Re-engineering the Hong Kong Quality of Life Questionnaire to Assess Cataract Surgery Outcomes

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ABSTRACT

PURPOSE: To assess psychometric properties of the Hong Kong Quality of Life Questionnaire (HKQ) using Rasch analysis and use it to assess cataract surgery outcomes.

METHODS: The HKQ was interviewer administered to participants at baseline (preoperative) and 12 months of follow-up (postoperative). Rasch analysis was used to assess and improve psychometric properties of the HKQ using the preoperative data. The responsiveness of the HKQ was assessed on the stacked preoperative and postoperative data, reported with the effect size.

RESULTS: One hundred ninety-nine participants (median age: 72 years; interquartile range: 65 to 78 years) with cataract completed the HKQ at the preoperative assessment. There were more women (58%) and most of the participants had bilateral cataract (83.9%). Nearly half of the participants had undergone surgery in one eye (45.2%) followed by bilateral surgery (38.7%). Psychometric assessment guided by Rasch analysis resulted into a 15-item HKQ with promising psychometric properties including adequate measurement precision (2.09), no misfitting items, near perfect targeting (-0.05), unidimensionality, and with no evidence of item bias. For those who completed the HKQ (n = 82, 41.2%) at the 12-month follow-up visit, all groups demonstrated statistically significant gains in the HKQ scores, with the highest gain in participants who had undergone bilateral surgery (effect size: 2.61).

CONCLUSIONS: The 15-item HKQ was valid and psychometrically sound and might be a highly responsive instrument to measure cataract surgery outcomes in China. This study demonstrated that cataract surgery significantly improves quality of life in the Chinese population.

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Cataract remains the leading cause of blindness in the world and cataract surgery is the most commonly performed elective surgery worldwide, with high success rates in improving vision and quality of life.[1,2] During the past few decades, we have witnessed a rapid progression in cataract surgical techniques, including a push to bilateral cataract surgery due to the prospect of rapid rehabilitation and economic benefits.[3]

In addition to blindness and visual impairment, cataract is associated with a high rate of falls, accidents, and depression.[4-6] Although the impact of cataract is often explored during a typical cataract assessment, the information gathered that way is unstandardized to evaluate the patients' perspectives. A quantifiable method is to use a well-validated patient-reported outcome measure (PROM) that could

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provide a standardized score of the cataract impact and treatment outcomes. There are currently several cataract-specific PROMs.[7] However, almost all of them were either developed or validated in the western world.[8] We found only one cataract-specific PROM that was specifically developed to cater to the Chinese population (Hong Kong Quality of Life Questionnaire [HKQ]).[8]

The HKQ was validated using a traditional psychometric method called Classical Test Theory.[9] Owing to the shortcomings of the Classical Test Theory, it is important to test whether the HKQ could face up to the standards of the sophisticated psychometric methods such as Rasch analysis. Because its content was primarily developed for a Chinese population, we hypothesized that the HKQ could form a psychometrically superior, better targeted, and highly responsive PROM to cataract surgery in a Chinese population. To test this hypothesis, we first aimed to rescale the HKQ with Rasch analysis and then tested its responsiveness to cataract surgery.

PATIENTS AND METHODS

Study Population

Participants were on the waiting list for cataract surgery at the Eye Hospital of Wenzhou Medical University in China. Participants aged 18 years or older with the primary diagnosis of cataract were enrolled in the study. These patients also had coexisting ocular and/or systemic comorbidities that were not deemed serious enough to affect their answers to the HKQ. All of the participants underwent a comprehensive preoperative assessment. Habitual visual acuity was assessed by Snellen chart and converted into logMAR equivalent for statistical analysis.[10] The HKQ was administered at baseline (preoperative) and postoperative follow-up at 12 months. The study followed the tenets of the Declaration of Helsinki and ethics approval was obtained from the Office of Research Ethics, Eye Hospital of Wenzhou Medical University. All participants provided written consent after the nature and intent of the study were fully explained.

Surgery was performed by experienced surgeons who discussed in person with participants during the preoperative assessment regarding the unilateral and bilateral surgical options and their benefits and risks. For those who opted for bilateral surgery, surgery on the other eye was performed within 48 hours of the first-eye surgery. All participants were admitted as inpatients after surgery and monitored for complications for at least a day.

