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Psychometric properties of a Chinese asthma quality of life questionnaire

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ABSTRACT

Purpose: To assess the acceptability, reliability, validity, and responsiveness of the Chinese Asthma Quality of Life Questionnaire (C-AQLQ) in a sample of Chinese asthma patients. **Methods:** The C-AQLQ and Short Form 36 Health Survey (SF-36) scales were administered to patients at baseline and 3 months later. Asthma severity condition and lung function were evaluated. Necessary data were gathered to assess the psychometric properties such as the feasibility, internal consistency, test-retest reliability, structural validity, discriminant validity, convergent validity, and responsiveness of the C-AQLQ. **Results:** One hundred and thirty-seven patients completed the investigation. The Cronbach's alpha coefficient for the total scale was 0.96. Factor analysis yielded five factors that generally corresponded to the five proposed subscales. Patients with mild asthma reported higher scores than patients with moderate/severe asthma on all subscales other than environmental stimuli. Lung function measurement and the asthma severity score correlated significantly with domains of the C-AQLQ but with fewer domains of the SF-36. The questionnaire detected within-subject changes in patients' asthma status during follow-up. **Conclusions:** Results indicated preliminary support that the C-AQLQ is a reliable, valid, discriminating, and responsive measure of quality of life in Chinese asthma patients. It is more sensitive than the generic SF-36 in detecting differences in asthma severity.

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Introduction

Asthma is an important international health priority because of its high and increasing prevalence, high morbidity and mortality, and direct and indirect costs [1–4]. Approximately 300 million people worldwide are diagnosed with asthma, and approximately one in every 250 deaths may be attributable to asthma [5–7]. In order to get a more comprehensive description of the impact of the illness on the life of asthma patients, interest in the development and use of patient-reported outcomes is increasing [8]. One key outcome is health-related quality of life (HRQOL), which is defined as the patient's subjective perception of the effects of a disease and its treatment on his or her well-being. Determination of HRQOL is important for the management of patients in clinical practice and for research [9].

Accurate HRQOL assessments require effective instruments. Well-established English-language instruments such as Juniper Asthma Quality of Life Questionnaire (J-AQLQ) for measuring HRQOL in adults with asthma have existed for many years [10–16], but translations are often not suitable for Chinese populations. For example, some activities mentioned in the J-AQLQ are not

traditional activities for Chinese people, including mowing the lawn, vacuuming, performing woodwork or carpentry, and gardening. Instead, the majority of Chinese adults typically engage in activities such as bicycling, taking the bus, chatting, and shopping. The Chinese Asthma Quality of Life Questionnaire (C-AQLQ) was developed by Li F. et al. [17] based on the Juniper AQLQ in conjunction with Chinese cultural characteristics. It is a promising instrument for assessing HRQOL among adult Chinese patients with asthma.

An initial evaluation indicated that the C-AQLQ could be used to detect changes in quality of life (QOL) of 50 patients with asthma [18]. Test-retest reliability and criterion validity of the C-AQLQ were evaluated in a study with 26 enrolled patients [17]. To the best of the authors' knowledge, very few studies have shown detailed data to support the comprehensive measurements properties of C-AQLQ, and the psychometric properties of its domains (i.e., activity limitation, symptoms, mental health, environmental stimuli, and health perceptions) have not been characterized. Therefore, further studies are needed to provide detailed assessment of measurement properties of the C-AQLQ. Also, as Chinese is a widely spoken language with nearly 1300 million native speakers with

high prevalence of asthma, there is a critical need for additional studies of C-AQLQ that further examine its feasibility and other properties. The aim of this study was to evaluate psychometric properties of the C-AQLQ, including its feasibility, internal consistency, test-retest reliability, construct validity, and responsiveness.

Methods

Study population

The study included male and female patients over 18 years of age who had been diagnosed with bronchial asthma according to the Chinese national standards, were able to understand and respond to the Chinese language, and were receiving regular checkups and asthma treatment in our outpatient clinic. A total of 145 asthma patients were approached to participate in the study. The study excluded individuals who (1) were illiterate or reluctant to participate, (2) were reported to have other chronic diseases or mental disorders, or (3) had been hospitalized within one month before the investigation period. All subjects were recruited from the outpatient departments of two triple-A hospitals in Beijing, China, between January 2012 and December 2014. This study was approved by the Ethics Committee of the School of Public Health, Capital Medical University of China. Informed consent forms were signed by all participants. The asthma patients were informed about the purpose of the study and what would be expected of them. Participants were assured of their rights of refusal to participate in or to withdraw from the study at any stage without any negative consequences.

Measurement

The C-AQLQ is a 35-item, self-administered rating scale that was developed to measure asthma-specific aspects of HRQOL in adults. The scale measures five conceptual dimensions of HRQOL: activity limitation (12 items), symptoms (9 items), mental health (5 items), environmental stimuli (5 items), and health perceptions (4 items). All of these items relate to the state of health over the two weeks prior to administration. Responses are rated on 7-point Likert scales (1 = always, 2 = very frequently, 3 = frequently, 4 = often, 5 = sometimes, 6 = occasionally, 7 = never; or 1 = completely restricted, 2 = extremely limited, 3 = severely restricted, 4 = moderately restricted, 5 = mildly restricted, 6 = seldom restrained, 7 = not restricted). Higher scores indicate better HRQOL. Subscale scores are computed as the sums of the constituent items divided by the number of items answered. If more than 50% of the items in a scale are missing, subscale scores are not calculated [19].

