☑ CE Article

Development of a Mobility-Related Quality-of-Life Measure for Individuals with Vision Impairments

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Structured abstract: *Introduction:* Scientifically valid measures of functional vision and quality of life, designed to explore individuals' experiences of vision impairment (that is, blindness and low vision) are widely available; however, there is a paucity of measures specifically considering the quality of life afforded by an individual's mobility. The aim of this research was to develop a mobility-related quality-of-life measure. *Methods*: An 11-item measure was developed by adapting the Seeing It My Way (Vision Strategy UK, 2011) theoretical framework of outcomes for measuring quality of life when living with vision impairments to explore the effect of mobility. These items are on a seven-point Likert scale from strongly disagree to strongly agree to form the Mobility-Related Quality-of-Life measure (MRQoL). *Results:* Data from 688 participants revealed that the MRQoL had appropriate reliability, with the items on the scale being highly related and demonstrating sufficient internal consistency. When tested over time without significant intervention, the MRQoL was observed to be stable, with high test-retest reliability. Exploratory factor analysis revealed two distinct sub-factors: factor one, representing a construct containing aspects of independent mobility; and factor two, comprised of the skills and knowledge that enhance mobility. Together, the constructs accounted for 52.2% of the variability within in the data. *Discussion:* The MRQoL is evidentiarily reliable and has a useful two-factor structure exploring both independent mobility and mobility-enhancing skills and knowledge. *Implications for practitioners:* The MRQoL is a practical, sensitive, and reliable tool for use in assessing mobility-related quality of life in individuals with vision impairments. The measure is appropriate for use within research or in the field to assess the mobility-related quality of life of individuals or demographics with vision impairments, as well as the success of individual training, group mobility training, or other interventions. The MRQoL measure can be used as a stand-alone tool or alongside other measures.

Vision impairments (that is, blindness and low vision) have been revealed in cross-sectional studies to negatively affect mobility in adults when mobility is assessed through walking speeds, mobility tasks, and scales that measure activities of daily living (Friedman, Freeman, Munoz, Jampel, & West, 2007; Patel et al., 2006; Turano et al., 2004). One of the largest research efforts, the Salisbury Eye Evaluation Study, explored the mobility of 2,520 participants aged 65 and over, following up at two, six, and eight years post-baseline (Swenor, Muñoz, & West, 2013). It was observed that individuals with vision impairments were significantly more likely to report difficulty in performing mobility tasks than did individuals with no impairments; for example, more difficulty walking up steps, increased difficulty walking down steps, or difficulty walking 150 feet (Swenor et al., 2013). The study also observed that the trajectory of mobility disability did not differ by vision impairment status over the years recorded from baseline to six years (Swenor et al., 2013). Due to this reduction in mobility associated with vision impairment, many services offered to individuals with vision impairments aim to increase mobility including, but not limited to: rehabilitation, training with long canes, and partnership training with a dog guide. However, there are few well-validated measures that specifically explore mobility-related quality of life in measuring the effect of mobility interventions or differences between population demographics in their perception of the effect on their mobility.

There are well-validated and reliable measures of overall quality of life; however, none of these tools consider the effect of mobility specifically on a vision impaired person's ability to live life in the manner in which he or she wishes. The Vision Core Measure1 (VCM1), a 10-item scale, assesses the person's perceptions associated with their vision impairment with relation to the holistic aspects of life satisfaction (Frost et al., 1998). However, only one item of the VCM1 considers the potential impact of experiencing an inability to perform preferred activities, making it potentially inappropriate for assessing how a person's mobility affects their quality of life. Another quality-of-life measure, the Vision and Quality of Life index (VisQoL), measures the effect of vision loss through items considering areas of social, emotional, and physical well-being; independence; self-actualization; and planning and organization (Peacock et al., 2008). Again, however, this measure does not directly consider the effect of mobility as a factor of the person's quality of life. The Low Vision Quality-of-Life Questionnaire (LVQOL), developed by Wolffsohn and Cochrane (2000), contains five sub-sections pertaining to general vision, mobility and lighting issues, psychological adjustment, reading and fine work, and activities of daily living. However, not all the content is relevant to mobility and, therefore, some would be redundant and potentially cumbersome to administer and analyze if the aim was to specifically consider the effect of mobility.

