used to describe the characteristics of the study population. Floor and ceiling effects of the PACCI sum score and problem index scores were evaluated to determine whether respondent scores were clustered at the low or high ends of these scales; such clustering would suggest that the PACCI is not useful in discriminating different levels of asthma control. We used Cronbach α values to evaluate the internal reliability of the PACCI Control domain. To evaluate concurrent construct validity, we evaluated the correlations between the PACCI Control domain (sum score and problem index) with (1) the ACT/C-ACT, (2) the PACQLQ (among English-speaking patients only), and (3) lung function for JHCC patients (FEV_1 as a percentage of predicted values using Stanojevic equations[28] and FEV_1/FVC ratio) using Spearman correlation coefficients. We hypothesized that higher PACCI Control domain scores would correlate with worse rating of disease status, as assessed based on ACT/C-ACT, PACQLQ, and lung function values.

To test for discriminative properties, we examined mean asthma ACT/C-ACT, PACQLQ, and lung function values across the PACCI categories (controlled to poorly controlled) using ANOVA.[29,30] We also examined mean PACCI sum scores and problem index scores across clinicians' ratings of asthma disease status using ANOVA (known-groups validity). We calculated receiver operating characteristic (ROC) curves to assess the accuracy of the PACCI Control domain in identifying "not controlled" asthma, as determined by clinicians[31] using a logistic regression model. Areas under the ROC curve (AUCs) of greater than 0.8 were considered good levels of accuracy.[32] C-statistics for each sum score and index value were calculated to determine the ideal cut point for identifying uncontrolled asthma. The Hosmer-Lemeshow test was used to further assess the performance (goodness of fit) of the logistic regression model.[33] Positive and negative likelihood ratios were also calculated to quantify how much a given PACCI score changes the odds of the clinician characterizing a child's asthma status as "uncontrolled."[34] All analyses were performed separately for each of the age categories currently defined in NIH asthma guidelines: less than 5 years, 5 to 11 years, and 12 years or greater. The Spanish PACCI was analyzed separately but not by age group categories because there were not enough participants. Participants with incomplete data were excluded. All analyses were 2-sided, and a *P* value of less than .05 was considered statistically significant. Analyses were performed with STATA 11 software (StataCorp, College Station, Tex).

RESULTS

There were a total of 265 English-speaking and 52 Spanish-speaking participants. Seventy-nine percent of the English-speaking subjects were recruited from JHCC, whereas all of the Spanish-speaking participants were recruited from SFGH. Table I provides an overview of

the participants. A higher percentage of boys and a lower percentage of African Americans were observed among patients less than 5 years of age (P <.01 for both comparisons). Parental education levels were quite varied. Compared with English speakers, the Spanish-speaking population was slightly younger (mean age, 6.6 years), reported lower levels of parental education, and had a higher proportion of male participants (P < .05). Approximately half the participants were classified as having controlled asthma (Table I).

The floor and ceiling effects of the PACCI sum score were 29% and 0.4% (17% and 0% for Spanish-speaking patients) and those of the problem index were 39% and 10% (44% and 8% for Spanish-speaking patients), respectively. The floor and ceiling effects were not significantly different according to patient's age or by language spoken, but the floor effects differed between African American and white patients (23% vs 37%, P < .05).

Internal reliability

The PACCI Control domain showed good internal reliability overall (0.84) and among each of the subgroup participant populations, including English speakers (0.84), Spanish speakers (0.82), white subjects (0.83), African American subjects (0.86), those less than 5 years old (0.75), those 5 to 11 years old (0.87), and those 12 years of age and older (0.85).

Concurrent validity

The PACCI Control domain showed convergent construct validity with the ACT/C-ACT and PACQLQ (Table II) but not for FEV_1 percent predicted or FEV_1/FVC ratio. For the PACCI sum score and PACCI problem index, higher values represent better asthma status, which explains the direction of the correlations with the ACT/C-ACT and PACQLQ. The above findings held true across all age, ethnicity, and Spanish-speaking patient groups.

