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# Development and validation of the Asthma Life Impact Scale (ALIS)

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**Summary**
*Background:* Current asthma patient-reported outcome (PRO) measures focus on symptoms and functioning and may not capture the holistic impact of asthma on the quality of life of the patient.
*Objective:* To develop a PRO measure capturing the overall impact of asthma on patient's quality of life.
*Methods:* Items for the Asthma Life Impact Scale (ALIS) were generated from patients with asthma during interviews in the UK and focus groups in the US. The ALIS was tested with UK and US asthma patients during cognitive debriefing interviews and included in large, two-administration, validation studies in the UK and US.
*Results:* Issues raised by asthma patients during interviews ($n = 39$ patients) and focus groups ($n = 16$ patients) were included in the draft ALIS. Cognitive debriefing interviews with 29 UK and US asthma patients showed that the scale was relevant and comprehensive. 140 UK and 185 US asthma patients participated in the validation study. The analysis showed that the ALIS measures a single construct, namely the overall impact of asthma on patients' quality of life. Internal consistency (Cronbach's Alpha) was high (UK = 0.94; US = 0.92) as was test-retest reliability (UK = 0.93; US = 0.83). Patients reporting worse general health or more severe asthma had significantly higher ALIS scores ($p < 0.001$) (indicating greater negative impact of asthma). Correlations with the Asthma Quality of Life Questionnaire were moderate to high.

*Abbreviations:* ALIS, Asthma life impact scale; AQLQ, Asthma quality of life questionnaire; IRT, Item response theory; RUMM, Rasch unidimensional measurement model; QoL, Quality of life; PRO, patient-reported outcome.

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*Conclusions:* The final 22-item ALIS is unidimensional, reliable and valid, and a valuable tool for comprehensively assessing the holistic impact of asthma from the patient's perspective.


## Introduction

Asthma represents a significant public health concern. It is estimated to affect 300 million people globally and to have accounted for approximately 255,000 deaths in 2005.[1] People with asthma may experience more depression or anxiety,[2,3] lower life satisfaction and higher levels of psychological distress[4] than non-asthmatics. Asthma also has significant negative implications for social relationships and interaction,[5,6] sex,[7] employment[8,9] and academic study.[9]

Clinical assessments of asthma such as lung function tests and symptom assessments provide little information about the overall impact of asthma on the patient's life. There is evidence that clinical assessments do not fully capture the experience of living with the condition[10] and there are generally low levels of agreement between clinical assessments and patient-reported outcomes (PROs).[11,12] Consequently, in order to gain a complete picture of the impact of asthma on the patient, it is important to assess patients' heath-status and quality of life (QoL) when evaluating treatment efficacy.

A comprehensive review of currently available, asthma-specific QoL measures revealed that those most commonly used — including the Asthma Quality of Life Questionnaire (AQLQ),[13] Airways Questionnaire (AQ20)[14] and AQLQ-Marks[15] — are predominantly assessments of impairment (symptoms), disability (functioning) and environmental triggers, with emotional and QoL issues generally assessed by a small proportion of the total items. For example, 6 out of the 20 AQ20 questions could be considered to capture the impact of asthma on QoL. Given this, it was decided to develop a new asthma measure, the Asthma Life Impact Scale (ALIS), that would comprehensively capture the holistic impact of asthma on the QoL of the patient, from the patient's perspective. The aim was to produce a unidimensional measure that could be used in combination with existing PRO measures which capture the symptomatic and functional impact of asthma.

## Methods

The development of the ALIS involved three stages: qualitative, patient-led interviews and focus groups to derive the scale content; cognitive debriefing of the draft questionnaire items; and a validation study to reduce the number of items in the draft measure and to establish its psychometric properties. The development of the ALIS was undertaken in parallel in the UK and US. Ethics approval was sought and gained in both countries and patients recruited from clinics provided informed consent.

### Qualitative interviews

The items for the ALIS were derived directly from patients with asthma during in-depth, unstructured individual interviews in the UK and focus group meetings in the US. Patients with a diagnosis of asthma who were 18 or over were included. Exclusion criteria included the presence of COPD and any other major co-morbidity considered likely to influence QoL. These co-morbidities were pre-defined and included conditions such as cardiac failure, persistent anaemia, cancer and major depression. Patients were recruited using press advertisements in the UK and from US clinics. The interviewees and focus group participants were encouraged to talk at length about their experience of asthma and the impact it had on all areas of their life.

Audio recordings were made of the interviews and focus groups and content analysis applied to the transcripts in order to derive the item pool. Each transcript was read by 2 experienced researchers independently with patients' comments being highlighted and extracted if they represented expressions of how asthma affected their lives. The needs-based quality of life model[16–18] was used as the conceptual framework for the ALIS. This model asserts that QoL is dependent on an individual's ability to fulfill fundamental needs and that QoL is high when these needs are met. As far as possible the original words of the interviewees were used to make the items more personal and immediate to future respondents. Items were selected for the draft ALIS if;

- they were applicable to all potential respondents,
- they reflected a single idea,
- they were unambiguous,
- they were short and simple,
- they were relevant to the needs model and
- they referred to issues raised by more than one respondent.

