Int J Ophthalmol, Vol. 7, No. 1, Feb.18, 2014 www. IJO. cn
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·Clinical Research·

An enhanced functional ability questionnaire (faVIQ) to measure the impact of rehabilitation services on the visually impaired

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Received: 2013-05-31 Accepted: 2013-10-25

Abstract

• **AIM: To develop a short, enhanced functional ability Quality of Vision (faVIQ) instrument based on previous questionnaires employing comprehensive modern statistical techniques to ensure the use of an appropriate response scale, items and scoring of the visual related difficulties experienced by patients with visual impairment.**

• **METHODS: Items in current quality-of-life questionnaires for the visually impaired were refined by a multi-professional group and visually impaired focus groups. The resulting 76 items were completed by 293 visually impaired patients with stable vision on two occasions separated by a month. The faVIQ scores of 75 patients with no ocular pathology were compared to 75 age and gender matched patients with visual impairment.**

• **RESULTS: Rasch analysis reduced the faVIQ items to 27. Correlation to standard visual metrics was moderate (r=0.32-0.46) and to the NEI-VFQ was 0.48. The faVIQ was able to clearly discriminate between age and gender matched populations with no ocular pathology and visual impairment with an index of 0.983 and 95% sensitivity and 95% specificity using a cut off of 29.**

• **CONCLUSION: The faVIQ allows sensitive assessment of quality-of-life in the visually impaired and should support studies which evaluate the effectiveness of low vision rehabilitation services.**

• **KEYWORDS:** quality of life; visual impairment; low vision; functional ability; sensitivity; specificity
DOI:10.3980/j.issn.2222-3959.2014.01.14

Wolffsohn JS, Jackson J, Hunt OA, Cottriall C, Lindsay J, Gilmour R, Sinclair A, Harper R. An enhanced functional ability questionnaire (faVIQ) to measure the impact of rehabilitation services on the visually impaired. *Int J Ophthalmol* 2014;7(1):77-85

INTRODUCTION

Over the past couple of decades, "quality of life" (QoL) questionnaires have been developed to overcome the limitations of conventional measures of visual function in capturing the impact of visual rehabilitation. These QoL questionnaires assess self reported aspects of ability and/or independence in performing daily tasks, orientation and mobility, self-care, and social, functional and mental/psychological status [1]. While these questionnaires purport to assess QoL, there is no widely accepted definition of QoL and what patients attribute to contributing to their QoL will depend on the context. The World Health Organisation, for example, define QoL as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns"[2].

Numerous generic tools are available for the assessment of health-related QoL such as the Medical Outcomes Short Form 36 (SF-36), the Sickness Impact Profile (SIP) and the EuroQol (EQ-5D) [3-5]. More focused, disease specific questionnaires have been developed to assess their impact on QoL such as the Visual Function questionnaire (VF-14) for cataract and the Macular Degenertation Quality-of-Life questionnaire (MacDQOL) for age related macular degeneration [6,7]. However, these instruments are not broad enough to assess a low vision population with a range of eye conditions causing visual impairment nor to assess the

rehabilitation interventions for such patients. Many questionnaires that have been applied to assess rehabilitation have been developed with a non-visually impaired population, such as the National Eye Institute Visual Functioning Questionnaire (NEI-VFQ) and hence it cannot be assumed that content validity of a questionnaire will be sustained when the tool is transferred to a different patient population *e.g.* to a group of visually impaired people with mixed diagnoses [8-10] The NEI-VFQ has had its psychometric properties checked across a range of conditions causing low vision, showing reasonable reliability and consistency, but consisting of 51 questions it can be quite burdensome to apply[8]. Shorter forms of the NEI-VFQ have been developed, but as with those questionnaires created with a visually impaired population to assess the impact of low vision rehabilitation such as the LVQoL and VCM-1, it was not developed with the full range of modern analyses that ensure optimum sensitivity such as an interval, rather than ordinal, scoring system using Rasch analysis [9-13]. As a result, the validity of its subscales has been questioned and the sensitivity to low vision rehabilitation changes has been found to be limited [14,15]. While attempts have been made to apply Rasch analysis to the seven-items of the NEI-VFQ that were found previously to be responsive to low vision rehabilitation, this approach is likely to be less robust than applying an interval scoring system to reduce items from a full question bank, as perhaps evidenced by the lack of differentiation found between a community and hospital based low vision service [16,17]. More recent instruments to assess visual function have utilised more modern Rasch analysis techniques: the Veterans Affairs Low-Vision Visual Functioning Questionnaire is quite long with 48 questions and the USA veteran cohort may not represent the wider visually impaired population [18]; and the Activity Inventory (AI) which is an adaptive visual function questionnaire that consists of 459 tasks nested under 50 goals that in turn are nested under three objectives but this would be too long to implement in low vision clinical practice[19].

Therefore the aim of the study was to develop a tool responsive to low vision rehabilitation using questionnaires already established to assess vision, and to measure the social, physical, functional, psycho-social and other impacts of low vision rehabilitation services on older visually impaired people [10,13]. As Rasch analysis required a uni-dimensional theoretical construct, this was taken as functional visual ability as defined by previous instruments.