The HKQ

The HKQ consists of 20 items that are grouped into six different quality of life concepts based on the semantic meaning and the way the items are worded (ie, question format): activity limitation/mobility (9 items); concerns of self-care, safety, and work capability (4 items); symptoms (3 items); social well-being (2 items); emotional well-being (1 item); and global item of overall visual function (1 item) (**Table A**, available in the online version of this article).[9] Each item group has a different question format. Each item was rated on a 5-point scale of disability with descriptive words for each response, such as "very severely affected," "severely affected," "moderately affected," "a little bit affected," and "not affected"; an additional category "not applicable" was scored as missing data.

Psychometric Assessment Using Rasch Analysis

Because there were six different question formats used in the HKQ, an individual Andrich rating scale was applied for each question format. A series of important Rasch-based metrics were assessed, including ordering of the category threshold, person separation (measurement precision), dimensionality, targeting, and differential item functioning. Detailed descriptions of these metrics have been widely published in our previous publications.[11-13] Briefly, category thresholds should monotonically advance in an expected order; a scale should have an adequate precision (ie, person separation index > 2.00). Items should "fit" the underlying construct (fit mean-square: 0.7 to 1.3). Items should be unidimensional (ie, all items together measure a meaningful single underlying trait), which was assessed by the principal component analysis of the residuals (a scale is considered unidimensional if the variance explained by the measure > 50%; eigenvalue of the first contrast < 2.00). Items should be well targeted (< 1.00 logit) to the study population, which is basically calculated as the difference between person mean and item mean, and no item bias, which is represented by differential item functioning for any items by subgroups such as age or gender, where notable differential item functioning occurs when the differential item functioning contrast is greater than 1 logit. If the HKQ demonstrated deficiencies in any of the above metrics, an iterative process to optimize its metrics was performed.

We used preoperative data to test the psychometric properties of the HKQ, then combined preoperative and postoperative data into a single analysis to assess the responsiveness of the HKQ.

Validity

The construct validity of the HKQ was demonstrated by item separation reliability. An item separation reliability of 0.9 or greater indicates that the sample size

TABLE 1
Rescaling Response Categories Across 6 Question Formats

Concept (Original Item No.)	Scale	Ordered Thresholds	New Scale	Ordered Thresholds
Activity limitation (1 to 9)	12345	No	12233	Yes
Concerns (10 to 13)	12345	Yes	12345	Yes
Social (14 to 15)	12345	Yes	12233	Yes
Symptoms (16, 19, 20)	12345	No	12334	Yes
Emotional well-being (17)	12345	No	12334	Yes
Global function (18)	12345	Yes	12345	Yes

is satisfactorily large enough to draw strong inference about the items hierarchy on a difficulty continuum scale. The criterion validity was tested by assessing the correlation between the HKQ scores and visual acuity. A moderate correlation (0.2 to 0.8) is desirable, which indicates that two measures have related constructs but are providing different information.

Responsiveness

The effect size was calculated to assess responsiveness of the HKQ to cataract surgery. The effect size is the mean change in the HKQ scores between the baseline and postoperative follow-up divided by the pooled standard deviation of the preoperative and postoperative scores. The pooled standard deviation was calculated to attenuate the effect of dissimilar sample sizes.[14] It was weighted to each group's standard deviation by its sample size and calculated using the following formula:

$$SD^{*}_{pooled} = \sqrt{[(n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2]/(n_1 + n_2 - 2)}$$

where n_1 = preoperative sample size and n_2 = postoperative sample size; SD_1 = standard deviation of the preoperative HKQ mean score; and SD_2 = standard deviation of the postoperative HKQ mean score.

For this study, the effect sizes of 0 to 0.20, 0.20 to 0.80, and greater than 0.80 were considered small, medium, and large. The effect size was also considered large if the 95% confidence interval was greater than 1.0.[15]

Statistical Analysis

Winsteps software (version 3.91.0; Winsteps, Beaverton, OR) was used for Rasch analysis. For the outcome assessment, Rasch analysis was performed on the stacked-up preoperative and postoperative data. Sociodemographic statistics were computed using SPSS statistical software (version 22; IBM Corporation, Armonk, NY). The Mann–Whitney *U* and Wilcoxon signed-rank tests and Spearman rank correlation were used if one datum or both data were not distributed normally. An independent-sample *t* test was used to compare improvement in HKQ score (the HKQ scores were normally distributed) before and after surgery. Multi-group comparisons of the means were performed by one-way analysis of variance (ANOVA) test with post-hoc contrasts by the Student–Newman–Keuls test. A *P* value of less than .05 was considered statistically significant. The effect size and the 95% confidence interval were calculated using Centre for Evaluation & Monitoring online effect size calculator (http://www.cem.org/effect-size-calculator). We also calculated post-hoc power calculation in effect size estimates to determine whether the sample size was adequately powered using an online calculator (http://www.danielsoper.com/statcalc/calculator.aspx?id=49).