Discriminative properties

The PACCI categories (Table III) and PACCI problem index (see Table E1 in this article's Online Repository at www.jacionline.org) significantly discriminated levels of asthma control and quality-of-life values. More specifically, ACT/C-ACT and PACQLQ values decreased as PACCI categories and problem index domains worsened. Among Spanish-speaking patients, we observed higher than expected PACQLQ scores among the subgroups with poorly controlled asthma, as well as higher than expected ACT/C-ACT scores, for those classified as having poorly controlled asthma by using the Spanish PACCI (Table III). No significant linear trends were observed in association with lung function.

Known-groups validity

The PACCI Control domain measures significantly discriminated values between groups known to differ in level of asthma, control as defined by the clinician's asthma classifications (Tables IV and V). Specifically, the mean sum score and problem index values varied significantly across the groups of patients who differed in their clinician-rated level of severity (intermittent to severe persistent) and control (controlled vs not controlled); all P values were less than .001.

Performance of PACCI Control domain

The AUC of the PACCI sum score (0.85; 95% CI, 0.81–0.89) and problem index (0.83; 95% CI, 0.79–0.87) showed that both methods of scoring accurately predicted clinician ratings of uncontrolled asthma overall and across each of the 3 age groups by ethnicity and by language. A PACCI sum score cutoff value of 3 or greater and a problem index of 2 or greater showed an optimal sensitivity/specificity ratio to identify subjects considered to have uncontrolled asthma (see Tables E2 and E3 in this article's Online Repository at www.jacionline.org). The Hosmer-Lemeshow test showed no departure from goodness of fit ($P > .05$) of the logistic model, and thus the model was well calibrated.

DISCUSSION

The present study demonstrates that the PACCI is a valid measure of control in pediatric patients with self-reported doctor-defined asthma who are treated at an asthma clinic. Specifically, the PACCI (1) effectively measures asthma control status in children, (2) distinguishes clinically important differences of disease status, (3) accurately categorizes patients with controlled or uncontrolled asthma compared with the clinician's assessment, (4) can be used in children of different ages and ethnicities, and (5) performs adequately in African American, Latino, and English- and Spanish-speaking populations. The findings should make the PACCI potentially appealing to clinicians who provide pediatric asthma care to ethnically/racially varied populations.

Although the PACCI categories accurately categorized patients of differing levels of asthma control, we did observe overlap in the 95% CIs of mean ACT scores across the PACCI categories, particularly for those with uncontrolled or poorly controlled asthma. These findings are likely due to (1) the small number of participants classified as having poorly controlled asthma (n 5 31) and (2) the definitional closeness of these 2 categories in the National Heart, Lung, and Blood Institute's asthma guidelines on which the PACCI categories are based, particularly in terms of daytime symptom and rescue medication use: patients might not fully appreciate the differences between "daily" and "throughout the day" or "several times per day" or for uncontrolled or poorly controlled asthma, respectively. Notably, ROC and Hosmer-Lemeshow analyses demonstrated that PACCI sum scores and problem index scores accurately identified patients classified by the clinician with "uncontrolled" asthma (AUC ≥ 0.8).

Among those with uncontrolled or poorly controlled symptoms, we observed that mean PACQLQ scores were the same or higher in the poorly controlled asthma group than in the uncontrolled asthma group. The PACCI control domain might be associated with quality of life, but there are no accepted measures of asthma quality of life according to the NIH asthma outcomes workshop, and therefore this association will require further evaluation.

The PACCI is unique in that it was developed with input from a diverse group of patients and clinicians.[21,22,35] In particular, the incorporation of terminology used and/or understood by patients (eg, "difficulty taking a deep breath," "flema," "nebulizer," and "spray") can help in ensuring an acceptable level of understanding across a variety of patient populations, including inner-city, African American, and Spanish-speaking patients. Cognitive interviews

conducted during validation of the ACCI confirmed good acceptability and understanding by patients. The PACCI has a color-coded item-response algorithm (eg, green, yellow, and red) for rapid screening and identification by health care providers of patient problem areas. The color-coded format could also enhance communication between patients and clinicians. For example, the clinician can highlight to the patient that a red response is an area of concern to discuss. Such a method of sharing information with patients might be more effective in establishing a mutual understanding of disease activity level than providing them with a score or even a category of morbidity (eg, moderate persistent),[36,37] especially in populations with low health literacy.

