1040-5488/16/9302-0181/0 VOL. 93, NO. 2, PP. 181–187
OPTOMETRY AND VISION SCIENCE

ORIGINAL ARTICLE

Rasch Analysis of the Independent Mobility Questionnaire

Eva K. Fenwick*, Fleur O'Hare†, Lil Deverell‡, Lauren N. Ayton*, Chi D. Luu*, Shane McSweeney§, Sharon A. Bentley*, Robyn H. Guymer*, and Robert P. Finger*

ABSTRACT

Purpose. The Independent Mobility Questionnaire (IMQ) assesses participants' perceived ability for independent mobility. However, it has not been validated in a severely visually impaired population. The aim of this study was to explore the IMQ's psychometric properties in participants with severe visual impairment.

Methods. This was a cross-sectional study of 40 participants with retinitis pigmentosa (better eye visual acuity <20/200 and/or visual field <10%). The key psychometric properties of the IMQ were examined using Rasch analysis, including precision, targeting, and item fit. Construct validity was assessed by testing the correlation between the IMQ and the Mobility and Independence subscale of the Impact of Vision Impairment questionnaire (Pearson correlation coefficient, r). Criterion validity was also assessed.

Results. The IMQ had excellent precision (Person Separation Index, 3.01) with the capacity to distinguish at least four strata of participant ability, and item difficulty was well targeted to participant ability (difference between mean person and item measures, −0.21). Items 34, 35, 21, and 14 displayed misfit (infit MnSq >1.4); however, given our sample size restrictions, these items were not removed from the analysis. The IMQ had good construct validity (moderate correlation with the Impact of Vision Impairment Mobility subscale, $r = 0.595$, $p < 0.05$) but did not demonstrate criterion validity.

Conclusions. The psychometric properties of the IMQ were promising. Our findings are useful for researchers evaluating the effectiveness of novel treatment technologies on mobility in a severely visually impaired population from the participant's perspective. However, further validation studies in larger samples are required to confirm our results.
(Optom Vis Sci 2016;93:181–187)

Key Words: Rasch analysis, mobility, questionnaire, retinitis pigmentosa, visual impairment

Inherited retinal diseases such as retinitis pigmentosa (RP) cause severe vision impairment and blindness over time.[1–3] Potential future treatments to restore vision from such conditions include retinal transplants, artificial retinal implants, gene therapy, and stem cells. As part of the assessment of effect (or efficacy) required by regulatory authorities as part of any clinical trial of these novel interventions, patient-reported outcomes (PROs) are increasingly used as outcome measures in clinical practice, research, audits, and trials involving patients.[4] However, most currently available vision-related PRO measures were developed and validated in patients with mild or moderate visual impairment and may not be valid for use in severely visually impaired samples.[5,6] Therefore, these vision-related PROs need to be validated and/or adapted for use in these participants.[7]

Orientation and mobility (O&M) are vital real-world functions and principal fields of inquiry for many new interventions for people with severe visual impairment.[8] However, very few PRO measures have been developed to specifically and comprehensively assess O&M.[9] Most visual functioning questionnaires, such as the Visual Functioning Index (VF-14)[10] and the Activities of Daily Vision Scale,[11] primarily contain items about day to day tasks (e.g., reading) but not mobility or orientation. Only one questionnaire, to our knowledge, has been specifically developed to assess peoples' perceived ability for independent mobility, namely, the Independent

*PhD
†MPhil(Med)
‡MEd
§BOT

Center for Eye Research Australia, University of Melbourne, Royal Victorian Eye and Ear Hospital, Melbourne, Victoria, Australia (EKF, FO'H, LD, LNA, CDL, SMc, RHG, RPF); and Australian College of Optometry, University of Melbourne, National Vision Research Institute Melbourne, Victoria, Australia (SAB).

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.optvissci.com).

Mobility Questionnaire (IMQ).[9,12] The IMQ is composed of 35 items (questions) covering themes related to O&M such as moving around, using steps and stairs, walking in challenging lighting conditions, and avoiding objects.

The IMQ was initially validated in a sample of participants with RP.[9] However, the validation sample only included those with moderate visual impairment (mean logMAR visual acuity [VA], 0.26; range, −0.12 to 1.02), approximately Snellen 20/40 (range, 20/16 to 2/200), and, as such, it is unclear whether the IMQ is valid for use in a sample that is severely vision impaired or blind (i.e., VA <20/200 or field <10 degrees), such as subjects who are currently candidates for many of the restorative treatments undergoing trials and even approved interventions such as with prosthetic retinal implants.

