

Validation of the Asthma Quality of Life Questionnaire With Momentary Assessments of Symptoms and Functional Limitations in Patient Daily Life

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BACKGROUND: The ecological momentary assessment method may collect more accurate data about a patient's symptoms and functioning during the patient's normal daily life than does a retrospective measurement method such as the standardized Asthma Quality of Life Questionnaire (AQLQ-S), which relies on the patient's recollections of symptoms and functioning. **OBJECTIVE:** To determine how well the AQLQ-S predicts actual asthma symptoms and functional limitations in patients' daily lives. **METHODS:** With 91 patients with asthma, we measured quality of life at baseline with the AQLQ-S. Each participant then carried a palm-top computer for 1 week, which signaled the patient 5 times a day to complete a momentary assessment of his or her asthma symptoms, mood, activities, and peak expiratory flow. Once a day, upon awakening, the participants were asked to enter data on their sleep and nocturnal asthma symptoms. **RESULTS:** The AQLQ-S scores were strongly associated with the momentary assessments of asthma symptoms and patient functioning. The unstandardized slope value indicates, for each 1-unit increase in quality of life, the corresponding change in the outcome variable (in the original units of measurement). Specifically, each 1-unit increase in quality of life was associated with better ambulatory outcomes (assessed on a 7-point scale): fewer coughing and wheezing symptoms (unstandardized slope = -0.44 , $P < .001$); less symptom interference with sleep (unstandardized slope = -0.48 , $P < .001$); less negative affect (unstandardized slope = -0.65 , $P = .04$); and fewer activity restrictions (unstandardized slope = -0.54 , $P < .001$). An increase in quality of life did not significantly predict peak expiratory flow (unstandardized slope = 11.53 L/min, $P = .10$). **CONCLUSIONS:** With ecological momentary assessment we found that the AQLQ-S is a valid tool for assessing asthma symptoms and functional limitations. The AQLQ-S scores correctly predicted asthma symptoms, mood, sleep-interference, and activity restrictions in asthma patients' daily lives over a 1-week interval. These data support the AQLQ-S in the clinical management of asthma. *Key words:* asthma; quality of life; ecological momentary assessment; ambulatory experiences; respiratory symptoms; patient care. [Respir Care 2010;55(4):427–432. © 2010 Daedalus Enterprises]

Introduction

The Asthma Quality of Life Questionnaire (AQLQ-S) is a useful clinical measurement in the management of asthma.

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ma.¹ Respiratory symptoms, inconsistent health-care utilization, and night waking are associated with impaired quality of life (QOL).^{2–4} QOL assessments, however, typically rely on retrospective self-reporting, which can be quite fallible.^{5,6} Demand characteristics and biases in recall due to emotional states or salient events over the recall period may elicit an inaccurate reflection of patient QOL,⁷ potentially reducing the clinical utility of retrospective self-

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report tools. It is, therefore, unclear the degree to which a retrospective measure of QOL is useful in the clinical management of asthma. Thus, it is important to determine whether recall data from questionnaires accurately predict actual asthma symptoms and functional limitations in daily life.

Diary studies have been used to validate self-reported QOL and asthma-control among patients with asthma.^{8,9} Although diary data studies have attempted to eliminate the inherent biases of retrospective self-reporting by providing daily reports of experiences, limitations still exist. For instance, biases in self-reporting occur from summing across the day; salient or recent experiences from the day appear to exert undue influence on patient responses.¹⁰ Further, participants may fake adherence by waiting until the end of the week to complete all daily reports rather than completing the diary every evening.¹¹ Thus, it is important to move beyond daily diaries in validating retrospective measurements.

A newer methodology, ecological momentary assessment, was developed to provide a more reliable means of validating retrospective measures. Ecological momentary assessment aims to test the validity of retrospective measurements by determining whether data gathered in a laboratory setting are in fact similar to data gathered in the person's usual environments (eg, home or office). Patients may under-report or over-report symptoms or behaviors in a laboratory setting, as compared to in their usual environments.¹²⁻¹⁴ Thus, establishing the ecological validity of measurements made in clinical settings is important in determining if the information actually represents the patient's daily life.