RESULTS

One hundred ninety-nine participants completed the HKQ at baseline. Eighty-two (41.2%) participants came for follow-up assessment and completed the HKQ at 12 months. There were more women, almost 60% had other ocular comorbidities, slightly more than 40% were illiterate, and most of the participants came for the first eye surgery (**Table B**, available in the online version of this article).

Psychometric Assessment and Optimization

Items 5 (difficulty in driving) and 12 (work capability) had missing data for 86.2% and 52%, respectively, and were excluded. The 18-item HKQ demonstrated borderline measurement precision (1.92) with disordered categories. Except for the concerns (items 10 to 13) and global (item 18) items, all other question formats demonstrated disordered thresholds, indicating that the categories were not functioning as per Rasch expectations (**Table 1**, **Figure A** top, available in the online version of this article). Ordering was restored by collapsing categories (**Table 1**, **Figure A** bottom).

Three items were grossly misfitting (item 16 = sensitivity to light, infit = 1.8 and outfit = 2.07; item 18

TABLE 2
Psychometric Properties of the Hong King Quality of Life Questionnaire

Parameter	Rasch Model Expectation	The Hong Kong Quality of Life Questionnaire		
		1st Iteration[a]	2nd Iteration[b]	3rd Iteration
No. of items	–	18	18	15
Response categories ordering	Ordered	Disordered[a]	Ordered	Ordered
Person separation Index	> 2.0	1.92	1.58	2.09
Item separation Index	> 3.0	7.42	7.41	8.90
No. of items with infit mean-square >1.5	0	2	2	0
PCA analysis: % variance explained by measure	> 50%	48.1	42.0	53.3
PCA analysis: Eigenvalue 1st contrast	< 2.0	2.8	2.9	2.1
Targeting	< 1.0 logits	-0.36	-0.20	-0.05
DIF (age, gender, first vs second eye surgery, ocular & systemic comorbidities)	< 1.0 logits and $P > .05$	None	None	None

PCA = principal component analysis of the residuals; DIF = differential item functioning, was assessed for age and gender
[a]Items 5 (89%) and 12 (59%) deleted due to high missing value.
[b]Disordered categories fixed and items 16, 18, and 19 deleted due to high misfitting.
[c]Disordered for 4 of 6 question formats.

TABLE 3
Preoperative and Postoperative HKQ Scores, Change in Scores, and Effect Size

Parameter	Preoperative Mean ± SD[a]	Postoperative Mean ± SD[a]	Change Mean ± SD[a]	t[b]	Effect Size (95% CI)	Post-hoc Power Calculation
Overall (n = 82)	-0.22 ± 0.99	-2.80 ± 1.30	2.58 ± 1.46	15.96	2.23 (1.83 to 2.61)	1.0
First-eye (n = 36)	-0.46 ± 0.93	-2.67 ± 1.50	2.20 ± 1.58	8.35	1.77 (1.21 to 2.30)	0.92
Bilateral (n = 37)	0.08 ± 1.00	-2.87 ± 1.25	2.95 ± 1.35	13.24	2.61 (1.96 to 3.20)	0.99
Without ocular comorbidity (n = 31)	-0.45 ± 0.94	-3.19 ± 1.26	2.73 ± 1.41	10.82	2.46 (1.78 to 3.09)	0.99
With ocular comorbidity (n = 51)	-0.08 ± 1.00	-2.56 ± 1.38	2.48 ± 1.50	11.81	2.06 (1.56 to 2.52)	0.99
Without systemic comorbidity (n = 30)	-0.51 ± 1.13	-3.54 ± 1.35	2.54 ± 1.52	9.09	2.43 (1.74 to 3.07)	0.99
With systemic comorbidity (n = 52)	-0.06 ± 0.87	-2.66 ± 1.37	2.60 ± 1.43	13.05	2.27 (1.76 to 2.74)	1.0

HKQ = Hong Kong Quality of Life Questionnaire; SD = standard deviation; CI = confidence interval
[a]Higher negative score indicates better visual function.
[b]Independent-samples t test, P < .001 for all.