SUBJECTS AND METHODS

The items for the questionnaire were sourced from existing questionnaires and the 136 identified discrete items were reviewed for relevance, coverage and comprehension by a multidisciplinary group of professionals experienced in low vision rehabilitation including ophthalmologists, optometrists, psychologists and rehabilitation workers[8,9,11,20-49]. This process included consideration of theoretical models of low vision rehabilitation [50,51]. The reference group also reached consensus on the use of a simple Likert anchored scale between 1 (very easy/little) and 5 (very difficult/great) with "stopped due to poor vision" rated as 6. An additional response option to indicate "not a task I do" was not scored. It has been shown that a 5-option rating scale is the most optimal for vision-related quality-of-life instruments [52]. However, non-discriminative response options are identified by statistical analysis, but additional response options cannot be added post completion. Hence a 6 point Likert scale was adopted. Although Likert scales have limitations in quantifying the overall response between individuals due to their ordinal nature, the statistical techniques employed can estimate an interval scale to overcome this limitation[13].

Patient interviews (with the same inclusion/exclusion criteria as the main study) allow item comprehension to be refined and new items to be devised if the item coverage does not fully describe first-hand experience. Therefore three focus groups of 10-12 patients with low vision were conducted across the UK. These focus groups, representative of the visually impaired in terms of gender, race, age, and socio-economic background were assisted by an experienced facilitator to ensure the discussion was less influenced by their preconceived ideas [8,53]. This approach ensures that all items in the questionnaire were simple, easy to understand and relevant, non-ambiguous or double-barrelled and value-laden (socially loaded) words, such as 'healthy' were avoided. Items were worded positively since negativity may affect their validity. The order in which items were presented was also considered, as it has been shown that responses given to the first few items may impact on the subsequent responses[54]. The resulting questionnaire had 76 items.

Self-administration of a large-print (N18 size) was chosen as the method of administration as it is less expensive than telephone and in-person interviews, does not rely on memory of the scale options and has minimal influence from external bias, since any 'assistance' is not linked to the rehabilitation professions and any third-person bias is likely to be consistent when repeated to assess the change in quality-of-life with rehabilitation [21,55]. Telephone and in-person interview responses have been found to be similar [21]. However, these administration methods under-report problems compared to self-administration [21,22]. Any patients who struggled to read the questionnaire were encouraged to seek assistance from a friend or relative.

Ethical approval was received from the Belfast Local Research Ethics Committee with site-specific assessments at each of the centres. The research followed the tenets of the Declaration of Helsinki and informed consent was gained from each patient following explanation of the study and

Table 1 Category function of response scale for the 76 initial items

Category		Observed	Observed	Sample	Infit	Outfit	Structure	Category
Label	Score	Count (%)	Average	Expected	Mean SQ	Mean SQ	Measure	Measure
1	1	2600 (12)	-12.90	-13.50	1.20	1.22	None	(-2.694)
2	2	3357 (15)	-7.50	-7.31	0.96	0.96	-12.83	-1.266
3	3	4405 (20)	-2.47	-2.51	0.95	0.94	-7.57	-0.426
4	4	3182 (14)	1.34	1.91	1.01	1.01	-2.96	0.250
5	5	5563 (25)	5.90	6.42	1.11	1.26	-1.43	1.214
6	6	2048 (9)	13.06	11.41	0.78	0.87	19.87	(3.083)

SQ: Square; n=293. Observed indicates number of occurrences of each category and percentage of total. Sample expected, stracture and category measures are based on the Rasch model probability of observation for a Likert scale.

potential risks. The items were administered on 2 occasions separated by 6 weeks on 293 visually impaired patients (average age 80.1 ±9.7 years, range 47-99; 69.4% female). The first completion was tied to a scheduled review visit at the five recruitment centres (Altnagelvin Area Hospital Londonderry, Aston University Birmingham, Fife Low Vision Centre, Oxford Eye Hospital, Manchester Royal Eye Hospital and the Royal Victoria Hospital Belfast) with the clinician recording habitual distance visual acuity (logMAR chart; Bailey-Lovie, 1976), contrast sensitivity (Pelli-Robson chart), near acuity at a 25cm working distance with habitual near vision spectacle correction and near acuity with the patients most used near low vision aid (logMAR chart). Patients with stable visual function over at least a 1 year period were recruited to minimise a reduction in vision affecting the repeat assessment. In addition, patients who reported a decrease in vision since the first completion were excluded from the reliability assessment. On the second application, the NEI-VFQ and EuroQol general health questionnaire were also completed as a direct comparison[5,8,9].

The reduced, validated questionnaire, named the functional ability of the Visually Impaired Questionnaire (faVIQ) was administered to 75 age-matched individuals with normal vision (average age 67.8 ±7.2 years, range 55-85; 58% female) recruited from general optometric practice. Comparison with 75 age and gender matched low vision patients from the original cohort allowed the instrument's sensitivity to visual loss to be assessed.

Statistical Analysis Rasch Analysis was carried out for all 76 items of the questionnaire using Winsteps ® Rasch Measurement Program v3.63.2 which uses the Rating Scale Model of Andrich for optimising category function, calculating item fit statistics, assessing item targeting and determining the separation index. Frequency of endorsement (>60%), skew and kurtosis for each item was calculated using Excel (Microsoft Corporation, Redmond, WA., USA). The approach used was similar to that described in the development of other vision-related questionnaires, including the Activity Breakdown Structure (ABS), and the Independent Mobility questionnaire (IMQ) [8,36]. Existing questionnaires have also been re-analysed in a similar fashion, including the VF-14, the NEI-VFQ, the ADVS and the RSVP[56-59].