The Impact of Vision Impairment (IVI) profile contains 32 items that aim to explore the level of restriction of participation in common daily experiences that individuals with vision impairments experience, with an emphasis on mobility (Weih, Hassell, & Keeffe, 2002). This measure could often be a good measure of mobility-related quality of life, but its length may make it inconvenient to administer in the field. The Visual Disability Assessment (VDA) also measures the practical implications of vision loss; the 18 items relate to how one's vision interferes with performance of visual tasks and, although seven of the items concern mobility, the remaining items consider elements such as distance, lighting, reading, and near and related tasks (Pesudovs & Coster, 1998). Not all the content would be relevant to measuring mobility-related quality of life, and thus there would be significant redundancy in the measure. Finally, the National Eye Institute Visual Function Questionnaires (NEI-VFQ) were designed to provide a patient-reported, vision-related, quality-of-life instrument suitable for a wide range of conditions (Mangione et al., 1998). This measure is both a functional and a quality-of-life scale, since it contains functional (general vision, near vision, distance vision, driving, peripheral vision, and color vision) and more general quality-of-life items (including general health, ocular pain, vision expectations, social problems, emotional health, role problems, and dependency). However, with 51 items, the NEI-VFQ is very long in its complete form. The shortening of the scale to 25 items makes it a potentially viable measure of mobility-related quality of life; however, the items consider mobility and quality of life separately and do not specifically consider the manifestation of mobility-related quality of life in the holistic manner that is necessary.

The aim of this research was to develop a succinct and practical measure to accurately quantify the mobility-related quality of life experienced by individuals with vision impairments in order to complement the functional vision measures and broader quality-of-life scales that have been already developed.

Methods

Development of the measure of mobility-related quality of life

The Seeing It My Way (SIMW) initiative generated a theoretical framework for measuring important aspects of quality of life when living with vision impairments (Vision Strategy UK, 2011). The initiative was part of the UK VISION 2020 strategy in the United Kingdom and was a collaboration between several voluntary organizations, including: the Thomas Pocklington Trust, Guide Dogs, Action for Blind People, the Royal National Institute of Blind People (RNIB), and the Royal London Society for Blind People. In addition to the collation of previously available scientific evidence, a total of 1,182 participants responded to a questionnaire via post, telephone, and Internet, or took part in a discussion group. Through analysis of the results of the available literature and the responses to the questionnaires, 10 primary outcome areas that were considered pertinent to maintaining a good quality of life while living with a vision impairment were generated; these were:

- I understand my eye condition and the registration process.
- I have someone to talk to.

- I can look after myself, my health, my home, and my family.
- I receive statutory benefits and information and support that I need.
- I can make the best use of the sight I have.
- I can access information making the most of the advantages that technology brings.
- I can get out and about.
- I have the tools, skills, and confidence to communicate.
- I have equal access to education and lifelong learning.
- I can work and volunteer.

This framework was supported by subsequent work by the RNIB (2015) called *My Voice*, which analyzed the qualitative data obtained from 1,200 phone interviews with individuals living with vision impairments exploring factors most affecting their quality of life (RNIB, 2015).

To construct an outcome suitable for use in specifically assessing mobility-related quality of life, these outcome areas were transformed into psychometric items designed to apply the construct of mobility to the SIMW outcomes. This resulted in the development of an 11-item self-report measure; the included items were:

1. I am aware of how and where I can obtain advice and support to help me get out and about.
2. I understand my eye condition and can use any remaining sight and other senses in the best way possible.
3. I can travel safely on routes I know.
4. I feel confident to try new routes.
5. I feel happy to ask for help when I'm out and about.
6. I understand my rights and entitlements regarding access to transport, shops, workspace, etc.
7. I am aware of how technology may assist me when I'm out and about.
8. My mobility allows me to consider education, lifelong learning, volunteering, and work opportunities.
9. I am able to look after myself, my health, my home (and my family).
10. My mobility helps me lead my life as I wish.
11. My mobility helps me participate within my local community.

