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An 18-item standardized Asthma Quality of Life Questionnaire-AQLQ(S)

Eirini Grammatopoulou · Emmanouil Skordilis · Dimitra Koutsouki · George Baltopoulos

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Abstract The purpose of the present study was to examine the validity and reliability of the Asthma Quality of Life Questionnaire-AQLQ(S) in a sample of 160 Greek patients with asthma. Following evidence for sample-specific validity, the AQLQ(S) model was examined through exploratory and confirmatory factor analysis. An 18-item AQLQ(S) with the four factors of symptoms, activity limitations, sleep, and exposure in environmental stimuli fits the data (χ^2/df ratio = 2.26, NNFI = 0.92, CFI = 0.94, SRMR = 0.05). The 18-item AQLQ(S) showed a high internal consistency (Cronbach' a coefficient ranged from 0.83 to 0.96) and high 9-week test-retest reliability (overall $r = 0.88$, ICC = 0.94). Responsiveness was confirmed throughout 2X2 ANOVA and 2X2 MANOVA, with respect to the total score ($F = 42.30$, $P < 0.05$), and the four AQLQ(S) factors (Wilks' $\lambda = 0.68$, $F = 17.59$, $P < 0.05$). The cross-sectional correlations between the 18-item AQLQ(S) and the: (1) FEV1% predicted and (2) Borg scale were low and moderately high, respectively. In conclusion, the 18-item AQLQ(S) derived from exploratory and confirmatory factor analysis appeared to have sufficient construct validity, cross-sectional validity, responsiveness, satisfactory test-retest reliability and internal consistency evidence for the Greek sample of adults with asthma.

Keywords Asthma · Cross-cultural adaptation · Factor analysis · Health-related quality of life · Reliability · Validity

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Introduction

Health-related quality of life (HRQoL) has been defined as 'the functional effects of an illness and its consequent treatment on a patient's life as perceived by him' [1]. Quality of life (QoL) is a distinct component of asthma health status [2, 3], and therefore it must be measured by suitable generic and specific questionnaires [4]. The Asthma Quality of Life Questionnaire-AQLQ and the Standardized Asthma Quality of Life Questionnaire-AQLQ(S) [4, 5] are the most popular specific questionnaires. They have been used in a variety of populations from different countries, such as Spain, France, Serbia, etc., to assess the health-related quality of life of asthmatic patients [6–9]. Overall, the validity and reliability of the AQLQ and AQLQ(S) reported with different methods [3–17] in a variety of cultures have presented detailed findings from factor analysis analytical techniques.

The theory of sample-specific validity and reliability [18–21] indicates the importance of presenting statistical validity and reliability evidence for each instrument or protocol used in every study. More specifically, it has been stated that the validity and reliability of data collection instruments and protocols vary by sample [18]. Validity

and reliability refers to the administration of the measure rather than the measure as such [19]. Further, a significant number of published articles have not appropriately addressed and/or provided sample-specific validity evidence to justify their findings [19]. Reliability is a property of the scores on a test for a particular population of examinees [20]. The administration of a measure, without comprehension of the appropriate process of validity evidence, might lead to the misinterpretation of results [21]. Finally, referring to the estimation of measurement validity, it has been suggested that authors should provide validity coefficients for the data being analyzed even when the focus of their research is not psychometric [21]. Specifically, it has been stated that measurement theory, particularly the knowledge base on validity, has changed tremendously over the past 20 years [21]. Many researchers appear unaware of these changes and jeopardize the publication of their studies by discussing validity in old ways and implying that a test has a single validity coefficient that is generalizable to all samples [21].

Further, the role of culture in behavior variation is very important so that it is impossible to use standard instruments across cultures. To accept the concept of health-related quality of life as invariant across cultures, it needs to be supported by empirical evidence of validity [22].

Based on the above, the present study was designed to provide validity and reliability for the AQLQ(S) in a Greek sample of asthmatics. Specifically, it was hypothesized that, for the Greek patients with asthma, the 32 items of the AQLQ(S) would be classified under its four factors: symptoms, activity limitations, emotional function, and exposure to environmental stimuli. Furthermore, (1) high internal consistency [5, 7–10, 13, 15–17], (2) detection of clinical changes over time [5, 7, 9, 15, 16], (3) low and high to moderate correlations with FEV1% predicted and Borg scale, respectively [3, 7, 13–15], and (4) acceptable test-retest reliability coefficients for the patients with stable clinical condition [4–17] were anticipated.