The Short Form 36 Health Survey (SF-36) is a 36-item questionnaire that assesses 8 dimensions of health: physical functioning, social functioning, role limitation due to physical problems, role limitation due to emotional problems, mental health, energy/vitality, bodily pain, and general health [20]. The SF-36 has been widely used, and its reliability and validity have been thoroughly documented across different conditions. The Chinese version of SF-36 is the most widely used general questionnaire in asthma patients [21].

Patients' views on C-AQLQ are surveyed by a questionnaire that includes several questions: (1) Do you feel the C-AQLQ is generally easy to understand? (Yes or No). (2) Can you complete most of the C-AQLQ all by yourself? (Yes or No). (3) Are you willing to fill in the C-AQLQ again after 3 months? (Yes or No). (4) Which item is the most difficult for you to understand? (Please write the item number: ____; if there is no item difficult for you, please write 0.)

The asthma severity score was calculated as the sum of the scoring for medications (1 – bronchodilators as required alone; 2 – bronchodilators as required and inhaled steroids up to 800 µg/day; 3 – bronchodilators as required and inhaled steroids in excess of 800 µg/day; 4 – bronchodilators as required, inhaled steroids in excess of 800 µg/day and oral steroids) and the scoring for airflow obstruction (0–FEV1% predicted >80; 1–FEV1% predicted 70–79; 2–FEV1% predicted 60–69; 3–FEV1% predicted 50–59; 4–FEV1% predicted <50). A score ≤3 was regarded as mild and >3 as moderate-to-severe asthma, which proved to be valid in discriminating the severity of asthma condition [22, 23].

Spirometry was performed with a Jaeger spirometer. The following parameters were measured in spirometry: forced vital capacity (FVC) in liters [l] and forced expiratory volume in one second (FEV1) in liters [l] [24, 25].

Study design and procedures

We conducted a study in adults who presented to our outpatient clinics for asthma assessment. At baseline, we used standardized forms to collect demographic data and assessed all the included patients with the C-AQLQ and SF-36. Asthma severity condition and lung function were evaluated. Fifty patients were asked to complete the C-AQLQ again after one week. During the follow-up visit, 3 months later, we also assessed patients with the C-AQLQ and evaluated asthma severity condition and lung function. According to the change of asthma severity score during the 3-month period, a patient was categorized either as having “stayed the same” (Group A) if the patient's score on the second occasion deviated within −1 to +1 of the initial score or “changed” (Group B) if the

severity of their asthma score was $>+1$ or <-1 than the initial score at the time of the follow-up examination [23].

Data collection

Three postgraduate students majoring in respiratory medicine were trained as interviewers by the project manager before the study commenced. Detailed clinical histories were obtained from all patients, and data about the patients' diagnoses and treatments were recorded. The interviewers were available to assist with the completion of the questionnaires if the patients had questions about semantics or conceptual understanding; they were also responsible for collecting and reviewing the questionnaires to ensure that there were no missing data or logical mistakes. All items were coded and scored, and the completed questionnaires were included in the data set.

Analysis

Data were analyzed with SPSS 19.0 for Windows. Values <0.05 were considered statistically significant unless otherwise stated. Descriptive analyses were used to report the sociodemographic characteristics of the patients. Continuous variables were presented as means and standard deviations ($\bar{X} \pm SD$), and categorical variables were shown as observed frequencies and proportions. Missing item score was replaced with the subscale mean item score.

The presence of floor and ceiling effects ($>25\%$ of the respondents having the minimum and/or maximum score) was evaluated for the five subscale scores [26]. Feasibility was determined by the average completion time and the response of the patients.

Internal consistency was determined using Cronbach's alpha coefficient [27]. Subscales with $\alpha \geq 0.70$ were recommended for comparing patient groups, whereas a reliability criterion of 0.90 was recommended for analyzing individual patients [28]. The intraclass correlation coefficient (ICC) was used to evaluate the test-retest reliability of the subscales. Values greater than 0.80 indicated high test-retest reliability [29]. The corrected item-total correlations and the alpha-if-item-deleted procedure were included in the analysis.

Convergent validity was assessed by the correlations between the scale scores of the domains of the C-AQOL and both the Chinese SF-36 scores and clinical parameters during the initial visit. Longitudinal validity correlations were measured by the correlation of changes in the scores of the clinical parameters with changes in the C-AQOL scores in patients whose clinical status had changed between the two visits.

Discriminant validity for the C-AQLQ was evaluated by means of the known-groups method, which compares subscale scores across groups that are known to differ with

regard to the health conditions being investigated [30]. In this study, patients were divided into two groups according to the severity of asthma (mild vs. moderate to severe). The independent sample t-test was used to compare the questionnaires scores between the two groups of patients.

Pearson correlation analyses were performed to calculate the item-subscale correlations. Content validity was further evaluated through analyses of inter-scale correlation and the inter-correlations among the subscale scores.

The item scores were subjected to an exploratory factor analysis using principal component analysis and varimax rotation to determine the factor structure of the C-AQLQ. Before conducting the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test were performed to evaluate whether a satisfactory factor analysis can be performed, as indicated by a KMO value >0.5 [31].

The responsiveness of the C-AQOL was determined by (1) its ability to detect statistically significant within-subject changes for patients whose clinical status had changed (Group B) and (2) its ability to distinguish between Groups A and B in terms of changes in QOL during follow-up.

