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The Marks Asthma Quality of Life Questionnaire: Further Validation and Examination of Responsiveness to Change

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ABSTRACT. We performed analyses to examine the structure, validity, and responsiveness to change of the Marks Asthma Quality of Life Questionnaire (AQLQ), originally validated in Australia in a self-administered format, among 539 U.S. subjects with asthma. Subjects were interviewed twice by telephone over an 18-month period. Based on factor analyses, the subscale structure of the AQLQ was modified slightly to eliminate item overlap among subscale scores. Cross-sectionally, total AQLQ scores were significantly correlated in expected directions with baseline asthma severity scores ($r = 0.58$), SF-36 physical ($r = -0.66$) and mental ($r = -0.40$) health status scores, and pulmonary function (FEV_1% predicted, $r = -0.14$). Longitudinally, changes in AQLQ total and subscale scores were significantly ($P < 0.01$) associated with changes in asthma severity and both physical and mental status. The AQLQ, administered by telephone, appears to be useful for assessing changes in the impact of adult asthma. J CLIN EPIDEMIOL 52;7:667–675, 1999. © 1999 Elsevier Science Inc.

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INTRODUCTION

Historically, studies of patient outcomes in asthma have focused on clinical and physiologic measures [1]. More recently, however, there is growing recognition that such clinical measures do not provide a complete, or in some cases, accurate, view of the impact of a disease on an individual's physical, social, or emotional well-being [1–3]. In response, health-related quality of life measures are increasingly being integrated into clinical research in asthma.

Both generic and disease-specific measures can be used to evaluate health-related quality of life. Generic instruments have the advantage of allowing comparisons among different diagnostic groups or to healthy populations [2–7]. However, generic instruments may not tap particular domains relevant to the disease of interest and, thus, may not be sensitive enough to monitor health-related quality of life for a specific patient population [2,3,5,6,8,9].

Several asthma-specific quality of life instruments have been developed. The Juniper Asthma Quality of Life Questionnaire is a 32-item questionnaire for adults with asthma that contains items in four domains (symptoms, emotions, exposure to environmental stimuli, and activity limitations), and requires respondents to specify some of the activity limitations items [10,11]. The Living with Asthma Questionnaire [12,13] contains 68 items in 11 domains: social/leisure, sport, holidays, sleep, work, colds, morbidity, effects on others, medication use, sex, and dysphoric states and attitudes. The Life Activities Questionnaire for Adult Asthma, developed by Creer and colleagues [14], contains 70 items in seven domains (physical activities, work activities, outdoor activities, emotions and emotional behavior, home care, eating and drinking activities, and miscellaneous). The St. George's Respiratory Questionnaire (SGRQ) has also been used to assess quality of life among persons with asthma, although it was not designed specifically for asthma [15,16]. The SGRQ contains 76 items in three domains: symptoms, activity, and impact on daily life.

This article focuses on the Marks Asthma Quality of Life Questionnaire (AQLQ) [17,18]. The AQLQ is brief (20 items), easy to complete (takes 5 minutes), and lends itself well to telephone administration. Although not used as widely as some other instruments, the AQLQ has been applied in studies in the United Kingdom [19] and in the United States [20–23], as well as in Australia [17,18], where it was developed. A Spanish-language version has also been developed [24].

Several studies have addressed the reliability and validity of the AQLQ and, on a limited basis, its responsiveness to change [17,18,25]. All the previous validation studies were

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constrained, however, by small samples, limited indicators of asthma severity, and a brief follow-up period in which to assess responsiveness to change. Although part of the original validation, subscale differentiation has not been addressed in subsequent studies, despite overlap among subscales that may limit their application. For the original psychometric analyses of the AQLQ, the questionnaires were self-administered. Although in one study of the AQLQ, telephone administration was used, there was no examination of the scale's responsiveness to change when used in that context [25]. In summary, earlier assessments of the reliability, validity, and responsiveness to change of the AQLQ have supported the potential strengths of this measure but have remained somewhat fragmentary.

The purposes of this study were to examine the factor structure of the AQLQ, the correlation of AQLQ with asthma severity and general functioning, and the responsiveness of the AQLQ to changes in asthma severity and general functioning, using data from a large sample of persons with asthma interviewed by telephone at baseline and followed longitudinally.