Specifically, ecological momentary assessment involves providing the patient with a palm-top computer that signals the patient to report on his or her current ("momentary") experiences in his or her usual living environments. Self-report and recollection biases are decreased because the patient reports on current symptoms, behavior, and psychological state, not on information from previous days.^{7,10} Multiple momentary reports are used to characterize the person's experience, rather than relying on a global retrospective summary of experiences.¹⁰ Biases are also reduced by having the patients report from their usual environments, rather than in a clinic or laboratory setting. Momentary reports on a palm-top computer are date and time stamped, which allows researchers to determine when the assessments were made and thus to evaluate patient adherence.

We used ecological momentary assessment to validate the AQLQ-S.¹ Given the widespread reliance on AQLQ-S in clinical settings, we sought to determine if AQLQ-S has predictable real-world consequences on clinically relevant variables. Establishing that AQLQ-S is ecologically valid would provide a better understanding of what AQLQ-S

scores mean for patients in their usual environments. Such information would inform treatment decisions and provide confidence in implementing this measure of QOL in the assessment and treatment of patients with asthma. We hypothesized that AQLQ-S scores would predict patients' momentary self-assessments of asthma symptoms, mood, sleep, and activity restrictions. Specifically, we expected that patients with lower QOL would experience poorer functioning on all outcome variables than patients with higher QOL.

Methods

This study was performed at Syracuse University, Syracuse, New York.

Study Design

Ninety-one adults with asthma participated. Patients were recruited from the community through medical professionals and media advertisements. Patients were included if they had: physician-diagnosed asthma, no current eating disorders or substance abuse, and no psychiatric disorders that might interfere with their participation. The protocol consisted of a baseline health evaluation and training session, followed immediately by a 1-week period of momentary assessments.

During the baseline health evaluation in the laboratory, spirometry was conducted by a trained research assistant. The spirometry test was considered acceptable when 2 spirometry maneuvers had a less than 5% difference. We used the largest forced expiratory volume in the first second (FEV₁) in the analyses. Asthma severity was classified per the National Heart, Lung, and Blood Institute's guidelines¹⁵: an FEV₁ ≥ 80% of predicted was classified as mild intermittent/persistent asthma, an FEV₁ of 60–80% of predicted was classified as moderate asthma, and an FEV₁ ≤ 60% of predicted was classified as severe asthma. As we relied solely on FEV₁ for determining asthma severity, our measure of severity reflects the severity of air-flow obstruction.

During the training session we trained the patients to use the palm-top computer (Pilot m105, Palm, Sunnyvale, California) and the peak-flow meter. Following the training session, patients carried the palm-top computer for 1 week. At 5 random times each day the palm-top computer signaled the patient to complete the momentary assessment. Responses that did not occur within 20 minutes of the signal were counted as missing data.

This study was approved by the institutional review board of Syracuse University and Upstate Medical University. Written consent was obtained from all study participants.

Asthma Quality of Life Questionnaire

Each patient completed the standardized 32 item version¹ of the AQLQ-S during the baseline health evaluation. The AQLQ-S has 4 domains: activity limitations (11 items), symptoms (12 items), emotional function (5 items), and exposure to environmental stimuli (4 items). The AQLQ-S also asks the patient to consider the last 2 weeks when responding. Example questions include:

- “How often during the past 2 weeks did you feel frustrated as a result of your asthma?”
- “How often during the past 2 weeks did you wake up in the morning with asthma symptoms?”

Other AQLQ-S responses are made on two 7-point Likert scales: one ranges from “all of the time” to “none of the time”; the other ranges from “severely limited” to “not limited at all.” On each item, a lower score reflects impairment. Thus, an AQLQ-S total score of 6 or 7 suggests that the person is experiencing fewer symptoms, fewer activity limitations, and less emotional dysfunction than someone with an AQLQ-S total score of 1 or 2. The standardized version of the AQLQ (ie, the AQLQ-S) differs from the original AQLQ¹⁶ in that the AQLQ-S includes 5 “standardized” activities rather than allowing the patient to select 5 activities from a list. The AQLQ-S was validated with the original AQLQ.¹ The AQLQ-S was found to be reliable, with an internal consistency (Cronbach’s alpha) of 0.78 in that sample.