The items were worded such that they would be understood in the same way in the UK and US. The draft measure would comprise of a list of statements which patients consider and state whether it applies to them at the moment using 'True'/'Not true' response options. Dichotomous response options were chosen as they are the easiest to complete and score and have been shown to be acceptable to patients.[19] As the questionnaire asks patients to respond thinking about how they feel at the moment it negates concerns over the accuracy of recall, which are especially pertinent when considering the recall of emotions.[20]

### Cognitive debriefing interviews

The draft ALIS was then tested by means of cognitive debriefing interviews with people with asthma in the UK and US. Interviewees were again aged 18 or over and were recruited using advertisments in the UK and through clinics in the US. The purpose of these one-to-one, semi-structured interviews was to examine the practicality, face and

content validity of the ALIS. Patients were asked to complete the draft ALIS in the presence of an interviewer. They were then asked questions about ease of completion, whether they could understand and answer the questions, whether all important issues had been covered by the questionnaire, whether any items appeared to be redundant and about any problems that had been observed during its completion.

## Validation study

To reduce the number of items in the ALIS and assess its scaling properties, reliability and construct validity, it was necessary to analyse a large set of ALIS data. These data were collected in studies conducted in the UK and US. Patients were recruited through a UK District Hospital and UK patient support groups and through four US clinics. As with the first two stages of the study, patients were included if they were aged 18 years or over and were diagnosed with asthma. Patients were excluded if they were unable to read and respond to questionnaires or if they had co-morbidity deemed likely by the consulting clinician to influence their QoL. Clinicians were given the following examples of co-morbidity that should lead to exclusion; COPD, cardiac failure, persistent anaemia, cancer and major depression. Patients were required to complete the ALIS on two occasions, two weeks apart. UK patients filled-in the measure at home (posting back the completed questionnaire) and US patients at visits to the clinic. Patients also completed demographic questions, a question asking how severe they perceived their asthma to be ('Mild', 'Moderate', 'Severe' or 'Very severe') and a question asking how they perceived their health to be in general ('Very good', 'Good', 'Fair' or 'Poor'). In the US the clinicians were also asked how severe they thought their patient's asthma was ('Mild', 'Moderate' or 'Severe'). The level of severity was based on clinician report and thresholds for lung volume tests were not provided. Patients in the US were also asked if they had experienced an exacerbation (defined for the patient as being a worsening of symptoms requiring an hospitalization or unscheduled visit to a doctor) in the past week. Finally, patients completed the AQLQ[13] on both occasions.

## Scaling and item reduction

The study data were then subjected to Rasch analysis[21] for final item reduction using the Rasch Unidimensional Measurement Model (RUMM).[22] The Rasch model used is a one-parameter logistic item response theory (IRT) model that is widely used in health outcome measurement.[23–25] Rasch analysis is a key tool for the development and improvement of questionnaires[26] and has been shown to have several advantages over traditional analyses such as classical test theory and factor analysis.[27–30]

The Rasch model tests the assumption that the scale has the basic property of unidimensionality and that all items reflect a single underlying construct – in this instance the holistic impact of asthma on QoL. Only when questionnaires have been shown to be unidimensional is it acceptable to add together individual item responses to derive a total score for each patient. The Rasch model gives each item in the Scale and each respondent a location on the same continuum of the construct or trait being captured; the distance between these locations dictates the probability that a person will affirm an item. For scales and items to be working in the intended way (and thus fit the Rasch model) there should be evidence that respondents with severe disease (or high levels of the construct being measured – asthma impact) are highly likely to affirm items representing mild levels of the construct and that respondents with mild disease (low asthma impact) are highly unlikely to affirm items representing high levels of the construct. The Rasch model is explained in detail elsewhere.[31,32]

For a scale to be considered unidimensional local independence of items is also necessary.[33] Items that may be influencing each other (suggesting multidimensionality) are assessed by investigating correlations between item residuals. Those with residual correlations above 0.3 may be considered for removal.

Rasch analysis also provides the opportunity to assess differential item functioning (DIF),[34] that is, the extent to which responses to individual items are affected by factors that are external to the measurement tool (e.g. age and gender). Finally, information about the extent to which the levels of the construct experienced by the respondents are accurately covered by the items is gained by viewing the item maps. The item maps plot respondents and items on the same continuum making it easy to identify gaps in measurement. The maps also indicate the order of the items in terms of their severity.

The fit of the overall ALIS and individual items to the Rasch model was evaluated through $Chi^2$ fit statistics with non-significant results indicating fit to the model. If the data are shown to fit the Rasch model and a solution is achieved, a test for the absence of multidimensionality is conducted.[35] For a scale to be unidimensional the responses to any subset of the items should give the same estimate of person trait level, given appropriate targeting. To try to break the assumption of unidimensionality responses to 2 subsets of items (loading most differently on first factor of the Residual Principal Components Analysis) were assessed (using *t*-tests) to see whether they produced significantly different estimates for each respondent. If fewer than 5% of the *t*-tests are significant then the measure may be considered to be unidimensional. A 95% confidence interval is used to indicate the reliability of the estimate.