METHODS

Study Sample

This study used data from an ongoing panel study of adults with asthma. The overall study design and methods have been detailed previously [20]. Briefly, subjects were derived from a random sample of board-certified pulmonary or allergy subspecialists. During a prospective 4-week period, each participating physician maintained a registry of all persons aged 18–50 years seen with a diagnosis of asthma consistent with American Thoracic Society guidelines. Physicians were instructed not to include persons with chronic bronchitis or emphysema.

Participating subjects from the registries underwent structured, close-ended, computer-assisted telephone interviews. Interviews were administered by a single trained survey worker and lasted 45 minutes on average. In total, we interviewed patients recruited from 74 physicians' practices (57 pulmonologists and 17 allergists). Of 698 eligible subjects registered, the overall participation rate was 86% (n = 601) in the baseline Wave 1 interview. The subjects were reinterviewed 18 months after their first interview; approximately 90% of the subjects (n = 539) completed the Wave 2 interview [26].

Interviews included assessment of demographic characteristics, work history, asthma symptoms and severity, health care utilization, general health status, and asthma-specific quality of life using the Marks AQLQ [17,18]. Baseline pulmonary function data (FEV_1% predicted) were also available for 362 (67%) of the 539 subjects included in these analyses [20].

Asthma Quality of Life Questionnaire

The AQLQ is a 20-item questionnaire developed to measure the impact of asthma on the lives of adults with the condition in the 4 weeks preceding administration of the questionnaire [17]. The items in the AQLQ are shown in Appendix 1. The AQLQ was designed to be self-administered. Four subscales were identified by the developers: Breathlessness, Mood Disturbance, Social Disruption, and Health Concerns. There was item overlap in the calculation of the subscale scores; that is, some items were used in the calculation of more than one subscale. Internal consistency was high; Marks *et al.* [17] cited Cronbach's alphas for the total score of 0.92 and from 0.82 to 0.94 for the subscale scores. Test–retest reliability has been shown to be adequate [17]. Individual items are scored from 0 ("not at all") to 4 ("very severely"), and a total score ranging from 0 to 80 can be calculated. This total score can be converted to a 0 to 10 scale by multiplying the score by 2.5 and then dividing by 10. In scoring the AQLQ, higher scores represent a greater impact of asthma on quality of life.

Data from the AQLQ presented here were obtained from telephone interviews in which the AQLQ is embedded within a longer structured telephone interview. Two changes in AQLQ format were made to facilitate administration. First, the number of response options was changed back from five to four, consistent with the response format used in the development of the AQLQ. (Marks *et al.* [17] conducted analyses during the item-selection portion of development among an Australian patient group using four response options: "not at all," "mildly," "moderately," and "severely," and only added the fifth option, "very severely," when testing the 20-item scale.) Although five to seven response options are often considered optimal in a written questionnaire, telephone administration is facilitated with a smaller number of response options [27]. The second change was in the wording of the verbal rating scale. Many of the other items in our overall telephone interview used the response scale "not at all," "a little," "somewhat," and "a great deal." To minimize the number of verbal response options scale to which subjects were exposed, these same response options were used for the AQLQ. Responses were scored from 0 ("not at all") to 3 ("a great deal"), so that total AQLQ scores could range from 0 to 60. Table 1 shows the possible and actual ranges of scores for the total and subscale scores, as well as the mean scores from Waves 1 and 2.

Changes in AQLQ scores between Wave 1 and Wave 2 were calculated by subtracting the Wave 1 scores from the Wave 2 scores. Thus, positive change scores reflected an increase in the adverse impact of asthma on quality of life from Wave 1 to Wave 2, and negative change scores reflected a decrease in the adverse impact. The average total AQLQ change score for the entire group was close to zero (mean = –1.6, standard deviation = 13.0; Table 1).

TABLE 1. Asthma Quality of Life Questionnaire, asthma severity, and health status scores

	Possible range	Actual range	Mean ± SD		
			Wave 1	Wave 2	Change[a]
Asthma Quality of Life Questionnaire					
Total score	0–60	0–60	22.1 ± 13.8	20.5 ± 14.7	–1.6 ± 13.0
Physical Impact	0–15	0–15	5.2 ± 3.5	5.0 ± 4.1	–0.2 ± 4.0
Emotional Impact	0–15	0–15	5.6 ± 3.9	5.7 ± 4.0	0.1 ± 4.0
Social Impact	0–21	0–21	7.1 ± 6.1	6.0 ± 6.1	–1.1 ± 5.4
Health Concerns	0–9	0–9	4.2 ± 2.8	3.8 ± 2.9	–0.4 ± 2.8
Severity and health status indicators					
Severity of asthma score (range 0–28)	0–28	0–27	11.3 ± 5.9	10.5 ± 5.6	–0.8 ± 3.7
SF-36 Physical health status score	0–100	4.8–65.9	45.0 ± 12.1	45.9 ± 11.9	0.9 ± 11.2
SF-36 Mental health status score	0–100	14.2–67.1	45.6 ± 8.4	45.1 ± 7.8	–0.4 ± 8.8

[a]Higher Asthma Quality of Life Questionnnaire (AQLQ) scores reflect poorer quality of life. Higher severity of asthma scores reflect more severe asthma. Higher SF-36 scores reflect better health status.