Ecological Momentary Assessment Variables

Emotions such as depression, anxiety, frustration, and anger, broadly referred to as negative affect, were assessed with items from the Positive and Negative Affect Scales (PANAS).¹⁷ Patients rated the degree to which adjectives for negative affect (eg, depressed, frustrated, worried) reflected their current mood, on a scale from 0 = not at all, to 6 = extremely. Asthma symptoms were assessed by patient ratings of coughing/wheezing (0 = not at all, to 6 = extremely). Peak expiratory flow was measured at each assessment interval, with a peak-flow meter. Patients took 3 peak-flow measurements at each assessment, and we used the highest peak flow measurement in the analysis. Activity restrictions were reported as the degree to which asthma had restricted activities since the last assessment (on the 0 = not at all, to 6 = extremely). Several survey items inquire about the patient’s location (eg, home, work, bar/restaurant, vehicle, other) and whether the patient is with another person during that assessment (yes = 1, no = 0). Other items ask the patient to indicate: if any stressful experiences have occurred (yes = 1, no = 0); to rate the pleasantness of their day (on the 0 = not at all, to

6 = extremely); and to indicate how long they had slept (in hours and minutes), how well they had slept, and the degree to which their asthma symptoms had interfered with sleep (0 = not at all, to 6 = extremely).

Statistical Analysis

All analyses were performed with statistics software (SAS version 9.1, SAS Institute, Cary, North Carolina). By default, the software uses pairwise deletion of missing data, thus preserving contributions from all participants in the study. We utilized a sample size of 91 participants to achieve an effect size similar to that reported by Erickson et al,¹⁸ who reported a β coefficient of -0.34 for the relationship between AQLQ and symptom reporting. Because of the nested nature of the data (ie, intra-individual momentary measurements), a multi-level data analysis strategy was appropriate. We analyzed the QOL scores in multi-level random-intercept models (PROC MIXED for continuous dependent variables and PROC GLIMMIX for categorical dependent variables) to predict the subsequent ecological momentary assessment outcomes.¹⁹ We used person-level QOL to predict the ecological momentary assessment dependent variable and to determine whether patients with different QOL scores had different typical experiences, symptoms, peak flow, et cetera, in their daily lives. We included random intercepts in the models to account for expected between-person variability that might be driven by general dispositions and different experiences prior to the ecological momentary assessment. Each model provides a regression slope that represents the relationship between QOL and the dependent variable. We used mixed model analyses to determine the statistical significance of each relationship with QOL; this approach utilizes the *t* distribution, so the results are presented as the outcomes of *t* tests. A *P* value of $< .05$ was considered statistically significant.

Results

Demographic Characteristics

Table 1 shows the demographic and health characteristics. FEV₁ ranged from 30% to 128% of predicted (mean \pm SD $82 \pm 23\%$ of predicted). Based on the baseline clinical assessment, 56% of the patients had mild intermittent/persistent asthma, 27% had moderate asthma, and 17% had severe asthma. During the week of momentary assessments, 75% of the patients reported taking prescription asthma medication. The patients reported taking reliever medications (eg, albuterol, levalbuterol) in 42% of the completed momentary assessments, and controller medications (eg, montelukast, inhaled corticosteroids) in 41% of the assessments. On average, the patients reported taking asthma medications once a day. Thirty-three participants reported taking one prescribed medication, and 35

Table 1. Demographic and Health Characteristics of Participants (n = 91)

Age (mean ± SD y)	42.1 ± 13.8
Female (n, %)	66 (72)
Race (n, %)	
Caucasian	79 (87)
African American	7 (8)
Latino	1 (1)
Other	4 (4)
Highest Education Level (n, %)	
Less than high school	7 (8)
High school/vocational school graduate	48 (53)
College degree	21 (23)
Graduate or professional degree	15 (16)
Annual Household Income (n, %)	
< \$10,000	21 (23)
\$10,000–\$20,000	16 (18)
\$20,000–\$40,000	18 (20)
> \$40,000	36 (39)
FEV ₁ (mean ± SD % predicted)	83 ± 24
FVC (mean ± SD % predicted)	94 ± 20
PEF (mean ± SD % predicted)	92 ± 34

FEV₁ = forced expiratory volume in the first second
 FVC = forced vital capacity
 PEF = peak expiratory flow

reported taking more than one prescribed medication during the assessment week. The median adherence to the momentary-assessment signals from the palm-top computers was 86% (30 of 35 prompts per week). The response rates were not systematically related to sex, ethnicity, or AQLQ-S scores.

