The Impact of Vision Impairment on Vision-Specific Quality of Life in Germany

Robert P. Finger,[1,2] *Eva Fenwick,*[2] *Manjula Marella,*[2] *Mohammed Dirani,*[2] *Frank G. Holz,*[1] *Peggy Pei-Chia Chiang,*[2] *and Ecosse L. Lamoureux*[2,3]

Purpose. To validate the German–translated Impact of Vision Impairment (IVI) questionnaire, a vision-specific quality of life (QoL) scale, and determine the relationship between the severity of vision impairment, ocular conditions, and VRQoL.

Methods. This cross-sectional study was clinic based, with 184 patients with low vision recruited from an outpatient clinic at a German eye hospital. Participants underwent a clinical examination and completed the German IVI scale. The validity of the IVI scale was assessed using Rasch analysis. The main outcome measure was the overall functional and emotional score provided by the IVI.

Results. Overall, there were more female (n = 111, 60.3%) than male participants. Participants' mean ± SD age and visual acuity in the better eye were 69.0 ± 15.5 years and. 0.41 ± 0.35 logMAR, respectively. The main cause of vision loss was age-related macular degeneration (n = 54, 29.3%). Rasch analysis demonstrated the validity of the German IVI to assess VRQoL through two subscales: vision-specific functioning and emotional well-being. In adjusted multivariate analysis models, those with mild or moderate/severe vision impairment reported significantly poorer vision-specific functioning (mean change, −6.5, P = 0.018 and −11.98, $P < 0.001$ for mild and moderate to severe VI, respectively) and emotional well-being (mean change, −2.35; P = 0.043 and −3.13, P = 0.004 for mild and moderate/severe VI respectively) compared with non–visually impaired patients.

Conclusions. Using a psychometrically valid German IVI, even mild vision impairment was independently associated with poor VRQoL. These findings reinforce the importance of early preventative and rehabilitative efforts to prevent longitudinal deterioration in vision loss. (*Invest Ophthalmol Vis Sci.* 2011; 52:3613–3619) DOI:10.1167/iovs.10-7127

The detrimental impact of impaired vision on vision-related quality of life (VRQoL) has been well documented with several psychometric instruments.[1–3] Vision impairment affects daily functioning, falls, mobility, and emotional well-being.[4,5] Specifically, severe visual impairment has been associated with higher levels of depression,[6] greater life stress, lower satisfaction, and lower activity levels[7] compared with no or mild levels of vision loss.

The use of patient-reported outcomes (PROs), to assess the impact of vision impairment from the patient's perspective, is now common in clinical practice and ophthalmic research. PROs can be used to assess the benefits of treatment or interventions on patients' overall quality of life.[8] However, while several validated English language VRQoL instruments are currently available, few studies have assessed the impact of vision impairment in a German population with low vision, due mainly to the unavailability of a psychometrically valid VRQoL measure.

The Impact of Vision Impairment (IVI) profile is a vision-specific instrument to measure the impact of vision impairment on specific aspects of quality of life and was developed using focus group discussions and input from existing instruments.[9] The IVI has been shown to be reliable[3] and responsive to interventions[10] and has been rigorously validated by modern psychometric methods, such as Rasch analysis, for different ocular conditions and different levels of visual ability.[10–12]

Therefore, in this study, we used the Rasch analysis to determine the validity, reliability, and measurement characteristics of the German IVI and investigated the relationship between the severity of vision impairment, the main causes of vision loss and VRQoL in German outpatients with low vision.

Materials and Methods

Recruitment

This cross-sectional study took place between March and May 2009 at the Department of Ophthalmology, University of Bonn, Germany, where patients were recruited from outpatient clinics. All patients who attended any outpatient clinic during the study period, had ocular pathology that was either chronic or subacute (i.e., had been ongoing for at least 1 month), and met the inclusion criteria were eligible for participation. Inclusion criteria included presenting visual acuity worse than 6/12 or a long-standing symptomatic eye condition; 18 years of age or older; and ability to converse, read and write in German. Participants underwent a complete ophthalmic examination including presenting and best-corrected visual acuity; biomicroscopy; intraocular pressure measurements; and funduscopy. Further diagnostic tests (fluorescein angiography, optical coherence tomography, and electrophysiology) were performed as appropriate in each case. Visual acuity was tested as best corrected distance visual acuity by using a standard illuminated logMar E chart at 4 m. The ability of participants to complete the questionnaires was assessed by interviewers before recruitment. The questionnaires were interviewer-administered by two trained interviewers. Sample size calculations were based on good practice in validating psychometric instruments.[13] Ethical approval was obtained from the ethics committee of the University of Bonn. Informed consent was obtained from every participant before the

From the [1]Department of Ophthalmology, University of Bonn, Bonn, Germany; the [2]Centre for Eye Research Australia, Royal Victorian Eye and Ear Hospital, Melbourne, Victoria, Australia; and the [3]Singapore Eye Research Institute, Singapore.