Severity of Asthma

Asthma severity was quantified using a scoring system based on asthma symptom frequency, prior asthma hospitalization and mechanical ventilatory support for asthma, past and current use of systemic corticosteroids, and the use of asthma medications other than systemic steroids previously validated by Blanc and colleagues [20,28,29]. The maximum possible asthma severity score is 28, with higher scores representing more severe asthma. Table 1 shows the ranges and means of the asthma severity scores for Wave 1 and Wave 2.

Changes in asthma severity between Wave 1 and Wave 2 were calculated by subtracting the Wave 1 score from the Wave 2 score. Positive severity changes scores reflected increased severity from Wave 1 to Wave 2, and negative change scores reflected decreased severity. The mean severity change score was close to zero (mean = –0.8, standard deviation = 3.7; Table 1). For purposes of analysis, subjects were categorized into one of three severity change groups: those whose asthma worsened, those whose asthma was relatively stable, and those whose asthma improved. The "worse" group included subjects whose change scores were more than one standard deviation above the mean (i.e., ≥3, $n = 69$ [12.8%]); the "better" group's severity change scores were more than one standard deviation below the mean (i.e., ≤–5, $n = 74$ [13.7%]). The remainder of subjects were in the "no change" group ($n = 396$ [73.5%]; change scores ranging from +2 to –4).

General Health Status

The SF-36, a widely used, well-validated, measure of general health status, was also administered [30]. Two summary scores are derived from the SF-36, a physical health status score and a mental health status score, each of which ranges from 0 to 100, with higher scores reflecting better functioning. SF-36 scores are transformed so that both the physical and mental health status scores have a mean of 50 and a standard deviation of 10 in the general U.S. population [30,31]. Table 1 shows the mean scores among study subjects for Waves 1 and 2.

Mean physical and mental health status scores were very similar at Wave 1 and Wave 2. Changes in SF-36 scores between Wave 1 and Wave 2 were calculated by subtracting the Wave 1 score from the Wave 2 score. Unlike the AQLQ and asthma severity scale, positive changes in SF-36 scores indicate improved health status from Wave 1 to Wave 2, and negative changes indicate worsened health status. As with the asthma severity change scores, subjects were assigned to one of three change groups for each of the two SF-36 scores: better health status at Wave 2, worse health status at Wave 2, or no change in health status between Wave 1 and Wave 2. The "better" group included subjects whose change scores were more than one standard deviation above the mean for the entire group (i.e., change in physical health status score ≥13, $n = 74$ [13.7%]; change in mental health status score ≥9, $n = 63$ [11.7%]); the "worse" group's health status change scores were more than one standard deviation below the mean (i.e., change in physical health status scores ≤–10, $n = 67$ [12.4%]; change in mental health status scores ≤–10, $n = 68$ [12.6%]). The remainder of subjects were in the "no change" group (physical health status: $n = 398$ [73.8%]; mental health status: $n = 408$ [75.7%]).

Other Measures

Multivariate analyses assessing the relationship between AQLQ scores and severity of asthma controlled for variables that may affect quality of life, asthma severity, or general health status. The covariates included on an *a priori* basis in the multivariate models were the following: gender, race or ethnicity (categorized as white, non-Hispanic versus other), age, baseline marital status (married or living with a partner versus others), years of education, baseline house-

hold income, baseline smoking status (current smoker, ex-smoker, or never smoked), whether the individual had a history of atopic disease, and whether the subject reported childhood or adult onset of asthma.