Therefore, the aim of the current study was to examine the psychometric properties of the IMQ in the same sample of RP participants with severe visual impairment on whom we reported in our previous study on instrumental activities of daily living (Finger et al. Developing a very low vision orientation and mobility test battery as part of the Low Vision Assessment of Daily Activities (LoVADA) protocol. Submitted to *OVS* June 19, 2015). Given the limited sample size in this study (N = 40), we focus mainly on the precision and targeting of the IMQ.

RESEARCH DESIGN AND METHODS

The study was conducted between September 2012 and December 2013 at the Centre for Eye Research Australia, Royal Victorian Eye and Ear Hospital. Ethical approval was obtained from the Human Research and Ethics Committee at the Royal Victorian Eye and Ear Hospital. All participants gave informed consent for study participation. The study adhered to the tenets of the Declaration of Helsinki.

Study Design and Participants

All participants were adults (aged ≥18 years) and legally blind according to the Australian definition, which is based on either distance VA <20/200 in the better eye or a binocular visual field (VF) restriction to 10 degrees from fixation or less, or both. Participants answered background questionnaires and underwent a complete clinical ocular examination. Refraction was determined via autorefraction, followed by a monocular subjective refinement where possible. Best corrected VA was recorded both monocularly and binocularly using a standard testing protocol. All participants were first tested on an ETDRS (Early Treatment of Diabetic Retinopathy Study) logMAR visual acuity chart at 4 m. Because all participants had vision of equal to or worse than logMAR 1.0 (20/200) in their better eye, the vision was then tested on the ETDRS charts at 1 m. For participants who were unable to see the chart at 1 m, VA was measured using the Berkeley Rudimentary Vision Test.[13] Visual acuity was converted into logMAR values for subsequent statistical analyses.

Remaining VF was mapped using manual kinetic Goldmann perimetry,[14] with the V4e target size. Percentage of remaining field was quantified as described previously.[6] In brief, the hard copy Goldmann fields were scanned into ImageJ image processing software (Research Services Branch, National Institute of Mental Health, Bethesda, MD). The percentage of field seen was determined by comparing the field seen with the total possible field area. For the purposes of this study, the total VF remaining included both central field (within 10 degrees from fixation) and peripheral islands.

The Independent Mobility Questionnaire

The IMQ was developed to assess participants' perceived ability for vision-specific independent mobility in a cohort of patients with moderate visual impairment from RP.[9] It is composed of 35 items about mobility situations (e.g., "walking in familiar areas," see Appendix, available at http://links.lww.com/OPX/A230), and participants are directed to rate their level of difficulty in each situation without assistance (e.g., use of a cane, companion, guide dog, etc.). If an activity cannot be performed without assistance, a "nonapplicable" option applies. However, because more than 80% of our sample reported using a primary mobility aid habitually for travel (Table 1) and were therefore unable to answer most of the IMQ items, we directed participants to answer taking their preferred mobility aid, if required, into account.

In the original IMQ, each item was rated on a 5-point Likert-type scale ranging from 1 *no difficulty* to 5 *extreme difficulty*. Response categories 2, 3, and 4 did not have descriptors and were simply numbered. Content was developed based on clinical experience and a literature review.[9] The IMQ was validated using Rasch analysis and had good response category functioning, scale precision (content validity), and item fit and person fit (construct validity).[9] In this original validation article, person measures correlated significantly with visual field area and contrast sensitivity, and there was a linear relationship between person measures and years past onset of first visual field loss, indicating that visual ability for independent mobility decreases in proportion to years of disease progression.[9] The

TABLE 1.
Participant characteristics, N = 40

		Mean ± SD or n (%)
Age, yr		53 ± 16
Age category	55+	21 (52.5)
	<55	19 (47.5)
Sex	Male	21 (52.5)
	Female	19 (47.5)
Binocular VA (logMAR)		2.3 ± 1.0 (median, 2.0; range, 0.5–4.0)
VA category	>2.0 logMAR	19 (47.5)
	≤2.0 logMAR	21 (52.5)
% VF remaining		11.8 ± 20.4
% VF	0–10%	28 (70.0)
	>10%	12 (30.0)
Preferred mobility aid	None	7 (17.5)
	Long cane	19 (47.5)
	Guide dog	9 (22.5)
	Sighted guide	4 (10.0)
	Identification cane	3 (7.5)
	Other	1 (2.5)

logMAR, logarithm of the minimum angle of resolution; VA, visual acuity; VF, visual field.