Prediction of Momentary Assessment Variables From AQLQ-S Scores

In this sample, the mean ± SD AQLQ-S score was 4.63 ± 1.31 (range 1–7). Prior work¹ indicated that a moderately significant difference in AQLQ-S scores is 1.0. We assumed that patients with AQLQ-S scores greater than 5.63 had a significantly better QOL than patients whose scores were less than or equal to our mean AQLQ-S score, and that individuals with AQLQ-S scores of ≤ 3.63 had significantly worse QOL than patients whose scores were greater than or equal to our mean score. AQLQ-S scores were not significantly related to patient age, sex, or asthma severity;* we present the results for the models without those factors as covariates.

* Including asthma severity (FEV₁), sex, or age as a covariate did not change the relationships between AQLQ-S scores and experience reports. In addition, when tested as potential moderators, none of these covariates (severity, sex, or age) interacted with QOL in predicting any of the reported experiences.

Table 2. Differences in Standardized Asthma Quality of Life Questionnaire Scores Predicting Dependent Momentary-Assessment Variables*

	Slope [†]	P
Coughing and wheezing	-0.44	< .001 [‡]
Symptom interference with sleep	-0.48	< .001 [‡]
Negative affect	-0.65	.04 [§]
Activity restrictions	-0.54	< .001 [‡]
Peak expiratory flow (L/min)	11.53	.10
Time at home (hours, minutes)	-0.22	.007 [‡]
Sleep duration (hours, minutes)	-50.93	.05
Quality of sleep	0.14	.05
Time with others (hours, minutes)	-0.01	.79
Pleasantness of day	-0.07	.39
Stressful experiences (0 = no, 1 = yes)	-0.02	.50

* Unless otherwise noted, dependent variables were measured on a 7-point Likert scale from 0 = not at all, to 6 = extremely.

† Slope is interpreted as the number of scale units the dependent momentary-assessment variable changes on average given a 1-unit increase in Standardized Asthma Quality of Life Questionnaire scores.

‡ Significant at P < .01.

§ Significant at P < .05.

We used the baseline AQLQ-S scores to predict differences in the momentary-assessment outcome variables (cough/wheeze, peak flow, symptom interference with sleep, negative affect, and activity restrictions due to asthma). In each case, patients with higher baseline AQLQ-S scores subsequently reported better functioning in the momentary assessments than did patients with lower baseline AQLQ-S scores. High QOL predicted statistically significantly fewer cough/wheeze symptoms, less symptom interference with sleep, less negative affect, and fewer activity restrictions. There was a non-significant trend between high QOL and better peak flow. Table 2 shows the slopes* of the relationships between QOL and each negative experience and the results from the t tests for statistical significance of each slope.

To further analyze the relationships between the AQLQ-S scores and the momentary-assessment variables, we also divided patients into 2 groups: patients with AQLQ-S scores above the mean score of 4.63, and patients with AQLQ-S scores below the mean. We then determined the mean score on each ambulatory outcome for each subgroup of AQLQ-S scores (Table 3).

To explore the degree to which classification with these 2 metrics (AQLQ-S and ecological momentary assessment) overlap, we calculated the number of patients in each

* The slope is unstandardized and may be interpreted as the number of scale units the outcome variable will change on average given a 1-unit increase in QOL.

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Table 3. Mean Scores on Momentary-Assessment Variables and Number of Patients Above or Below the Mean, Stratified by High and Low Scores on the Standardized Asthma Quality Of Life Questionnaire

	Patients With AQLQ-S Scores < the Mean	Patients With AQLQ-S Scores > the Mean
Momentary-Assessment Variables		
Coughing/wheezing (mean ± SD)*	1.84 ± 1.07	0.84 ± 0.71
Activity restrictions (mean ± SD)*	1.66 ± 1.25	0.38 ± 0.43
Symptom interference with sleep (mean ± SD)*	1.87 ± 1.29	0.62 ± 0.80
Peak expiratory flow (L/min) (mean ± SD)*	388 ± 93	394 ± 82
Negative affect (mean ± SD)*	6.12 ± 4.59	4.72 ± 3.37
Classified Momentary-Assessment Variables (n) [†]		
Coughing/wheezing (Mean = 1.38, 6 cases unclassified)		
None/low	16	28
High/severe	30	11
Activity limitations (Mean = 1.07, 6 cases unclassified)		
None/low	17	35
High/severe	29	4
Symptom interference with sleep (Mean = 1.28, 11 cases unclassified)		
None/low	15	33
High/severe	27	5
Peak expiratory flow (L/min) (Mean = 390.43, 9 cases unclassified)		
None/low	23	19
High/severe	20	20
Negative affect (Mean = 5.48, 6 cases unclassified)		
None/Low	24	23
High/Severe	22	16