In the United States there is a growing need for asthma assessment tools that are available in Spanish, have been validated among Latino patient populations, or both.[38–42] The findings of our study suggest that the PACCI might be a valid measure of asthma morbidity for these populations. We did observe an unexpectedly higher ACT/C-ACT score among those classified as having poorly controlled asthma by the Spanish PACCI, possibly because of a small sample size or misunderstanding of questions on either the Spanish ACT/C-ACT (validated in Spain) or the PACCI. In addition, our participants do not represent all of the different Latino subgroups in the United States, and therefore we have assumed a similarity in experience across these subgroups. This limitation is common among other studies examining ethnic disparities and will ideally be addressed in future studies. Admittedly, our findings need to be verified among larger patient samples, including determining whether the PACCI is valid across the pediatric age spectrum in Latino patients.

The PACCI fills an important void among currently available pediatric asthma questionnaires. The Test for Asthma Respiratory Control in Kids (TRACK)[18] is the latest assessment tool that is designed for or is inclusive of children less than 5 years of age; others include the Pediatric Asthma Control Test,[11] the Pediatric Asthma Symptom Scale,[19] the Asthma Quiz for Kidz,[12] the Breathmobile Case Identification Survey,[43] and Asthma Control in Asthma.[44] Only PACT and QUIZ offer the combination of allowing assessment across the pediatric age spectrum, as well as assessing impairment and risk. However, the PACCI offers several advantages over these questionnaires: (1) impairment can be evaluated by using a continuous score, which might be more useful in research settings (eg, clinical trials), where responsiveness to treatment and smaller changes in asthma status are important; (2) impairment can be evaluated as guideline-based control categories (controlled and not controlled), which might be more useful to clinicians who are attempting to meet documentation requirements but for whom categories might be more meaningful than a given score; (3) a color-coded item-response algorithm (eg, green, yellow, and red) for rapid identification of problem areas; and (4) more comprehensive assessment of multiple dimensions of asthma health, including impairment, risk, adherence, disease burden (Bother domain), and interval changes in asthma status (Direction domain). Therefore the PACCI might also be beneficial as a training tool for clinicians learning the components of asthma morbidity classification (eg, symptom frequency or activity limitation), how to assign asthma morbidity levels (eg, poorly controlled), and to make treatment decisions based on such a classification. In summary, we would suggest that the categories approach be used by clinicians (for ease of understanding, facilitating communication of information with patients and other providers, and for documentation purposes), whereas the sum score

approach be used by researchers, who are more likely to be interested in capturing finer differences in asthma control over time (between patients, within patients, or both). Admittedly, more work needs to be done for the sum score to be used by researchers (eg, defining the minimal important difference and responsiveness of the PACCI).

The evolving expectations by payers and regulators of clinicians to show that certain standards of care are delivered (assessment, documentation, and treatment of persistent asthma) requires strategies to enhance and expedite the data retrieval and assessment process.[45–47] The PACCI facilitates the collection of information important in assessing asthma control[21,22,35,48] and provides this assessment in a meaningful way consistent with national asthma guideline classification schemes; therefore it can also be used as a documentation tool. The PACCI might be beneficial as a training tool for clinicians learning the components of, the assignment of, and how to make treatment decisions based on asthma severity/control classification.

There are several limitations to this study. First, this study was conducted in asthma specialty settings, and therefore these results might not be generalizable to children receiving care in other settings. However, our participants included a broad cross-section of sociodemographic populations. The SFGH site is also a federally qualified health center, which provides care to a patient population known to be at high risk for poor asthma outcomes, including ethnic minority, poor, and non–English-speaking patient populations. We have also included patients with intermittent asthma, a group common in general pediatrics settings.

Second, most of the data are based on parent self-report and therefore are subject to reporting bias. However, we would expect that underreporting or overreporting is a universal limitation to questionnaire-based data. Therefore this bias is nondifferential across self-reported questionnaires and toward the null. Furthermore, parent report is a standard method for obtaining clinical information. The study was conducted in real-world clinical settings, and therefore our findings are reflective of what information is capable of being retrieved during routine clinical encounters.