= subjective overall visual function, infit = 1.85 and outfit = 2.00; and item 19 = pain and discomfort in your eyes, infit and outfit > 1.50) and were deleted from the scale one at a time. The resulting 15-item HKQ demonstrated promising psychometric properties including ordered response categories, unidimensionality, excellent targeting, and free of item bias (**Table 2**).

Validity

The 15-item HKQ had excellent item separation index (8.80) and item separation reliability (0.99), indicating an adequate construct validity. Preoperative visual acuity was moderately correlated with the HKQ (better eye, $r = 0.50$; worse eye, $r = 0.34$; $P < .001$), indicating criterion validity of the HKQ.

Outcomes and Responsiveness

Only 9 participants in the second-eye surgery group came for the follow-up, so this group was not included in the post-hoc analysis. A significant difference in the mean HKQ scores was observed preoperatively between the first-eye and bilateral surgery groups (mean difference = -0.54, $P = .05$); however, there was no statistically significant difference postoperatively (mean difference = 0.20, $P = .69$). At 12 months, a significant gain in the HKQ scores was observed for the overall group (2.58, $P < .0001$), first-eye group (2.23, $P < .0001$), and bilateral surgery group (2.90, $P < .0001$). Similarly, all four comorbidity groups also significantly improved their scores postoperatively (**Table 3**).

The HKQ was highly responsive to cataract surgery (**Table 3**). Among all groups, the bilateral surgery

group had the lowest preoperative scores, the largest gain in postoperative scores, and subsequently demonstrated the largest effect size (**Table 3**). For all groups, the post-hoc power estimate was 90% or greater, indicating the sample sizes were adequate for the effect size estimates.

DISCUSSION

The re-engineered HKQ was psychometrically sound, valid, and highly responsive to cataract surgery. In terms of responsiveness, the HKQ is equivalent to the Catquest, which is considered the best cataract-specific instrument.[7,16]

Similar to this study, a high percentage of missing data on driving items was reported in other studies conducted in China.[17,18] Unlike in western countries, driving is not common in China, especially in the elderly population. Hence, the relevance of the driving items is questionable. Similarly, more than half of the participants did not respond to item 12 (work capability), probably because most were elderly and retired. Because high missing data could introduce bias on Rasch indices, these two items were excluded for further analysis.[19] Misfitting items are an indication that the items are not related to the underlying construct being measured by the scale and the presence of these items would most likely contaminate the measurement by introducing more noise. The advantage of Rasch analysis is that it flags misfitting items and provides an opportunity to discard them to create a unidimensional instrument. By doing so, Rasch analysis is minimizing possible noise in the measurement. In the case of the HKQ, items 16 and 19 were items on symptoms and appear to measure a distinctly different latent trait than the other items. Similarly, item 18 (global item on overall visual function) did not fit. From the content point of view, item 18 seems to be of value; however, it is too general to fit in with the other remaining items. A similar phenomenon was also observed while re-engineering other instruments in which global health and vision items often misfit.[11]

When compared to all of the existing translated and validated cataract-specific instruments in China (the Visual Function Index-14, targeting = -0.83; Catquest, targeting = 0.50; National Eye Institute Visual Functioning Questionnaire, targeting = -1.25), the HKQ demonstrated much better targeting in fact had a near perfect (item and person mean difference = -0.05) targeting.[16,17,20] This is probably because the HKQ items were specifically developed for Chinese people. This demonstrates the significance of population-specific content development in the performance of an instrument.

In this study, we found that the change in postoperative scores and the subsequent effect sizes for the HKQ were higher than those we observed with the Catquest.[16] Because the Catquest is considered the highest quality cataract-specific instrument, our results indicated that the HKQ was probably more sensitive to cataract in a Chinese population than any of the existing instruments. This study also confirmed our previous findings that people with bilateral cataract benefit from undergoing bilateral surgery.[16] Similar findings were reported in a study performed in Canada.[21] If bilateral surgery is uneventful, patients would mostly likely enjoy rapid rehabilitation and do not have to endure poor quality of life while waiting for the second eye surgery. These benefits may also translate to lower costs to the health system and the affected individuals.[22] These are important findings that we believe have policy implications in a country such as China where there is a huge backlog of people needing cataract surgery and a significant discrepancy exists between the available services and the need. In recent years, cataract surgery has demonstrated a high level of efficacy with minimal complications; therefore, bilateral surgery could be adopted as the new norm in routine practice.[23]

A limitation of this study was the low follow-up rate, which probably adds bias to our findings. Poor follow-up could be attributed to many factors, including cultural trend, such as elderly Chinese people generally do not like to travel away from their home towns and also those who are generally happy with the outcomes would not travel a long distance until there are obvious complications.[24,25] To assess the confidence in our analysis, we performed post-hoc power calculations. All groups had adequate power, indicating adequate sample sizes. However, a further study with a larger sample size and with better strategies to increase follow-up is warranted.