Results

Response rate and feasibility

The response rate was 94.48%. Of the 145 patients with asthma who participated in the study, 137 patients completed the investigation. Five patients refused to participate, and 3 answered fewer than 50% of the items. The average time needed to complete the C-AQLQ was 10 minutes ($SD = 5$ minutes). Among all the patients, 97.3% thought the questions of the C-AQLQ were generally easy to understand and 96.6% could complete most of the C-AQLQ all by themselves. 72.9% patients were willing to fill in the C-AQLQ again after 3 months follow-up period. Seven patients reported item 7 as the most difficult item to understand and five patients reported item 6. Three and one patients reported item 12 and item 16 as the most difficult item, respectively. Missing data were reported by 4 patients (2.9%) with 5 missing items altogether.

Subjects

The characteristics of the study population are presented in Table 1. The average age of the asthma patients was 53.55 ± 11.14 years (range: 28–77); most of the patients were female (56.9%) and married (64.2%). Many of the patients were retirees (31.4%) and had completed primary education (22.6%). The mean duration of illness was 11.96 ± 8.92 years (range: 1–34).

Table 1. Demographic and medical characteristics of the asthma patients ($n = 137$).

Variable	Category	n (%)
Age (years)	<35	21 (15.3)
	35–45	34 (24.8)
	46–55	35 (25.5)
	≥ 56	47 (34.3)
Sex	Female	78 (56.9)
	Male	59 (43.1)
BMI	< 18.5	29 (21.2)
	$\geq 18.5, < 25$	60 (43.8)
	≥ 25	48 (35.0)
Duration of illness	1–5 years	33 (24.1)
	6–10 years	45 (32.8)
	11–15 years	42 (30.7)
	≥ 15 years	17 (12.4)
Marital status	Married	88 (64.2)
	Single, divorced, or widowed	49 (35.8)
Work status	Unemployed	30 (21.8)
	Self-employed	19 (13.9)
	Working part-time at a regular job	16 (11.7)
	Working full-time at a regular job	29 (21.2)
	Retired	43 (31.4)
Education	Illiterate	23 (16.8)
	Primary	31 (22.6)
	Middle school	30 (21.9)
	High School	28 (20.4)
	University	25 (18.2)
Smoking history	Never smoked	69 (50.4)
	Smoke sometimes	31 (22.6)
	Smoke often	37 (27.0)

Reliability of the C-AQOL

As shown in Table 2, the mean score (SD) of the total C-AQLQ was 5.23 (1.05), and the mean scores (SDs) of the five subscales were as follows: activity limitation = 4.99 (1.10), symptoms = 5.57 (1.33), mental health = 5.36 (1.33), social activities = 5.75 (1.43), and health perceptions = 4.41 (1.85). Cronbach's alpha was 0.96 for the C-AQLQ and 0.82–0.93 for all subscales, indicating satisfactory internal consistency. The ICC was 0.95 for the C-AQLQ and 0.81–0.93 for the five subscales, indicating good test-retest reliability. Corrected item-total correlations ranged from 0.47 to 0.75. Cronbach's alpha-if-item-deleted ranged from 0.959 to 0.961.

Floor effects were modestly evident for all subscales, indicating that few respondents rated the items as

applying in an extremely negative fashion to themselves. Regarding ceiling effects, the environmental stimuli subscale evidenced substantial numbers of top-score ratings. Seventeen percent of the respondents rated the environmental stimuli items as highly positive.

Convergent validity of the C-AQOL

Table 3 presents the correlations between the mean scores of the various domains of the C-AQOL and SF-36. Significant correlations were observed between all domains of the C-AQOL and all domains of SF-36, with the exception of bodily pain. The correlations were 0.42–0.60 between activity limitation and the SF-36 subscales and 0.34–0.72 for symptoms, 0.47–0.74 for mental health, 0.31–0.49 for environmental stimuli, 0.38–0.51 for health perception, and 0.44–0.71 for the total average score. Of note was the lack of a significant correlation between the health perception domain of the C-AQOL and the physical functioning and role physical domains of the SF-36.

Table 4 presents the relationships between the clinical estimates of asthma severity and the C-AQOL. There were significant correlations between FEV1% predicted and each of the following: activity limitation, environmental stimuli, and the total average score of the C-AQOL ($r = 0.35$ – 0.44). FVC % predicted correlated with activity limitation, symptoms, environmental stimuli, and the total average score ($r = 0.36$ – 0.46), whereas FEV1/FVC only correlated with activity limitation ($r = 0.38$). The severity of asthma score significantly correlated with each of the five domains of the C-AQOL ($r = 0.20$ – 0.33), except environmental stimuli.

Longitudinal validity of the C-AQOL

Longitudinal construct validity correlations are also presented in Table 4. There were 43 participants whose clinical status changed between the two visits. There were small-to-moderate correlations between changes in the mean scores in most of the domains of the C-AQOL (with

Table 2. Subscale descriptive statistics for the C-AQLQ ($n = 137$).

Subscale	Total items	Theoretical range	Observed range	Mean	SD	Corrected item-total correlations	Cronbach's alpha	ICC	% floor	% ceiling
Activity limitation	12	1–7	2.33–7.00	4.99	1.10	0.47–0.69	0.90	0.89	0.0	0.5
Symptoms	9	1–7	1.56–7.00	5.57	1.33	0.54–0.73	0.93	0.92	0.0	7.3
Mental health	5	1–7	1.00–7.00	5.36	1.33	0.48–0.72	0.82	0.81	0.5	8.2
Environmental stimuli	5	1–7	1.20–7.00	5.75	1.43	0.70–0.71	0.93	0.93	0.0	17.0
Health perception	4	1–7	1.00–7.00	4.41	1.85	0.59–0.75	0.91	0.91	1.4	5.5
Total average score	35	1–7	2.11–6.83	5.23	1.05		0.96	0.95	0.0	0.0

Table 3. Correlations between the scale scores of the domains of the C-AQLQ and the domains of the Chinese SF-36 ($n = 137$).