Method

Participants

The sample selection was purposive, and participants were 160 Greek adults with asthma, all clinically diagnosed according to severity, able to comprehend and complete questionnaires and without further chronic, severe disease or disability. The participants were all patients of the asthma department of the Amalia Fleming Hospital in Athens, Greece. All patients were under controlled medications including inhaled glucocorticosteroids, long-acting inhaled β_2-agonists and long-acting oral β_2-agonists according to GINA [23]. The participants attended regular 4-week follow-up visits, for the routine management of their asthma.

Measuring instruments

The following measures were used for the purposes of the study: (1) a questionnaire regarding the demographics of the participants, (2) the AQLQ(S) for the evaluation of health-related quality of life, (3) a spirometry test referring to the forced expiratory volume in 1st *s* (FEV1)% predicted values and (4) the Borg Scale [24].

The AQLQ(S) [5] constitutes an extension of the original AQLQ [4]. The difference between the two measures lies in the fact that the AQLQ(S) does not include the five individualized activities found into the AQLQ. For the AQLQ(S), the aforementioned five individualized activities have been replaced with five general activities (vigorous activity, moderate activity, activities related to occupation, social interaction and sleep). The AQLQ(S) [5] includes 32 items under four factors: activity limitations (11 items), symptoms (12 items), emotional function (5 items) and exposure to environmental stimuli (4 items). Individuals who respond to the questionnaire recall the frequency, intension and severity of the health difficulties they have had due to asthma during the last 2 weeks. The responses to all 32 items are provided in a seven-point scale, varying from 1: minimum score to 7: maximum score. The total score is the average emerging from the responses in all 32 items. The score for each factor separately emerges from the average of its respective items. The higher the score is, the better the quality of life. The AQLQ(S) has strong psychometric properties [5].

Further, the Borg scale [24] was administered to the participants to define their perceived degree of dyspnea. Responses are provided in a 10-point scale, varying from 0: minimum score to 10: maximum score. The higher the Borg scale score is, the worse the degree of dyspnea. Overall, the Borg scale is considered valid and reliable (ICC = 0.78; correlation coefficients with % HRmax, VO2max, and total AQLQ score were 0.86, 0.89 and 0.61, respectively) [7, 25].

Procedure

All patients responded initially to the demographic data sheet and signed the informed consent form. Subsequently, they self-completed the AQLQ(S) and the Borg scale and were assessed in a spirometry test referring to their FEV1% predicted values. The participants indicated no use of bronchodilators, at least 4 h before the completion of questionnaires and the spirometry test [23]. They were re-examined 9 weeks later. The Research Ethics Committee

of the Amalia Fleming Hospital had approved our study protocol.

Statistical analysis

The validity and reliability of the AQLQ(S) in Greek adult patients with asthma were examined through: (1) exploratory factor analysis and Cronbach alpha reliability [26, 27], (2) confirmatory factor analysis [26, 27], (3) responsiveness [5, 7, 9, 15, 16], (4) cross-sectional validity [5, 6, 7, 13, 14] and (5) reliability testing [7, 9, 13, 15, 16]. Exploratory factor analysis was conducted with an oblique rotation and four pre-hypothesized factors with eigen values >1.00 [26]. Subsequently, the factor loadings on pre-hypothesized factors were examined [26]. The basic criterion for the remaining items under their respective factors was high factor loading (>0.50) [28]. Three major criteria were further used to exclude certain items from the AQLQ(S): (1) factor loadings less than 0.50, (2) factor loadings higher than 0.50 with more than one factor and (3) high factor loadings with a non-determined factor [26, 28]. Finally, the internal consistency for the AQLQ(S) factors was tested with Cronbach alpha reliability coefficients. For the exploratory factor analysis we used the responses of the first measurement.

The factor structure of the Greek AQLQ(S), which emerged from the above exploratory factor analysis, was examined through confirmatory factor analysis, using the EQS software [29]. Items were uniquely allowed to load on appropriate factors. The item loadings on the remaining factors were fixed to 0.00. The factors for the model identification were fixed to 1.00. Covariances among factors were freely estimated [29]. Statistical coefficients, absolute and incremental fit indices were used to estimate the sufficiency of the measurement models [30]. The assessment of the absolute fit concerns the ability of the model to reproduce the actual covariance matrix [31]. The absolute fit index in the present study was the chi-square (χ^2) statistic. Chi-square is a useful index for comparisons in nested models [32]. Further, it is important to take into account more indices, such as the ratio of the chi-square (χ^2) of the measurement model to the respective degrees of freedom (df), (χ^2/df ratio), as a more reliable index, compared to the χ^2 itself [32]. The χ^2/df ratios between 2 and 5 indicate a good fit of the data to the model [33]. Further, the non-normed fit index (NNFI), the comparative fit index (CFI), the standardized root mean square residual (SRMR) and the root mean square error of approximation (RMSEA) [34] were used. The NNFI and CFI are rather independent of sample and distribution and range from 0 to 1. Values above 0.90 represent an acceptable fit [35]. The SRMR was used to examine the residuals. Residuals close to and lower than 0.05 indicate an acceptable fit [36]. The cut-off criterion for the SRMR is lower than 0.05 [37]. For the confirmatory factor analysis we used the responses of the second measurement.