The item reduction process was driven by item fit, residuals, location and DIF. However, other aspects were also considered, such as:

- item frequency rate (items with too low or too high a rate of affirmation were considered for removal) and
- item-total correlations (item with correlations $<0.2$ or $>0.8$ were considered for removal).

At the same time it was considered important to ensure that the scale retained the face and content validity established in the cognitive debriefing interviews. Therefore, the content and meaning of the items were taken into account before removal. Items that covered a unique issue not captured by other items in the scale were not removed unless it was unavoidable.

The item reduction process was an iterative one since fit to the Rasch model is influenced by the removal of every item. Therefore items were removed individually and the analyses re-run.

### Reliability, reproducibility and construct validity

After the final version of the ALIS was derived the following traditional psychometric properties of the scale were assessed:

- Internal consistency: Cronbach's alpha coefficients were calculated. A value less than 0.70 indicates that individual items provide an inadequate contribution to the overall scale.[36]
- Test-retest reliability: Spearman's rank correlations of the ALIS scores at the two administrations were calculated. Intra-class correlations were also calculated. A high correlation (above 0.80 for population studies[37]) indicates that the scale produces an acceptably low level of random measurement error.

Convergent and divergent validity were evaluated by assessing the level of association (Spearman rank correlations) between scores on the ALIS and those on the AQLQ. It was hypothesised that higher correlations would be found between the ALIS and AQLQ Emotional and Activity scales than between the ALIS and the AQLQ Environmental stimuli scale.

Discriminative validity was assessed by examining ALIS scores of respondents who differed according to their self-rated asthma severity, self-perceived current general health and (in the US only) clinician rating of asthma severity and whether they had experienced an exacerbation in the previous week. ALIS scores were also compared for groups who differed according to their employment status, self-reported presence of anxiety or depression and treatment type. Non-parametric tests for independent samples (Mann–Whitney *U* Test for two groups and Kruskal–Wallis Test for three or more groups) were employed to test for differences.

Psychometric testing was completed using the SPSS 15.0 statistical package.

## Results

### Qualitative interviews

Qualitative interviews and focus groups were conducted with ($n = 39$ UK and $n = 16$ US) patients with asthma. The UK sample included 14 (36%) males and had an average age of 49 (range 22–82) while the US sample included 8 (50%) males and had an average age of 37 (range 22–60). See Table 1 for full demographic details. Interviews lasted between 1 and 3.5 h and focus groups were 1.5 h in duration.

It was clear that asthma has a considerable detrimental impact on the lives of patients. Table 2 summarises aspects of patients' lives that are affected by asthma. The table also includes comments made by patients and associated draft ALIS items. Figure 1 represents the conceptual framework

**Table 1** Study sample characteristics.

| | Interview/focus group sample | | Cognitive debriefing interview sample | | Validation sample | |
|---|---|---|---|---|---|---|
| | UK | US | UK | US | UK | US |
| Sample size | 39 | 16 | 16 | 13 | 140 | 185 |
| Number (%) male | 14 (36%) | 8 (50%) | 9 (56%) | 3 (23%) | 41 (29%) | 48 (26%) |
| Mean (SD) age (years) | 49 (17.6) | 37 (10.6) | 52 (17.7) | 46 (17.2) | 51 (16.2) | 46 (15.9) |
| Age range (years) | 22–82 | 22–60 | 29–82 | 18–73 | 18–83 | 18–85 |
| Mean (SD) duration of asthma (years) | 21 (14.4) | 19 (12.8) | 24 (14.7) | 21 (18.2) | 21 (16.2) | 18 (15.3) |
| Duration of asthma range (years)[a] | 0–68 | – | 6–60 | 0–46 | 1–71 | 0–66 |
| Patient perceived severity of asthma | | | | | | |
| Mild (%) | 21 (53.8%) | 6 (38.0%) | 9 (56.3%) | – | 50 (35.7%) | 95 (51.4%) |
| Moderate (%) | 10 (25.6%) | 4 (25.0%) | 6 (37.5%) | – | 54 (38.6%) | 64 (34.5%) |
| Severe (%) | 4 (10.3%) | 6 (38.0%) | 1 (6.3%) | – | 26 (18.6%) | 17 (9.2%) |
| Very severe (%) | 3 (7.7%) | 0 | 0 | – | 8 (5.7%) | 3 (1.6%) |
| Perceived general health | | | | | | |
| Very good (%) | 5 (12.8%) | – | 2 (12.5%) | – | 17 (12.1%) | 28 (15.1%) |
| Good (%) | 14 (35.9%) | – | 8 (50.0%) | – | 49 (35%) | 93 (50.3%) |
| Fair (%) | 15 (38.5%) | – | 4 (25.0%) | – | 54 (38.6%) | 50 (27%) |
| Poor (%) | 5 (12.8%) | – | 2 (12.5%) | – | 19 (13.6%) | 8 (4.3%) |
| Asthma exacerbation in last week? | | | | | | |
| Yes (%) | – | – | – | – | – | 11 (5.9%) |
| No (%) | – | – | – | – | – | 166 (89.7%) |

[a] 1 UK interviewee, 2 US cognitive debriefing interviewees and 11 US validation survey participants had an asthma duration of less than 1 year.