Third, we would be cautious in the use of the PACCI as a self-administered tool in nonliterate populations or those with or very low literacy. However, this limitation is universal to all currently available parent- or patient-completed asthma questionnaires, many of which have unpublished reading levels.

Fourth, we did not observe a significant association of the PACCI Control domain measures with lung function measurements. However, lung function has been observed to correlate poorly with a variety of asthma morbidity indicators, including symptoms,[19,49,50] quality of life,[27] and airway inflammation.[51] Furthermore, our ability to examine the associations of the PACCI Control domain measures with lung function was limited by the small sample of available children. This will require further investigation among a larger sample of children. We also have not captured controller medication use in this population, and therefore we cannot comment on the measurement properties of the PACCI as it pertains to asthma severity. In addition, we do not know the ideal timeframe for patient reporting of symptoms.

However, it has been recently suggested that questionnaires that use a longer timeframe for recall might underestimate the presence of uncontrolled asthma.[52] Further testing of the PACCI's psychometric properties (test-retest reliability, predictive validity, responsiveness, and minimal important difference) will help in understanding the full measurement capabilities of the PACCI.

Lastly, as with other asthma assessment questionnaires, we do not know the effect of routine use of the PACCI on asthma care and asthma outcomes.

In conclusion, our findings confirm that the PACCI is a valid measure of asthma control across the pediatric age spectrum, including among African American and Latino patient populations. The PACCI can help to standardize asthma care and to present information in a format that is understandable and useable across a variety of patient populations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Supported by National Heart, Lung, and Blood Institute grant HL089410.

Abbreviations used

ACCI	Asthma Control Communication Instrument
ACT	Asthma Control Test
AUC	Area under the curve
C-ACT	Childhood Asthma Control Test
FVC	Forced vital capacity
JHCC	Johns Hopkins Children's Center
NIH	National Institutes of Health
PACCI	Pediatric Asthma Control and Communication Instrument
PACQLQ	Pediatric Asthma Caregiver Quality of Life Questionnaire
ROC	Receiver operating characteristic
SFGH	San Francisco General Hospital

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Clinical implications

The results of this study support the validity of the PACCI as a measure of impairment from asthma in English- and Spanish-speaking children of all ages.

TABLE I

Sociodemographic characteristics of the participants*

	<5 y (n = 75)	5–11 y (n = 119)	≥12+ y (n = 71)	Spanish (all ages [n = 52])
Age (y) mean (SD); range	2.9 (1.3); 0.5–4.9	8.2 (2.1); 6.2–11.9	15.2 (2.1); 12.1–20.5	6.6 (3.5)†; 0.8–13.1
Female sex (%)	31‡	45	54	35
Ethnicity (%)				
African American	40	58	49	2†
White	41	30	45	0
Latino	8	3	0	75
Other§	9	8	3	0
Unknown	1	0	1	23
Parental education (%)				
<12th grade	8	6	7	12†
High school graduate	17	16	18	35
Some college/technical school	21	33	27	12
College graduate	17	14	17	6
Postcollege graduate	25	21	20	2
Unknown	11	10	11	35
Clinician-rated asthma (%)				
Controlled	48	50	42	58
Uncontrolled	52	50	58	42

*Not all columns of data add up to 100% because of rounding.

†$P < .05$ in comparisons of Spanish-speaking versus English-speaking participants.

‡Significantly lower proportion of female participants in the "<5 y" age group compared with other age groups ($P < .05$, χ^2 test).

§Includes American Indian (1%), Asian American (5%), and multiracial (2%) ethnic/racial groups.