The responsiveness was examined in a repeated measures design (9 weeks apart). The total sample ($N = 160$) was divided into three groups: (1) stable ($N = 142$), (2) improved ($N = 15$) and (3) deteriorated ($N = 3$). The validity of our decision to classify participants in the above groups (stability, improvement or deterioration) was based on the following two major criteria: (1) the cut-off difference of 12% in FEV1, commonly used in clinical practice, defining asthma according to GINA [23] and (2) the differences between the first and second measure in FEV1%. Specifically, we anticipated significant differences for the improved and deteriorated group, but no differences for the stable group. Statistical analyses, however, were not performed for the deteriorated group because of the limited sample size ($N = 3$). The above criteria for the classification of the sample supported our decision since the differences were significant for the improved group ($t = -7.59$, $P < 0.05$) between the first (mean = 68.87) and second measures (mean = 93.87). No significant differences were found for the stable group ($t = -0.390$, $P > 0.05$), between the first (mean = 78.88) and second measures (mean = 79.04).

For the cross-sectional construct validity, the correlation of the total score was examined with the: (1) FEV1% predicted and (2) Borg scale, for the first measurement, with the Pearson's r coefficient.

Intraclass correlation coefficients (ICC) of the: (1) total AQLQ(S) and (2) four separate factors, only for the 'stable' group of the participants, were estimated.

The 0.05 level of significance was selected to test the above statistical hypotheses.

Results

The total sample of 160 outpatient asthmatics, aged between 18 and 83 years [mean (SD) 47.82 (17.75) years] was classified according to gender [106 (66.3%) females], atopy [116 (72.5%) with atopy], and severity [86 (53.8%) with mild, 57 (35.6%) with moderate and 17 (10.6%) with severe asthma]. The responses to the AQLQ(S) and the assessments of FEV1% and the Borg scale for the first measurement are presented in Table 1.

Exploratory factor analysis and Cronbach alpha reliability

The four factors pre-hypothized with eigen values >1.00 [26, 27, 34, 35] explained a total of 63.10% of variance

Table 1 The responses to the AQLQ(S) and the assessments of FEV1% and the Borg scale for the first measurement

Variable	Mean	SD	*N*
Responses			
Activity limitations	5.12	1.39	160
Symptoms	4.70	1.46	160
Emotional function	5.30	1.53	160
Environmental stimuli	4.59	1.62	160
Total score	4.93	1.35	160
FEV1%	78.36	18.52	160
Borg scale	2.12	2.41	160

[34, 38]. Based on the exclusion criteria presented in the statistical analysis, 14 items were excluded and yielded an 18-item AQLQ(S). Specifically, the following items were excluded from each factor: (1) items 8, 10, 12, 16 and 20 from 'symptoms,' (2) items 11, 19, 25 and 28 from activity limitations' and (3) all four items (nos. 7, 13, 15, 21 and 27) from 'emotional function.' Only items 17 and 23 with high loadings on two factors were retained after examination of their respective content and internal consistency (under 'exposure to environmental stimuli').

Examination of item loadings indicated that three items (5, 24 and 29) were grouped around a stable fourth factor. These items were conceptually related with QoL during sleep, and their respective factor was called 'sleep' (item no. 5: How limited have you been during the last 2 weeks in sleeping as a result of your asthma? Item no. 24: In general, how much of the time during the last 2 weeks were you woken at night by your asthma? Item no. 29: In general, how much of the time during the last 2 weeks has your asthma interfered with getting a good night's sleep?). The loadings of the 32 items in all four factors are presented in Table 2. The 18-item AQLQ(S) showed a high internal consistency, with Cronbach's alpha of 0.91 for 'symptoms' (5 items), 0.92 for 'activity limitations' (6 items), 0.96 for 'sleep' (3 items) and 0.83 for 'exposure to environmental stimuli' (4 items). Table 3 presents the 32-item AQLQ(S) and the 18-item Greek AQLQ(S). Moreover, the inter-correlations among the four factors and the total score are presented in Table 4.