**Table 2** Example comments from patients and draft items.

| Example patient quotes | Issue | Associated need | Draft item |
|---|---|---|---|
| ''I don't like going out in case I start coughing and you want to bring phlegm up especially if you're in a group of people having a meal or something — it's not nice'' | Embarrassment/Reduced desire to socialise | Social/relationships | It restricts my social activities |
| ''It affects our sex life yeah, because I get very breathless'' | Sex/Personal relationships | Relationships/Affection | It affects my close relationships |
| ''The only problem is with people walking past me when I was sat down and thinking that I am lazy'' | Reduced capabilities/Reduced self-esteem | Self-actualisation/ self-esteem | I worry that other people will think I'm lazy |
| ''I couldn't physically get up the stairs….I was like an old woman and this really upset me'' | Reduced self-esteem | Self-esteem | I feel older than my years |
| ''There are a lot of times when I think, I can control it, but then it starts controlling me'' | Loss of control | Control | My illness controls me |
| ''I don't know what state my lungs will be in, I don't know how they'll react being in that country or that altitude.'' | Loss of spontaneity/Need to plan | Independence/Control | I find it difficult to make plans |
| ''It is a bit worrying for me, if I have got asthma and it progressively gets worse as I get older'' | Fear and worry | Safety and security | I worry about my asthma getting worse |
| ''It feels — uhm — well you are losing your independence aren't you? It makes you less dependent on yourself'' | Independence | Independence | I feel I'm a burden to others |
| ''Because my asthma is on my mind all the time I can't push myself to my limit'' | Reduced capabilities | Self-actualisation | It stops me reaching my full potential |
| ''I have to plan activities around my treatments'' | Loss of spontaneity/dependence on treatment | Independence/Control | I have to plan activities around my treatment |
| ''So you get very wary of trying new things, it stops me being adventurous'' | Loss of spontaneity/Reduced capabilities | Self-actualisation | Asthma stops me being adventurous |
| ''It is all consuming, you can't think of anything else.'' | Preoccupation with asthma | Control | My asthma is always on my mind |

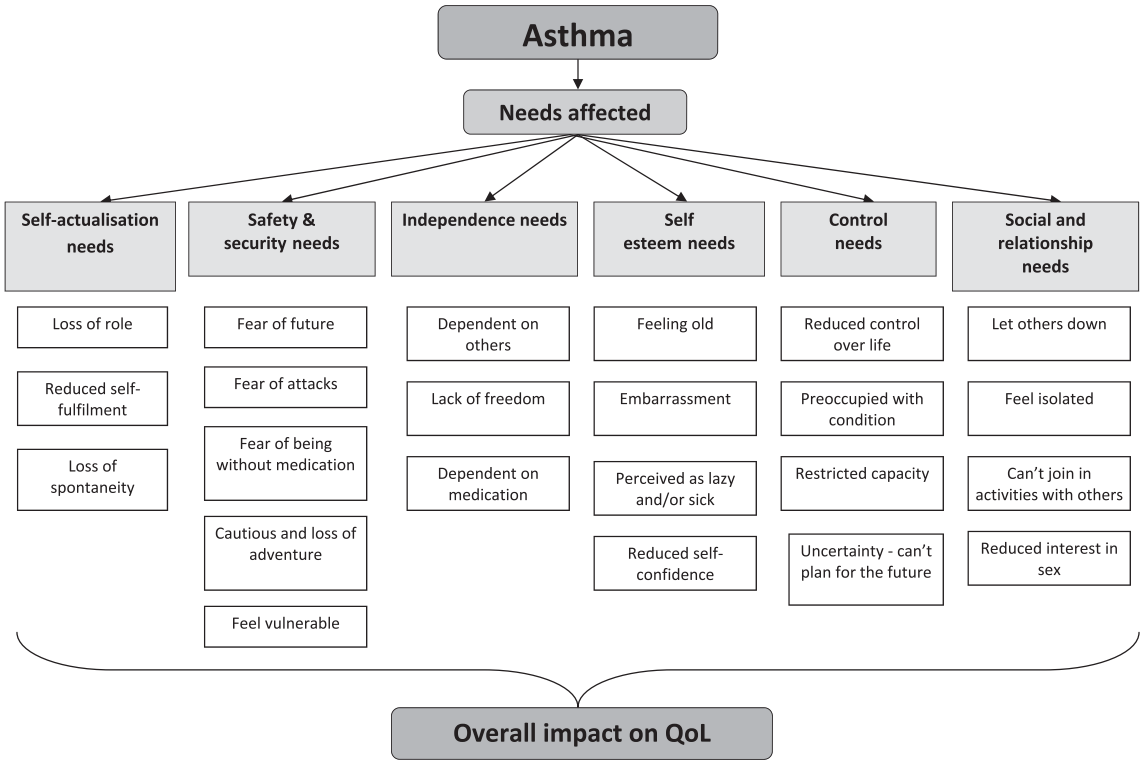


**Figure 1** ALIS conceptual framework.

for the ALIS and the issues raised by patients within the framework of the needs-based model.