Data Management and Statistical Analysis

Interviews used computer-assisted interview software with data exported into a PC-SAS (Statistical Analysis System; SAS Institute, Cary, NC) compatible format. To identify the factor structure of the AQLQ, factor analysis was used. The internal consistency of the AQLQ total and subscale scores was evaluated with Cronbach's alpha [32]. We evaluated the association of disease-specific and general health status with AQLQ scores both cross-sectionally and longitudinally. Because the distributions of both AQLQ scores and changes in AQLQ scores were normally distributed, we used parametric analytic methods. For the cross-sectional phase, Pearson product-moment correlations were calculated to assess the relationship between AQLQ scores and both asthma severity and general health status. Multiple linear regression analyses were performed to assess these relationships after controlling for covariates [33]. For the longitudinal phase, analyses of variance with post hoc means comparisons (Tukey) were calculated to test differences in the changes in AQLQ scores among the three asthma severity change groups (better, worse, or no change) and among the three SF-36 change groups [34]. Multiple linear regression analyses were also performed to assess the relationships between changes in both asthma severity and general health status and changes in AQLQ scores, controlling for covariates, by regressing AQLQ changes on changes in severity (or changes in health status) plus covariates. For these analyses, two dummy variables were created to reflect worsened asthma (or health status) and improved asthma (or health status). Individuals with stable asthma severity (or health status) composed the reference group in these analyses.

RESULTS

The mean age of the study sample was 39 years (Table 2). Approximately 70% of the subjects were female, about two-thirds were white, about two-thirds were married or cohabiting, and the mean education level was 14 years. Seven percent of the sample were current smokers, 31% were ex-smokers, 78% had a history of atopic disease, and 45% reported the onset of asthma in childhood.

TABLE 2. Characteristics at baseline among study sample

	Total (n = 539)
Age (y, mean ± SD)	39.4 ± 8.1
Female (%)	70.3
White, non-Hispanic (%)	67.7
Education (y; mean ± SD)	14.3 ± 2.5
Married/cohabit (%)	65.1
Current smoker (%)	6.9
Ex-smoker (%)	31.0
Family income (median annual)	$45,000
Atopic history (%)	77.9
Childhood onset (%)	45.3

Psychometric Analysis and Factor Structure

Internal consistency was high for the total AQLQ score at both administrations (α = 0.94 and 0.95, for Waves 1 and 2, respectively). Questionnaire responses from each year were entered into separate factor analysis programs with varimax rotation. Four factors with eigenvalues greater than 1.0 were identified. There was considerable cross loading for some items (Appendix 1), and therefore, subscales were constructed that both considered the factor analyses and, at the same time, corresponded to an *a priori* conceptually derived framework. Four subscales were thus identified, each of which demonstrated a high degree of internal consistency: (1) Physical Impact, or the original "Breathlessness" subscale (5 items, α = 0.83 and 0.89, in Waves 1 and 2, respectively); (2) Emotional Impact, or the original "Mood" subscale (five items, α = 0.83 and 0.84); (3) Social Impact (seven items, α = 0.92 and 0.93), which corresponds to the original AQLQ "Social" subscale; and (4) Health Concerns (three items, α = 0.78 and 0.83), which included some of the items from the original AQLQ "Concerns" subscale, but excluded those that were also included in the "Social" subscale. In summary, our analyses supported the originally defined factor structure of the AQLQ but eliminated the item overlap among two of the original four subscales; that is, each of the 20 items was included in only one subscale. This modified factor structure is shown in Appendix 1.

The subscale scores were strongly correlated both with the total AQLQ score and with other subscale scores (Table 3). Correlations of the subscale scores with the total AQLQ score ranged from 0.77 (Health Concerns) to 0.92 (Social Impact), and correlations among subscale scores ranged from 0.48 (Emotional Impact and Health Concerns) to 0.71 (Social Impact and Health Concerns).

Cross-Sectional Association of AQLQ with Asthma Severity

AQLQ scores were significantly correlated with asthma severity scores, with greater severity associated with higher AQLQ (greater adverse impact of asthma) (Table 4). All correlations were greater than 0.50, except for the correlation of severity score with the AQLQ Emotional Impact subscale (r = 0.33), which, although statistically significant, was substantially lower.

Both SF-36 physical and mental health status scores were significantly correlated in the expected directions with

TABLE 3. AQLQ total and subscale correlations (n = 539)

	AQLQ Total	Physical Impact	Emotional Impact	Social Impact
AQLQ total	—			
Physical Impact	0.84[a] (0.81, 0.86)	—		
Emotional Impact	0.80 (0.77, 0.83)	0.61 (0.56, 0.66)	—	
Social Impact	0.92 (0.91, 0.93)	0.65 (0.60. 0.70)	0.60 (0.54, 0.65)	—
Health Concerns	0.77 (0.73, 0.80)	0.50 (0.43, 0.56)	0.48 (0.41, 0.54)	0.71 (0.67, 0.75)

All correlations statistically significant, $P < 0.0001$.
[a] r (95% confidence interval).