IMQ was also subsequently validated using Rasch analysis in a sample of glaucoma patients.[12] In the current study, the adapted IMQ (with the questions relating to performance with their habitual mobility aid) was delivered face to face to 40 participants by a single trained interviewer.

Psychometric Validation of the IMQ

Modern psychometric methods such as Rasch analysis[15] convert ordinal-level data into data approximating interval-level measures.[16] In the case of the IMQ, a high person measure (in logits) indicates that a person possesses a low level of perceived independent mobility. Rasch analysis also provides significant insight into the psychometric properties of the scale, such as response category functioning, scale precision, unidimensionality, item 'fit' to the construct, targeting, and differential item functioning.[17] Given that response category functioning, differential item functioning (DIF), and dimensionality are affected by a small sample size, we focus our analysis on precision, targeting, and item fit.

Scale Precision

The ability of the IMQ to discriminate between different levels of perceived independent mobility was assessed by the Person Separation Index (PSI) and person reliability (PR). Generally, scales should have the capacity to distinguish between at least three levels of the latent trait, which corresponds to PSI and PR values higher than 2.0 and higher than 0.8, respectively.[18]

Scale Targeting

Targeting is determined through inspection of the person-item map. Poor targeting occurs when persons generally have a higher or lower "ability" than the most or least item difficulty threshold or when items are clustered at particular levels of difficulty, leaving large gaps.[19] Targeting is measured by calculating the difference between the mean of item "difficulty" (defined as 0.0 logits) and the mean of person "ability." Generally, a difference between the mean person and item score of more than 1.0 logits indicates notable mistargeting.[19]

Item Fit

To determine how well each item "fits" the underlying trait (i.e., O&M) and how predictably the data fit the model, we considered the "infit" and "outfit" MnSq statistics.[19] Values of less than 0.6 may indicate item redundancy, whereas values higher than 1.4 indicate measurement "noise" or distortion in the responses.[20] We consider infit first followed by outfit, as suggested in the Ophthalmology literature.[19]

Construct Validity

We tested the convergent validity (a type of construct validity) of the IMQ by assessing its correlation with the Mobility and Independence subscale of the Impact of Vision Impairment (IVI) questionnaire (Pearson correlation coefficient, r).[21,22] Because both scales assess similar constructs, we hypothesized that the IMQ would be significantly moderately correlated with the IVI Mobility and Independence subscale.

Criterion Validity

We assessed the criterion validity of the IMQ by testing its ability to discriminate between participants with VA ≥2.0 LogMAR and <2.0 LogMAR and total binocular remaining VF ≤10 and >10 degrees. The visual acuity categories reflect the cutoff of VA measurable by available VA charts (equivalent to 20/2000) and between "near-blindness" and "blindness" as defined in the American Medical Association *Guides to the Evaluation of Permanent Impairment*.[23] The visual function categories reflect the Australian definition of legal blindness. Differences between groups were evaluated using analysis of variance. Statistical analyses were undertaken using Statistical Package for the Social Sciences version 11.2.

RESULTS

Sociodemographics

A total of 40 participants were included. All were legally blind because of a rod-cone dystrophy, with the majority having autosomal recessive RP (>80%). Mean age was 53 years, and one-half of the sample was male (53%; Table 1). The mean binocular VA was 2.3 logMAR, which is in the range of hand movement to count finger vision, and 70% of the sample had less than 10% of VF remaining (Table 1).

Psychometric Evaluation of the IMQ

We performed Rasch analysis on the IMQ using Winsteps software (version 3.81; Chicago, IL)[24] using the Andrich single rating scale model.[25] The IMQ had excellent precision with the capacity to distinguish at least four strata of person ability (PSI, 3.01; PR, 0.90) (Table 2). Likewise, item "difficulty" was well

TABLE 2.