On completion of the Rasch Analysis procedure, the reduced questionnaire was assessed for its psychometric properties. Test-retest reliability was assessed using the intraclass correlation coefficient. Determination of questionnaire validity was based on: face validity - whether the questionnaire looked appropriate; content validity - judgements on the appropriateness of item coverage and content (both made during the process of questionnaire development)[28]; construct validity - assessed by comparison to habitual distance visual acuity, contrast sensitivity, near visual acuity, near magnifier acuity and the NEI-VFQ using Pearson's Product Moment Correlation coefficient (as the effect of low vision should be discriminated from a change in general health, the results were also compared to the EuroQOL health question); discriminative validity - determined by comparing the profile of final reduced questionnaire scores to an age and gender-matched cohort with no ocular pathology; and criterion validity - observed through the use of a Receiver Operating Characteristic curve and the index of discriminative ability between the low vision and no pathology groups was determined from the area under the curve.

RESULTS

Before any items were eliminated from a questionnaire, it was ensured that the response scale employed was appropriate and functioning as intended. All response scales were scored in the same direction with a larger number reflecting an increasing difficulty/amount of attribute (Table 1). As desired, the category measure column revealed an increasing value with each response option, an outfit mean square statistic less than a value of 2 for each response option (indicating that the data is not too predictable or too random) and similar measure-to-category and category-to-measure ratings (Table 1) [60]. Despite the lower frequency of endorsement of the "stopped due to poor vision" response

(graded '6'), this still accounted for about 1/10th of all choices and merging this option with the extreme difficulty end of the scale would potentially confuse respondents. The items were relevant to the majority of the subjects, with only 3% of items rated as "not a task I do" and despite their limited vision and self-administration, only 2% of the 76 original questionnaire item ratings were omitted.

Item reduction centred on the assessment of item fit statistics, item targeting, frequency of endorsement and tests of normality (skew and kurtosis) in priority order to indicate conformance with the Rasch model.

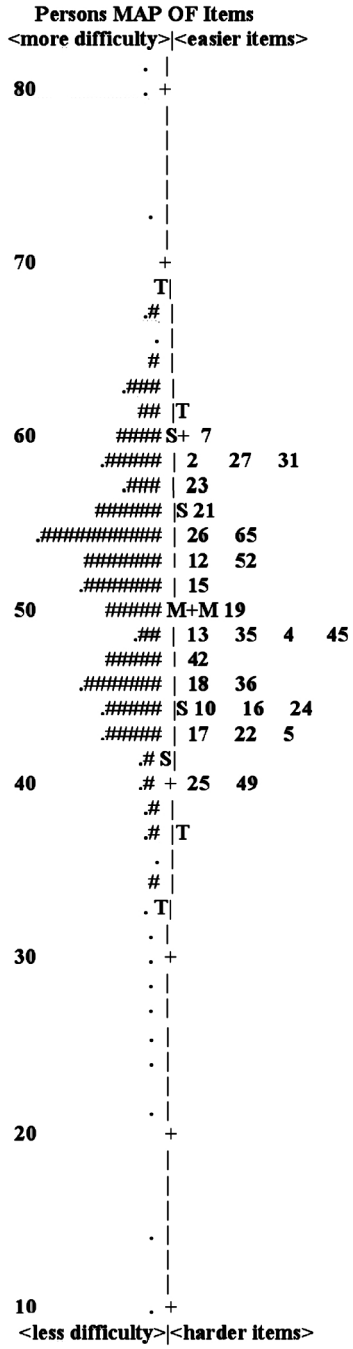
Item fit statistics were evaluated from infit and outfit statistics which have a value of '1' when the observed data perfectly fits the Rasch model. A value of substantially more than '1' suggests that observed data is too random and variable compared to that which was expected, whilst values substantially less than '1' indicate that the observed data is too predictable (termed misfitting). Acceptable limits of between 0.8 and 1.2 for both infit and outfit statistics were applied as suggested for critical multiple choice responses[60].

Item targeting was used to determine whether the difficulty of items matched the difficulty experienced by individuals. The person/item map (Table 2) indicated the remaining questions had a similar level of difficulty and that individual's had a similar level of ease in answering them (mean 4.960±0.742 logits). The items were spread across the range indicating sufficient coverage and limited redundancy of items.

Item targeting is used to determine whether the difficulty of items matches the difficulty experienced by individuals. The person/item map vertical ruler represents the amount of attribute and the subjects (3 of the 293 indicated by each #) on the left side whilst the item numbers are plotted on the right side. Individuals are located at the top of the map whilst those with least difficulty will be located at the bottom. Accordingly, easier items are located at the top of the map and more difficult items will be located at the bottom. The appropriateness of item targeting is indicated by the difference in mean score between items and subjects, with a small difference indicating better targeting. Items located furthest from the subject mean represent greatest disparity in difficulty and are indicative of a need for elimination. However, in order to capture a wide range of subject abilities, items ought to be located at all positions on the map, whilst gaps indicate the need to add further items; multiple items at one location indicate redundancy.

Assessment of skew and kurtosis describe the distribution of responses across the response scale and were under a value of 2 as desired. The separation index was 11.83 and indicates that this number of performance levels can be discriminated by the questionnaire[60]. The separation index is an assessment of the variance in observed responses adjusted for measurement error and describes the number of performance levels that can be discriminated by the questionnaire.