Each item is assessed on a 7-point Likert scale, from strongly disagree to strongly agree, to facilitate a larger range of potential responses than a smaller scale would provide, with a score of 1 indicating strongly disagree and 7 strongly agree. The scores on each item of the measure are summed to generate a total score.

The purpose of the measure, named the Mobility-Related Quality-of-Life measure (MRQoL), was twofold: first, to measure the outcomes of services that are designed to promote independent mobility; and, second, to provide a greater understanding of the service users' mobility-related quality of life.

The following research tested the reliability and construction of the MRQoL to ensure its suitability for measuring mobility-related quality of life.

Participants

In total, 688 participants were recruited through their application to vision loss services. At an initial service-need assessment, the MRQoL measure was completed and the participants were asked whether they would consent to the data being used for research. All participants gave their informed consent to voluntarily participate in the research and were informed that they could withdraw from the research without needing to provide a reason. A sub-population of 22 participants also undertook the questionnaire a second time at the point of a secondary assessment. These participants were selected through their need for a secondary assessment before interventional services had begun. Again, at the point of reassessment the participants were asked for their consent to participate.

Materials

The MRQoL measure and data input via Excel of the measure and demographic information were required for the research.

Procedure

The participants undertook the MRQoL and demographic questions with a researcher reading out the questions and the participant indicating their responses verbally either in person or over the telephone. These verbal responses were then recorded by the researchers in Excel. Once collected, the data were imported into SPSS statistical software for analysis.

Data analysis

Descriptive statistics for the MRQoL were analyzed with SPSS. Data were analyzed for internal reliability, test-retest reliability, and construct validity to explore the psychometric properties of the mobility-related quality-of-life measure. Potential differences in demographic populations were also explored.

Table 1
Descriptive statistics for the MRQoL measure.

Statistical analysis	Statistic
Mean	50.62
95% confidence interval for mean	
Lower bound	49.53
Upper bound	51.71
Median	52.00
Variance	209.56
Standard deviation	14.48
Minimum	11.00
Maximum	77.00
Range	66.00
Skewness	−.34
Kurtosis	−.46

Results

Data distribution

The MRQoL measure showed a reasonably central mean and an appropriate range of scores across the maximum potential range of 11 to 77 (see Table 1).

Analysis of the scores revealed a distribution with a skewness and kurtosis, between 1 and −1, suggesting that the distribution of scores met the criteria for a normal distribution (Dancey & Reidy, 2007). Furthermore, examination of the histograms suggests that the data presents normally (see Figure 1).

Reliability testing

Internal reliability

Internal reliability was observed to be very good, with a Cronbach's Alpha score of $\alpha = .86$, well above the minimum requirement for sufficient internal consistency of .7.

Test-retest reliability

The test-retest reliability of the measure in the sub-population who retook the survey was also sufficient, producing a highly