SF-36	Activity limitation	Symptoms	Mental health	Environmental stimuli	Health perception	Total average score
Physical functioning	0.46**	0.34**	0.47**	0.31**	0.24	0.44**
Social functioning	0.53**	0.52**	0.73**	0.49**	0.51**	0.64**
Physical role	0.47**	0.60**	0.49**	0.34**	0.25	0.54**
Bodily pain	0.01	0.13	0.07	0.11	0.08	0.07
Mental health	0.56**	0.49**	0.66**	0.47**	0.46**	0.61**
Emotional role	0.60**	0.71**	0.62**	0.45**	0.50**	0.71**
Vitality	0.56**	0.72**	0.74**	0.45**	0.51**	0.70**
General health	0.42**	0.51**	0.53**	0.31**	0.38**	0.50**

Pearson's correlation coefficient.

** $p \leq 0.01$.

the exception of mental health and health perception) and changes in FEV1% predicted ($r = 0.28$ – 0.38). Changes in all domains of the C-AQOL also correlated significantly with changes in the asthma severity scores ($r = 0.28$ – 0.39). FVC% predicted correlated significantly with symptoms of C-AQLQ ($r = 0.26$).

Structural validity of the C-AQLQ

The KMO value point was 0.91, and the chi-square value for Bartlett's test of sphericity was 4034.11 ($p = 0.000$), indicating that the sample size was sufficient to perform a satisfactory factor analysis and psychometric testing.

The initial factor analysis yielded a 6-factor solution that accounted for 70.37% of the variance. All but one factor had at least two item loadings of 0.50 or higher. Because we wanted to match the five-component solution of the standard scale, a second analysis was conducted that restricted the results to a five-component solution. This analysis yielded a solution accounting for 67.18% of the variance (Table 5). The five factors were activity limitation (factor 1), symptoms (factor 2), environmental stimuli (factor 3), health perception (factor 4), and mental health (factor 5), which generally corresponded with the five hypothesized subscales. The eigenvalues were 15.79, 3.06, 1.70, 1.62, and 1.34 for the first

to fifth factor. The first factor accounted for 17.94% of the variance, followed by 14.72, 12.74, 12.49, and 9.29% for the second to fifth factor. The scree plot is shown in Figure 1. The individual items that were retained in the model and factor loadings (≥ 0.40) are presented for our sample.

One notable exception was the loading of activity limitation, symptoms, and mental health items on two different components, suggesting some possible incongruity of the items comprising these two hypothesized subscales for this sample.

Discriminant validity of the C-AQLQ

The discriminant validity of the C-AQLQ was assessed by the known-groups method. The patients were divided into two groups according to their asthma severity scores. Sixty-seven patients had asthma severity scores ≤ 3 (mild), and 70 patients had scores > 3 (moderate to severe). Patients with mild asthma reported significantly higher subscale scores than the patients with moderate/severe asthma for all subscales, except for the response to stimulus subscale of the C-AQOL. The mean score of activity limitation, symptoms, mental health, environmental stimuli, health perception, and total score were (5.42 ± 0.77 vs. 4.85 ± 1.20 , $p = 0.065$), (6.12 ± 0.79 vs. 5.18 ± 1.15 , $p = 0.002$), (5.95 ± 1.14 vs. 5.04 ± 1.18 ,

Table 4. Correlations between the scale scores of C-AQOL and clinical parameters at the initial visit and correlations between changes in the scale scores and clinical parameters.

C-AQLQ	FEV1% predicted	$n = 137$ FVC% predicted	FEV1/FVC	Severity	Δ AQLQ	Δ FEV1% predicted	$n = 43$ Δ FVC% predicted	Δ FEV1/FVC	Δ Severity
Activity limitation	0.44**	0.46**	0.38*	– 0.20*	Δ Activity limitation	0.38*	0.16	– 0.16	0.28*
Symptoms	0.25	0.36**	0.14	– 0.27*	Δ Symptoms	0.28*	0.26*	– 0.15	0.33*
Mental health	0.18	0.28	0.08	– 0.29*	Δ Mental health	0.10	0.12	– 0.29	0.27*
Environmental stimuli	0.35**	0.42**	0.24	– 0.15	Δ Environmental stimuli	0.35*	0.18	– 0.22	0.33*
Health perception	0.21	0.33	0.18	– 0.32*	Δ Health perception	0.09	0.09	– 0.24	0.31*
Total average score	0.35*	0.46**	0.25	– 0.28*	Δ Total average score	0.37*	0.19	– 0.23	0.39*

Spearman's rank correlation coefficient. * $p \leq 0.05$. ** $p \leq 0.01$.

Table 5. Five factors with their factor loadings for the asthma patients ($n = 137$).