Fit parameters of the IMQ compared with the Rasch model in patients with retinitis pigmentosa

Parameters	Rasch model	IMQ overall (N = 40)
Item no.	—	1–35
Disordered thresholds	No	Yes*
Person Separation Index	>2.0	3.01
Person reliability	>0.8	0.90
Model measurement error (SD)	—	0.18 (0.55)
Item fit (infit MnSq)	>0.6 and <1.4	Item 34 (1.75)* Item 35 (1.53)* Item 21 (1.51)* Item 14 (1.40)*
Item fit (outfit MnSq)	>0.6 and <1.4	Item 34 (1.65)* Item 21 (1.51)* Item 6 (1.47)*
Targeting, difference between person and item mean	<1.0	−0.12

*Values indicate suboptimal fit to Rasch model parameters.
SD, standard deviation.

targeted to patient ''ability,'' with the difference between person and item means only −0.12 logits. Inspection of the person-item map (Fig. 1) demonstrated that the ability levels experienced by the participants were well covered by the difficulty level of the 35 items, with very few gaps apparent. Item 3 ''Moving about at home'' was perhaps too ''easy'' for the majority of participants, whereas another more difficult item may be required to target those at the extreme end of the ability spectrum.

Item 3 ''Moving about at home'' and item 1 ''Walking in familiar areas'' (1.82 and 1.25 logits, respectively) required the least visual ability, and item 35 ''Seeing cars at intersections'' and item 2 ''Walking in unfamiliar areas'' (−1.15 and −0.85 logits, respectively) required the most visual ability (Appendix, available at http://links.lww.com/OPX/A230).

Category thresholds were slightly disordered, and categories 2 and 4 were never the most probable categories to be chosen, irrespective of the respondent's level of perceived independent mobility (Fig. 2). However, we did not collapse categories because the disordering is likely caused by our small sample size and also related to the truncated population (i.e., our sample is limited to those with severe visual impairment). Moreover, it is possible that patients' VA will improve after treatments such as retinal implants, rendering the full spectrum of the IMQ's response options relevant.

Five items (items 6, 14, 21, 34, and 35) displayed misfit (infit MnSq and/or outfit MnSq >1.4). Item 34 ''Finding restrooms/washrooms in public places'' had a particularly high infit MnSq value of 1.75, suggesting that there is more noise than signal associated with this item. We did not remove any items during our analysis because the item fit statistics should be replicated in another study with a larger sample size before confident decisions about scale amendments can be made. The IMQ had moderate to high correlation ($r = 0.595$, $p < 0.05$) with the IVI Mobility and Independence subscale, suggesting good convergent validity.