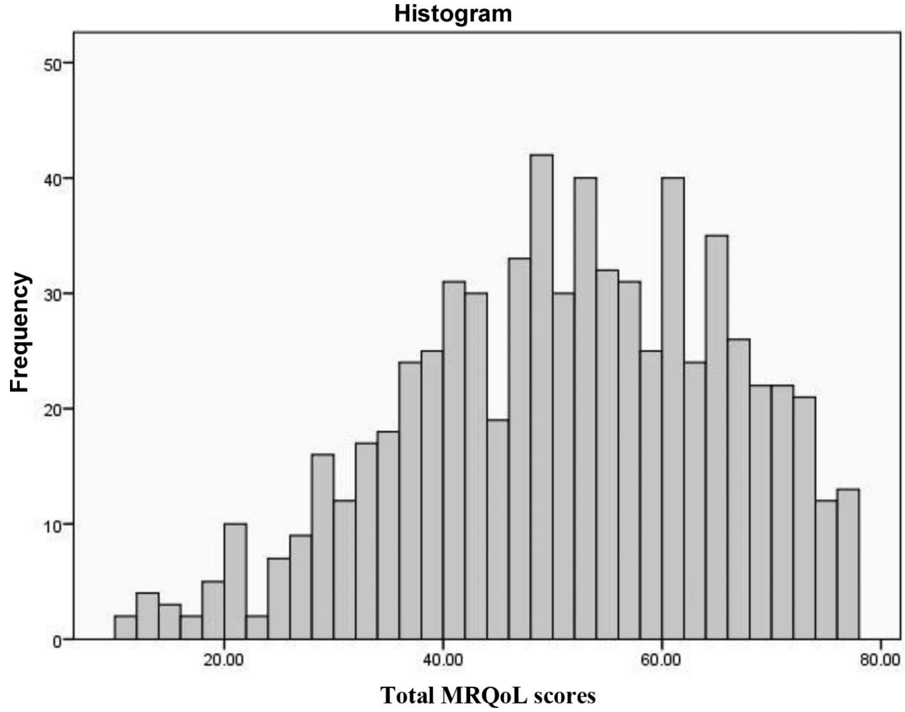

Figure 1. Distribution of the scores from the MRQoL measure.

significant Pearson's correlation ($r = .65$, $n = 22$, $p = .001$).

Exploratory factor analysis

Data screening

The data were screened for univariate outliers; however, none were present. The minimum requirement of data points for factor analysis was appropriately satisfied with a final sample size of 688; and a case-to-variable ratio of 62.55:1, or 62.55 cases per variable.

Factor analysis

The factorability of the 11 MRQoL items was examined. All of the 11 items correlated with a coefficient of at least .3 with at least two other items; this suggests reasonable factorability. Employing the Kaiser-Meyer-Olkin measure revealed a sampling adequacy of .90, which is well above the standard recommended value of .7. Furthermore, Bartlett's test of sphericity was observed to be significant, χ^2 (55) = 2449.11, $p < .001$. Finally, the communalities between each item in the factor analysis were all above .35. These results suggest that each item in the measure shared some common variance with other items. Since no one item stood out as having limited communality with the other items of the measure, factor analysis was conducted with all 11 items of the MRQoL.

Principal components analysis (PCA)

The purpose of this further analysis was to observe and compute the assimilated scores for the factor structure underlying the measure; therefore, principal components analysis was used. Consideration of the initial eigenvalues revealed that there were two significant factors. The first

Table 2
Initial eigenvalues and the cumulative percentages.

	Initial eigenvalues			Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4.63	42.10	42.10	4.63	42.10	42.10
2	1.11	10.10	52.20	1.11	10.10	52.20
3	.89	8.12	60.32			
4	.81	7.34	67.66			
5	.66	6.01	73.67			
6	.63	5.70	79.37			
7	.56	5.06	84.42			
8	.52	4.69	89.11			
9	.47	4.30	93.40			
10	.40	3.67	97.07			
11	.32	2.93	100.00			

factor, with a value of 4.63, explained 42.10% of the variance of responses to the measure. The second factor had an eigenvalue of 1.11 and explained a further 10% of the variance. Beyond this two-factor solution, the eigenvalues dropped below 1.0 and explained less than 10% of the variance (see Table 2). One- and two-factor solutions were examined, using both varimax and oblimin rotations of the factor-loading matrix. The oblimin rotation was preferred due to the presence of a theoretically stronger differentiation between the components with regards to the content of the items. Acceptance of the two-factor oblimin rotation-factor-loading matrix explained 52.3% of the variance within the measure, the highest percentage of the examined rotations and, therefore, the oblimin rotation was statistically preferred. Eigenvalues plotted on a scree plot show a leveling off after the two factors, confirming the validity of the two-factor structure (see Figure 2). Horn's Parallel Analysis was also run, and the generated eigenvalue for extraction of a two-component structure was 1.15, only .04 away from the 1.11 observed (defaults of 100 correlation matrices and 95 percentiles of eigenvalues were used).

Due to the strong two-factor construct, only one item failed to meet the minimum criteria of having a primary factor loading of .4 or above and no cross-loading of .3 or above. The item "I feel happy when I'm out and about" did, however, load at .37 onto factor one and was considered to provide important information; therefore, despite a cross-loading of .36 onto factor two, the item was kept as part of factor one within the two-factor construct solution (see Table 3).