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor loading
Activity limitation						
1	0.78					0.69
2	0.77					0.73
3	0.71					0.68
4	0.68					0.66
5	0.55					0.47
6	0.81					0.78
7	0.81					0.78
8					0.72	0.64
9					0.61	0.69
10					0.80	0.72
11					0.65	0.63
12					0.58	0.53
Symptoms						
13	0.61	0.49				0.74
14	0.56	0.45				0.68
15	0.61					0.50
16		0.66				0.60
17		0.72				0.62
18		0.66				0.64
19		0.60	0.40			0.71
20		0.61				0.68
21	0.43	0.46				0.53
Mental health						
22					0.67	0.72
23					0.56	0.63
24					0.58	0.43
25				0.50		0.49
26				0.60		0.65
Environmental stimuli						
27			0.789			0.81
29			0.78			0.80
29			0.71			0.74
30			0.73			0.79
31			0.62			0.69
Health perception						
32				0.73		0.77
33				0.79		0.80
34				0.79		0.78
35				0.77		0.74

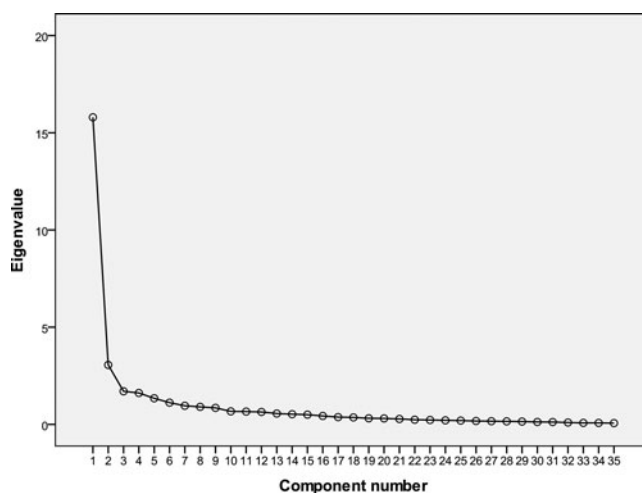
Extraction method: Principal component analysis.

Rotation method: Varimax with Kaiser Normalization.

$p = 0.008$), (6.27 ± 1.05 vs. 5.74 ± 1.58 , $p = 0.195$), (4.89 ± 1.79 vs. 4.00 ± 1.46 , $p = 0.050$), (5.74 ± 0.75 vs. 4.99 ± 1.08 , $p = 0.010$), respectively.

Content validity of the C-AQLQ

There were significant correlations among all of the subscales of the C-AQLQ (Table 6). The highest correlation coefficient was observed between “symptoms” and

**Figure 1.** The scree plot for factor analysis of the C-AQLQ.

“mental health” ($r = 0.76$). The correlation coefficients between the total average score and all the subscales were very high ($r = 0.79$ – 0.87). The inter-scale correlations ($r = 0.53$ – 0.76) were smaller than the internal consistency coefficients for all scales ($r = 0.82$ – 0.93).

The correlations between items and their subscales were generally 0.60 or above, with a few falling in the range 0.50–0.60 (Table 7). The correlations between items and their subscales were higher than the correlations with other subscales. The item-scale correlations within the same subscale were generally similar, except for activity limitation and mental health.

Responsiveness of the C-AQLQ

Seventy-six patients returned for a follow-up visit at 3 months. Of these, 33 were classified as having “stayed the same” (Group A) and 43 as having “changed” (Group B).

There were no significant differences between the mean scores on the two separate occasions for Group A. The within-subject changes in Group B were all statistically significant, except for the changes in activity limitation and environmental stimuli. The mean change in the overall C-AQLQ average score between the two visits was 0.05 (SD = 0.91) for Group A and 0.30 (SD = 0.98) for Group B. The differences between the changes in

Table 6. Correlation coefficients between the domains and the total average score on the C-AQLQ ($n = 137$).

	Activity limitation	Symptoms	Mental health	Environmental stimuli	Health perception	Total average score
Activity limitation	1					
Symptoms	0.72**	1				
Mental health	0.61**	0.76**	1			
Environmental stimuli	0.58**	0.57**	0.66**	1		
Health perception	0.53**	0.59**	0.73**	0.64**	1	
Total average score	0.87**	0.88**	0.86**	0.79**	0.79**	1

Pearson's correlation coefficient. ** $p \leq 0.01$.

Table 7. Item-subscale correlations between the items and subscale scores ($n = 137$).