TABLE II

Concurrent validity of the PACCI sum score and problem index with measures of asthma control (ACT/C-ACT), quality of life (PACQLQ), and lung function by using the Spearman correlation coefficient

PACCI domains	Sum score	*P* value	Problem index	*P* value
ACT/C-ACT				
English* (n = 265)	−0.718	<.0001	−0.707	<.0001
<5 y (n = 75)	−0.601	<.0001	−0.618	<.0001
5–11 y (n = 119)	−0.779	<.0001	−0.759	<.0001
≥12 y (n = 71)	−0.710	<.0001	−0.698	<.0001
African American (n = 134)	−0.656	<.0001	−0.643	<.0001
White (n = 99)	−0.723	<.0001	−0.712	<.0001
Spanish (n = 52)	−0.788	<.0001	−0.747	<.0001
Quality of life (PACQLQ)				
English* (n = 265)	−0.643	<.0001	−0.629	<.0001
<5 y (n = 75)	−0.601	<.0001	−0.580	<.0001
5–11 y (n = 119)	−0.654	<.0001	−0.654	<.0001
≥12 y (n = 71)	−0.695	<.0001	−0.668	<.0001
African American (n = 134)	−0.600	<.0001	−0.591	<.0001
White (n = 99)	−0.685	<.0001	−0.684	<.0001
Spanish (n = 52)	−0.567	<.0001	−0.508	.001
FEV_1 (% predicted)				
Overall† (n = 118)	−0.129	.164	−0.136	.142
English* (n = 79)	−0.184	.104	−0.176	.120
5–11 y (n = 50)	−0.159	.270	−0.133	.357
≥12 y (n = 29)	−0.208	.280	−0.216	.261
African American (n = 38)	−0.148	.374	−0.167	.316
White (n = 33)	−0.181	.314	−0.082	.651
Spanish (n = 39)	0.011	.945	0.007	.968
FEV_1/FVC ratio				
Overall† (n = 118)	−0.157	.089	−0.177	.056
English* (n = 79)	−0.091	.427	−0.059	.604
5–11 y (n = 50)	−0.109	.453	−0.072	.617
≥12 y (n = 29)	−0.031	.872	0.033	.863
African American (n = 38)	−0.138	.409	−0.107	.523
White (n = 33)	−0.082	.650	−0.031	.865
Spanish (n = 39)	−0.323	.045	−0.313	.053

*Refers to all patients who completed the English version of the PACCI.

†Includes both English- and Spanish-speaking patients who performed spirometry.

TABLE III

PACCI discriminant properties: trend in mean values (95% CIs) of C-ACT and PACQLQ across PACCI categories by using ANOVA

Mean value of validated measure (95% CI)	PACCI categories				
	Controlled (n = 125)	Partly controlled (n = 80)	Uncontrolled (n = 81)	Poorly controlled (n = 31)	*P* value
ACT/C-ACT score					
English* (n = 265)	22.9 (22.2–23.5)	18.4 (17.5–19.3)	15.6 (14.6–16.5)	13.1 (11.8–14.5)	<.0001
<5 y (n = 75)	22.7 (21.5–24)	19 (17.8–20.3)	15.7 (14.1–17.3)	13.4 (8.8–18)	<.0001
5–11 y (n = 119)	23.2 (22.4–24)	19 (17.8–20.3)	15.6 (14.3–16.8)	14.7 (13–16.3)	<.0001
≥12 y (n = 71)	22.6 (21.6–23.7)	17.6 (15.9–19.2)	15.3 (13.6–17.1)	12.3 (9.9–14.6)	<.0001
African American (n = 134)	22.1 (21.1–23.1)	17.8 (16.6–19)	14.9 (13.7–16)	13 (10.9–15.1)	<.0001
White (n = 99)	23.5 (22.4–24.5)	20.1 (18.5–21.7)	16.7 (15.1–18.4)	13.6 (11.8–15.3)	<.0001
Spanish (n = 52)	23.3 (22.4–24.3)	19.9 (18.5–21.4)	15.4 (13.1–17.7)	20.3 (18.9–21.7)	<.0001
PACQLQ score					
All patients* (n = 265)	6.4 (6.2–6.5)	5.2 (4.9–5.5)	4.8 (4.5–5.1)	4.6 (4.2–5.1)	<.0001
<5 y (n = 75)	6.2 (5.9–6.5)	5.1 (4.6–5.5)	4.4 (4–4.9)	5.4 (4.5–6.2)	.0001
5–11 y (n = 119)	6.2 (6–6.4)	5.4 (4.9–5.8)	4.6 (4.1–5)	4.7 (4.3–5.1)	<.0001
≥12 y (n = 71)	6.6 (6.4–6.9)	5.2 (4.6–5.8)	5.1 (4.7–5.6)	4.5 (3.4–5.7)	<.0001
African American (n = 134)	6.2 (5.9–6.5)	5 (4.6–5.4)	4.5 (4.2–4.9)	4.5 (3.8–5.2)	<.0001
White (n = 99)	6.6 (6.4–6.7)	5.6 (5.3–6)	5.1 (4.6–5.5)	4.8 (4.4–5.2)	<.0001
Spanish (n = 52)	5.9 (5.5–6.4)	5.5 (4.5–6.4)	3.4 (2.6–4.1)	6.3 (5.6–7)	.0001
FEV_1 (% predicted)					
Overall† (n = 118)	0.90 (0.85–0.94)	0.88 (0.81–0.96)	0.88 (0.79–0.96)	0.84 (0.71–0.96)	.84
English* (n = 79)	0.88 (0.82–0.94)	0.84 (0.74–0.93)	0.86 (0.77–0.96)	0.79 (0.69–0.9)	.72
5–11 y (n = 50)	0.84 (0.78–0.9)	0.82 (0.63–1)	0.82 (0.73–0.91)	0.82 (0.71–0.93)	.98
≥12 y (n = 29)	0.97 (0.86–1.08)	0.85 (0.75–0.95)	0.96 (0.73–1.19)	0.62‡	.31
African American (n = 38)	0.83 (0.77–0.89)	0.75 (0.62–0.88)	0.76 (0.70–0.82)	0.81 (0.65–0.97)	.55
White (n = 33)	0.94 (0.84–1.04)	0.97 (0.88–1.06)	1.08 (0.92–1.24)	0.78 (0.64–0.93)	.14
Spanish (n = 39)	0.92 (0.85–0.99)	0.97 (0.88–1.06)	0.92 (0.77–1.07)	0.98‡	.79