Through consideration of the content of items clustering on factor one (items 3, 4, 5, 8, 9,10, and 11) and factor two (items 1, 2, 6, and 7), two factor labels were proposed: "independent mobility" for factor one and "mobility-enhancing knowledge and skills" for factor two (see Table 3). The internal consistency for each of the scales was examined using Cronbach's alpha; the alpha value for factor one was .82, which is very good; and .71 for factor two, which is still above the minimum acceptable level of .7. Analysis found that no substantial

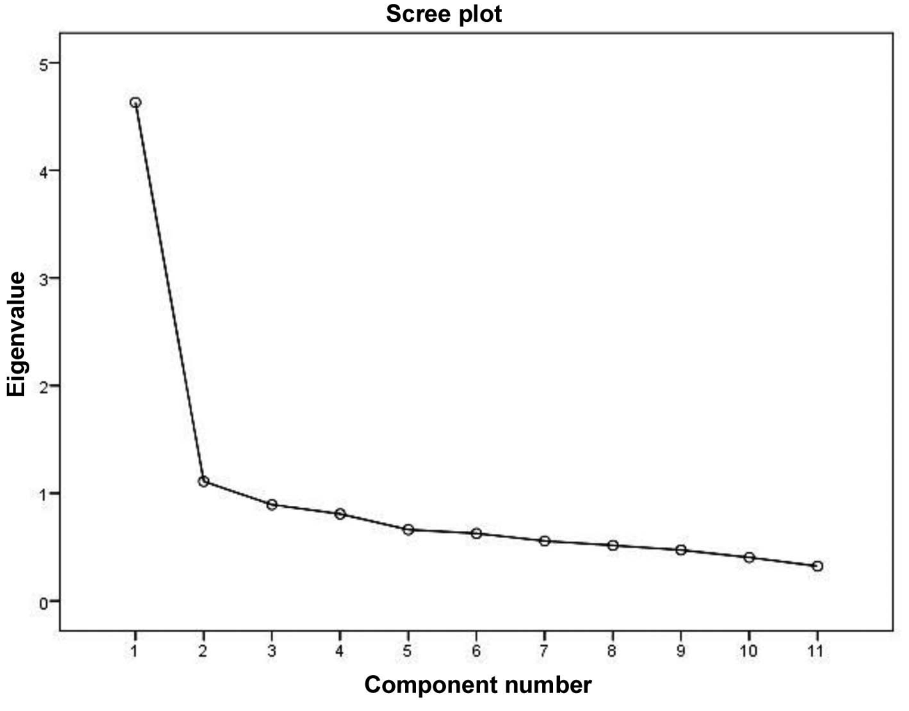

Figure 2. Scree plot of the eigenvalues of the extracted component solutions.

increases in alpha for any of the scales could have been achieved by eliminating more items.

Running analysis on each of the extracted components using an oblimin rotation reveals that both have one-factor solutions and that no further sub-factors can be extracted. Within factor one, all of the seven items correlated with a coefficient of at least .3 with at least four other items; this suggests reasonable factorability. The Kaiser-Meyer-Olkin test revealed a sampling adequacy of .87, which is well above the standard recommended value of .6. Bartlett's test of sphericity was also observed to be significant, χ^2 (21) = 1571.19, $p < .001$. The component analysis with an oblimin rotation revealed a one-factor solution with an eigenvalue of 3.53, explaining 50.47% of the variance; all other eigenvalues were below 1.0. Within factor two, all of the four items correlated with a coefficient of at least .3 with at least two other items. Again, the Kaiser-Meyer-Olkin test revealed an acceptable sampling adequacy of .73 and Bartlett's test of sphericity was observed to be significant, χ^2 (6) = 485.78, $p <$ .001. Factor two also underwent component analysis with an oblimin rotation and revealed a one-factor solution with an eigenvalue of 2.14, explaining 53.37% of the variance; again, all other eigenvalues were below 1.0. This suggests that the two-factor solution is stable and cannot be further fractionated into sub-factors.