Content analysis of the interview data identified over 2000 potential items for the measure. The item pool was reduced by removing duplicated and other unsuitable items. This left a draft version of the ALIS containing 38 items (Table 3).

## Cognitive debriefing interviews

Patients with asthma in the UK ($n = 16$) and US ($n = 13$) participated in cognitive debriefing interviews. The UK sample included 9 (56%) males and had an average age of 52 (range 29—82) while the US sample included 3 (23%) males and had an average age of 46 (range 18—73). See Table 1 for full demographic details.

All respondents were clear about the purpose of the interview and all participants completed all of the items. Similarly, none of the respondents had any difficulty with the instructions.

Overall, patients in both countries found the questionnaire clear and easy to complete. One respondent apologised for frequently answering 'not true' because his asthma was so mild that, to him, most of the items were 'irrelevant'. In fact, he answered 'true' to 9 of the 38 items. Two respondents said that the item *I can't think of anything but my asthma* was irrelevant to them. It is likely that this item was not 'irrelevant' for these individuals but merely 'not true', as their Asthma was mild. Two respondents did not feel that the scale was relevant. One stated that he did not want asthma to control his life, indicating that this was not a redundant issue. The other commented

**Table 3** Results of Item reduction process.

| Stage | Number of items | Reasons for item removal/addition |
|---|---|---|
| Qualitative interviews | 2070 | Assessed other outcome constructs,<br>Duplicated other items,<br>Idiosyncratic,<br>Poorly worded,<br>Unsuitable for miscellaneous reasons |
| Cognitive debriefing interviews | 38 | Addition of item on interest in sex<br>2 items too severe<br>1 item ambiguous |
| Validation survey | 36 | 2 items too severe<br>1 item high item—total correlation<br>3 items misfit in UK and US<br>3 items misfit in UK only<br>1 item misfit in UK and US<br>1 item misfit in UK only<br>1 item misfit in US only<br>2 items misfit revealed after removal of above<br>12 items |
| Final ALIS | 22 | |

that the measure was too extreme — again suggesting that his asthma did not have a major impact on his QoL.

Only a few changes to the questionnaires were required (Table 3). For example, an item relating to sex (My asthma affects my interest in sex) was added as this omission was mentioned by one interviewee. Checking back to the original qualitative interview transcripts found that this issue had been raised indirectly by four interviewees. Three items were removed as they were too severe (affirmed by none of the respondents) or were misinterpreted. The wording of five items was changed from 'It' to 'My asthma' (for example in the item, *My asthma limits the places I can go*) as US respondents found it difficult to respond to items that did not specify the disease — even though this is clearly explained in the instructions.

## Validation study

The new draft ALIS was then completed by patients with asthma ($n = 140$ UK patients via post and $n = 185$ US patients during clinic visits) on two occasions, approximately two weeks apart (demographic details are included in Table 1).

### Scaling and item reduction

Data from the UK and US were separately applied to the Rasch model. Two items were removed due to a low item frequency rate and one due to a high item-total correlation. A further 11 items were removed from the scale due to misfit or DIF (see Table 3). The same items were retained in the US and UK so that — apart from minor wording differences — the US and UK scales would be the same. The final 22-item ALIS fit the Rasch model in the UK and the US ($Chi^2$ $p > 0.01$ in both countries; see Table 4). Only one item ('*I have to pace myself*' in the UK) misfit the Rasch model. However, this item was retained because it did not misfit at the second time point. One pair of items showed local dependence in both countries. However, participants in the cognitive debriefing interviews suggested that the two items described different issues and wanted both to be included in the scale.

Only one patient in the combined samples had a high fit residual.

When UK and US data were combined there was minimal DIF according to country. Tests confirmed that both the UK and US ALIS were unidimensional. The unidimensional *t*-test results shown in Table 4 indicate that the assumption of unidimensionality cannot be broken. Investigation of residual correlations showed that 2 item pairs in the UK and 1 item pair in the US had residual correlations above 0.3. These item pairs were further investigated and it was found that while these item pairs measure related concepts they are conceptually different and have different locations on the logit scale.

The item maps indicated that the ALIS has a good spread of items on the underlying trait. The items assessing the greatest level of construct (the most severe items) in both the UK and US were '*I feel isolated because of my asthma*' and '*My asthma affects my close relationships*' and the three mildest items in both countries were '*I feel dependent on my treatment*', '*I have to pace myself*' and '*My asthma makes me cautious of where I go*'. The item ordering, location and overall range of coverage were similar in each country (see Table 5).