Confirmatory factor analysis

The examination of the distributional properties of the 18-item AQLQ(S) was conducted with three major criteria: (1) skewness lower than ±2, (2) kurtosis lower than ±5 [33, 36, 38] and (3) the Mardias multivariate non-normality index of kurtosis [39] lower than $p(p+2)$ (p = number of items). Skewness ranged from −0.18 to −1.05, kurtosis ranged from −0.32 to −1.33, and the Mardias index was 24.15 [<18(18 + 2) = 360], all at the appropriate range. For the 18-item AQLQ(S), the ratio of chi square to its respective degrees of freedom (χ^2/df ratio = 291.31/129 = 2.26), the Bentler-Bonett Normed Fit Index = 0.89, the Bentler-Bonett Non-normed Fit Index = 0.92, the Comparative Fit Index = 0.94, the Robust Comparative Fit Index = 0.94, the Bollen (IFI) Fit Index = 0.94 and the Standardized Root Mean Square Residual = 0.05 were in the appropriate range, indicating an acceptable fit to the data [32–38]. The results are presented in Table 5 and Fig. 1.

Reliability analyses

For the 'stable' group ($N = 142$), overall r was 0.884, while test-retest correlation coefficients for the four separate factors ranged from 0.82 to 0.92. Furthermore, ICC was found 0.94 for the total score and ranged from 0.89 to 0.96 for the four separate factors.

Responsiveness

Responsiveness was examined only for the 'stable' and 'improved' group of patients. Therefore, the interaction of clinical status (two levels) and time (two levels) was tested for the total score (2 × 2 ANOVA) and the four factors (2 × 2 MANOVA). Regarding the total score, significant interaction was found between clinical status and time ($F_{AXB} = 42.30$, $P < 0.05$, $\eta^2 = 0.21$) (Fig. 2). Post hoc analysis with repeated t-tests and Bonferonni adjustment (0.05/2 = 0.025), examined the differences between the first and the second measurement for each group separately. No significant differences were found for the 'stable' group ($t = -1.36$, $P > 0.025$, $\eta^2 = 0.01$). On the contrary, significant differences were found for the 'improved' group, confirming therefore our research hypotheses ($t = -3.49$, $P < 0.025$, $\eta^2 = 0.46$).

Regarding the multivariate 2 × 2 analysis, significant interaction was found between clinical status and time, with respect to the four factors (Wilks' $\lambda = 0.68$, $F_{AXB} = 17.59$, $P < 0.05$, $\eta^2 = 0.32$). The post hoc univariate results are presented in Figs. 3, 4, 5, 6. Post hoc analysis examined the differences between the first and the second measurement for each group separately.

No significant differences were found in the 'stable' group with respect to the four factors (Wilks' $\lambda = 0.96$, $P > 0.05$, $\eta^2 = 0.04$). On the contrary, significant differences were found for the 'improved' group, confirming therefore our research hypotheses (Wilks' $\lambda = 0.36$, $P < 0.05$, $\eta^2 = 0.64$). The univariate post hoc analysis determined that there were significant differences in the

Table 2 Results of the exploratory factor analysis (item loadings above 0.30 are presented)

Items	Symptoms (S)	Activity limitations (AL)	Emotional function (EF)	Exposure to environmental stimuli (EES)
1 (AL[b])		0.79		
2 (AL[b])		0.86		
3 (AL[b])		0.60		
4 (AL[b]		0.71		
31 (AL[b])	0.40	0.57		
32 (AL[b])	0.40	0.66		
6 (S[a])	0.59	0.35	0.34	
14 (S[a])	0.68	0.34	0.35	
18 (S[a])	0.53	0.33		
22 (S[a])	0.64	0.36	0.44	
30 (S[a])	0.60	0.40	0.46	
9 (EES)[c]	0.37			0.46
17 (EES)[c]	0.51			0.56
23 (EES)[c]	0.51			0.53
26 (EES)[c]				0.91
5[d] (AL)		0.35	0.78	
24[d] (S)			0.88	
29[d] (S)			0.90	
7[d] (EF)	0.69			0.33
8[e] (S)	0.44	0.61		
10[f] (S)	0.33	0.33	0.31	
11[d] (AL)	0.34			0.46
12[d] (S)			0.40	0.30
13[d] (EF)	0.61			0.39
15[d] (EF)	0.45			
16[d] (S)				0.34
19[d] (AL)	0.44			0.61
20[e] (S)	0.44		0.37	0.40
21[d] (EF)	0.44	0.35		
25[d] (AL)	0.42			0.52
27[d] (EF)	0.55			0.36
28[d] (AL)				0.93

