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Clinical Impact Versus Factor Analysis for Quality of Life Questionnaire Construction

Elizabeth F. Juniper,[1,*] *Gordon H. Guyatt,*[1,2] *David L. Streiner,*[1,3] *and Derek R. King*[1]

[1]Department of Clinical Epidemiology and Biostatistics; [2]Department of Medicine, and [3]Department of Psychiatry, McMaster University Faculty of Health Sciences, Hamilton, Ontario, Canada L8N 3Z5

ABSTRACT. *Objective*: We have compared two philosophically different methods for selecting items for a disease-specific quality of life questionnaire. The impact method selects items that are most frequently perceived as important by patients whereas the psychometric method (factor analysis) selects items primarily according to their relationships with one another. *Patients*: 150 adults with symptomatic asthma and a wide range of disease severity were enrolled from asthma clinics and notices in the local media. *Study Design*: From a list of 152 items that are potentially troublesome to patients with asthma, the patients identified those items they had experienced in the previous year and scored the importance of each on a five-point scale. For the impact method, items that were identified most frequently and that scored the highest were included in the final instrument. For the psychometric method, factor analysis was performed after highly skewed items had been removed. Items with high factor loading were included in the final instrument. *Results*: The impact method resulted in a 32-item instrument and psychometric analysis in one with 36 items. Twenty items were common to both instruments. The psychometric approach discarded the highest impact emotional function and environmental items and included in their place lower impact items mainly associated with fatigue. *Conclusions*: Although some items were the same for both methods, there were also some important differences. Different approaches to item reduction led to appreciably different instruments. J CLIN EPIDEMIOL 50;3:233–238, 1997. © 1997 Elsevier Science Inc.

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INTRODUCTION

An increasing recognition of the importance of incorporating health-related quality of life (HRQL) evaluations into clinical studies has led to a growth in disease-specific instruments. These instruments are usually differentiated from functional status questionnaires in that they include the items of physical, emotional and social function that patients themselves perceive as most troublesome [1].

When developing a new disease-specific instrument, the investigator first generates a pool of items that includes all the impairments that might be troublesome to patients with the defined condition [2]. This pool is usually assembled from discussion with patients, focus groups, a review of the literature, other HRQL instruments, and discussion with health professionals. The investigator must now select items from this pool for the final questionnaire. At present, there are two schools of thought as to how this should be accomplished.

The approach we use, which we shall call the impact method, is consistent with what Feinstein has called "clinical sensibility" [3]. Patients are asked to identify the impairments that are most important to them in their everyday lives. Items identified most frequently and rated the most important are selected for the final questionnaire.

The older and more conventional method of selecting items is to use psychometric techniques (factor analysis). Until now, there have been no studies that have compared these two approaches. In this study, we have reviewed the data that was used to select items for our Asthma Quality of Life Questionnaire [4] and reanalyzed them using factor analysis. We have compared the items selected by the two methods to determine the effect of the method of item reduction on the final questionnaire.

METHODS

Patients

We have described previously the details of patient recruitment and entry criteria for the item reduction phase of the Asthma Quality of Life Questionnaire development [4]. In brief, we recruited 150 adults (18–70 years) with symptomatic asthma. We excluded patients if they had evidence of

*Address for correspondence: Elizabeth Juniper, MCSP, MSc., Department of Clinical Epidemiology and Biostatistics, McMaster University Medical Centre, 1200 Main Street West, Hamilton, Ontario, Canada, L8N 3Z5.

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fixed airflow limitation (FEV1 post bronchodilator < 70% predicted), had illness other than asthma that impacted on quality of life, or spoke inadequate English. All participants signed a consent that had been approved by the McMaster University Medical Centre Research Committee.

Item Generation

Initially, we generated a comprehensive pool of impairments that might be important to patients with asthma by interviewing six patients, reviewing the current HRQL literature, consulting with local asthma health professionals, and drawing on our own experience in developing other disease-specific quality of life questionnaires. One hundred and fifty two items were generated.

Item Reduction—Impact Method

Each of the 150 patients was asked to identify which of the 152 items in the item pool they had experienced during the last year. For each item that was positively identified, the patient was asked to rate the importance of that item on a five-point scale (1 = not important to 5 = extremely important). Results were expressed as 'frequency' (the proportion of patients experiencing a particular item), 'importance' (the mean importance score attached to each item), and 'impact,' which is the product of 'frequency' and 'importance'.