	Activity limitation	Symptoms	C-AQLQ Mental health	Environmental stimuli	Health perception	Total average score
Activity limitation						
1	0.59**	0.48*	0.25	0.17	0.26	0.45*
2	0.75**	0.64**	0.45*	0.25	0.41*	0.64**
3	0.63**	0.58**	0.47*	0.12	0.48*	0.58**
4	0.78**	0.71**	0.53**	0.43*	0.39	0.72**
5	0.74**	0.57**	0.57**	0.43*	0.42*	0.68**
6	0.70**	0.55**	0.32	0.29	0.21	0.55**
7	0.75**	0.59**	0.40*	0.34	0.32	0.62**
8	0.54**	0.20	0.19	0.42*	0.25	0.41*
9	0.62**	0.40*	0.50**	0.60**	0.54**	0.63**
10	0.66**	0.33	0.29	0.44*	0.31	0.52**
11	0.61**	0.41*	0.49*	0.58**	0.32	0.59**
12Symptoms	0.66**	0.48*	0.40*	0.37	0.35	0.57**
13	0.63**	0.78**	0.65**	0.49*	0.46*	0.73**
14	0.57**	0.81**	0.62**	0.47*	0.45*	0.71**
15	0.50**	0.74**	0.50**	0.42*	0.36	0.62**
16	0.62**	0.73**	0.64**	0.33	0.43*	0.67**
17	0.48*	0.73**	0.44*	0.31	0.42*	0.59**
18	0.51**	0.73**	0.56**	0.36	0.46*	0.63**
19	0.54**	0.84**	0.79**	0.59**	0.59**	0.78**
20	0.64**	0.81**	0.62**	0.51**	0.50**	0.75**
21	0.51**	0.72**	0.44*	0.42*	0.42*	0.62**
Mental health						
22	0.45*	0.73**	0.78**	0.39	0.46*	0.65**
23	0.57**	0.68**	0.85**	0.65**	0.63**	0.78**
24	0.34	0.33	0.58**	0.47	0.35	0.47*
25	0.54**	0.56**	0.79**	0.55**	0.53**	0.68**
26	0.33	0.49*	0.67**	0.37	0.66**	0.56**
Environmental stimuli						
27	0.54**	0.60**	0.60**	0.92***	0.60**	0.75**
29	0.54**	0.50**	0.60**	0.90***	0.61**	0.72**
29	0.51**	0.45*	0.59**	0.91***	0.50**	0.68**
30	0.56**	0.53**	0.58**	0.89***	0.54**	0.72**
31	0.47*	0.48*	0.59**	0.90***	0.62**	0.69**
Health perception						
32	0.51**	0.62**	0.75**	0.62**	0.90***	0.77**
33	0.51**	0.56**	0.66**	0.59**	0.94***	0.74**
34	0.45*	0.48*	0.65**	0.60**	0.88**	0.68**
35	0.38	0.39	0.48*	0.39	0.76**	0.54**

Values denote Pearson correlation coefficients. * $p \leq 0.05$. ** $p \leq 0.01$. *** $p \leq 0.001$. Bold values represent correlations between items and their hypothesized subscales.

scores for Group A and Group B were statistically significant with regard to the total average score and the activity limitation domain (Table 8).

Discussion

Most questionnaires that were designed to measure HRQOL in asthmatic patients were originally created in English [32, 33]. The C-AQLQ was developed based on the living habits and actual asthma characteristics of Chinese individuals. Our study made preliminary confirmation that the C-AQLQ was applicable and valid for Chinese patients with asthma.

A total of 137 patients completed the present investigation. The response rate was fairly high and was likely due to the fact that our interviewers assisted the completion of the C-AQLQ by the asthmatic patients. Lower response rates are common when researchers collect questionnaire data by mail [34]. The high response rate may also

partly be due to the simplicity and rapidity of completing the C-AQLQ questionnaire. The average time needed to complete the C-AQLQ was acceptable, and nearly all the patients found the questions easy to understand and acceptable. Thus, we conclude that the C-AQLQ is feasible and practical.

Floor effects, which represent the percentage of respondents reporting the lowest possible scores on the subscales, were very limited (such responses accounted for less than 5% on any one subscale). Ceiling effects, representing the highest possible score on items, suggested that several of the environmental stimuli items may have had low discriminatory power; 17% of the sample rated these items with the highest of the possible positive ratings. However, the percentage of ceiling scores in our findings was still lower than that of other questionnaires reported in previous studies [23, 35].

The internal consistency of the C-AQLQ was estimated by Cronbach's alpha coefficient, which was 0.96, higher

Table 8. Mean scores on the C-AQLQ at two different time points for Group A and Group B.

AQLQ	Group A (n = 33)		T	P	Group B (n = 43)		T	P	Mean changes		T	P
	First visit (n = 33)	Second visit (n = 33)			First visit (n = 43)	Second visit (n = 43)			Group A (n = 33)	Group B (n = 43)		
Activity limitation	5.11 ± 1.24	4.92 ± 0.94	− 1.807	0.283	5.02 ± 0.94	5.30 ± 1.14	1.812	0.075	− 0.18 ± 1.12	0.26 ± 1.11	2.004	0.048
Symptoms	5.54 ± 1.33	5.59 ± 1.06	0.271	0.788	5.54 ± 0.92	5.92 ± 1.04	2.619	0.011	0.05 ± 1.18	0.38 ± 1.12	1.459	0.148
Mental health	5.41 ± 1.38	5.33 ± 1.30	− 0.460	0.648	5.36 ± 1.11	5.68 ± 1.38	2.437	0.018	− 0.08 ± 1.17	0.31 ± 0.99	1.949	0.057
Environmental stimuli	5.90 ± 1.64	5.73 ± 1.27	− 1.260	0.215	5.97 ± 1.21	5.87 ± 1.31	0.692	0.492	− 0.17 ± 0.90	− 0.10 ± 1.11	0.354	0.721
Health perception	4.36 ± 1.50	4.67 ± 1.97	1.167	0.250	4.32 ± 1.72	5.06 ± 1.67	3.213	0.002	0.30 ± 1.74	0.74 ± 1.78	1.233	0.213
Total average score	5.29 ± 1.19	5.24 ± 1.04	− 0.375	0.710	5.26 ± 0.89	5.56 ± 1.11	2.373	0.021	− 0.05 ± 0.91	0.30 ± 0.98	2.009	0.050

than that of the Juniper AQLQ (Cronbach's $\alpha = 0.92$). On all five domains of the C-AQLQ, Cronbach's α coefficients exceeded 0.80, higher than the Juniper AQLQ (Cronbach's α s = 0.61–0.89) [36], indicating a satisfactory reliability of the C-AQLQ. The ICCs that were used to examine test-retest reliability were all >0.80 for all subscales, and the homogeneity of the C-AQLQ appeared to be adequate in terms of item correlations, indicating that the C-AQLQ had a high degree of reliability in the present study.