[a] High loadings to the proposed factor 'symptoms' (S)

[b] High loadings to the proposed factor 'activity limitations' (AL)

[c] High loadings to the proposed factor 'exposure to environmental stimuli' (EES)

[d] High loadings to wrong factor

[e] High loadings to two factors

[f] Low loadings to the proposed factor

following factors: 'symptoms' ($F = 7.45$, $P < 0.05$, $\eta^2 = 0.35$), 'activity limitations' ($F = 23.51$, $P < 0.05$, $\eta^2 = 0.63$) and 'sleep' ($F = 8.81$, $P < 0.05$, $\eta^2 = 0.39$). For the 'exposure to environmental stimuli,' the differences were close to the significance level ($F = 4.31$, $P > 0.05$, $\eta^2 = 0.23$). Overall, for the 'improved' group, the total score and the scores for each factor were higher in the second measurement compared to the baseline.

Cross-sectional validity

A low correlation coefficient ($r = 0.31$) between total score and FEV1% predicted, and a moderately high correlation coefficient ($r = -0.74$) between the total AQLQ(S) score and Borg scale were found [40].

Discussion

In the present study, the validity and reliability of the AQLQ(S) measurements were tested in a Greek sample of asthmatic patients. In the exploratory factor analysis the extracted factors: 'symptoms,' 'activity limitations,' 'exposure to environmental stimuli' and 'sleep' interpreted the 63.10% of the variance. A percentage of 60% of the explained variability or a percentage of more than 50% of variance for the first two or three factors [27] is satisfactory

Table 3 Presentation of the 32-item and 18-item AQLQ(S)

32-Item AQLQ(S)	18-Item AQLQ(S)
'Symptoms'	'Symptoms'
Items: nos. 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 29, 30	Items: nos. 6, 14, 18, 22, 30
'Activity limitations'	'Activity limitations'
Items: nos. 1, 2, 3, 4, 5, 11, 19, 25, 28, 31, 32	Items: nos. 1, 2, 3, 4, 31, 32
'Emotional function'	'Sleep'
Items: nos. 7, 13, 15, 21, 27	Items: nos. 5, 24, 29
'Exposure to environmental stimuli'	'Exposure to environmental stimuli'
Items: nos. 9, 17, 23, 26	Items: nos. 9, 17, 23, 26

for the social sciences [38]. In the present study, the first factor contained items from 'symptoms.' The second factor contained items from the 'activity limitations' and the third factor contained items from the 'exposure to environmental stimuli.' A fourth factor, 'sleep,' with three items, replaced the 'emotional function,' with a 12.97% of explaining variance. The number of items for 'sleep' is also acceptable, since it has been reported that a factor can safely be defined by at least three variables [41–43].

Finally, according to our confirmatory factor analysis results, we believe that the 18-item AQLQ(S) model is valid for the sample of Greek asthmatics examined.

In the present study, 'sleep' was perceived as a separate factor of the health status and quality of life of patients with asthma [44, 45]. According to Babiniotis [46], sleep is a temporary state of lethargy characterized by the reduction of consciousness and voluntary motor activity, abolition of alertness, which is immediately reversible, as well as by reduction of the responsiveness to stimuli. Further, 'sleep' resulted from the already existing pool of 32 items of the AQLQ(S). More precisely, 'sleep' resulted from an item of 'symptoms' (item no. 29) and from two items of 'activity limitations' (item nos. 5 and 24). Based on the content of the above items, we attempted to define 'sleep' as: 'limitation of duration and quality as well as an increased frequency of nocturnal symptoms due to asthma.' Overall, it appeared that cultural differences such as the Mediterranean climate, the strong sun, the working hours and the living habits of the Greek patients with asthma have revealed the significance of sleep as a distinct factor of their quality of life. This result reinforces the argument that cultural adaptations should undergo a complete measurement validation process [47, 48]. We would add that cultural adaptation of the AQLQ(S) requires factor analysis as in the present sample, since other relevant factors, such as 'sleep,' may appear.

Responsiveness is evidence of validity and not a separate dimension [49]. During the responsiveness testing in the present study, the 18-item AQLQ(S) detected clinical changes, thus supporting its validity [5, 7, 9, 15, 16].