Table 2 Item targeting of the final 27 items, rescaled between 0 and 100



The criterion of the remaining items is presented in Table 3. The Rasch corrected measure on a scale of 0 to 100 calculated from the summed item scores (sum) is presented in Table 4. The scale has been reversed so that a higher value corresponds to a higher quality-of-life. The measures can be calculated using the equation:

faVIQ measure=y=100-{50+8.725×ln[(x-26.56)/(162.44-x)]}

Psychometric Properties Test-retest Reliability was classified as good (Intraclass Correlation Coefficient =0.913)[60]. Construct validity was assessed by comparison to standard visual function measures and the most widely used vision-loss related QoL instrument, the NEI-VFQ25. The correlation based on the hypothesis "compared to a person who scores low on the questionnaire a person who scores

Table 3 Item fit statistics for the 27 items remaining after Rasch analysis

Item No.	Infit MNSQ	Infit Zstd	Outfit MNSQ	Outfit Zstd	Skew	Kurtosis
65	1.03	0.4	1.17	1.9	0.14	-0.80
15	1.10	1.2	1.15	1.7	-0.13	-0.70
12	1.02	0.3	1.14	1.6	0.00	-0.64
52	1.13	1.6	1.07	0.9	0.13	-1.09
42	1.13	1.3	1.08	0.8	-0.15	-1.37
26	1.10	1.2	1.04	0.5	0.22	-0.89
31	1.09	1.0	1.04	0.5	0.47	-0.60
22	1.08	0.9	1.03	0.4	-0.83	-0.25
49	1.08	0.8	0.96	-0.3	-1.23	0.41
18	1.07	0.8	1.05	0.5	-0.28	-1.32
21	1.06	0.8	1.01	0.1	0.41	-0.73
5	0.93	-0.8	1.06	0.6	-1.09	0.41
19	1.05	0.6	1.02	0.3	-0.11	-1.17
16	1.00	0.0	1.04	0.5	-0.71	-0.24
45	1.03	0.4	1.03	0.3	-0.42	-0.70
17	1.03	0.3	0.97	-0.3	-0.46	-1.31
4	0.89	-1.4	1.00	0.0	-0.31	-0.27
23	1.00	0.0	0.98	-0.2	0.45	-0.44
2	0.99	-0.1	0.97	-0.2	0.54	-0.07
24	0.98	-0.2	0.93	-0.8	-0.75	-0.35
27	0.98	-0.3	0.92	-0.8	0.59	-0.46
36	0.96	-0.4	0.96	-0.4	-0.64	-0.42
7	0.88	-1.3	0.94	-0.6	0.55	-0.16
35	0.93	-0.8	0.88	-1.4	-0.27	-0.77
10	0.90	-1.3	0.87	-1.5	-0.66	-0.20
13	0.89	-1.3	0.89	-1.3	-0.34	-0.82
25	0.88	-1.2	0.82	-1.8	-1.15	0.19

MNSQ: Mean square; Zstd: Z standardised (compared to a standard normal distribution); n=293.

high will have a poorer" "habitual distance visual acuity" was 0.46 (mean acuity=0.83±0.38 logMAR, range 0.1 to 1.7 logMAR); "contrast sensitivity" was -0.42 (mean contrast= 0.89±0.40 log CS units, range 0.0 to 1.7 log CS units); "near visual acuity" was 0.44 (mean near acuity=0.77±0.37 logMAR, range 0.1 to 2.5); "near acuity with the patient's low vision aid" was 0.32 (mean magnifier acuity=0.35±0.27 logMAR, range -0.1 to 1.3 logMAR); and "NEI-VFQ score" was 0.48 (mean score=73±7, range 45 to 89). As the effect of low vision should be discriminated from a change in general health, the results were also compared to the EQ-5D health question [termed representational (divergent or discriminant) validity] with which there was found to be no correlation (r=-0.06, P=0.476)[61]. Elaborative or discriminative validity was determined by comparing the profile of final reduced questionnaire scores to an age and gender-matched cohort with no ocular pathology, showing a clear difference (Figure 1)[61].

Criterion validity was observed through the use of a Receiver Operating Characteristic curve (Figure 2). The index of discriminative ability between the low vision and no pathology groups (area under the curve) was 0.983 (95% confidence interval). An faVIQ cut off value of 29 allowed 95% sensitivity and 95% specificity (95% CIs) in distinguishing those being rehabilitated for low vision compared to those with no ocular pathology.

DISCUSSION

The development of the Functional ability of the Visually Impaired questionnaire (faVIQ) is one of the first to employ comprehensive modern statistical techniques from conception to ensure the use of an appropriate response scale, items and scoring of the visual related difficulties experienced by patients with low vision. This approach has overcome some of the criticisms of previous instruments used to assess low vision services [10]. The faVIQ's basis was all previously published visual impairment questionnaires, refined by patients and practitioners[8,9,11,20-49]. As the faVIQ was shown to be sensitive to visual impairment 'quality-of-life', repeat assessment before and after low vision rehabilitation services should contribute to determining which elements of these services are beneficial and/or most cost effective.

The faVIQ was self-administration to avoid the issue of under-reporting problems as well being less expensive than telephone and in-person interviews and not relying on memory of the scale options [21,22]. The questionnaire needs to be in sufficiently large type to allow independent completion wherever possible. Where assistance is required, external bias