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

interview. The study adhered to the tenets of the Declaration of Helsinki.

The IVI Questionnaire

The IVI is an instrument to measure the impact of vision impairment on VRQoL. It contains 28 items with three to four active response options using Likert scaling, ranging from *not at all* to *a lot*. Items 1 to 15 have an additional response: *don't do this for other reasons*. Items form three specific subscales: reading and accessing information, mobility and independence, and emotional well-being (Table 1). A slightly modified version of the Rasch-validated IVI[12] was used, in which all items had four active response options. The IVI questionnaire was professionally translated into German and back translated into English. After a pilot test with 10 German patients, to assess comprehensibility and appropriateness of the wording and content of each question, a final version of the questionnaire was drafted (Supplementary Table S1, http://www.iovs.org/lookup/suppl/doi:10.1167/iovs.10-7127/-/DCSupplemental). Sociodemographic data and information about the patients' medical history (including psychiatric illnesses and significant life events) were also collected using a separate questionnaire.

Psychometric Validation of the German IVI

Rasch analysis is a modern psychometric method that transforms raw ordinal scores into estimates of interval-level measurement (expressed in log of the odds units, or logits), permitting the use of parametric statistical techniques. It calculates item difficulty (item measure) in relation to person ability (person measure) by placing both on the same linear continuum. A high person measure (in logits) indicates that a person possesses a high level of the assessed latent trait (e.g., VRQoL).[14–16] To ease interpretation, the rating scale of the IVI was reversed for Rasch analysis so that patients with a high level of VRQoL were given high scores. Rasch analysis also provides insight into the psychometric properties of a scale, such as how well items fit the underlying latent trait being measured, how well items discriminate between the respondents, how well item difficulty targets person ability, and the appropriateness of the response scale used.[17]

Rasch analysis was undertaken to validate the IVI questionnaire using commercial software (Winsteps software, ver. 3.68; Winsteps, Chicago, IL).[18] The Andrich rating scale model[19] was used, and two rating scales were applied, the first to items 1 to 15 and the second to items 16 to 28, as these groups of items shared the same item and response option characteristics. Several key indicators assessing the psychometric properties of the IVI were examined. We assessed the response category threshold ordering by visually checking for disordered thresholds. Disordered thresholds may result when a category is underused, the category definition is unclear, or participants have difficulty discriminating between response options. Disordered thresholds can cause significant item and model misfit, and collapsing response categories may be necessary to improve model fit. The scale's ability to discriminate different strata of person ability was then assessed, using the person separation index (PSI) and person reliability (PR) coefficient.[20] A PSI value of 2.0 and PR coefficient of 0.8 indicate that the scale can successfully distinguish three levels of person ability, which is the minimum level for a satisfactory scale.[21]

A major requirement of the Rasch model is unidimensionality—namely, that a scale measures a single underlying latent trait and that the items "fit" the underlying trait. The two parameters of unidimensionality are item "fit statistics" and testing the assumption of local independence. The key statistic assessing item fit is the mean square standardized residuals (MNSQ), and items with an MNSQ value of 0.7 to 1.3 are considered acceptable.[22] Values below 0.7 may indicate redundancy, and values over 1.3 indicate an unacceptable level of "noise" in the responses. To test for local independence, the principle component analysis (PCA) of the residuals was examined. The first factor should explain at least 50% of the variance and the first contrast of the residuals (i.e., the second dimension) should be <2.0 eigenvalues.[23] A value of >2.0 is considered greater than that observed in random data and may suggest the existence of another dimension.