The cross-sectional validity of the 18-item Greek AQLQ(S) showed: (1) a weak correlation with the FEV1% predicted and (2) a higher correlation with the Borg scale. The weak correlation between lung function and QoL of asthmatics may be explained by the different activity levels of asthma patients [4]. Another explanation may be that the lung function only shows the health status at the time of measurement, while the responses indicate the patient's discomfort during the last 2 weeks. Finally, the fact that quality of life and FEV1% predicted are two distinct components of asthma, health status might be another explanation [44].

The weak correlation of the Greek AQLQ(S) with the FEV1% and the moderate with the Borg scale are mainly in agreement with previous studies [3, 7, 13–15]. Little

Table 4 Inter-correlations among the four factors and the total score

	Variables				
	F^a	F^b	F^c	F^d	Total AQLQ(S)
F^a	1.00	0.57*	0.63*	0.51*	0.83*
F^b		1.00	0.54*	0.38*	0.83*
F^c			1.00	0.41*	0.81*
F^d				1.00	0.70*
Total AQLQ(S)					1.00

[a] Factor 1: symptoms

[b] Factor 2: activity limitations

[c] Factor 3: sleep

[d] Factor 4: exposure to environmental stimuli

* $p < 0.05$

Table 5 Fit indices of the 18-item model

Fit index	Value
χ^2	291.31
Df	129
P	0.05
χ^2/df	2.26
NNFI (Non-normed fit index)	0.92
CFI (Comparative fit index)	0.94
SRMR (Standardized root mean square residual)	0.05

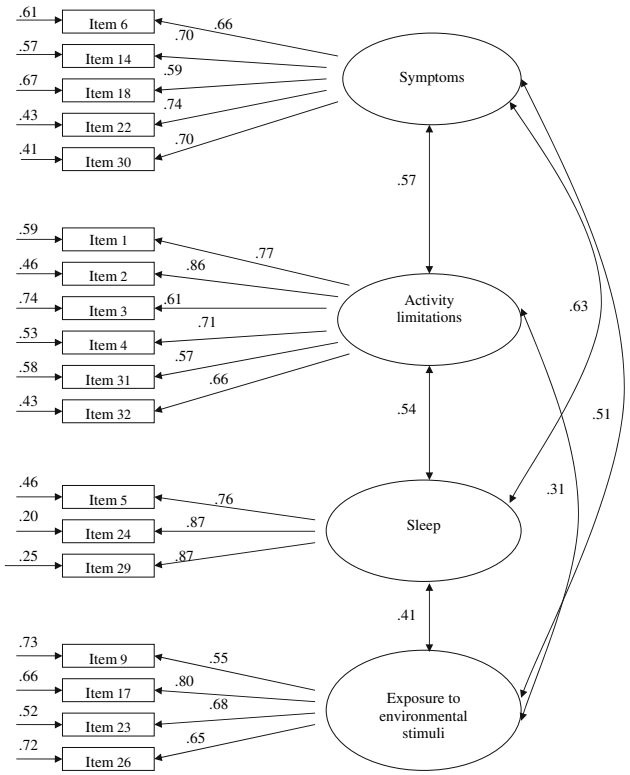

Fig. 1 The 18-item model: error variance, item loadings and intercorrelations

research [8], however, has reported a strong correlation of FEV1% with the total AQLQ(S) score.

Further, the satisfactory reliability indices of the Greek AQLQ(S) agree with previous studies [5, 15, 17].

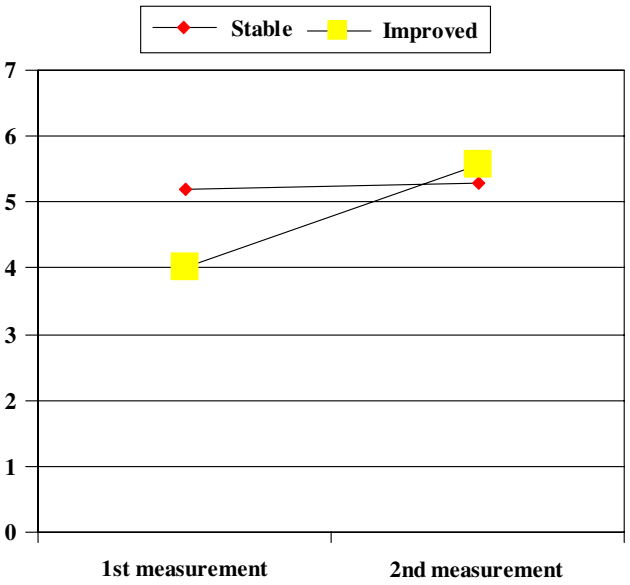

Fig. 2 Interaction between clinical status and time ($F_{AXB} = 42.30$, $P < 0.05$) concerning the total score