Scores on the final version of the ALIS can range from 0 to 22 with a high score indicating that asthma has a major negative impact on the QoL of the respondent.

### Internal consistency and reliability

The Cronbach's Alpha and test-retest coefficients were acceptable for both the UK and US Scales (Table 6).

### Convergent validity

The ALIS correlations were highest in the UK and US with the AQLQ Activities scale, reflecting that activity limitation plays an important role in the overall impact of asthma on patients' daily life. ALIS scores had the lowest correlations with the AQLQ Environment scale in both countries.

There were no significant correlations between ALIS scores and age or duration of asthma in the UK or with age in the US (data not shown). There was a small but statistically significant correlation between ALIS scores and duration of illness in the US ($r = 0.22$; $p = 0.004$).

### Discriminative validity

Table 7 includes ALIS scores by known group factors and Figure 2 illustrates ALIS scores by severity and general health ratings. The ALIS was able to distinguish between respondents according to (patient- and clinician-rated) asthma severity, perceived general health and whether or not they had experienced an exacerbation over the previous week. In all cases patients reporting more severe asthma or worse health had significantly ($p < 0.01$) higher ALIS scores than those reporting milder asthma or better health. Significantly higher scores were also found for those not working due to their asthma and those with self-reported mental health problems.

## Discussion

This study was designed to develop a patient-reported outcome measure — the ALIS — that comprehensively

**Table 4** ALIS: Overall Rasch fit statistics.

| | n | Item—Trait Interaction $Chi^2$ | PSI | Item—Person interaction | | | | Unidimensional *t*-test results (CI) |
|---|---|---|---|---|---|---|---|---|
| | | | | Items | | Persons | | |
| | | | | Mean | SD | Mean | SD | |
| UK | 132 | 0.05 | 0.92 | −0.60 | 0.93 | −0.32 | 0.82 | 0.03 (−0.01—0.07) |
| US | 170 | 0.02 | 0.90 | −0.41 | 1.12 | −0.25 | 0.82 | 0.04 (0.01—0.08) |

**Table 5** Rasch item fit statistics.

| Item | Location | Fit residual | $Chi^2$ | *p* |
|---|---|---|---|---|
| UK | | | | |
| Dependent on treatment | −2.61 | −0.07 | 4.5 | 0.11 |
| Need to pace activities | −2.25 | 0.85 | 11.5 | 0.00 |
| Cautious where go | −1.49 | 0.36 | 3.1 | 0.22 |
| Prevents visiting | −1.44 | −0.98 | 1.5 | 0.47 |
| Need for energy | −1.44 | −1.00 | 1.5 | 0.48 |
| Limits potential | −0.9 | −1.29 | 2.8 | 0.25 |
| Preoccupation with medication | −0.35 | 1.39 | 4.3 | 0.12 |
| Limit activities | −0.33 | −1.73 | 3.3 | 0.19 |
| Inability to be adventurous | −0.14 | −1.57 | 2.6 | 0.27 |
| Limit social activities | −0.08 | −2.44 | 3.3 | 0.19 |
| Feel old | 0.10 | 0.75 | 0.2 | 0.92 |
| Interest in sex | 0.37 | −0.60 | 1.9 | 0.39 |
| Let others down | 0.64 | −0.84 | 0.3 | 0.85 |
| Preoccupation with asthma | 0.67 | 0.55 | 3.8 | 0.15 |
| Self-confidence | 0.68 | −0.59 | 2.0 | 0.38 |
| Lowered mood | 0.80 | −1.30 | 3.4 | 0.18 |
| Social limitations | 0.90 | −0.93 | 0.2 | 0.93 |
| Controlled by illness | 1.05 | −0.64 | 1.4 | 0.51 |
| Planning activities | 1.14 | −0.83 | 1.2 | 0.56 |
| Appear lazy | 1.15 | −0.13 | 0.0 | 0.98 |
| Affects relationships | 1.19 | −0.86 | 1.1 | 0.57 |
| Feel isolated | 2.33 | −1.29 | 7.0 | 0.03 |
| US | | | | |
| Need to pace activities | −2.53 | −0.06 | 1.5 | 0.46 |
| Dependent on treatment | −2.09 | 1.56 | 3.2 | 0.20 |
| Cautious where go | −1.70 | −0.19 | 0.6 | 0.76 |
| Need for energy | −1.54 | −1.03 | 1.4 | 0.51 |
| Limits potential | −1.02 | −1.96 | 7.7 | 0.02 |
| Prevents visiting | −0.94 | 0.06 | 0.1 | 0.97 |
| Inability to be adventurous | −0.76 | −2.11 | 4.6 | 0.10 |
| Preoccupation with medication | −0.32 | 0.34 | 3.5 | 0.17 |
| Feel old | −0.25 | 1.48 | 5.1 | 0.08 |
| Limit activities | −0.18 | −1.85 | 5.8 | 0.05 |
| Limit social activities | −0.12 | −1.94 | 2.7 | 0.26 |
| Appear lazy | 0.00 | 0.45 | 0.7 | 0.72 |
| Social limitations | 0.49 | −0.05 | 2.9 | 0.23 |
| Preoccupation with asthma | 0.75 | 1.39 | 4.3 | 0.12 |
| Let others down | 0.86 | −0.46 | 3.1 | 0.21 |
| Lowered mood | 0.88 | −1.05 | 1.7 | 0.43 |
| Planning activities | 0.99 | 0.68 | 5.8 | 0.06 |
| Self-confidence | 1.24 | −1.19 | 4.5 | 0.10 |
| Interest in sex | 1.27 | 0.07 | 2.5 | 0.28 |
| Controlled by illness | 1.39 | −0.86 | 1.3 | 0.53 |
| Affects relationships | 1.48 | −1.23 | 1.6 | 0.44 |
| Feel isolated | 2.09 | −1.02 | 2.1 | 0.35 |