Table 1. Structure, Item Content, and Scales of the German IVI Questionnaire

Items	Summary Scales Original Version	Summary Scales German Version
1. Ability to see and enjoy television?	Reading and accessing information	
3. Finding things during shopping?		
5. Recognizing or meeting people?		
6. Generally looking after your appearance?		
7. Opening packaging?		
8. Reading labels or instructions on medicines?		
9. Operating household appliances and the telephone		
14. Reading ordinary-sized print?		
15. Getting information that you need?		
2. Taking part in sporting activities?	Mobility and independence	Functional IVI
4. Visiting friends or family?		
10. Getting about outdoors?		
11. Made you go carefully to avoid falling or tripping?		
12. Interfered with travelling or using transport?		
13. Going down steps, stairs, or curbs?		
16. Your general safety at home?		
17. Spilling or breaking things?		
18. Your general safety when out of your home?		
19. Stopped you from doing the things you want to do?		
20. Needed help from other people?		
21. Felt embarrassed?	Emotional well-being	Emotional IVI
22. Felt frustrated or annoyed?		
23. Felt lonely or isolated?		
24. Felt sad or low?		
25. Worried about your eyesight getting worse?		
26. Concerned or worried about coping with everyday life?		
27. Felt like a nuisance or a burden?		
28. Interfered with your life in general?		

How well item difficulty targets person ability is assessed through visual inspection of the person-item map and the difference between person and item mean logits. In a perfectly targeted instrument, the difference in means would be 0; a difference of >1.0 logits indicates notable mistargeting. 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.[24]

Finally, we assessed for differential item functioning (DIF) which occurs when sample subgroups, such as sex or age group, systematically respond differently to an item, despite having similar underlying ability. A DIF contrast of >1.0 logits is notable and suggests that the interpretation of the scale differs by group and may be biased.

To facilitate the interpretation of the person measure scores, they were recalibrated from a negative–positive scale to range between 0 and 40 for the IVI functional subscale and 0 and 16 for the IVI emotional subscale, with a higher score indicating better VRQoL.

Statistical Analysis

Descriptive statistical analyses were performed to characterize the participants' sociodemographic, clinical, and IVI data. VRQoL was the main outcome (SPSS statistical software; ver, 17.0; SPSS Science, Chicago, IL). The overall and individual person scores linearly estimated after Rasch analysis were fitted to linear regression models and used *t*-based 95% confidence intervals (CIs) for the regression coefficients. The associations between specific aspects of VRQoL, vision impairment, and ocular conditions were analyzed using linear regression. No adjustment for confounding was made in univariate analyses to pick up all factors potentially related to VRQoL. In multivariate analyses, all variables that were found to be univariately associated with visual functioning (i.e., age, sex, general health, and visual impairment) were adjusted for in the model using Bonferroni adjustments for post hoc tests. Visual acuity was categorized into three categories: Normal presenting vision in the better eye (≤0.3 logMAR); mild visual impairment (0.3<logMAR<0.5); and moderate to severe visual impairment (logMAR ≥0.5). Moderate and severe visual impairment were grouped together in this analysis due to sample size restrictions.

Results

Sociodemographics and Clinical Characteristics of the Participants

The majority of the participants were female (60.3%, $n = 111$ Table 2). The mean ± SD age was 69.0 ± 15.5 years (range, 21–90) and mean visual acuity in the better eye was 0.41 ± 0.35 logMAR. One hundred six (57.6%) of the participants reported only poor to fair health. The majority had no or just primary school education (52.2%, $n = 96$) and most were retired (78.8%, $n = 145$). Most had at least one nonocular comorbidity, with approximately two thirds reporting having hypertension (59.2%, $n = 109$), cardiovascular diseases (46.2%, $n = 85$), and diabetes (29.9%, $n = 55$). One third were moderately to severely visually impaired (34.8%, $n = 64$), one third were mildly visually impaired (26.6%, $n = 49$), and one third had no visual impairment (38.6%, $n = 71$). The main cause of visual impairment was age-related macular degeneration (29.3%, $n = 54$), followed by other retinal diseases (26.6%, $n = 49$), diabetic retinopathy (14.7%, $n = 27$), and glaucoma (8.2%, $n = 15$).