Mean value of validated measure (95% CI)	PACCI categories				*P* value
	Controlled (n = 125)	Partly controlled (n = 80)	Uncontrolled (n = 81)	Poorly controlled (n = 31)	
FEV_1/FVC ratio					
Overall† (n = 118)	0.90 (0.87–0.93)	0.88 (0.83–0.92)	0.86 (0.82–0.90)	0.85 (0.74–0.96)	.33
English* (n = 79)	0.85 (0.82–0.88)	0.83 (0.79–0.88)	0.85 (0.81–0.89)	0.82 (0.73–0.91)	.86
5–11 y (n = 50)	0.85 (0.81–0.89)	0.84 (0.75–0.92)	0.84 (0.79–0.88)	0.86 (0.79–0.92)	.96
≥12 y (n = 29)	0.84 (0.79–0.89)	0.83 (0.78–0.88)	0.88 (0.81–0.95)	0.58‡	.04
African American (n = 38)	0.86 (0.81–0.9)	0.8 (0.73–0.87)	0.84 (0.78–0.89)	0.79 (0.62–0.96)	.58
White (n = 33)	0.85 (0.81–0.89)	0.85 (0.81–0.9)	0.87 (0.8–0.94)	0.84 (0.75–0.93)	.94
Spanish (n = 39)	1.00 (0.96–1.04)	0.97 (0.90–1.04)	0.89 (0.81–0.98)	0.96‡	.12

*Refers to all patients who completed the English version of the PACCI.

†Includes both English- and Spanish-speaking patients who performed spirometry.

‡No CI is presented because there was only 1 patient in this category.

TABLE IV

PACCI known-groups validity: trend in mean PACCI (95% CI) sum score and problem index values across clinician rating of asthma disease status using ANOVA