Our study showed significant correlations among all domains of the C-AQOL and almost all domains of SF-36. The correlations of C-AQOL with lung function measures were weak to moderate, corroborating previous findings [37, 38]. Similarly, in the longitudinal study, there were only weak-to-moderate correlations between changes in clinical parameters and changes in various domains of the C-AQOL. Weak-to-moderate correlations between changes in C-AQOL and changes in clinical outcomes indicate that the questionnaire assesses parameters that are not included in clinical measures.

The results of exploratory factor analysis supported the underlying factor structure of the C-AQLQ. Factor analysis yielded five factors that accounted for 67.18% of the variance: activity limitation, symptoms, environmental stimuli, health perception, and mental health. The factor loadings of the items ranged from 0.43 to 0.81. The 5-factor solution was not perfect but generally corresponded with the five hypothesized subscales. There were several items that loaded on multiple factors as the results showed. As the sample of population in this study was not large, further study is needed to confirm the properties of this measure.

The C-AQLQ adequately discriminated between groups of individuals who are known to differ by type of medical condition. Support for clinical validation of a scale is provided when known groups differ significantly on factors known to contribute to differences in HRQOL [39]. Significant differences were observed between the patients with mild asthma and those with moderate/severe asthma. Patients with mild asthma reported higher subscale scores than those with moderate/severe asthma on all subscales, except response to stimuli.

Similar to the findings from other questionnaires for asthma [40], the results demonstrated that inter-scale correlations were significant, as were the correlations between the total average score and all of the subscales. Item-subscale correlations revealed that all items correlated at moderate-to-strong levels with their hypothesized subscales, which were higher than those with other subscales, indicating good content validity for the C-AQLQ. The present study also demonstrated that the C-AQLQ

was responsive to asthma patients as it detected statistically significant within-subject and between-subject changes. Thus, we believe that the C-AQLQ is responsive to asthma patients.

The present study does have the following potential limitations: (1) participants in the present study may have been particularly compliant, which may have influenced the representativeness of the study compared with the general population of Chinese individuals with asthma; (2) the present study only included patients treated at triple-A hospitals in Beijing, which may limit the generalizability of the findings to the current Chinese population with asthma; (3) the sample size was relatively small, and research assistants helped participants in completing the C-AQLQ, which may limit the utility of the findings in this study; and (4) the research assistants reviewed the survey with participants, which may increase the social desirability bias. Further confirmation of the findings of the present study is needed with larger and different types of populations. The accuracy of the findings in this study also needs future investigation with better design and procedure to prove.

In conclusion, the C-AQLQ demonstrated statistically acceptable levels of reliability, validity, and responsiveness. Based on its good psychometric properties, we believe that the C-AQLQ is a culturally appropriate tool for evaluating Chinese asthma patients. Future researchers should consider performing studies with larger sample sizes including individuals from different regions and different levels of hospitals.

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Declaration of interest

The authors declare that they have no conflict of interest.

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Appendix 1

Chinese asthma QOL questionnaire (English)

The following are the most common daily activities. Please select five activities that you engage in most frequently in your daily life and write the number on the _____ in the item 1 to 5.

(1) bicycling, (2) indoor cleaning, (3) pushing the bike, (4) jogging, (5) slow walk, (6) playing games with children, (7) singing, (8) dancing, (9) visiting relatives or friends, (10) taking the bus, (11) climbing stairs, (12) daily physical activity, (13) cleaning the floor, (14) chatting, (15) shopping.

Responses for item 1 to 7 are indicated on the following 7-point scale:

1–completely restricted, 2–extremely limited, 3–severely restricted, 4–moderately restricted,

5–mildly restricted, 6–seldom restrained, 7–not restricted

1. _____ In the past two weeks, to what degree has this activity been impacted by asthma: ()
2. _____ In the past two weeks, to what degree has this activity been impacted by asthma: ()
3. _____ In the past two weeks, to what degree has this activity been impacted by asthma: ()
4. _____ In the past two weeks, to what degree has this activity been impacted by asthma: ()
5. _____ In the past two weeks, to what degree has this activity been impacted by asthma: ()
6. In the past two weeks, to what degree have the activities that you must participate in been impacted by asthma: ()

7. In the past two weeks, to what degree have the activities that you should participate in been impacted by asthma: ()

Responses for item 8 to 35 are indicated on the following 7-point scale:

1–always, 2–very frequently, 3–frequently, 4–often, 5–sometimes, 6–occasionally, 7–never

8. In the past two weeks, you have walked away from cigarette smell in the surrounding environment: ()
9. In the past two weeks, you have walked away from perfume smell in the surrounding environment: ()
10. In the past two weeks, you have walked away from dust in the surrounding environment: ()
11. In the past two weeks, you have walked away from cooking fumes or soot smell in the surrounding environment: ()
12. In the past two weeks, you were forced to stay at home or go out because of the climate change or the smoke in the surrounding environment: ()
13. In the past two weeks, you have felt out of breath because of asthma: ()
14. In the past two weeks, the frequency of your asthma attack was: ()
15. In the past two weeks, you have felt uncomfortable because of a cough: ()
16. In the past two weeks, you have had a choking sensation or sense of impending doom: ()
17. In the past two weeks, you have felt chest tightness: ()
18. In the past two weeks, you have experienced difficulty in expiration: ()
19. In the past two weeks, you have had an asthma attack in the morning: ()
20. In the past two weeks, you have been awakened due to asthma attack: ()
21. In the past two weeks, your sleep quality has been influenced by asthma attack: ()
22. In the past two weeks, you have felt sad or depressed because of asthma: ()
23. In the past two weeks, you lost confidence in treatment because of recurrent asthma attacks: ()
24. In the past two weeks, you have felt embarrassed by aerosol inhalation in front of other people: ()
25. In the past two weeks, you have worried that there were no drugs for asthma by your side: ()
26. In the past two weeks, you have worried about asthma attack: ()
27. In the past two weeks, you have had an asthma attack due to cigarette exposure: ()
28. In the past two weeks, you have had an asthma attack due to exposure to dust: ()