Psychometric Validation of the German IVI Questionnaire

The data for the German IVI were fitted to the Rasch model, and key indicators of fit were explored (Table 3). All thresholds were ordered, suggesting that the number and clarity of the response categories were appropriate. Similarly, the PSI and the PR values were 3.95 and 0.94, respectively, which indicates that the scale was able to discriminate between five strata of VRQoL. The targeting of the instrument was excellent, with minimal difference in person and item means (0.04 logits). However, there was evidence of multidimensionality in the scale. Although the raw variance explained by the PCA of the residuals was adequate (60.8%), the unexplained variance in the first contrast of the residuals was 4.6 suggesting the existence of a second dimension. Moreover, three items (items 21, 22, and 25) demonstrated substantial misfit, with MNSQ values of >1.3. Removal of these items revealed further misfitting items (items 21, 23, 24, 26, and 27) and did not improve other fit statistics. All these items referred to aspects of emotional well-being and had standardized residual loadings of >0.4 units, suggesting that they belonged to the same domain. Therefore, the IVI was split into a functional scale (items 1–20) and an emotional scale (items 21–28). This strategy resulted in both scales fitting the Rasch model (Table 3).

For the functioning scale (visual functioning), PSI and PR were 3.66 and 0.93, respectively, indicating excellent discriminant ability. Targeting was again optimal, with a difference in person and item mean of only 0.16 logits. No misfitting items were detected, and there was minimal evidence of multidimensionality with the PCA for the first factor explaining >60% of the variance and the first contrast of the residuals being acceptable (2.3 eigenvalues). No DIF was found for sex, age or vision impairment. The emotional scale (vision-specific emotional well-being) had a PSI of 2.58 and a PR of 0.87, indicating that three levels of person strata can be detected. The difference between the person and item mean values was 0.33 suggesting that the scale is well targeted. One item (item 21) displayed borderline misfit (1.38 logits), but was retained, as it captures important information pertaining to emotional well-being (i.e., embarrassment caused by impaired eyesight). The PCA of the residuals was >60%, and the first contrast of the residuals was 1.6 eigenvalues, which satisfies the requirements for unidimensionality.

The participants' mean ± SD overall score was 35.05 ± 12.41 logits for the functional IVI and 14.41 ± 4.94 logits for the emotional IVI. In linear regression models, independent significant predictors of VRQoL were therefore considered to be clinically meaningful if the confidence interval limits of the beta coefficients were >6.2 or < −6.2 for the functional IVI and >2.5 or < −2.5 for the emotional IVI, which is approximately half the standard deviation of the overall mean. This is generally considered to be a useful estimate of a clinically meaningful difference.[25,26]

Relationship between VI and VRQoL

Patients with mild ($n = 49$) as well as moderate/severe VI ($n = 64$) had significantly poorer vision-specific functioning and emotional well-being than did those with no vision loss ($n = 71$, $P < 0.001$; Table 2). In addition, education, work status, self-reported health rating, several nonocular comorbid conditions, and causes of vision impairment were also univariately associated with the IVI visual functioning score (all $P < 0.05$; Table 2), and self-reported health rating and self-reported pulmonary disease were univariately associated with vision-specific emotional well-being.

In adjusted multivariate analysis models, only the severity of VI remained independently associated with vision-specific functioning and emotional well-being (all $P < 0.05$; Table 4). Both consistently declined with poorer vision. Compared with participants with no VI, those with mild, or moderate/severe VI recorded significantly poorer vision-specific functioning (mean change, −6.5 logits, $P = 0.018$; and −11.98 logits, $P < 0.001$ for mild and moderate/severe VI, respectively) and emo-