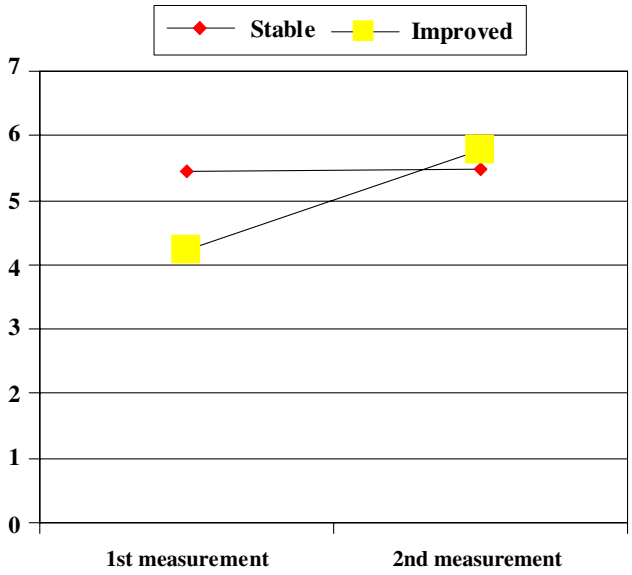

Fig. 3 Interaction between clinical status and time ($F_{AXB} = 70.14$, $P < 0.05$) with respect to 'activity limitations'

The 18-item AQLQ(S) resembles the 15-item Mini AQLQ [43]. The Mini AQLQ [43] is a short form of the AQLQ(S). Both the 18-item AQLQ(S) and the Mini AQLQ are short and share six common items. However, their items grouped under four, but different factors, have resulted through two philosophically different methods: (1) the 18-item AQLQ(S) through the factor analysis/psychometric method, while (2) the Mini AQLQ through the impact/clinimetric method [50].

Furthermore, referring to the differences between the impact method used to develop the AQLQ(S) and the Mini

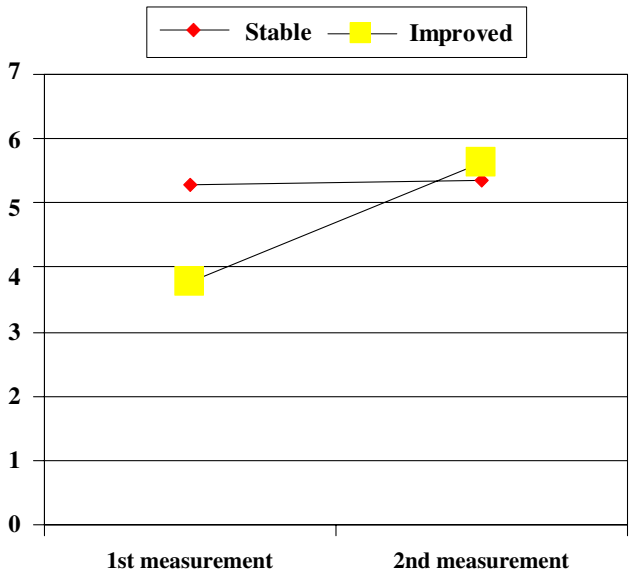

Fig. 4 Interaction between clinical status and time ($F_{AXB} = 18.42$, $P < 0.05$) with respect to 'symptoms'

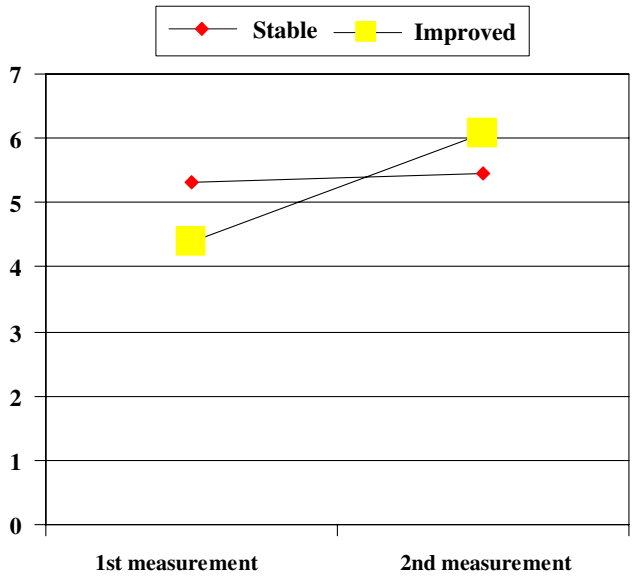

Fig. 5 Interaction between clinical status and time ($F_{AXB} = 23.61$, $P < 0.05$) with respect to 'sleep'