The items were ranked according to their impact score and, in general, we selected the highest scoring items for the questionnaire. Two clinicians then grouped the items into domains based on intuition, informed by clinical and methodological experience.

Item Reduction—Factor Analysis

For the factor analysis approach, wherever possible we followed the steps, criteria, and procedures described by both Hyland [5] and Marks [6] to develop their asthma-specific health-related quality of life instruments (Table 1). However, with a different number of items in the original item pool, a different number of patients, and in order to reduce the number of items to that which would be consistent with the minimum ratio of patients to items we considered acceptable for factor analysis (5 to 1), some of the empirical cut-points we selected for discarding items needed to be slightly different.

Initially, we examined the skewness of the data and discarded items identified by fewer than 40% of patients (frequency < 40%). We then removed items that showed item-total correlations less than 0.40. If items appeared to be measuring the same impairment (e.g., fatigue and tiredness) and were highly correlated ($r > 0.7$) with one another, we eliminated the item with the lowest item-total correlation.

TABLE 1. Item reduction—factor analysis

Item reduction steps—criteria for item deletion	
Hyland (5)	**Marks (6)**
1. Poor discriminators removed (items in which 70% or more patients endorsed one response—responses were dichotomous. (*We only discarded infrequently endorsed items. Discarding frequently endorsed items would have led to nearly all the high impact items being removed.*)[a]	1. Highly skewed distributions (items with very low scores)[a]
2. Loading on 1st factor <0.3[a]	2. Frequency and severity of symptoms: selected descriptor with highest item-total correlation
3. Question problematic	3. Items with high item-item correlations: selected item with highest item-total correlation[a]
4. Domain of "doctor items" deleted	4. Items with low loading on any component[a]
5. Low item variability	5. Items with low item-total correlations[a]
6. Informal patient comment	

[a]Criteria used in the present study.

After a principal component analysis, we removed items loading by less than 0.4 on the first factor [5].

Domains were elicited using varimax rotations for 3, 4, 5, and 6 factors. Three clinicians reviewed these groupings and, on the basis of intuition informed by clinical and methodological experience, selected the one that made the most sense. No items were removed after rotation.

RESULTS

Impact Method

In general, we selected items with the highest impact scores for the Asthma Quality of Life Questionnaire (Table 2). When we reviewed the highest scoring items, we felt that they fell into four distinct domains: symptoms; emotional function; physical activity limitations; and problems associated with exposure to environmental stimuli. Initially, we selected the top 35 scoring items. However, when we did this, the emotional function domain contained only three items and therefore, since this was one of the domains specified in the initial criteria [4], the next two highest scoring emotional problems were added. We found that items concerning the weather and air pollution were closely correlated with each other and so we combined them into one item. Similarly, we combined items concerning strong smells and perfumes. The range of physical activities undertaken by adult asthma patients is very wide. The final version of the Asthma Quality of Life Questionnaire utilizes five "individualized" items in the activity domain [4] (i.e., individual patients choose the activities that are important to them). In addition, one item asks whether the range of

TABLE 2. Highest scoring of the original 152 items

	Frequency	Importance	Impact
Symptoms			
Shortness of breath	0.92	3.60	3.31
Chest tightness	0.96	3.35	3.22
Wheeze	0.87	3.15	2.73
Chest heaviness	0.81	3.22	2.60
Cough	0.86	2.83	2.43
Difficulty breathing out	0.72	3.37	2.43
Fighting for air	0.56	4.04	2.26
Heavy breathing	0.70	3.22	2.25
Difficulty getting a good night's sleep	0.60	3.48	2.09
Woken during the night by symptoms	0.61	3.43	2.08
Waking in the morning with symptoms	0.71	2.89	2.06
Need to clear throat	0.73	2.76	2.01
Emotions			
Afraid of not having medications when needed	0.50	3.75	1.88
Concerned about having to use medications	0.53	3.24	1.71
Concerned about having asthma	0.56	2.92	1.65
Frustrated	0.55	2.90	1.60
Afraid of getting out of breath	0.37	3.50	1.31
Environment			
Problems on Exposure to			
Cigarette smoke	0.82	3.81	3.12
Dust	0.81	3.46	2.79
Air pollution	0.76	3.51	2.67
Hot humid weather	0.68	3.54	2.41
Pollen	0.61	3.84	2.35
Cold weather	0.70	3.30	2.31
Strong smells	0.57	3.21	1.82
Perfumes	0.50	3.07	1.54
Activity Limitation			
Jogging/exercising	0.77	3.09	2.39
Running	0.76	2.78	2.13
Running uphill/upstairs	0.70	3.00	2.10
Keeping surroundings dust-free	0.51	3.96	2.03
Playing sports	0.59	3.27	1.91
Walking uphill/upstairs	0.55	3.13	1.73
Having to avoid			
Cigarette smoke	0.81	3.66	2.98
Dust	0.75	3.20	2.39
Air pollution	0.54	3.57	1.93
Hot humid weather	0.54	3.56	1.92
Cold weather	0.43	3.58	1.55
Strong smells	0.48	3.14	1.51
Perfumes	0.42	3.13	1.31