TABLE 2. Personal Characteristics of the Sample

		Functional IVI		Emotional IVI	
	n **(%)**	**Mean ± SD**	***P***	**Mean ± SD**	***P***
All subjects, $n = 184$		35.05 ± 12.41		14.41 ± 4.94	
Sex*					
Female	111 (60.3)	33.91 ± 12.17	0.136	14.18 ± 4.96	0.438
Male	72 (39.1)	36.72 ± 12.73		14.76 ± 4.95	
Age*					
≤60, y	48 (26.1)	36.70 ± 13.69	0.287	13.85 ± 5.60	0.361
>60, y	136 (73.9)	34.47 ± 11.93		14.61 ± 4.69	
Education*					
None/primary school	96 (52.2)	33.45 ± 12.07	**0.012†**	14.12 ± 5.04	0.311
Some secondary, some technical or commercial	49 (26.6)	34.26 ± 12.18		14.34 ± 5.02	
Secondary completed	15 (8.2)	43.07 ± 9.98		16.69 ± 3.51	
Trade, TAFE or university	22 (12.0)	39.36 ± 13.60		14.70 ± 5.05	
Work status*					
Not working	145 (78.8)	33.74 ± 11.80	**0.001**	14.25 ± 4.81	0.507
Working	33 (17.9)	41.91 ± 13.24		14.88 ± 5.42	
Eye conditions					
AMD	54 (29.3)	32.44 ± 12.63	**0.018**	14.10 ± 4.37	0.143
DRP	27 (14.7)	29.47 ± 9.33		12.38 ± 4.92	
Glaucoma	15 (8.2)	39.17 ± 12.80		16.25 ± 5.38	
Other retinal disease	49 (26.6)	37.79 ± 12.91		14.98 ± 5.03	
Corneal disease	12 (6.5)	37.85 ± 8.71		15.59 ± 5.57	
Others	27 (14.7)	37.35 ± 12.84		14.51 ± 5.02	
Presenting VI					
None	71 (38.6)	41.58 ± 11.39	**<0.001‡**	16.23 ± 4.94	**<0.001§**
Mild	49 (26.6)	35.98 ± 10.12		14.36 ± 4.29	
Moderate/severe	64 (34.8)	27.10 ± 10.61		12.44 ± 4.69	
General health*					
Fair to poor	106 (57.6)	30.97 ± 11.12	**<0.001‖**	13.03 ± 4.94	**<0.001‖**
Good	68 (37.0)	40.48 ± 11.30		16.38 ± 3.97	
Very good to excellent	7 (3.8)	47.45 ± 16.32		18.16 ± 5.82	
Nonocular co-morbid conditions					
Hypertension	109 (59.2)	34.81 ± 12.27	0.753	14.66 ± 4.97	0.413
Cardiovascular diseases	85 (46.2)	33.36 ± 10.70	0.086	13.81 ± 4.66	0.124
Diabetes	55 (29.9)	32.25 ± 11.60	**0.045**	13.56 ± 5.88	0.126
Pulmonary diseases	36 (19.6)	31.09 ± 13.42	**0.033**	12.87 ± 4.71	**0.036**
CNS diseases	21 (11.4)	31.64 ± 10.90	0.182	12.91 ± 6.11	0.140
Restricted mobility	66 (35.9)	31.77 ± 10.44	**0.007**	13.72 ± 4.72	0.152
Neoplastic diseases	28 (15.2)	37.17 ± 11.64	0.329	15.11 ± 4.38	0.418
Depression and other mental illness	16 (8.7)	31.73 ± 11.25	0.263	12.74 ± 6.16	0.157
Other chronic diseases	64 (34.8)	33.53 ± 10.68	0.224	13.79 ± 4.68	0.214

Bold *P* values indicate statistical significance.

* Data incomplete.

† Significance found between group 1 and 3 only.

‡ Significance found between all groups.

§ Significance found between groups 1 and 3, but not between 1 and 2, and 2 and 3.

‖ Significance found between groups 1 and 2, and 1 and 3, but not between 2 and 3.

tional well-being scores (mean change, −2.35, $P = 0.043$; and −3.13, $P = 0.004$ for mild and moderate/severe VI, respectively). The independent association was clinically significant for both mild and moderate/severe VI for vision-specific functioning and for moderate/severe VI for vision-specific emotional well-being. In addition to severity of VI, a self-reported poor to fair health rating was independently associated with worse visual functioning, but not with vision-specific emotional well-being.

DISCUSSION

Using two interval-transformed subscale scores from the IVI, our findings indicate that the severity of vision impairment is independently associated with vision-specific functioning and emotional well-being in German patients with low vision. Specifically, we found that both mild and moderate-severe vision impairment was independently associated with deteriorating vision functioning and emotional well-being.

The consistent decline of VRQoL with worsening vision impairment found in our study has also been shown in other Western countries[27–31] and Asia.[29,32] Of note, this decline was independent of specific ocular conditions such as glaucoma or diabetic retinopathy, suggesting that VRQoL is affected across ocular conditions once they reach the severe stage of disease, where distance visual acuity and visual fields may be considerably affected. Similar results have been found in other studies.[28,31,33] For example, in a study by Ahmadian and Massof,[34] the impact of vision impairment on visual functioning (as assessed by the Rasch-validated Activity Inventory) was found to be similar, regardless of the underlying ocular condition. In contrast, other studies have shown that VRQoL further de-

TABLE 3. Fit Parameters of the Complete IVI, Functional IVI, and Emotional IVI Compared with Rasch Model Requirements