AQLQ scores; better general health status (higher SF-36 scores) was associated with less asthma impact (lower AQLQ scores). Correlation coefficients of SF-36 physical health status scores with total AQLQ scores and the Physical and Social Impact subscales were –0.66, –0.61, and –0.66, respectively. Correlations with the Emotional Impact and Health Concerns subscales were markedly lower (r = –0.43, –0.45), although still statistically significant. In contrast, the AQLQ Emotional Impact subscale was most highly correlated with SF-36 mental health status scores (r = –0.60). Correlations of other AQLQ scores with SF-36 mental health status scores were statistically significant, although the correlations were not as strong.

As expected, negative correlations were also noted between AQLQ scores and pulmonary function (FEV_1% predicted), indicating that better pulmonary function was associated with less adverse asthma impact. However, these correlations were much lower than those described above, ranging from –0.06 to –0.17, and, for some of the subscale scores (Physical Impact and Emotional Impact), the correlations were not statistically significant.

Multivariate analyses controlling for the covariates of age, race, gender, education, income, marital status, smoking status, history of atopic disease, and age of asthma onset did not affect any of these findings in a meaningful way (data not shown).

Responsiveness of AQLQ Scores to Change

CHANGES IN ASTHMA SEVERITY. Table 5 presents changes in the AQLQ scores for the three asthma severity change groups (better, no change, worse). Mean differences among the groups were tested using analysis of variance (ANOVA), followed by post hoc pairwise means comparisons. For the total AQLQ score and all subscale scores, differences among the three groups as a whole were statistically significant, and all pairwise comparisons were also statistically significant. The AQLQ scores of subjects in the "Better" asthma severity group decreased, reflecting reduced asthma impact, and the AQLQ scores of those in the "Worse" severity group increased, reflecting greater asthma impact.

TABLE 4. Cross-sectional correlations among AQLQ scores and asthma severity and health status measures at baseline

AQLQ Score[a]	Severity of Asthma Score[b] (n = 539)	SF-36 Physical Function[c] (n = 539)	SF-36 Mental Function[c] (n = 539)	FEV_1 % Predicted[d] (n = 362)
Total	0.58[e] (0.52, 0.64)	–0.66 (–0.71, –0.61)	–0.40 (–0.47, –0.33)	–0.14 (–0.24, –0.04)
Physical Impact	0.52 (0.46, 0.58)	–0.61 (–0.66, –0.55)	–0.22 (–0.30, –0.14)	–0.08* (–0.18, +0.02)
Emotional Impact	0.33 (0.25, 0.46)	–0.43 (–0.50, –0.36)	–0.60 (–0.65, –0.54)	–0.06* (–0.16, +0.04)
Social Impact	0.54 (0.46, 0.60)	–0.66 (–0.71, –0.61)	–0.28 (–0.36, –0.20)	–0.16 (–0.26, –0.06)
Health Concerns	0.54 (0.46, 0.60)	–0.45 (–0.52, –0.38)	–0.25 (–0.33, –0.17)	–0.17 (–0.27, –0.07)

$P < 0.05$ unless otherwise noted.
[a] Higher AQLQ scores indicate greater negative impact of asthma.
[b] Higher Severity of Asthma scores indicate more severe asthma.
[c] Higher SF-36 scores indicate better physical or mental functioning.
[d] Higher FEV_1 % predicted indicates better pulmonary function.
[e] r (95% confidence interval).
*$P > 0.05$.

TABLE 5. Changes in AQLQ scores for asthma severity and health status change groups over 18 months follow-up from baseline