The 15-item HKQ was a valid, unidimensional scale and it might be a highly responsive cataract-specific instrument for the Chinese population with cataract. The HKQ was probably the best instrument in terms of its psychometric properties and responsiveness than any of the previously translated and validated cataract-specific instruments. Furthermore, our study also added to the existing evidence that cataract surgery significantly improves quality of life more in people who undergo cataract surgery in both eyes. Due to its relevant content, relatively shorter length, and probable high responsiveness, the HKQ might be the best suited instrument to measure the impact of cataract and its treatment in Chinese settings.

AUTHOR CONTRIBUTIONS

Study concept and design (JK, RG, QW); data collection (HC, SZ, JH); analysis and interpretation of data (JK, QW, JH, KP); writing the manuscript (JK, JH); critical revision of the manuscript (RG, HC, SZ, QW, JH, KP); statistical expertise (JK, RG, JH); administrative, technical, or material support (JK, HC, SZ); supervision (QW, JH, KP)

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TABLE A

Items of the Original and Revised HKQ and Concepts They Measure

Item	Concept	HKQ-15 items
1. Do you experience difficulties seeing cars, traffic lights, or road signs in the street?	Activity limitation	Yes
2. Do you experience difficulties recognizing people's faces and gestures across the street?	Activity limitation	Yes
3. Do you experience difficulties recognizing shops, banks, or other places across the street?	Activity limitation	Yes
4. Do you experience difficulties recognizing the number or destination of approaching buses or vans or whether a taxi is vacant?	Activity limitation	Yes
5. Do you experience difficulties driving because of visual impairment?	Activity limitation	No
6. Do you experience difficulties reading small print in newspapers, books, or magazines because of visual impairment?	Activity limitation	Yes
7. Do you experience difficulties seeing prices tags in supermarkets or shops, bank slips, electric or water bills, or food or medicine labels because of visual impairment?	Activity limitation	Yes
8. Do you experience difficulties making telephone calls, taking medicine, or signing your name because of visual impairment?	Activity limitation	Yes
9. Do you experience difficulties going down stairs, curbs, or slopes because of visual impairment?	Activity limitation	Yes
10. Do you have experience of bumping into objects and other people or falling down because of visual impairment?	Concerns	Yes
11. Is your ability to take care of yourself affected by visual impairment?	Concerns	Yes
12. Is your working capability affected by visual impairment?	Concerns	No
13. Are your usual entertainments affected by your visual impairment (exercise, mah-jongg, card games, watching television or movies, sewing)?	Concerns	Yes
14. Do you avoid going out, visiting people, or traveling because of visual impairment?	Social well-being	Yes
15. Do you need assistance from others because of visual impairment?	Social well-being	Yes
16. Do you experience sensitivity to light, seeing shadows around a light, or seeing multiple images?	Symptoms	No
17. Do you feel worried, emotional, or frustrated by your visual impairment?	Emotional well-being	Yes
18. What is your subjective overall visual function using both eyes?	Global item	No
19. Do you experience pain or discomfort in your eyes?	Symptoms	No
20. Do you experience redness or discharge in your eyes?	Symptoms	Yes