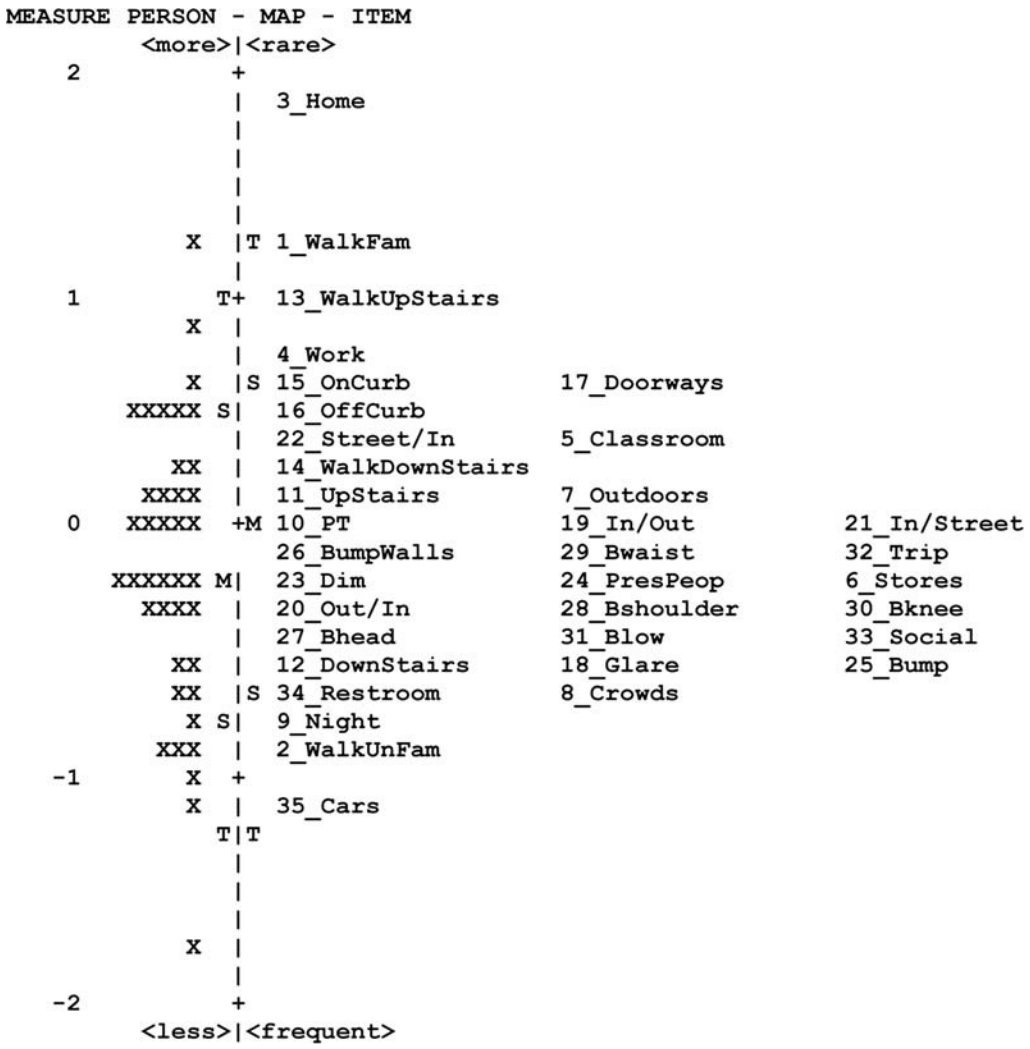

FIGURE 1.

Person-item map for the IMQ (all 35 items). To the left of the dashed line are the participants, represented by X, and on the right are the items, denoted by their item number. Participants with lower perceived independent mobility and the most ''difficult'' items are near the bottom of the diagram, and participants with higher perceived independent mobility and items that can be performed with least ''difficulty'' are near the top. This figure demonstrates that the mean of person perception and item difficulty are very close, suggesting that targeting of item difficulty to patient ability is very good. Item 3 ''Moving about at home'' is the easiest to endorse item and is not optimally targeted to the ability level of this sample. Item 35 ''Seeing cars at intersections'' is the hardest to endorse item. M, mean; PSI, Person Separation Index; S, 1 SD from the mean; T, 2 SD from the mean.

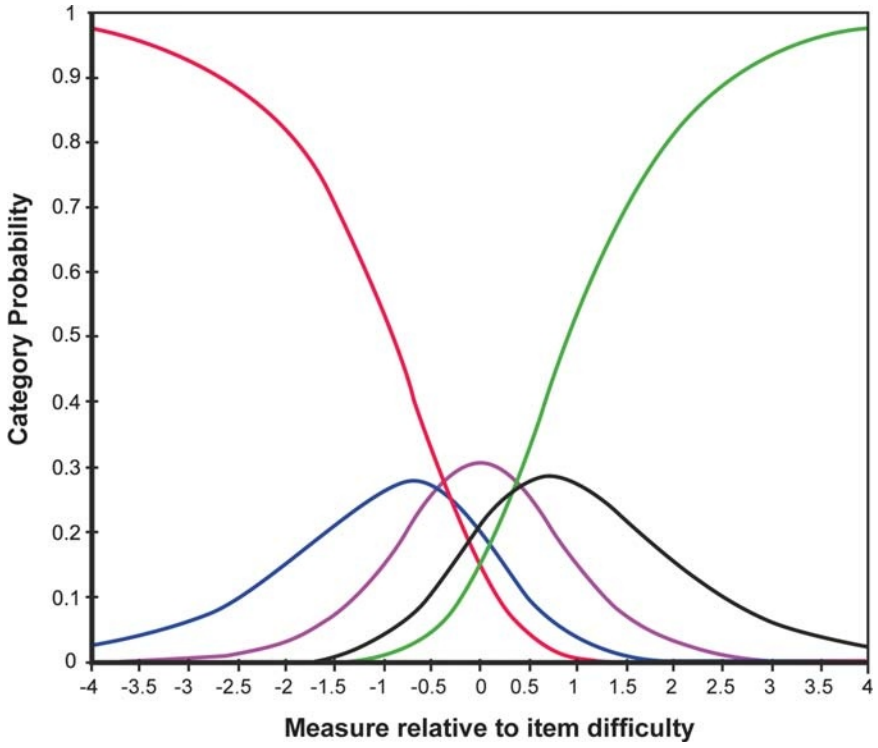

FIGURE 2.