Parameters	Rasch Model	IVI_C	IVI_F	IVI_E
Misfitting items, *n*	0	**3**	0	**1**
PSI	>0.2	3.95	3.66	2.58
PR	>0.8	0.94	0.93	0.87
Difference in person and item mean	<1	0.04	0.16	0.33
Variance by the first factor	>50%	60.8%	64.2%	69.7%
PCA (eigenvalue for first contrast)	<2.0	**4.6**	**2.3**	1.6
Differential item functioning	<1.0	—	None	None

IVI_C, complete IVI; IVI_F, Functional subscale of the IVI; IVI_E, Emotional subscale of the IVI. Bold values represent misfit to the Rasch model.

creases according to specific ocular conditions independent of visual acuity.[27,32] These interstudy discrepancies may be due to specific symptoms, such as peripheral visual field loss or problems with nocturnal vision caused by specific conditions that are not reflected by psychometric measures.

One of the critical findings of this article is that even mild visual impairment (0.3<logMAR<0.5) had a significant and independent impact on vision-specific functioning. Although our sample was clinically based and moderate in size, this key finding is supported by three population-based studies. The Singapore Malay Eye Study (SiMES) found that unilateral mild vision loss or normal vision in one eye and low vision in the other was independently associated with poorer vision functioning.[35] Similar findings were observed in two population-based, cross-sectional eye health surveys conducted in Timor-Leste[33] and in a Mexican-American population, the Proyecto VER.[27] This finding is highly relevant to eye health professionals, as it suggests that even patients at the mild spectrum of vision loss should be targeted for treatment or referral as early as possible, to prevent deterioration in vision impairment and minimize the potential impact on their VRQoL. Similarly, intervention strategies aimed at patients with even mild vision impairment could substantially improve their daily functioning and emotional stability. As has been postulated previously, the common practice of deferring low vision referrals until visual impairment becomes severe should be reviewed.[36]

TABLE 4. Differences in Functional IVI and Emotional IVI Score in Linear Regression Models

	Functional IVI RC (95% CI)	*P*	Emotional IVI RC (95% CI)	*P*
Age, y				
≤60 (reference)	36.70 ± 13.69		13.85 ± 5.60	0.679
>60	−1.81 (−7.77 to 4.15)	0.548	−0.57 (−3.26 to 2.11)	
Gender				
Male (reference)	36.72 ± 12.73		14.76 ± 4.95	0.427
Female	−0.85 (−5.40 to 3.70)	0.713	−0.82 (−2.87 to 1.23)	
Education				
Trade, TAFE or university (reference)	39.36 ± 13.60		14.70 ± 5.05	
Secondary completed	14.86 (−0.11 to 29.84)	0.052	6.00 (−0.40 to 12.40)	0.066
Some secondary, technical or commercial schooling	4.02 (−6.13 to 14.17)	0.433	2.29 (−2.05 to 6.63)	0.296
None/primary school only	−3.75 (−14.80 to 7.30)	0.501	0.57 (−4.15 to 5.29)	0.811
Work status				
Working (part or full time) (reference)	41.91 ± 13.24		14.88 ± 5.42	
Not working (retired, home duties, disability pension, unemployed)	2.14 (−6.83 to 11.10)	0.636	2.23 (−1.60 to 6.07)	0.249
Presenting categories of VI				
None (reference)	41.58 ± 11.39		16.23 ± 4.94	
Mild	−6.50 (−11.84 to −1.16)	**0.018**	−2.35 (−4.64 to −0.07)	**0.043**
Moderate-severe	−11.98 (−16.95 to −7.01)	**<0.001**	−3.13 (−5.26 to −1.01)	**0.004**
Self-reported health rating				
Very good to excellent (reference)	47.45 ± 16.32		18.16 ± 5.82	
Good	−7.47 (−24.68 to 9.73)	0.390	−5.88 (−13.23 to 1.48)	0.116
Poor to fair	−26.61 (−46.62 to −6.60)	**0.010**	−7.88 (−16.44 to 0.68)	0.071
Eye condition				
ARMD	32.44 ± 12.63	0.730*	14.10 ± 4.37	0.723*
Diabetic retinopathy	29.47 ± 9.33		12.38 ± 4.92	
Glaucoma	39.17 ± 12.80		16.25 ± 5.38	
Other retinal disease	37.79 ± 12.91		14.98 ± 5.03	
Corneal diseases	37.84 ± 8.71		15.59 ± 5.57	
Other	37.35 ± 12.84		14.51 ± 5.02	

Adjusted means are given for the reference categories.Bold coefficients represent independent variables found to be statistically ($P < 0.05$) associated with visual functioning. Bold and underlined coefficients represent independent variables found to be statistically ($P < 0.05$) associated with visual functioning and clinically meaningful.