HQK = Hong Kong Quality of Life Questionnaire

TABLE B

Demographic Characteristics of the Participants

Characteristic	Preoperative (n = 199)	Postoperative (n = 82)
Median age, y (interquartile range; range)	72.0 (65 to 78; 28 to 92)	72.50 (65 to 79; 45 to 86)
Sex, n (%)		
Female	116 (58)	53 (64.6)
Surgery type, n (%)		
First eye one eye surgery	90 (45.2)	36 (43.9)
First eye both eyes surgery	77 (38.7)	37 (45.1)
Second eye surgery	32 (16.1)	9 (11.0)
Visual acuity logMAR, median, range (Snellen equivalent)		
First eye (operated)	1.0 (6/60), 0.10 to 2.70 (6/7.5 to 1/500)	0.15 (6/8.4), -0.08 to 2.70 (6/4.8 to 1/500)
Second eye (operated)	1.15 (6/85), 0.30 to 2.28 (6/12 to 1/190)	0.00 (6/6), -0.1 to 0.30 (6/4.8 to 6/12)
Both eyes (worse eye)	1.0 (6/60), 0.00 to 2.70; 2.0 (6/6 to 1/500)	0.22 (6/10), -0.1 to 1.40 (6/4.8 to 6/150)
Both eyes (better eye)	0.78 (6/36), 0.00 to 2.00 (6/6 to 6/600)	0.1 (6/7.5), -0.1 to 0.40 (6/4.8 to 6/15)
Cataract classification, n (%)		
Age-related	126 (63.3)	
Diabetic	36 (18.1)	
Complicated cataract	35 (17.6)	
Steroid-induced	2 (1.0)	
Ocular comorbidity,n (%)[a]	115 (57.8)	45 (54.8)
Glaucoma	7 (3.5)	3 (6.7)
Age-related macular degeneration	4 (2.0)	3 (6.7)
Diabetic retinopathy	8 (4.0)	0
Pathological myopia	31 (15.6)	12 (26.7)
Corneal disorders	8 (6.9)	3 (6.7)
Other	86 (43.2)	24 (53.4)
Systemic comorbidity,[a] n (%)	131 (65.8)	51 (62.2)
Hypertension	99 (49.7)	27 (52.9)
Diabetes	45 (22.6)	17 (33.3)
Other	28 (14.1)	7 (13.7)
Literacy, n (%)		
Illiterate	83 (41.7)	31 (37.8)
Primary school	54 (27.1)	26 (31.7)
Junior middle school	35 (17.6)	13 (15.9)
Senior middle school	14 (7.0)	5 (6.1)
University	13 (6.5)	7 (8.5)
Subjective rating of overall visual function		
Not affected	1.2%	
A little bit affected	20.7%	
Moderately affected	56.1%	
Severely affected	22.0%	

[a]*Percentages of comorbidities equal more than the total sum because some ocular and systemic conditions coexist.*

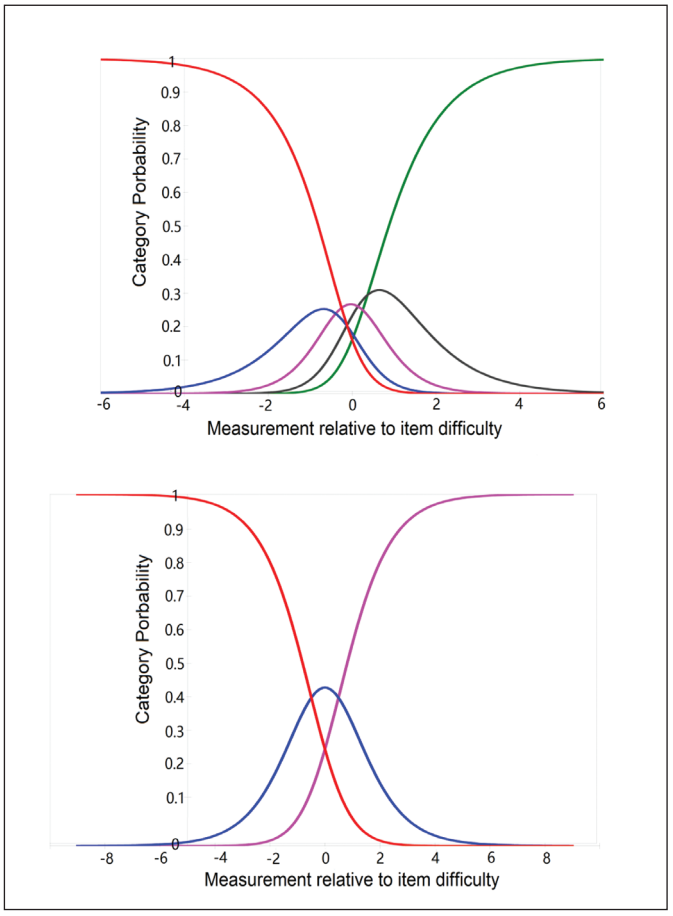

Figure A. Category probability curves for the "activity limitation" items showing disordered categories (top). After disordered categories were fixed for the "activity limitation" items (bottom).