29. In the past two weeks, you have had an asthma attack due to exposure to cooking fumes or soot smell: ()
30. In the past two weeks, you have had an asthma attack due to exposure to perfume smells or strange odors: ()
31. In the past two weeks, you have had an asthma attack because of climate change or smoke in the surrounding environment: ()
32. In the past two weeks, you have worried about your current health condition because of asthma: ()
33. In the past two weeks, you have worried about your future health condition because of asthma: ()
34. In the past two weeks, you have worried about shortening of life due to asthma: ()
35. In the past two weeks, you have worried about your dependence on asthma sprays: ()

Appendix 2

成人哮喘生存质量评分表 (Chinese):

下面是人们最常见的日常活动, 请指出您平时最经常参与的5项活动, 若您平时生活中的活动未列入下列表中, 请您另选, 然后将您选出的5条项目填到下列1-5题的5个横线上, 并逐项打分。

(1) 骑自行车; (2) 室内打扫; (3) 推自行车; (4) 快步走; (5) 慢步走; (6) 与儿童游戏; (7) 唱歌; (8) 跳舞; (9) 亲戚家、朋友家串门; (10) 乘公共汽车; (11) 上楼梯或爬坡; (12) 日常身体锻炼; (13) 搽地板; (14) 闲聊; (15) 商店购物。

1~7选项均为: 1-完全受限, 2-极度受限, 3-重度受限, 4-中度受限, 5-轻度受限, 6-很少受限, 7-不受限

1. ____ 在上2周中受哮喘的影响如何: ()
2. ____ 在上2周中受哮喘的影响如何: ()
3. ____ 在上2周中受哮喘的影响如何: ()
4. ____ 在上2周中受哮喘的影响如何: ()
5. ____ 在上2周中受哮喘的影响如何: ()
6. 上2周中, 您必须参加的活动中, 哮喘对您的影响程度是: ()
7. 上2周中, 您应该参加的活动中, 受哮喘的影响如何: ()
8. ~35选项均为: 1-一直, 2-非常频繁, 3-频繁, 4-经常化, 5-有时候, 6-偶尔, 7-从未有
8. 在上2周中, 您因身边或周围环境中香烟气味而走开: ()
9. 在上2周中, 您因身边或周围环境中异味或香水味而走开: ()

10. 在上2周中, 您因身边或周围环境中灰尘而走开: ()
11. 在上2周中, 您因身边或周围环境中煤烟味或炒菜油烟而走开: ()
12. 在上2周中, 您因身边或周围环境中烟雾或气候变化而被迫呆在家中或被迫外出: ()
13. 在上2周中, 您常因哮喘而上气不接下气: ()
14. 在上2周中, 您的气喘发作是: ()
15. 在上2周中, 您因咳嗽而觉得不适: ()
16. 在上2周中, 您有窒息感或濒死感: ()
17. 在上2周中, 您觉得胸闷: ()
18. 在上2周中, 您觉得呼气费力: ()
19. 在上2周中, 您在早晨醒来时哮喘发作: ()
20. 在上2周中, 您因哮喘发作而惊醒: ()
21. 在上2周中, 您因哮喘发作而影响睡眠: ()
22. 在上2周中, 您因哮喘而感到悲观或心情压抑: ()
23. 在上2周中, 您因哮喘反复发作而对治疗失去信心: ()
24. 在上2周中, 您当着别人面吸入气雾剂感到难为情: ()
25. 在上2周中, 您总担心身边没有哮喘防治药物: ()
26. 在上2周中, 您担心哮喘发作: ()
27. 在上2周中, 您因接触到香烟而引起哮喘发作: ()
28. 在上2周中, 您因灰尘引起的哮喘发作: ()
29. 在上2周中, 您因接触到煤烟气味或炒菜油烟引起的哮喘发作: ()
30. 在上2周中, 您因接触到异味或香水味引起哮喘发作: ()
31. 在上2周中, 您因气候变化或烟雾引起哮喘发作: ()
32. 在上2周中, 您因哮喘担心目前的健康状况: ()
33. 在上2周中, 您因哮喘担心将来的健康状况: ()
34. 在上2周中, 您担心哮喘缩短自己的寿命: ()
35. 在上2周中, 您担心自己对药物有依赖: ()

Appendix 3

Patients' views on survey questionnaire (English):

1. Do you feel the C-AQLQ is generally easy to understand? (1)Yes (2)No
2. Can you complete most of the C-AQLQ all by yourself? (1)Yes (2)No
3. Are you willing to fill in the C-AQLQ again after 3 months? (1)Yes (2)No
4. Which item is the most difficult for you to understand? ____ (Please write the item number on the line; if there is no item difficult for you, please write 0.)