* No statistically significant differences between categories.

Our finding that emotional well-being is affected in patients with even mild vision impairment is also important, as evidence suggests that patients with vision impairment and emotional distress are likely to show increased functional disability independent of that caused by their vision impairment.[37–39] Depression is considered to result in functional decline in this group by reducing motivation, initiative and resiliency,[37] and people with depression are less likely to access vision rehabilitation services than those who are not depressed.[40,41] This finding suggests that interventions should not simply focus on increasing involvement in activities of daily living and use of low-vision devices, but rather should be more holistic and address emotional distress, family functioning, roles, work, and social issues.

In the present study, Rasch analysis was used to determine the validity and psychometric characteristics of the IVI in a German outpatient sample. Overall, the German IVI was found to be a valid instrument to assess the impact of low vision on VRQoL in this population. Our psychometric analyses found that the IVI performs optimally when split into two subscales, assessing visual functioning and emotional well-being. The two subscales conform to the key fit indices for the Rasch model: unidimensionality, minimal item misfit, and ordered thresholds. We note that the outcome of Rasch analysis in this study differed from that of the original analysis,[12] in which the IVI functioned as three subscales and as an overall score. These differences could be related to the inclusion of a number of not visually impaired patients (not included in the original work) and cultural and linguistic factors. Indeed, in the original IVI validation study, the scale demonstrated borderline multidimensionality due to the presence of the emotional items. Instead of systematically deleting these emotional items in search of a unidimensional overall score, we maintained the integrity of the original scale and the capacity of the IVI to assess QoL as opposed to simply visual functioning. Of importance, this finding demonstrates the necessity of revalidating patient-reported outcome measures when used in a different population. It is not unusual, however, to detect changes in a scale when used in different populations. For example, the VF-14, a well-known visual functioning scale, had to be modified when used in other populations, such as the VF-11 in an Asian population.[42]

The use of Rasch analysis, an important step in modern scale validation, to assess the psychometric properties of the German IVI and to produce estimates of interval-level measurements of vision-specific functioning and emotional well-being is a major strength of this study. To our knowledge, this is the first study to report the use of modern psychometric principles to validate a VRQoL instrument in Germany and our analyses demonstrate the importance of using Rasch analysis to evaluate patient-reported outcome measures and attain robust interval-level measurement for statistical analyses. Other studies have demonstrated substantial increases in measurement precision using Rasch-validated measurement compared with traditional summary scoring.[43,44]

Our rich sample representing the continuum of visual acuity and major eye diseases typically seen in German tertiary eye clinics is another strength of this study, as is the inclusion of patient feedback into the German version of the IVI, which was carefully translated and back translated. Conversely, our study is limited by a moderate sample size, which included several patients with no significant vision impairment. Future studies would benefit from a greater proportion of patients with low vision. Also, in this study, our categories of vision impairment were based only on better eye visual acuity. Although the adverse effects of vision loss in one eye can be substantial despite good visual acuity in the fellow eye,[45] we believe that our categorization is acceptable as the proportion of patients with normal visual acuity in one eye and moderate-severe vision impairment in the other eye was very small (n = 20, 11%). Finally, because our study is not population based, the generalizability of our results may be limited. However, since our main findings are reflected by previous population-based studies,[27,33,35] this limitation is of minimal consequence.

In conclusion, our study showed that the German IVI is a valid psychometric tool that can assess the impact of differing levels of vision impairment on VRQoL using two scales: vision-specific functioning and emotional well-being. Using Rasch-calibrated interval level measurements, we showed a dose–response relationship between visual impairment and VRQoL in this German outpatient population—namely, that both mild and moderate to severe vision impairment are significantly independently associated with worsening VRQoL, when compared to no vision impairment. The finding that even patients with mild vision loss reported poorer vision functioning and emotional well-being when compared to those with no vision impairment is highly relevant to eye health professionals, researchers, and policy planners, and it highlights the importance of timely, comprehensive treatment and referral processes and appropriate interventions for low-vision patients in Germany.

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