activities usually done by the patient has been limited and a second asks about activity limitations in general. The final questionnaire contains 32 items (symptoms: 12; emotional function: 5; activity limitation: 11; environmental exposure: 4).

Factor Analysis Method

Of the initial 152 items, 96 were identified by fewer than 40% of the patients and these were discarded (i.e., frequency $< 40\%$). At the second step, (item-total correlation < 0.4), seven items were removed, three of which are in the Asthma Quality of Life Questionnaire. The third step (item-item correlation > 0.7) removed a further 11 items, 3 of which are in the Asthma Quality of Life Questionnaire.

We included the remaining 38 items in the principal component analysis. The eigenvalues for the first five factors were 11.64, 2.33, 1.87, 1.58, and 1.55. Thirty-seven of the items loaded most strongly onto the first factor; only one (shoveling snow) loaded more strongly on to the second factor. Two items, neither of which is in the Asthma Quality of Life Questionnaire, loaded less than 0.4 onto the first factor and were discarded.

The final 36 items went into the varimax rotation which suggested an optimal 5 factor solution (Table 3). The first factor includes, with the exception of the item related to

TABLE 3. Varimax rotation with 5 factors (Ordered by loading)

	Factor 1	Factor 2	Factor 3[b]	Factor 4	Factor 5
Items	Chest tightness (0.73) Fighting for air (0.73) Chest heaviness (0.62) Shortness of breath (0.61) Uncomfortable (0.59) Heavy breathing (0.57) Difficulty breathing out (0.57) Feeling heart is racing (0.47) Concerned about having asthma (0.47)	Exhaustion[a] (0.74) Tiredness[a] (0.67) Irritable[a] (0.65) Poor concentration[a] (0.57) Frustrated (0.55) Ex. hot humid day (0.55) Difficulty getting to sleep[a] (0.44)	Shoveling snow (0.76) Running uphill/stairs (0.70) Walking uphill/stairs (0.67) Ex. cold day (0.65) Hurrying (0.62) Playing sports (0.43) Av. strong smells (0.41)	Cough (0.71) Wheeze (0.68) Woken by symptoms (0.66) Need to clear throat (0.62) Waking with symptoms (0.61) Difficulty getting a good night's sleep (0.56)	Ex. dust (0.82) Keeping environment dust free[a] (0.69) Ex. air pollution (0.62) Ex. basements[a] (0.52) Ex. pollen season (0.49) Ex. foggy days (0.48) Av. cigarette smoke (0.45)
% of variance explained	12.8	11.0	10.1	9.7	9.1

Abbreviations: Av. = problems associated with avoidance of this environmental stimulus, Ex. = problems associated with exposure to this environmental stimulus.

[a]Items not in the Asthma Quality of Life Questionnaire.

[b]Physical Activities in the Asthma Quality of Life Questionnaire are self-identified.

being concerned about asthma, items related to unpleasant chest sensations. Most of these items are included in the symptoms domain of the Asthma Quality of Life Questionnaire. The second factor includes items related to fatigue and emotional function, which are either included in the emotional function domain of the Asthma Quality of Life Questionnaire or not included at all. Most of the items in the third factor are activities that are limited by asthma, which are implicitly included in the Asthma Quality of Life Questionnaire because of the decision to use an individualized approach to activity limitation. The fourth domain includes symptoms associated with nocturnal asthma (if one makes the assumption that cough and wheeze are mainly troublesome at night) and included in the symptoms domain of the Asthma Quality of Life Questionnaire. The fifth domain includes impairments associated with environmental stimuli and included in either the activity limitation or environmental exposure domains of the Asthma Quality of Life Questionnaire. Table 3 includes the variances explained by each factor.

Comparison of Methods

At the end of the item reduction processes there were 32 items using the impact method and 36 using the psychometric method. In Table 4, we have listed the items that form part of the Asthma Quality of Life Questionnaire that would not have been included if we had used the psychometric methods. The list includes six high impact items related to the effect of the environment and to emotional function.