Composite scores were generated for each of the two sub-factors of the measure, based on the items that had their primary loadings on each factor. Higher scores on factors one and two indicated

Table 3
Principal component analysis factor solution using an oblimin rotation with Kaiser normalization.

	Component	
Item content	Factor 1: Independent mobility	Factor 2: Mobility-enhancing knowledge and skills
1. I am aware of how and where I can obtain advice and support to help me get out and about.		.75
2. I understand my eye condition and can use any remaining sight and other senses in the best way possible.		.63
3. I can travel safely on routes I know.	.77	
4. I feel confident to try new routes.	.72	
5. I feel happy to ask for help when I'm out and about.	.37	.36
6. I understand my rights and entitlements regarding access to transport, shops, workspace, etc.		.80
7. I am aware of how technology may assist me when I'm out and about.		.71
8. My mobility allows me to consider education, lifelong learning, volunteering, and work opportunities.	.48	.25
9. I am able to look after myself, my health, my home (and my family).	.56	
10. My mobility helps me lead my life as I wish.	.89	
11. My mobility helps me participate within my local community.	.82	

greater independent mobility and mobility-enhancing knowledge and skills, respectively. Descriptive statistics for both factors are presented in Table 4. Examination of the distributions' properties revealed that the skewness and kurtosis were within a tolerable range for assuming a normal distribution for both factors one and two (see Table 4).

The age of the participants ($M = 53.58$, $SD = 18.89$) showed a very small positive correlation with the MRQoL total, $r(666) = .09$, $p = .026$; and factor one, $r(666) = .10$, $p = .014$; however, no correlation was found between factor two and the age of the participants, $r(669) = .05$, $p = .214$.

When participants have only a singular condition, where that condition is represented by ten or more participants, there is a significant difference between the MRQoL total scores for different conditions, $F(5) = 3.36$, $p = .006$ (see the descriptives for each condition in Table 5). However, when these conditions are analyzed via post hoc independent *t*-tests, participants with cataract and diabetic retinopathy were observed to have significantly

Table 4
Descriptive statistics for the two-factor solution of the MRQoL.

Factor number and title	Number of items	*M* (*SD*)	Skewness	Kurtosis
1. Independent mobility	7	30.32 (10.41)	−.17	−.84
2. Mobility-enhancing knowledge and skills	4	20.30 (5.56)	−.79	.07

Table 5
Mean and standard deviation of the MRQoL scores of different conditions.

		MRQoL total		Factor 1		Factor 2	
Condition	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Retinitis pigmentosa	76	52.68	12.37	31.43	9.86	21.25	4.46
Cataract	12	42.00	13.75	23.08	10.27	18.92	5.60
Glaucoma	37	53.54	12.15	32.51	9.07	21.03	4.59
Detached retina	21	52.67	12.18	30.76	9.19	21.90	4.41
Macular degeneration	44	53.61	15.11	33.27	10.20	20.49	6.40
Diabetic retinopathy	27	44.33	14.42	26.67	9.47	17.67	6.33
Total	217	51.45	13.82	30.87	9.98	20.55	5.33

lower MRQoL scores than did those with all other visual disorders ($p < .05$), though there was no significant difference in the MRQoL scores of participants with cataract and diabetic retinopathy ($p > .05$).

A difference between the scores on factor one was also observed between different vision conditions, $F(5) = 3.35$, $p = .006$. Again, post hoc analysis revealed that participants with cataract and diabetic retinopathy had lower scores on the independent-mobility scale than did those with other conditions ($p < .05$), with the exception that there was no difference between those with diabetic retinopathy and those with detached retinas ($p > .05$). No difference was found between participants with cataracts and diabetic retinopathy ($p > .05$). Interestingly, when factor two is investigated via the MRQoL a difference is also found between participants with differing eye conditions, $F(5) = 2.48$, $p = .033$; however, participants with cataracts were not significantly different from those with other conditions with regards to their mobility-enhancing knowledge and skills ($p > .05$). Those individuals with diabetic retinopathy maintained lower scores on the second factor's measure of mobility-related skills than do those with all other conditions, except for those experiencing cataract ($p < .05$).