Table 4 FaVIQ summed score to rasch measure conversion table

Summed score	faVIQ	Summed score	faVIQ	Summed score	faVIQ
		70	57.17	120	43.29
		71	56.87	121	42.98
		72	56.57	122	42.67
		73	56.27	123	42.35
		74	55.98	124	42.03
		75	55.69	125	41.71
		76	55.40	126	41.38
27	100.00	77	55.12	127	41.05
28	90.98	78	54.83	128	40.71
29	85.70	79	54.55	129	40.36
30	82.56	80	54.27	130	40.01
31	80.29	81	54.00	131	39.65
32	78.49	82	53.72	132	39.28
33	77.00	83	53.45	133	38.90
34	75.71	84	53.18	134	38.52
35	74.58	85	52.91	135	38.13
36	73.56	86	52.64	136	37.72
37	72.63	87	52.37	137	37.31
38	71.78	88	52.11	138	36.88
39	70.99	89	51.84	139	36.43
40	70.25	90	51.57	140	35.97
41	69.55	91	51.31	141	35.50
42	68.89	92	51.04	142	35.00
43	68.27	93	50.78	143	34.49
44	67.67	94	50.51	144	33.95
45	67.10	95	50.25	145	33.38
46	66.55	96	49.98	146	32.79
47	66.03	97	49.72	147	32.16
48	65.52	98	49.45	148	31.49
49	65.03	99	49.19	149	30.78
50	64.56	100	48.92	150	30.01
51	64.10	101	48.65	151	29.19
52	63.65	102	48.39	152	28.30
53	63.22	103	48.12	153	27.32
54	62.80	104	47.85	154	26.25
55	62.39	105	47.58	155	25.04
56	61.99	106	47.30	156	23.68
57	61.60	107	47.03	157	22.09
58	61.22	108	46.76	158	20.20
59	60.84	109	46.48	159	17.81
60	60.48	110	46.20	160	14.54
61	60.12	111	45.92	161	9.13
62	59.77	112	45.64	162	0.00
63	59.43	113	45.35		
64	59.09	114	45.07		
65	58.76	115	44.78		
66	58.43	116	44.48		
67	58.11	117	44.19		
68	57.79	118	43.89		
69	57.48	119	43.59		

could affect the results, but should have minimal influence as it is not linked to the rehabilitation professions[21,55]. Responses were relatively evenly distributed (between 10%-20%) across the 6 point response scale between 1 (very easy/little) and 5 (very difficult/great) and "stopped due to poor vision" option (rated as 6). This indicates that Differential Item Functioning due to some of the established patients examined having had a more successful intervention than others affecting the fit statistics for items that were responsive to the patients' earlier interventions, is unlikely to have influenced the faVIQ

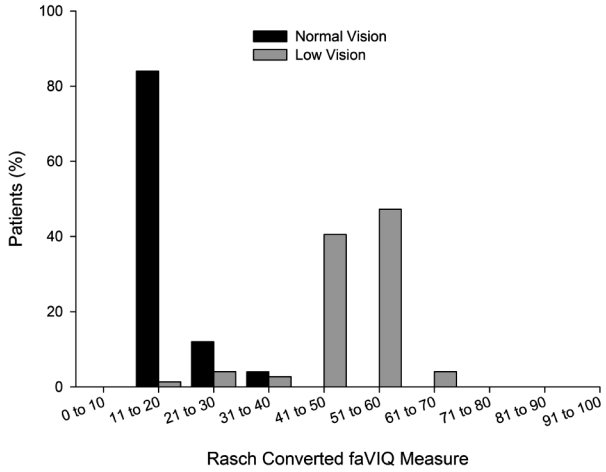


Figure 1 Comparison of faVIQ outcome between age and gender match patients with normal (n=75) and low (n=75) vision.

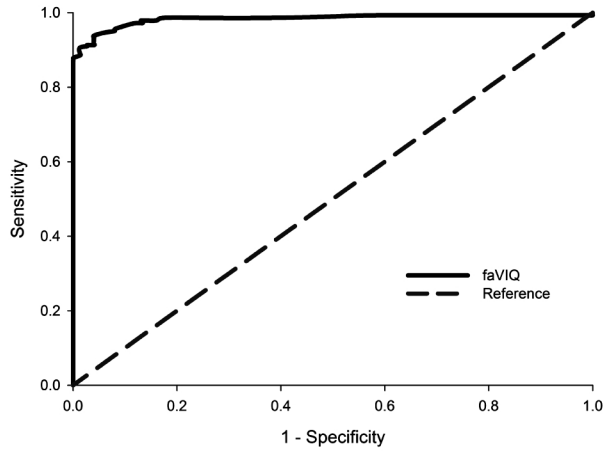


Figure 2 Receiver operating characteristic curve for differentiating normal (n=75) from low (n=75) vision.

design [15]. The items were relevant to most patients, with few responses endorsing "not a task I do". Despite the 76 items in the initial questionnaire and self-completion, only 2% of the items were not scored and this would be expected to reduce in the faVIQ which only has one third of the items and therefore is less of a burden to complete even than more recent well-designed questionnaires[18,19].

Rasch analysis identified items that were too random and variable or too predictable and these 49 items were removed[58]. The remaining 27 items making up the faVIQ were found to be well targeted as the difficulty level of the items closely matched that experienced by the patients with low vision and the items covered the difficulty range with minimal redundancy (Figure 2) [55]. The separation index was high indicating a wide range of performance levels could be discriminated by the faVIQ [60]. Using a cubic equation, the summed faVIQ score can be converted into a measure of vision-related 'quality-of-life' between 0 (poor) and 100 (good).