Change in asthma/health status	AQLQ score change (follow-up–baseline)				
	Total	Physical impact	Emotional impact	Social impact	Health concerns
Asthma severity					
Better	−11.6[a] ± 13.8	−3.9 ± 4.7	−1.5 ± 4.2	−4.4 ± 5.7	−1.9 ± 2.9
Same	−1.8 ± 11.6	−0.5 ± 3.9	−0.01 ± 3.7	−1.0 ± 4.9	−0.3 ± 2.5
Worse	6.9 ± 15.0	2.4 ± 4.5	2.1 ± 4.3	1.5 ± 6.4	1.0 ± 3.3
	All	All	All	All	All
SF-36 physical health status					
Better	−12.2 ± 15.3	−3.9 ± 5.3	−1.5 ± 4.6	− 5.3 ± 5.8	−1.5 ± 3.2
Same	−2.2 ± 10.6	−0.5 ± 3.6	−0.03 ± 3.6	−1.2 ± 4.4	−0.4 ± 2.5
Worse	10.0 ± 15.6	2.8 ± 4.8	2.2 ± 4.2	3.7 ± 6.5	1.3 ± 3.2
	All	All	All	All	All
SF-36 mental health status					
Better	−10.5 ± 15.5	−2.1 ± 2.9	−3.7 ± 6.4	−1.8 ± 5.1	−3.0 ± 4.0
Same	−2.0 ± 11.7	−0.3 ± 2.6	−1.0 ± 4.8	−0.6 ± 4.1	0.02 ± 3.5
Worse	4.9 ± 15.5	0.9 ± 3.1	0.3 ± 6.9	0.8 ± 4.8	3.1 ± 4.2
	All	—[b]	All	—[c]	All

All = All groups are significantly different from each other in pairwise post-hoc means comparisons. Overall ANOVAs $P < 0.0001$.

[a]Mean AQLQ change ± standard deviation.

[b]"Worse" group significantly different from "Better" and "Same" groups. "Better" and "Same" groups not significantly different from each other. Overall ANOVA $P = 0.0025$.

[c]"Better" group significantly different from "Worse" and "Same" groups. "Worse" and "Same" groups not significantly different from each other. Overall ANOVA $P = 0.0001$.

CHANGES IN PHYSICAL AND MENTAL HEALTH STATUS. Mean differences in AQLQ scores among SF-36 change groups were also tested using ANOVAs, followed by post hoc pairwise means comparisons. Significant group differences were found for all AQLQ scores among both the SF-36 physical and mental health status change groups. All pairwise comparisons among the physical health status change groups were statistically significant; all but two were statistically significant among the mental health status change groups, as shown in Table 5. AQLQ scores of subjects in the "Better" health status groups decreased (less asthma impact at Wave 2 than at Wave 1), and AQLQ scores of those in the "Worse" health status groups increased (greater asthma impact at Wave 2).

MULTIVARIATE ANALYSES. Multiple regression analyses were conducted to determine whether the covariates of age, race, gender, education, income, marital status, smoking status, history of atopic disease, and age of asthma onset affected the relationships between changes in asthma severity or general health status and changes in AQLQ. Results of these analyses were similar to those of the bivariate analyses and indicated that the covariates had very little influence on AQLQ scores (data not shown). Although all the regression models except one produced statistically significant ($P < 0.0001$) overall model F-statistics, the model R^2s were rather small (ranging from 0.01 to 0.18), indicating that the regression models accounted for only small amounts of the variation in changes in AQLQ scores.

DISCUSSION

The current study assessed the factor structure of the AQLQ, the association of the AQLQ with asthma severity and general health status, and the responsiveness of the AQLQ to changes in asthma severity and general health status.

Our analyses support the originally defined factor structure of the AQLQ but eliminated item overlap among subscales (i.e., each item is scored in one subscale only), thus producing conceptually more distinct subscales. However, the intercorrelation among the subscales suggests that the AQLQ measures a single construct, even though different aspects of that construct can be identified.

The current study supports the construct validity of the AQLQ. In their developmental study, Marks and colleagues [17] found weak and nonsignificant correlations between measures of pulmonary function and AQLQ scores. The correlations between pulmonary function and AQLQ scores observed in the current study were of the same magnitude, but because of the larger sample size, some achieved statistical significance. Others have also noted only modest associations between pulmonary function and both the Marks and other asthma-specific quality of life measures [4,8,11]. Marks and colleagues have suggested that these weak correlations show that quality of life represents a distinct dimension of asthma. It is also possible that pulmonary function tests do not measure severity of asthma in a

way that is meaningful to individuals with the condition, that pulmonary function measured on one day is not reflective of function over time, that individuals cannot accurately and consistently assess their own airflow obstruction, or that the same degree of asthma severity is interpreted differently by different individuals.

In the developmental study, Marks did find significant correlations between another proxy for asthma severity, the number of asthma medications taken by the subject, and AQLQ scores [17]. This proxy for severity may be more reflective of patients' perceptions of the impact of asthma, because taking medications is a daily reminder of their asthma. Symptoms and medication use, which are integrated into the calculation of the asthma severity score used in the current study, are factors that patients deal with daily. Hospitalization and intubation, other components of the severity score we used, are rare and possibly alarming events, and are they likely to make strong impressions on patients. We would thus expect a severity measure based on symptoms, medications, and hospitalization to be more closely related to patients' perceptions of quality of life than pulmonary function measured at a single point in time [20]. Consistent with this interpretation, the correlations found in the current study between asthma severity and AQLQ scores were of similar magnitude to those reported by Marks *et al.* [17] between AQLQ scores and the number of drugs taken by respondents.