Table 5 presents the items that would have been included in the Asthma Quality if Life Questionnaire if we had used psychometric methods instead of the impact method. The items that would have been included are largely related to symptoms which fell just below the cut-point for impact. In the factor analysis, however, these items would have been associated not with symptoms but with emotional function (Table 2).

TABLE 4. Items in the asthma quality of life questionnaire that would not have been included if psychometric methods had been used

Item	Impact score
Problems associated with exposure to cigarette smoke	3.12
Having to avoid going outside because of weather or air pollution	2.67
Having to avoid dust	2.39
Afraid of not having medications available when needed	1.88
Problems associated with exposure to strong smells and perfumes	1.82
Concerned about having to use medications	1.71
Afraid of getting out of breath	1.31

TABLE 5. Items that would have been included in the asthma quality of life questionnaire if psychometric methods had been used

Item	Impact score
Tiredness	1.81
Exhaustion	1.73
Feeling heart is racing	1.70
Uncomfortable	1.58
Poor concentration	1.46
Difficulty getting to sleep	1.46
Problems associated with going into basements	1.24
Irritable	1.23

DISCUSSION

The two approaches to item reduction and domain construction that we have compared both use a combination of empirical methods and intuitive judgement. In terms of choice of items, the impact method relies largely on the frequency with which patients label items as a problem and the importance they associate with them. However, there were components of judgement that were part of the procedure, including decisions to include two emotional function items that were not among the top impact scoring items and to rely on individualized activities as part of the activity domain. The impact method's categorization of items into domains relied exclusively on clinical sensibility.

While the factor analysis approach is based largely on the structure of correlations between items, investigators must make a number of subjective decisions throughout the process. These include the order of steps in the item reduction process, the choice of cut-points, method of rotation, and the decision about which final factor structure is most satisfactory. Thus, to characterize one approach as relying on intuitive judgement and the other as empirically-based is an oversimplification.

To avoid the criticism that we chose incorrect procedures for the factor analysis, we decided to base our choices entirely on previously published studies. We have followed the steps, criteria, and methods used by both Hyland [5] and Marks [6] to develop asthma-specific disease quality of life questionnaires. These approaches, chosen by two independent investigative teams in different parts of the world, represent one established and reasonable strategy for factor analysis. Different investigators have their own favourite approaches and the strategies of credible experts often differ substantially from one another.

Given the differences in the impact and psychometric strategies and the extent to which they rely on investigators' judgement, the final instruments we generated using two methods are remarkably similar. Of the 32 items in the Asthma Quality of Life Questionnaire, 20 would have been included in the questionnaire based on factor analysis (25 if one includes the items implicitly included in the Asthma Quality of Life Questionnaire as individualized activities). In addition, the domain structure we created for the Asthma Quality of Life Questionnaire on the basis of clinical sensibility corresponds closely to the domain structure derived from the factor analysis. These results are consistent with previous work in which factor analyses conducted by other investigators on instruments we had developed using the impact method resulted in factor structures very similar to those we had adduced based on clinical sensibility [7].

At the same time, the two approaches did yield some important differences. Three items of the greatest importance to patients with asthma would have been excluded from the Asthma Quality of Life Questionnaire if we had used the psychometric method. Most, but not all, items in the factor-analysis derived domains make clinical sense. However, there were exceptions that include the "concerned about having asthma" item in the domain related to chest sensations and the "exposure to hot humid weather" item included in the domain related to fatigue and emotional dysfunction. The psychometric method led to inclusion of a number of moderate-impact items related to fatigue that were not included in the Asthma Quality of Life Questionnaire.

Given these differences, is it possible to decide which approach is "better"? Depending on their philosophy, investigators may find one strategy more appealing than the other. We believe that all items of functional impairment that are important to patients, irrespective of their association with each other, should be included in a disease-specific quality of life instrument and therefore we use the impact method. Those who believe that there should be a mathematical linkage between items within a questionnaire will continue to rely primarily on factor analysis.

Ultimately, however, the only definitive way of deciding on the optimal approach is to test the measurement properties of the instruments developed using the two strategies. If the instrument is to be used to discriminate between patients according to their quality of life, this will involve testing the reliability of the questionnaire and the cross-sectional correlations with independent measures. If the purpose is to use the instrument in a clinical trial to evaluate change over time, the instruments' responsiveness and longitudinal correlations with independent measures will be the key properties that must be tested [8]. Such a study would elucidate which approach to instrument development yields a superior final result.

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