The faVIQ proved to be internally consistent and reliable, producing consistent results over a month. The faVIQ scores were moderately correlated with acuity and contrast measures

Table 5 The functional ability of the Visually Impaired Questionnaire (faVIQ). Item numbers relate to the original order within the 76 tested items

Considering your vision, how easy is it for you to:	Very easy	Moderately difficult			Very difficult	Stopped due to vision	Not a task I do
2 Attend to your personal appearance?	1	2	3	4	5	X	N/A
4 Watch television?	1	2	3	4	5	X	N/A
5 Carry out small repair tasks?	1	2	3	4	5	X	N/A
7 Manage food on your plate?	1	2	3	4	5	X	N/A
10 Read your mail?	1	2	3	4	5	X	N/A
12 Get around outdoors?	1	2	3	4	5	X	N/A
13 Enjoy scenery?	1	2	3	4	5	X	N/A
15 Use steps/stairs?	1	2	3	4	5	X	N/A
16 Write (a card, cheque or letter)?	1	2	3	4	5	X	N/A
17 Play indoor hobbies (Board games, bingo, cards)?	1	2	3	4	5	X	N/A
18 Enjoy outdoor activities (Bowling, gardening)?	1	2	3	4	5	X	N/A
19 Recognise people at arm's length?	1	2	3	4	5	X	N/A
21 Choose your clothing?	1	2	3	4	5	X	N/A
22 Manage your own correspondence?	1	2	3	4	5	X	N/A
23 Prepare a drink?	1	2	3	4	5	X	N/A
24 Recognise people across a room?	1	2	3	4	5	X	N/A
25 Read road signs?	1	2	3	4	5	X	N/A
26 Avoid bumping into objects at head height?	1	2	3	4	5	X	N/A
27 Grasp an object within arm's reach?	1	2	3	4	5	X	N/A
31 Avoid bumping into objects at waist height?	1	2	3	4	5	X	N/A
35 Read the time?	1	2	3	4	5	X	N/A
36 See a person's facial features?	1	2	3	4	5	X	N/A
42 Tend to your garden?	1	2	3	4	5	X	N/A
45 Identify money?	1	2	3	4	5	X	N/A
49 See the number on the front of a bus?	1	2	3	4	5	X	N/A
52 Read items in large print?	1	2	3	4	5	X	N/A
65 Overall how would you rate your ability to see objects close-up?	1	2	3	4	5	X	

as expected, accounting for between 10 and 21% of the variance in scores. Interestingly, best near acuity with the patient's low vision aid correlated weakest of the visual function measures with the patient's 'quality-of-life'. This suggests that other metrics of near visual function such as reading speed may have more impact on quality-of-life that near acuity alone. The faVIQ score appeared to be independent of patient age (r=-0.059, P=0.349) and gender (P=0.833). Vision-related 'quality of life' in the visually impaired was not related to general health as expected, but did correlate with a well validated vision-related 'quality of life' instrument.

The faVIQ clearly discriminated patients with low vision from an age and gender matched cohort of patients with no ocular pathology (Figure 2). It demonstrated an index of discriminative ability of close to perfect on the Receiver Operating Characteristic curve and 95% sensitivity and 95% specificity for an faVIQ cut off value of 29.

Therefore it would appear the faVIQ has optimum sensitivity, specificity and separation to discriminate between different levels of low vision and will perform an important role alongside measures of visual function in assessing and optimising models of low vision rehabilitation. The items cover functional, social and physical aspects of vision loss (Table 5). Although 17 of the original items related to psychological aspects of vision loss, they were all excluded by Rasch analysis.

ACKNOWLEDGEMENTS

Simon Lannon who co-ordinated the data collection and the Royal National Institute for the Blind who helped to coordinated the focus groups.

Foundation: Supported by the Royal National Institute of the Blind, UK (No.226227)

Conflicts of Interest: Wolffsohn JS, None; **Jackson J**, None; **Hunt OA**, None; **Cottriall C**, None; **Lindsay J**, None; **Gilmour R**, None; **Sinclair A**, None; **Harper R**, None.

REFERENCES

1 Binns AM, Bunce C, Dickinson C, Harper R, Tudor-Edwards R, Woodhouse M, Linck P, Suttie A, Jackson J, Lindsay J, Wolffsohn J, Hughes L, Margrain TH. How effective is low vision service provision? A systematic review. *Surv Ophthalmol* 2012;57(1):34-65

2 Orley J, Saxena S. What quality of life? The WHOQOL Group. World health organization quality of life assessment. *World Health Forum* 1996; 17:354-356

3 Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992;30 (6):473-483

4 Bergner M, Bobbitt RA, Carter WE, Gilson BS. The Sickness Impact Profile: development and final revision of a health status measure. *Med Care* 1981;19(8):787-805

5 Rabin R, de Charro F. EQ-5D: a measure of health status from the

EuroQol Group. *Ann Med* 2001;33(5):337-343

6 Steinberg EP, Tielsch JM, Schein OD, Javitt JC, Sharkey P, Cassard SD, Legro MW, Diener-West M, Bass EB, Damiano AM. The VF-14. An index of functional impairment in patients with cataract. *Arch Ophthalmol* 1994;112(5): 630-638

7 Mitchell J, Wolffsohn J, Woodcock A, Anderson SJ, ffytche T, Rubinstein M, Amoaku W, Bradley C. The MacDQoL individualized measure of the impact of macular degeneration on quality of life: reliability and responsiveness. *Am J Ophthalmol* 2008;146(3):447-454

8 Mangione CM, Lee PP, Pitts J, Gutierrez P, Berry S, Hays RD. Psychometric properties of the National Eye Institute Visual Function Questionnaire (NEI-VFQ). NEI-VFQ Field Test Investigators. *Arch Ophthalmol* 1998;116(11):1496-1504

9 Mangione CM, Lee PP, Gutierrez PR, Spritzer K, Berry S, Hays RD. Development of the 25-item National Eye Institute Visual Function Questionnaire. *Arch Ophthalmol* 2001;119(7):1050-1058