The pattern of cross-sectional correlations of AQLQ scores with asthma severity and general health status that we observed supports the factor structure of the AQLQ. Although the asthma severity score was significantly correlated with all AQLQ scores, the lowest correlation coefficient was noted with the Emotional Impact subscale. Similarly, the lowest correlations with SF-36 Physical health status scores were with the AQLQ Emotional Impact and Health Concerns subscale scores. In contrast, the SF-36 Mental health status score was most highly correlated with the AQLQ Emotional Impact subscale.

In their study of the responsiveness of the AQLQ to changes in lung function, bronchial hyperresponsiveness, symptoms, daily peak flow variability, and scores on the Sickness Impact Profile, Marks and colleagues [18] found that AQLQ correlations with those changes were weak and generally not statistically significant. In contrast, in the current study, we found that changes in asthma severity and changes in general health status were significantly correlated with changes in AQLQ scores, suggesting that the AQLQ was responsive to changes in both disease-specific and general health status. However, the model R^2s from the multiple regression analyses were rather small, indicating that the models were accounting for only trivial portions of the overall variance in the changes in AQLQ scores. Once again, this suggests that the AQLQ is sensitive to both generic and disease-specific health measures but that it also captures a distinct dimension of patient perception.

Marks and colleagues [18] were able to use the AQLQ to distinguish between subjects whose asthma was classified as stable and those whose asthma was classified as improved. Our analyses were able to distinguish not only subjects who were stable and those whose asthma had improved, but those whose asthma had worsened as well. These associations were strong and consistent.

It is possible that some of the study subjects had lung diseases other than asthma. We do not have data such as FEV_1 before and after bronchodilator administration or a measure of nonspecific airway responsiveness such as methacholine challenge, but all patients were diagnosed by subspecialists (allergists and pulmonologists) consistent with standardized American Thoracic Society guidelines for the diagnosis of asthma. Physicians were specifically instructed not to enroll individuals with chronic bronchitis or emphysema. In addition, our recruitment age cut-off of 50 years minimizes misclassification of chronic obstructive pulmonary disease as asthma. Thus, we believe that our recruitment of subjects through board-certified subspecialists using specific and standardized criteria minimizes the possibility that subjects had pulmonary conditions other than asthma.

Another possible study limitation is that we did not obtain subjects' responses to the AQLQ from both telephone and self-administration to ensure comparability of responses across methods of administration. The AQLQ was originally developed for self-administration. The primary difficulties that arise in transferring questionnaires from self-administration to telephone administration occur if the questions require the respondents to look at cards, pictures, or products, or if the number of response options is large [27]; neither of these conditions exists for the current version of the AQLQ. Of the three developmental or validation studies of the Marks AQLQ, two [17,18] used self-administration, and one [25] used telephone administration. Internal consistency coefficients obtained in these three studies and those we obtained were high and similar, suggesting equivalent levels of internal consistency using the two methods of administration. Correlations with other indicators were also similar among the three previous studies as well as in our analyses, suggesting that both methods of administration yield valid instruments. Thus, although we did not conduct a direct test of the equivalence of telephone and self-administration, our data and data from other studies support the usefulness of the AQLQ in both settings.

The study sample we analyzed is not from the general population but, rather, from a population with access to care, particularly access to health care by medical subspecialists. Even though our sample was drawn from a clinical population, a potentially skewed sample, there was a wide range in responses, suggesting that broad ranges of asthma quality of life, asthma severity, and general health status were represented. Furthermore, demographic variables, although also skewed in our population (which was largely female, older than 30, and relatively well-educated), appeared to have little impact on AQLQ scores or changes in

those scores. Nonetheless, we cannot exclude the possibility that the sample or design could have introduced selection bias into the study, and generalizations to all adults with asthma should be viewed with this potential limitation in mind. It is also possible that some of the associations we observed were due to chance, even those with probabilities less than 0.05. We have not adjusted for multiple tests with a conservative criterion such as that obtained with the Bonferroni adjustment, because our models were based on *a priori* assumptions. However, even a very rigid adjustment ($P = 0.0016$ for 30 statistical tests) would have little effect on our principal findings, as many of the statistical comparisons were significant at the $P < 0.001$ level.