	Clinician rating of asthma disease status				
	Mild intermittent (n = 132)	**Mild persistent (n = 81)**	**Moderate persistent (n = 82)**	**Severe persistent (n = 21)**	***P* value**
Mean PACCI sum score					
English* (n = 264)	2.1 (1.5–2.6)	5.2 (4.3–6.1)	6.6 (5.6–7.7)	8.4 (6.2–10.6)	<.0001
<5 y (n = 75)	2.6 (1.6–3.5)	5 (3.5–6.5)	6 (3.8–8.2)	9†	.001
5–11 y (n = 119)	1.7 (0.9–2.5)	5.3 (3.7–6.9)	7 (5.3–8.7)	9.8 (6.8–12.7)	<.0001
≥12 y (n = 70)	1.9 (0.7–3.1)	5.4 (3.6–7.1)	6.5 (4.3–8.6)	5.5 (1.3–9.7)	.0008
African American (n = 134)	2.4 (1.5–3.3)	5.7 (4.4–7.1)	7.1 (5.6–8.6)	8.1 (5.8–10.5)	<.0001
White (n = 98)	1.5 (0.9–2.1)	5 (3.4–6.6)	5.9 (3.9–7.8)	12.5 (0–31.6)	<.0001
Spanish (n = 52)	2.4 (1.2–3.7)	2.9 (0.7–5.1)	4.5 (3.0–6.0)	7.6 (4.3–11.0)	.001
Mean PACCI problem index					
English* (n = 259)	0.8 (0.5–1)	2.1 (1.7–2.5)	2.6 (2.1–3)	3.3 (2.3–4.2)	<.0001
<5 y (n = 73)	1 (0.6–1.4)	2.1 (1.3–2.8)	2.3 (1.1–3.5)	3†	.01
5–11 y (n = 117)	0.6 (0.3–0.9)	2.2 (1.5–2.9)	2.6 (2–3.3)	3.9 (2.7–5)	<.0001
≥12 y (n = 69)	0.7 (0.2–1.2)	2 (1.2–2.9)	2.6 (1.8–3.4)	2.3 (0–5)	.002
African American (n = 131)	0.9 (0.5–1.3)	2.4 (1.8–3)	2.7 (2.1–3.3)	3.4 (2.4–4.4)	<.0001
White (n = 96)	0.6 (0.3–0.8)	1.9 (1.2–2.6)	2.3 (1.4–3.2)	4.5 (0–10.9)	<.0001
Spanish (n = 52)	0.7 (0.1–1.3)	1.1 (0.1–2.1)	1.6 (0.8–2.3)	3.3 (1.9–4.6)	.001

*Includes both English- and Spanish-speaking patients who performed spirometry.

†No CI is presented because there is only 1 patient in this category.

TABLE V

PACCI known-groups validity: mean (95% CI) PACCI Control domain sum scores and problem index values across clinician ratings of asthma disease status

	Clinician rating of asthma disease status		
	Controlled (n = 161)	**Not controlled (n = 156)**	***P* value**
Mean PACCI sum score			
English* (n = 265)	1.9 (1.4–2.4)	6.5 (5.8–7.2)	<.0001
<5 y (n = 75)	2.1 (1.2–2.9)	5.3 (4.1–6.4)	<.0001
5–11 y (n = 119)	1.9 (1.1–2.7)	7.2 (6.0–8.3)	<.0001
≥12 y (n = 71)	1.6 (0.7–2.5)	6.8 (5.5–8.0)	<.0001
African American (n = 134)	1.7 (1.0–2.4)	7.1 (6.2–8)	<.0001
White (n = 99)	1.9 (1.1–2.6)	5.9 (4.7–7.2)	<.0001
Spanish (n = 52)	2.5 (1.5–3.5)	6.4 (4.9–7.9)	.0001
Mean PACCI problem index			
English* (n = 259)	0.7 (0.5–0.9)	2.6 (2.3–2.9)	<.0001
<5 y (n = 73)	0.7 (0.4–1.1)	2.1 (1.6–2.6)	.0001
5–11 y (n = 117)	0.7 (0.4–1)	2.9 (2.4–3.3)	<.0001
≥12 y (n = 69)	0.5 (0.1–0.9)	2.7 (2.2–3.3)	<.0001
African American (n = 131)	0.6 (0.3–0.9)	2.8 (2.5–3.2)	<.0001
White (n = 97)	0.6 (0.3–0.9)	2.4 (1.8–3.0)	<.0001
Spanish (n = 52)	0.8 (0.3–1.3)	2.5 (1.7–3.3)	.0004

* Refers to all patients who completed the English version of the PACCI.