10 de Boer MR, Moll AC, de Vet HC, Terwee CB, Volker-Dieben HJ, van Rens GH. Psychometric properties of vision-related quality of life questionnaires: a systematic review. *Ophthalmic Physiol Opt* 2004;24(4): 257-273

11 Wolffsohn JS, Cochrane AL. Design of the low vision quality-of-life questionnaire (LVQOL) and measuring the outcome of low-vision rehabilitation. *Am J Ophthalmol* 2000;130(6):793-802

12 Frost NA, Sparrow JM, Durant JS, Donovan JL, Peters TJ, Brookes ST. Development of a questionnaire for measurement of vision-related quality of life. *Ophthalmic Epidemiol* 1998;5(4):185-210

13 Massof RW, Rubin GS. Visual function assessment questionnaires. *Surv Ophthalmol* 2001;45(6):531-548

14 Pesudovs K, Gothwal VK, Wright T, Lamoureux EL. Remediating serious flaws in the National Eye Institute Visual Function Questionnaire. *J Cataract Refract Surg* 2010;36(5):718-732

15 Stelmack JA, Stelmack TR, Massof RW. Measuring low-vision rehabilitation outcomes with the NEI VFQ-25. *Invest Ophthalmol Vis Sci* 2002;43(9):2859-2868

16 Ryan B, Court H, Margrain TH. Measuring low vision service outcomes: Rasch analysis of the seven-item National Eye Institute Visual Function Questionnaire. *Optom Vis Sci* 2008;85(2):112-121

17 Court H, Ryan B, Bunce C, Margrain TH. How effective is the new community-based Welsh low vision service? *Br J Ophthalmol* 2011;95(2): 178-184

18 Massof RW, Ahmadian L, Grover LL, Deremeik JT, Goldstein JE, Rainey C, Epstein C, Barnett GD. The activity inventory: An adaptive visual function questionnaire. *Optom Vis Sci* 2007:84(8);763-774

19 Stelmack JA, Szlyk JP, Stelmack BR, Demers-Turco P, Williams RT Moran D, Massof RW. Psychometric properties of the Veterans Affairs Low-Vision Visual Functioning Questionnaire. *Invest Ophthalmol Vis Sci* 2004;45(11):3919-3928

20 Mangione CM, Phillips RS, Seddon JM, Lawrence MG, Cook EF, Dailey R, Goldman L. Development of the 'Activities of Daily Vision Scale'. A measure of visual functional status. *Med Care* 1992 (12);30: 1111-1126

21 Wolffsohn JS, Cochrane AL, Watt NA. Implementation methods for vision related quality of life questionnaires. *Br J Ophthalmol*2000;84(9): 1035-1040

22 Frost NA, Sparrow JM, Hopper CD, Peters TJ. Reliability of the VCM1 Questionnaire when administered by post and by telephone. *Ophthalmic Epidemiol* 2001;8(1):1-11

23 Massof RW. A systems model for low vision rehabilitation. I. Basic concepts. *Optom Vis Sci* 1995;72(10):725-736

24 Massof RW. A systems model for low vision rehabilitation. II. Measurement of vision disabilities. *Optom Vis Sci* 1998;75(5):349-373

25 Becker SW, Lambert RW, Schulz EM, Wright BD, Burnet DL. An instrument to measure the activity level of the blind. *Int J Rehabil Res* 1985;8(4):415-424

26 Horowitz A Reinhardt JP. Development of the adaptation to age-related vision loss scale. *J Vis Impairm Blind* 1998;92:30-41

27 Crabtree HL, Hildreth AJ, O'Connell JE, Phelan PS, Allen D, Gray CS. Measuring visual symptoms in British cataract patients: the cataract symptom scale. *Br J Ophthalmol* 1999;83(5):519-523

28 Javitt JC, Wang F, Trentacost DJ, Rowe M, Tarantino N. Outcomes of cataract extraction with multifocal intraocular lens implantation: functional status and quality of life. *Ophthalmology* 1997;104(4):589-599

29 Lawrence DJ, Brogan C, Benjamin L, Pickard D, Stewart-Brown S. Measuring the effectiveness of cataract surgery: the reliability and validity of a visual function outcomes instrument. *Br J Ophthalmol* 1999;83 (1): 66-70

30 Denny F, Marshall AH, Stevenson MR, Hart PM, Chakravarthy U. Rasch Analysis of the Daily Living Tasks Dependent on Vision (DLTV). *Invest Ophthalmol Vis Sci* 2007;48(5):1976-1982

31 Terwee CB, Gerding MN, Dekker FW, Prummel MF, Wiersinga WM. Development of a disease specific quality of life questionnaire for patients with Graves' ophthalmopathy: the GO-QOL. *Br J Ophthalmol* 1998;82(7): 773-779

32 Terwee CB, Gerding MN, Dekker FW, Prummel MF, van der Pol JP, Wiersinga WM. Test-retest reliability of the GO-QOL: a disease-specific quality of life questionnaire for patients with Graves' ophthalmopathy. *J Clin Epidemiol* 1999;52(9):875-884

32 Hassell JB, Weih LM, Keeffe JE. A measure of handicap for low vision rehabilitation: the impact of vision impairment profile. *Clin Experiment Ophthalmol* 2000(3);28:156-161

34 Weih LM, Hassell JB, Keeffe J. Assessment of the impact of vision impairment. *Invest Ophthalmol Vis Sci* 2002;43(4):927-935

35 Lamoureux EL, Pallant JF, Pesudovs K, Rees G, Hassell JB, Keeffe JE. The impact of vision impairment questionnaire: an assessment of its domain structure using confirmatory factor analysis and Rasch analysis. *Invest Ophthalmol Vis Sci* 2007;48(3):1001-1006