**Table 6** Reliability of the ALIS and correlations with the AQLQ.

| | UK ALIS | *n* | US ALIS | *n* |
|---|---|---|---|---|
| Reliability coefficients | | | | |
| Alpha | 0.94 | 128 | 0.92 | 182 |
| Test-retest | 0.93 | 63 | 0.83 | 53 |
| ICC | 0.92 | 63 | 0.82 | 53 |
| Correlations with AQLQ | | | | |
| Symptoms | 0.75** | 119 | 0.70** | 179 |
| Activities | 0.84** | 100 | 0.80** | 178 |
| Environment | 0.53** | 121 | 0.60** | 182 |
| Emotion | 0.72** | 122 | 0.71** | 181 |
| Total | 0.79** | 95 | 0.78** | 174 |

**Correlation $p < 0.01$ (2-tailed).

captures the holistic impact of asthma and its treatment on the quality of life of patients. It is intended that the ALIS will be used alongside more traditional measures of symptoms and functional capacity to allow patients to describe the full impact of their condition.

There has been much debate about the nature of QoL assessments, and no consensus has been reached on how QoL should be defined or assessed.[38] Some researchers consider QoL to be multidimensional, comprising at least three factors (usually social, emotional and physical). However, it is unclear how some issues raised by patients with asthma in this study — relating to limited self-actualisation, loss of independence and autonomy and loss of spontaneity, for example — would fit into such a framework. In addition, many issues raised by patients do not fit neatly into just one of these categories. For example, if

**Table 7** Discriminative validity — mean ALIS scores by sub-group.

| | UK | | US | |
|---|---|---|---|---|
| | *n* | Mean (SD) | *n* | Mean (SD) |
| Gender | | | | |
| Male | 36 | 7.1 (6.7) | 47 | 6.2 (5.5) |
| Female | 91 | 9.3 (6.9) | 131 | 6.7 (5.8) |
| P | | 0.09 | | 0.67 |
| Employment | | | | |
| Working | 59 | 6.5 (6.0) | 126 | 5.8 (4.7) |
| Not working due to asthma | 16 | 16.6 (5.8) | 16 | 16.2 (6.0) |
| P | | <0.001 | | <0.001 |
| Exacerbation in last week? | | | | |
| No | — | — | 166 | 6.0 (5.18) |
| Yes | — | — | 11 | 14.5 (5.84) |
| P | | | | <0.001 |
| Self-reported mental health problems | | | | |
| No anxiety or depression | — | — | 125 | 5.5 (4.9) |
| Anxiety | — | — | 20 | 8.2 (6.4) |
| Depression | — | — | 14 | 8.6 (6.1) |
| Anxiety and depression | — | — | 18 | 10.2 (7.4) |
| p | | — | | 0.011 |