* Mean momentary-assessment scores. Unless otherwise noted, the dependent variables were measured on a 7-point Likert scale (0 = not at all, to 6 = extremely).

† Number of patients who reported scores above or below the mean on each momentary-assessment variable.

AQLQ-S subgroup who reported scores above or below the mean score of each ambulatory outcome (classified as either none/low or high/severe). The number of patients with AQLQ-S scores above the mean score who reported a similar functioning in daily life (eg, none/low symptoms, none/low activity limitations) is presented in the second part of Table 3. The findings generally suggest that patient reports on the AQLQ-S are consistent with patient reports in daily life.

Discussion

We found that, in a sample of patients with predominantly mild to moderate asthma, scores on the AQLQ-S accurately predicted the degree of symptoms, activity limitations, negative affect, and symptom interference with sleep, as identified in momentary assessments in the patient’s usual environments across the subsequent week. Across all the outcome domains, the patients with higher AQLQ-S scores reported better ambulatory functioning than those with lower AQLQ-S scores. This suggests that clinicians gain information about multiple domains of asthma-related functioning from a single use of the AQLQ-S, and that the AQLQ-S responses do reflect daily life.

Our finding that AQLQ-S scores accurately reflect asthma impairment measured in momentary assessments in the patient’s usual environments is consistent with previous studies that examined associations between AQLQ score and health outcomes.^{18,20-22} Unlike previous studies, we reduced concerns about adherence and recall bias by utilizing ecological momentary assessment, which more reliably captures the patient’s daily life across multiple domains of functioning. We found that the AQLQ-S reliably predicted patients’ day-to-day functioning over the 1-week period of momentary assessments. This enables researchers and physicians to anticipate the ongoing experiences of patients with asthma and to predict specific limitations and problems a patient is likely to experience, based on the AQLQ-S score.

Our findings further support that information obtained from the AQLQ-S is similar to that from momentary assessments in the patient’s usual environments. In fact, we found that for several QOL indicators (eg, coughing/wheezing symptoms, activity limitations, and asthma symptom interference with sleep), two thirds of the patients may be reporting accurately on the AQLQ-S in a clinic setting. Thus, for a large majority of patients, the AQLQ-S responses may be consistent with the patient’s experiences

in daily life. Further, for patients who do not report accurately on the AQLQ-S, it appears that their reports in the clinic may be worse (ie, lower AQLQ-S scores) than they actually experience in real life.

As evaluating patients' ambulatory functioning in their usual environments is often not feasible,⁷ researchers and physicians should feel confident that the AQLQ-S administered in a laboratory or clinic setting provides information that meaningfully relates to that gathered from a real-world assessment. Further, as patient-reported QOL is not specific to the evaluation setting, physicians may reliably use patient reported QOL as the basis for discussions about treatment response and daily functioning. This would be one way for the physician to establish a partnership with the patient, the importance of which is highlighted in the National Heart, Lung, and Blood Institute's clinical practice guidelines.¹⁵ Finally, we also recommend continuing the practice of using ambulatory approaches (eg, ecological momentary assessment) to validate retrospective self-report measurements of functioning in patients with chronic illnesses, to ensure that those retrospective reports correspond to the patient's daily functioning in the real world.

Conclusions

Our findings suggest that the AQLQ-S is highly predictive of ambulatory asthma status in patients with mild to moderate asthma, over a period of 1 week. Low AQLQ-S score was associated with worse asthma symptoms, worse activity limitations, and worse negative affect in the momentary assessments. Our findings suggest that the AQLQ-S is a valuable assessment tool for evaluating patient functioning and monitoring response to treatment. Patients who report compromised QOL may be experiencing adverse effects across several domains (eg, disease symptoms, activity limitations, distressed affect, disturbed sleep) in their everyday lives.

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