36 Turano KA, Geruschat DR, Stahl JW, Massof RW. Perceived visual ability for independent mobility in persons with retinitis pigmentosa. *Invest Ophthalmol Vis Sci* 1999;40(5):865-877

37 Ross CK, Stelmack JA, Stelmack TR, Guihan M, Fraim M. Development and sensitivity to visual impairment of the Low Vision Functional Status Evaluation (LVFSE). *Optom Vis Sci* 1999;76 (4): 212-220

38 Gothwal VK, Lovie-Kitchin JE, Nutheti R. The development of the LV Prasad-Functional Vision Questionnaire: a measure of functional vision performance of visually impaired children. *Invest Ophthalmol Vis Sci* 2003;44(9):4131-4139

39 Foss AJ, Lamping DL, Schroter S, Hungerford J. Development and validation of a patient based measure of outcome in ocular melanoma. *Br J Ophthalmol* 2000;84(4):347-351

40 Haymes SA, Johnston AW, Heyes AD. The development of the Melbourne low-vision ADL index: a measure of vision disability. *Invest Ophthalmol Vis Sci* 2001;42(6):1215-1225

41 Dodds AG, Bailey P, Pearson A, Yates L. Psychological factors in acquired visual impairment: the development of a scale of adjustment. *J Vis Impairm Blind* 1991;85:306-310

42 Dodds AG, Flannigan H, Ng L. The Nottingham Adjustment Scale: a validation study. *Int J Rehabil Res* 1993;16(3):177-184

43 Carta A, Braccio L, Belpolitti M, Soliani L, Sartore F, Gandolfi SA, Maraini G. Self-assessment of the quality of vision: association of questionnaire score with objective clinical tests. *Curr Eye Res* 1998;17 (5):506-511

44 Stelmack JA, Szlyk JP, Stelmack TR, Demers-Turco P, Willians RT, Massof RW. Psychometric properties of the Veterans Affairs Low-Vision Visual Functioning Questionnaire. *Invest Ophthalmol Vis Sci* 2004;45 (11):3919-3928

45 Szlyk JP, Stelmack JA, Massof RW, Demers-Turco P, Williams RT, Wright BD. Performance of the Veterans Affairs Low Vision Visual Functioning Questionnaire. *J Vis Impairm Blind* 2004;98:261-275

46 Pesudovs K, Coster DJ. An instrument for assessment of subjective visual disability in cataract patients. *Br J Ophthalmol* 1998;82 (6): 617-624

47 Nelson P, Aspinall P, O'Brien C. Patients' perception of visual impairment in glaucoma: a pilot study. *Br J Ophthalmol* 1999;83 (5): 546-552

48 Bernth-Petersen P. Visual functioning in cataract patients: methods of measuring and results. *Acta Ophthalmol (Copenh)* 1981;59(2):198-205

49 Uusitalo RJ, Brans T, Pessi T, Tarkkanen A. Evaluating cataract surgery gains by assessing patients' quality of life using the VF-7. *J Cataract Refract Surg* 1999;25(7):989-994

50 Massof RW, Hsu CT, Baker FH, Barnett GD, Park WL, Deremeik JT, Rainey C, Epstein C. Visual disability variables. II: The difficulty of tasks for a sample of low-vision patients. *Arch Phys Med Rehabil* 2005;86(5): 954-967

51 Massof RW, Ahmadian L, Grover LL, Deremeik JT, Goldstein JE, Rainey C, Epstein C, Barnett GD. The activity inventory: an adaptive visual function questionnaire. *Optom Vis Sci* 2007;84(8):763-774

52 Nagata C, Ido M, Shimizu H, Misao A, Matsuura H. Choice of response scale for health measurement: comparison of 4, 5, and 7-point scales and visual analog scale. *J Epidemiol* 1996;6(4):192-197

53 Berry S, Mangione CM, Lindblad AS, McDonnell PJ. Development of the National Eye Institute refractive error correction quality of life questionnaire: focus groups. *Ophthalmology* 2003;110(12):2285-2291

54 Holden RR, Fekken GC, Jackson DN. Structured personality test item characteristics and validity. *J Res Pers* 1985;19:386-394

55 Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. Oxford University Press Inc. Oxford: 2008

56 Velozo CA, Lai JS, Mallinson T, Hauselman E. Maintaining instrument quality while reducing items: application of Rasch analysis to a self-report of visual function. *J Outcome Meas* 2000;4(3):667-680

57 Massof RW, Fletcher DC. Evaluation of the NEI visual functioning questionnaire as an interval measure of visual ability in low vision. *Vision Res* 2001;41(3):397-413

58 Pesudovs K, Garamendi E, Keeves JP, Elliott DB. The Activities of Daily Vision Scale for cataract surgery outcomes: re-evaluating validity with Rasch analysis. *Invest Ophthalmol Vis Sci* 2003;44(70):2892-2899

59 Garamendi E, Pesudovs K, Stevens MJ, Elliott DB. The Refractive Status and Vision Profile: evaluation of psychometric properties and comparison of Rasch and summated Likert-scaling. *Vision Res* 2006;46 (8-9):1375-1383

60 Bond TG, Fox CM. Applying the Rasch Model. Fundamental Measurement in the Human Sciences. 2nd Edition. Institute of Objective Measurement, USA: 2007

61 Mallinson T, Stelmack J, Velozo C. A comparison of the separation ratio and coefficient alpha in the creation of minimum item sets. *Med Care* 2004(1 Suppl);42:I17-24