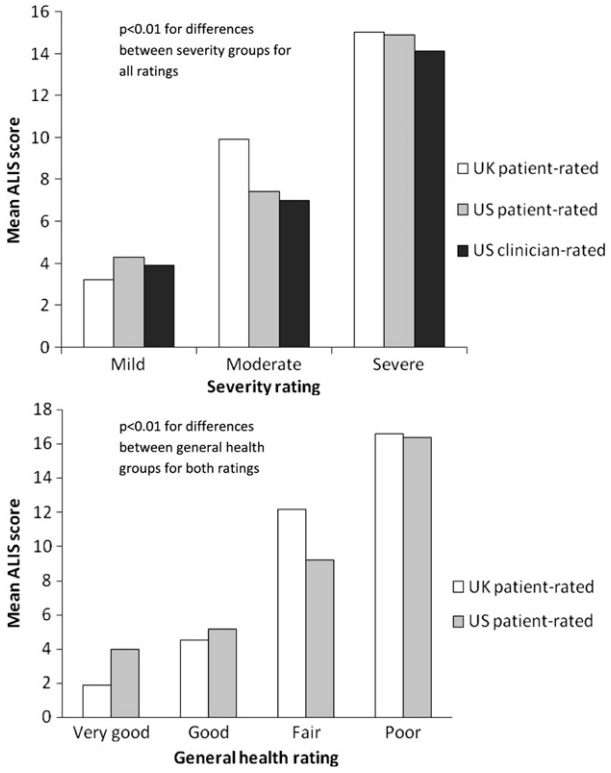


**Figure 2** ALIS scores by asthma severity and general health ratings.

a patient is unable to participate in activities with their friends due to their asthma they have impaired physical functioning but this also has social and emotional implications for them. The use of the needs-based QoL conceptual framework overcomes the need to have a separate subscale for each factor under consideration and gives an overall picture of the impact of the disease. The use of item response theory techniques (in this study, Rasch analysis) allows the development of a scale that can be shown empirically to capture a single trait or construct.

As the items in the Scale were derived directly from qualitative research in patients with asthma and capture issues of importance to them, the ALIS has high face and content validity. Patients contributing to the items in the ALIS spanned the asthma severity range thus ensuring that the measure will be acceptable to future respondents regardless of how much their lives are impacted by asthma. It is short, quick and easy to complete and score, hence it lends itself to inclusion in clinical studies.

The ALIS has excellent psychometric properties as it was shown to be reliable and valid in both the UK and US. The fact that the ALIS was validated using clinic-based administration in the US and administration via postal survey in the UK — and had satisfactory psychometric properties in both — indicates that it is suitable to administer the questionnaire using either mode.

The ALIS exhibited moderate to large correlations with the AQLQ. Despite the magnitude of these coefficients the results indicate that the AQLQ (total score) explains only 62% and 61% of the UK and US ALIS scores, respectively — highlighting that they are measuring distinct aspects of the asthma experience. The ALIS exhibited the lowest correlations with the environmental stimuli scale of the AQLQ in the UK and US, suggesting that triggers are not the most accurate indicator of the impact of asthma.

The ALIS was able to discriminate between patients according to their severity and general health groups providing further evidence of its validity. Differences were also apparent in ALIS scores according to self-reported mental health problems. Previous research has highlighted the influence of anxiety and depression on QoL and health status questionnaire scores in asthma.[39,40] Further research is necessary to establish how and to what extent depression and anxiety affect scores on the ALIS. It is also desirable that the correlation between ALIS scores and a patient-reported measure of asthma control is established. Given the burden placed on patients in the current study it was not possible to include a measure of control in addition to the questionnaires used.

One limitation of the study is that little clinical validation of the ALIS data was undertaken. However, the analyses showed that the ALIS was able to distinguish between patients who had and had not experienced a clinical worsening (necessitating hospitalisation or an unscheduled visit to a doctor) in the previous week and differentiated between patients according to the clinician's rating of severity. In addition, significant differences in ALIS scores were observed based on types of treatment received. Respondents using treatments associated with severe asthma (anticholinergics and corticosteroids) had significantly higher scores on the ALIS than those not using these treatments. These results help to interpret the meaning of ALIS scores and to understand the impact of asthma on quality of life. For example, patients who had experienced an exacerbation or needed to use anticholinergics and corticosteroids had ALIS scores over twice the magnitude of those who did not have an exacerbation or did not use either treatment.

Another limitation is that a proportion of the patients in the UK validation study were recruited through advertising. In these cases it was not possible to confirm that they had asthma or that they did not have concomitant COPD. Furthermore, clinics were not given consistent criteria to diagnose COPD when deciding whether or not to exclude participants.

It is important to note that the samples studied are unlikely to be representative of the asthma population as a whole. No attempt was made to stratify disease severity, age or gender as this was not necessary in order to validate the ALIS. That said, the study samples included a reasonable spread in terms of patient ages and asthma severity.

Since the time between questionnaire administrations in the study was only 2 weeks there was very little change observed in scores over time. This precluded the assessment of the responsiveness of the ALIS to changes in the status of the patient and represents another study limitation. However, studies are planned that will enable the determination of the responsiveness of the ALIS, the thresholds of changes in score that are considered clinically important and the association between ALIS scores and clinical variables.

The ALIS represents a new instrument measuring the overall impact that asthma has on patients; this is a valuable tool that will complement symptom and functioning patient-reported outcomes.

## Summary

- Quality of life is an important outcome in asthma that is distinct from symptoms and functional capacity — the focus of many current patient-reported outcome questionnaires.
- Asthma has a significant and broad impact on the quality of life of those affected.
- A key to understanding this impact is the accurate assessment of quality of life.
- The research describes the development of a new questionnaire — the Asthma Life Impact Scale — that will allow this assessment from the patient's perspective.

## Conflict of interest statement

David Meads, Stephen McKenna, Lynda Doward, Robin Pokrzywinski and Dennis Revicki work for research consultancies who have received funding from Novartis. Alastair Glendenning is employed by Novartis. Cameron Hunter has no conflicts of interest.

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