The number of eye conditions a person experienced was not found to predict the MRQoL total score, $R^2 = .002$, $F(1, 493) = .12$, $p = .728$; neither did the number of conditions predict the scores on the two sub-factors ($p > .05$).

Discussion

Consideration of the distribution of the scores of the 688 participants revealed a distribution within the criteria of normality. The mean was suitably central and a wide range of scores were recorded, suggesting that the MRQoL measure is sensitive to different levels of mobility-related quality of life and can record a variety of experiences in a quantitative format.

Analysis of the reliability of the MRQoL found that the items on the scale were highly related and that they demonstrated sufficient internal consistency. Furthermore, when tested over time without significant intervention, the measure was observed to be stable, with high test-retest reliability. This suggests that the measure is reliable and stable if used multiple times and that MRQoL is relatively stable if no intervention occurs. However, testing for interrater reliability and convergent validity is still recommended in the future to ensure that the measure is as accurate as possible in assessing mobility-related quality of life.

Factor analysis did not suggest that any of the items were irrelevant to the measure, so all 11 were kept and considered to provide theoretically and mathematically useful information. Components analysis revealed a two-factor solution, indicating that two distinct factors were underlying participants' responses to the MRQoL measure. Items 3, 4, 5, 8, 9, 10 and 11 were observed to form factor one and items 1, 2, 6, and 7 formed factor two. Observation of the content of the clustered items was consistent, with factor one representing a construct containing aspects of independent mobility, whereas the items that clustered on factor two revolved around the skills and knowledge that aid independent mobility. Calculating these factors in addition to the overall MRQoL score could enhance the measures' usefulness in practice by providing knowledge regarding the participants' mobility and mobility-enhancing skills, as well as whether an intervention is affecting either or both factors regarding how the participants' lives are affected by the intervention. Furthermore, both factors showed the properties necessary for parametric statistical analyses to explore service-user demographics and intervention outcomes. The MRQoL is, therefore, a useful addition to other quality-of-life measurements with regards to application within both practical service delivery and intervention outcome measurement, as well as within scientific research into the experience of sight loss. However, further investigation into interrater reliability and convergent validity would supplement the evidence that the MRQoL is an accurate measure of mobility-related quality of life.

When the MRQoL is applied to the population demographics, it can be seen that individuals with diabetic retinopathy and cataract experience a lower mobility-related quality of life than do individuals with other conditions. Although cataracts are associated with a particular deficit in independent mobility, those with diabetic retinopathy showed a global decrease in mobility-related quality of life over both the independent mobility and mobility-enhancing skills and knowledge areas. Both cataract and diabetic retinopathy have been previously associated with reductions in well-being and quality of life, but other conditions have also been associated with quality-of-life reductions and rarely are the effect of various conditions compared (Broman et al., 2002; Eramudugolla, Wood, & Anstey, 2013; Nirmalan et al., 2005; Nutheti et al., 2006). There is a paucity of research regarding the factors that may underlie the effect of various conditions. A larger population study could start to address these information deficits.

Conclusion

The aim of the research was to develop and test a measure of mobility-related quality of life. The 11-item MRQoL has shown suitable psychometric properties, being internally reliable and reliable over repetitions. Furthermore, it shows a useful two-factor structure exploring both independent mobility and mobility-enhancing skills and knowledge. Finally, it has revealed that individuals experiencing cataract and diabetic retinopathy may experience a lower mobility-related quality of life than do those with other visual conditions, although why this situation may be true needs further exploration.

Since the MRQoL is evidentiarily reliable and has a useful two-factor structure exploring both independent mobility and mobility-enhancing skills and knowledge, it may be considered a practical tool for use in assessing mobility-related quality of life in individuals with vision impairments. Suitable for research purposes or in the field to assess the mobility-related quality of life of individuals or demographics with vision impairments, the MRQoL could also be used to measure the outcomes of individual training, group mobility training, or interventions. Within the context of private service provision, public services, or the tertiary sector, the MRQoL could be used to explore the effectiveness of competing service delivery models or service intensities. If more than one service provision were to use the MRQoL, the outcomes of different service providers could be more directly compared. The MRQoL measure can be used as a stand-alone tool or alongside other measures.

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