Category probability curves for the IMQ (all 35 items) showing disordered thresholds. At no point are categories 2 (blue) and 4 (gray) the most probable categories to be chosen, irrespective of the respondent's location along the scale. Red, no difficulty; blue, response category 2; pink, response category 3; gray, response category 4; green, extreme difficulty.

The IMQ did not differentiate between categories of VA and VF, suggesting a lack of criterion validity.

DISCUSSION

The IMQ had promising psychometric properties in a population with severe visual impairment from RP, if participants can rate their level of difficulty in each situation with assistance from their habitual mobility aid (if required). The IMQ had excellent precision and targeting, suggesting that it is well suited for use in a severely visually impaired population and may be a useful outcome measure to assess change in patient mobility after intervention. Further validation in a larger sample of severely visually impaired patients is required to explore other psychometric properties, such as unidimensionality and DIF, which was not possible in the current study because of sample size restrictions.

Our findings largely support the initial validation studies of the IMQ, which found that the scale had excellent precision and targeting.[9,12] For example, the PSI of the IMQ in the original sample of patients with RP[9] and the subsequent glaucoma sample[12] was 4.55 and 4.05, respectively. In our sample of RP patients with severe visual impairment, the PSI was 3.01, which is excellent considering the small sample size of 40. Similarly, the targeting of the IMQ in our population was very good, with the mean of person measures −0.12 indicating that, on average, the perceived visual ability of the subjects in our sample was very close to the average ability required by the 35 items. Targeting of the IMQ was better in our sample than in the original RP sample (mean person measure, −0.45) and much better than in the glaucoma sample (mean person measure, 1.99). In our study, we found that items 34, 35, 21, and 14 had high infit MnSq values, which may indicate misfit to the Rasch model. In the original RP sample,[9] items 21 and 14 also had high infit MnSq values (1.62 and 1.55, respectively), whereas in the glaucoma sample,[12] items 34 and 35 had high infit MnSq values (10.60 and 1.46, respectively). These items may be contributing a high degree of measurement "noise," and future studies should investigate whether these findings are replicated.

In our study, we altered the original instructions to allow participants to rate their level of difficulty in each situation with assistance from a mobility aid, if required, to avoid overuse of the "nonapplicable" option. Although changing the preamble to the IMQ in a very visually impaired sample makes comparisons with less visually impaired participants problematic, it broadens the scale's applicability across the spectrum of disease severity. Other PRO measures in ophthalmology, such as the Activity Inventory,[26] allow performance to be rated with the use of aids. This allows improvement after interventions (which could include the provision of aids) to be measured.

Our assessment of the psychometric properties of the IMQ was restricted by our small sample size. Although Rasch analysis generally does not require large numbers of participants,[27] certain Rasch parameters are particularly affected by very small sample sizes, such as response category functioning, item fit,[28] and DIF.[29] Indeed, Chen et al.[28] have shown that analyses based on small sample sizes (<50) can lead to opposite conclusions to those based on large sample sizes (>100). Therefore, we have conducted an exploratory Rasch analysis on our data, taking precision and targeting as the most important parameters for this study. Although we identified some response category disordering and some item misfit, we have not

modified these aspects because the findings may be different in a larger sample. Given that the IMQ has been validated previously using Rasch analysis,[9,12] we feel that a limited validation in our population is justified and, moreover, is still valuable for researchers wishing to use the IMQ in a severely visually impaired patient group. In the original validation studies,[9,12] unidimensionality of the IMQ was not reported. Given the large number of items in the IMQ and the fact that some items are very similar (e.g., items 27 to 31), a thorough exploration of dimensionality and local item dependency is warranted in future studies with larger sample sizes.

In our sample, the easiest item related to moving around familiar areas and was identical to that which Turano et al.[9] reported in a sample of persons with RP with moderate visual impairment. Similarly, the two most ''difficult'' items reported in the original validation study were ''walking at night'' and ''walking about in crowded situations,'' which were the third and fourth most difficult items in the current study. This suggests that ''easy'' and ''difficult'' mobility situations are relatively comparable across persons with RP with differing levels of visual impairment.