In summary, when we tested the subscale structure of the AQLQ, it was supported by factor analysis and by assessments of internal consistency. Nonetheless, the subscales are highly intercorrelated, suggesting that a single construct may underlie the AQLQ and that examination of subscale scores may not be necessary. The greatest variation in associations was noted for the Emotional Impact subscale, suggesting that this subscale may reflect a more distinct aspect of the impact of asthma. Further work is needed to determine whether AQLQ subscales are differentially sensitive to clinical or other factors. Our analyses of the relationships of asthma severity and general health status with AQLQ scores, and of changes in severity and health status with changes in the AQLQ scores, are consistent with those reported by Marks and colleagues [17,18], although relationships noted in our analyses appear to be more robust. The AQLQ appears to be a useful tool for assessing the impact of asthma on the lives of persons with the condition. The AQLQ also appears to be capable of detecting changes in

APPENDIX 1.

	Wave 1 Administration Factor Loadings[a]					Wave 2 Administration Factor Loadings[a]				
	P	**E**	**S**	**C**	α	**P**	**E**	**S**	**C**	α
Total AQLQ					0.94					0.95
Physical Impact, or "Breathlessness"					.083					0.89
• I have been troubled by episodes of shortness of breath. (B)[b]	**0.84**					**0.78**		*0.27*		
• I have been troubled by wheezing attacks. (B)[b]	**0.81**					**0.76**				
• I have been troubled by tightness in the chest. (B)[b]	**0.85**					**0.78**		*0.29*		
• I have been restricted in walking down the street on level ground or doing light housework because of asthma. (B)[b]	**0.60**		0.55			**0.50**		0.64		
• I have been restricted in walking up hills or doing heavy housework because of asthma. (B)[b]	**0.60**		0.57			**0.48**		0.66		
Emotonal Impact, or "Mood"					0.83					0.84
• I have felt tired or a general lack of energy. (M)[b]	0.46	**0.45**	*0.38*			*0.33*	**0.63**	*0.30*		
• I have been unable to sleep at night. (M)[b]	0.40	**0.45**					**0.59**			
• I have felt sad or depressed. (M)[b]		**0.80**					**0.82**			
• I have felt frustrated with myself. (M)[b]		**0.77**	*0.28*				**0.79**	*0.30*		
• I have felt anxious, under tension, or stressed. (M)[b]		**0.82**					**0.76**			
Social Impact, or "Social"					0.92					0.93
• I have felt that asthma is preventing me from achieving what I want from life. (S, C)[b]	*0.26*	*0.27*	**0.71**				*0.33*	**0.67**	*0.37*	
• Asthma has interfered with my social life. (S)[b]	*0.28*		**0.74**				*0.27*	**0.76**		
• I have been limited in going to certain places because they are bad for my asthma. (S)[b]			**0.73**					**0.74**		
• I have been limited in going to certain places because I have been afraid of getting an asthma attack and not being able to get help. (S, C)[b]			**0.71**					**0.75**		
• I have felt generally restricted. (S)[b]	*0.27*		**0.77**				*0.32*	**0.73**	*0.31*	
• I have been restricted in the sports, hobbies, or other recreations I can engage in because of my asthma. (S)[b]	*0.28*		**0.71**					**0.64**	*0.33*	
• I have felt that asthma is controllling my life. (S, C)[b]			**0.73**	*0.33*			*0.27*	**0.70**	0.43	
Health concerns					0.78					0.79
• I have been worred about my present or future life because of asthma. (C)[b]		*0.28*	0.59	**0.51**			*0.35*	0.48	**0.60**	
• I have worried about asthma shortening my life. (C)[b]		*0.36*	0.52	**0.54**				0.45	**0.65**	
• I have felt dependent on my asthma sprays. (C)[b]	*0.28*			**0.77**		*0.25*			**0.77**	

Item factor loadings for the subscales in which they are scored are shown in bold. Factor loadings between 0.25 and 0.40 are shown in italics; factor loading below 0.25 are not shown.

[a]P = Physical impact, E = Emotional impact, S = Social impact, C = Health concerns, α = Cronbach's alpha.

[b]Original AQLQ subscale in which item was included. B = Breathlessness, C = Concerns, M = Mood, S = Social.

the impact of asthma, which makes it particularly useful for tracking patients over time, both for clinical and research purposes.

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