AQLQ, and the factor analysis, used to develop the 18-item AQLQ(S), it has been cited that it is unclear which of the two approaches is more appropriate, while the decision for using either one depends on the philosophy of the researcher [43]. The impact method indicates that all items referring to functional impairment are important to patients and should be included in a specific quality of life questionnaire [43]. For researchers, however, seeking mathematical linkage among questionnaire items, factor analysis should be conducted instead [43]. In the present

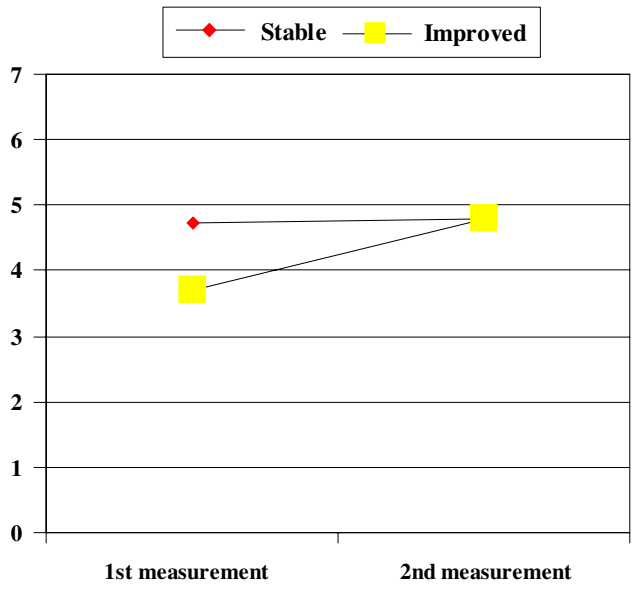

Fig. 6 Interaction between clinical status and time ($F_{AXB} = 17.19$, $P < 0.05$) with respect to 'exposure to environmental stimuli'

study, we relied on factor analysis in an attempt to provide mathematical linkage among separate items and testing their psychometric properties [43].

Health-related quality of life questionnaires are used in longitudinal and cross-sectional studies [51]. The 18-item AQLQ(S) is a research instrument that resulted from exploratory and confirmatory factor analysis. Additionally, it may be used in cross-sectional clinical studies because it: (1) may separate asthma patients according to age, severity and atopy [12] and (2) has cross-sectional validity and satisfactory reliability. Overall, the decision to use a health-related quality-of-life questionnaire depends on: (1) the purposes of the study [2, 50], (2) the researcher's philosophy [2] and (3) the cultural characteristics of the sample [52]. In any case, the researcher should provide the necessary psychometric properties for the instrument used [51].

Certain imitations in the present study were: (1) purposive sample selection, (2) limited sample size, (3) same sample for exploratory and confirmatory factor analysis, (4) the lack of other validated QoL questionnaires in Greek asthmatics and (5) difficulty to generalize our findings to children with asthma or patients with other respiratory diseases (e.g., COPD), etc. The purposive and not random sampling selection was chosen because there was a need for outpatients, commonly found in large urban centers, returning for the follow-up sessions with their physician. Another major limitation of this study was the small size of the sample used for conducting the factor analysis. However, the number of participants used in this study was at the acceptable ratio participants/variables (5/1) referred to in the literature [2]. Finally, our decision to use the first measurement for the exploratory and the second for the confirmatory factor analysis was based on the following criteria: (1) validity and reliability are not static properties of an instrument by itself, but of the measurement (with different psychometric properties) that is produced in a given sample [18–21, 26, 27] and (2) the outcome from a 9-week within-subject measurement is considered a priori as having different psychometric properties.

In conclusion, the 18-item AQLQ(S) derived from the factor analysis appeared to have sufficient validity and reliability evidence for the Greek sample of adults with asthma. Thus, the assessment, description and evaluation of the QoL of the Greek asthmatics may be conducted from now on with confidence. Future researchers may: (1) recommend a greater number of participants, (2) examine the validity for longitudinal data from clinical samples, (3) examine, through factor analysis, the validity and reliability of other HRQOL questionnaires, such as: the Mini AQLQ, ACQ, etc., and (4) adapt the 18-item AQLQ(S) in other respiratory diseases, such as COPD, etc.

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