We found that the IMQ demonstrated good construct validity, being moderately correlated with another well-validated measure of mobility and independence. However, the IMQ did not discriminate between clinical measures of visual function, which may be caused by our reasonably homogeneous sample. Our results are not unlike those of Turano et al.,[9] who found only a modest correlation between the IMQ and log retinal area and no correlation with VA.

Our findings are relevant for clinicians and researchers working in populations with severe visual impairment who wish to evaluate treatments where improvements in VA may be minimal or treatments that target a specific area of functional vision such as edge detection. Orientation and mobility have a substantial effect on quality of life[30–32] and are key fields of inquiry for studies wishing to improve participant outcomes. As the IMQ is the only vision-specific O&M PRO measure currently available, it is vital that it is rigorously validated. Our study supports and builds on the original validation studies and, for the first time, explores its application for use in very visually impaired populations.

The strengths of our study include the use of Rasch analysis to explore the IMQ's psychometric properties. The main limitation is our small sample size because evidence suggests that certain Rasch parameters may be unreliable in small sample sizes.[28] A replication of this analysis in a larger sample of severely visually impaired participants and in participants with other eye diseases is required to ensure that our results are valid.

In conclusion, we found that the psychometric properties of the IMQ were promising in our sample of people with severe visual impairment from RP when questioned about their self-perception of mobility while using their habitual mobility aid. These findings are useful for clinicians and researchers to evaluate, from the participant's perspective, the impact of novel treatment technologies on O&M in people with severe visual impairment.

ACKNOWLEDGMENTS

Supported by the Australian Research Council through its Special Research Initiative in Bionic Vision Science and Technology grant to Bionic Vision Australia, and a Retina Australia Research Grant to LNA and SAB. CERA receives Operational Infrastructure Support from the Victorian Government and is supported by NHMRC Centre for Clinical Research Excellence Award 529923. EKF is the recipient of an NHMRC Early Career Fellowship (1072987).

Received May 18, 2015; accepted September 18, 2015.

APPENDIX

The Appendix, a list of the 35 items in the IMQ and difficulty ratings, is available at http://links.lww.com/OPX/A230.

REFERENCES

1. Grover S, Fishman GA, Anderson RJ, Alexander KR, Derlacki DJ. Rate of visual field loss in retinitis pigmentosa. Ophthalmology 1997;104:460–5.
2. Alexander KR, Derlacki DJ, Fishman GA. Contrast thresholds for letter identification in retinitis pigmentosa. Invest Ophthalmol Vis Sci 1992;33:1846–52.
3. Marmor MF. Visual loss in retinitis pigmentosa. Am J Ophthalmol 1980;89:692–8.
4. U.S. Department of Health and Human Services FDA Center for Drug Evaluation and Research; U.S. Department of Health and Human Services FDA Center for Biologics Evaluation and Research; U.S. Department of Health and Human Services FDA Center for Devices and Radiological Health. Guidance for industry: patient-reported outcome measures: use in medical product development to support labeling claims: draft guidance. Health Qual Life Outcomes 2006;4:79.
5. Chader GJ, Weiland J, Humayun MS. Artificial vision: needs, functioning, and testing of a retinal electronic prosthesis. Prog Brain Res 2009;175:317–32.
6. Ayton LN, Apollo NV, Varsamidis M, Dimitrov PN, Guymer RH, Luu CD. Assessing residual visual function in severe vision loss. Invest Ophthalmol Vis Sci 2014;55:1332–8.
7. Csaky KG, Richman EA, Ferris FL 3rd. Report from the NEI/FDA Ophthalmic Clinical Trial Design and Endpoints Symposium. Invest Ophthalmol Vis Sci 2008;49:479–89.
8. Dagnelie G. Psychophysical evaluation for visual prosthesis. Annu Rev Biomed Eng 2008;10:339–68.
9. Turano KA, Geruschat DR, Stahl JW, Massof RW. Perceived visual ability for independent mobility in persons with retinitis pigmentosa. Invest Ophthalmol Vis Sci 1999;40:865–77.
10. Steinberg EP, Tielsch JM, Schein OD, Javitt JC, Sharkey P, Cassard SD, Legro MW, Diener-West M, Bass EB, Damiano AM, Steinwachs DM, Sommer A. The VF-14. An index of functional impairment in patients with cataract. Arch Ophthalmol 1994;112:630–8.
11. 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;30:1111–26.
12. Turano KA, Massof RW, Quigley HA. A self-assessment instrument designed for measuring independent mobility in RP patients: generalizability to glaucoma patients. Invest Ophthalmol Vis Sci 2002;43:2874–81.
13. Bailey IL, Jackson AJ, Minto H, Greer RB, Chu MA. The Berkeley Rudimentary Vision Test. Optom Vis Sci 2012;89:1257–64.
14. Bittner AK, Iftikhar MH, Dagnelie G. Test-retest, within-visit variability of Goldmann visual fields in retinitis pigmentosa. Invest Ophthalmol Vis Sci 2011;52:8042–6.

15. Rasch G. Probabilistic Models for Some Intelligence and Attainment Tests. Chicago, IL: University of Chicago Press; 1960.
16. Mallinson T. Why measurement matters for measuring patient vision outcomes. Optom Vis Sci 2007;84:675–82.
17. Lamoureux E, Pesudovs K. Vision-specific quality-of-life research: a need to improve the quality. Am J Ophthalmol 2011;151:195–7.
18. Bond TG, Fox CM. Applying the Rasch Model: Fundamental Measurement in the Human Sciences. Mahwah, NJ: Lawrence Erlbaum Associates; 2001.
19. Pesudovs K, Burr JM, Harley C, Elliott DB. The development, assessment, and selection of questionnaires. Optom Vis Sci 2007;84:663–74.
20. Linacre JM. What do infit and outfit, mean-square and standardized mean? Rasch Meas Trans 2002;16:878. Available at: http://www.rasch.org/rmt/rmt162f.htm. Accessed October 2, 2015.
21. Lamoureux EL, Pallant JF, Pesudovs K, Hassell JB, Keeffe JE. The Impact of Vision Impairment Questionnaire: an evaluation of its measurement properties using Rasch analysis. Invest Ophthalmol Vis Sci 2006;47:4732–41.
22. 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;48:1001–6.
23. Rondinelli RD. Changes for the new AMA Guides to impairment ratings, 6th Edition: implications and applications for physician disability evaluations. PM R 2009;1:643–56.
24. Linacre JM. WINSTEPS Rasch Measurement Computer Program. Chicago, IL: Winsteps.com; 2008.
25. Linacre JM. A User's Guide to Winsteps/Ministeps Rasch-Model Programs. Chicago, IL: MESA Press; 2005.
26. 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;84:763–74.
27. Linacre JM. Sample size and item calibration [or person measure] stability. Rasch Meas Trans 1994;7:328. Available at: http://www.rasch.org/rmt/rmt74m.htm. Accessed October 2, 2015.
28. Chen WH, Lenderking W, Jin Y, Wyrwich KW, Gelhorn H, Revicki DA. Is Rasch model analysis applicable in small sample size pilot studies for assessing item characteristics? An example using PROMIS pain behavior item bank data. Qual Life Res 2014;23:485–93.
29. Scott NW, Fayers PM, Aaronson NK, Bottomley A, de Graeff A, Groenvold M, Gundy C, Koller M, Petersen MA, Sprangers MA; EORTC Quality of Life Group; Quality of Life Cross-Cultural Meta-Analysis Group. A simulation study provided sample size guidance for differential item functioning (DIF) studies using short scales. J Clin Epidemiol 2009;62:288–95.
30. La Grow S, Yeung P, Towers A, Alpass F, Stephens C. The impact of mobility on quality of life among older persons. J Aging Health 2013;25:723–36.
31. Guest D. The relation between visual loss and orientation and mobility. Master's thesis. Melbourne, Australia: University of Melbourne; 1980.
32. Haymes S, Guest D, Heyes A, Johnston A. Mobility of people with retinitis pigmentosa as a function of vision and psychological variables. Optom Vis Sci 1996;73:621–37.

Robert P. Finger
Centre for Eye Research Australia
Department of Ophthalmology
University of Melbourne
Royal Victorian Eye and Ear Hospital
Level 1, 32 Gisborne St
East Melbourne, Victoria 3002
Australia
e-mail: robertfinger@gmx.net