Exploratory and Confirmatory Factor Analysis of the Persian Version of the Low Vision Quality of Life Questionnaire

Javad Heravian Shandiz; PhD[1], Hamed Momeni Moghaddam; PhD[2], James. S Wolffsohn; PhD[3], Maliheh Karimpour; MSc[4]

[1] Refractive Errors Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

[2] Department of Optometry, Zahedan University of Medical Sciences, Zahedan, Iran

[3] School of Optometry, Aston University, Birmingham, UK

[4] Department of Optometry, School of Paramedical Sciences, Mashhad University of Medical Sciences, Mashhad, Iran

Corresponding author: Maliheh Karimpour

Tel: + 98-51-38846710

Fax: +98-51-37285290
E-mail: Karimpour.opt@gmail.com

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Abstract

Purpose

Most of the visual quality assessment questionnaires are in English. None of the low vision related quality of life questionnaires have been translated or developed in Persian. It will help Persian optometrists and ophthalmologists to assess the improvement of visual function and quality of life during their low vision rehabilitation programs. In this study we aimed to translate the Low Vision Quality of Life (LVQOL) questionnaire into the Persian language and apply Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to assess the construct validity and fit model.

Methods

Translation and cultural adjustment of the English language Low Vision Quality Of Life (LVQOL) questionnaire to Persian was undertaken. Overall, 100 low vision patients participated to validate and model assessment the questionnaire by both EFA and CFA methods.

Results

Complementary EFA and CFA results provide detailed information about the item and scale performance of the Persian LVQOL. EFA showed items 15, 16 and 21 had factor loadings lower than 0.3. The modified model had The CFI and RMSEA of 0.89 and 0.06 respectively.

Conclusion

The translation, adjustment and fit analysis of the LVQOL questionnaire into Persian was successful and it will be valuable in both clinical practice and research.

Key words

Exploratory Factor analysis, Confirmatory Factor Analysis, Low vision, Quality of life, Questionnaire

Introduction

Quality of life has become an important fact in recent years (De Boer et al. 2006). It is defined as a person's satisfaction with his status in life about his aims, expectations and concerns according to the culture in which he lives (WHOQoL Group, 1993). Many questionnaires have been developed as instruments to measure quality of life. The fields of ophthalmology and optometry are not exception to this improvement (Zou et al. 2005). The evaluation and analyses of quality of life will enhance health services.

Most of the visual quality assessment questionnaires are in English (WHOQoL Group, 1993; Zou et al. 2005; Yingyong, 2007). It is estimated that near 110 million people spoke Persian as their major language around the world. Persian is the mother tongue of 74 million and 75% of them lives in Iran.

More than 3% of Iranian people are suffering from visual impairment (Afshari et.al. 2018). None of the low vision related quality of life questionnaires have been translated or developed in Persian.

Quality of life measurements to evaluate the cataract surgery achievements were the first efforts in ophthalmology (Elliott et al. 1990; Abrahamsson et al. 1996; Lundström et al. 1997). Later, patient contentment was evaluated for glaucoma, optic neuritis and other ophthalmologic diseases (Parrish 2nd, 1996; Ross et al. 1984; Gutierrez et al. 1997; Cleary et al. 1997). As the aging population and diseases affect the eye are increased, low vision has grown up since the last decade (Raasch et al. 1997). Although since 1948, after the World Health Organization (WHO) definition of the health, Quality of life issues have become steadily more important in health care practice and research, a few developed scales are suitable for quality of life and the effect of rehabilitation assessment in patients with very low vision (Testa & Simonson, 1996; Stein, 2004; Terheyden & Finger, 2019). The aim of these questionnaires is to identify the effect of low vision on daily life (Abrahamsson, 1996).

There are some specific instruments to assess Quality of life of patients with the ophthalmologic condition. A few of them are used routinely in the delivery of low-vision services (Khadka et al.

2013). The Veterans Affairs Low Vision Visual Functioning Questionnaire (VALV VFQ) that was with 48 items (Stelmack et al. 2004) and Low Vision Quality of Life questionnaire (LVQOL) with 25 items (Wolffsohn & Cochrane, 2000) are the most used instruments in adult low vision practices that originally developed in English. The LVQOL is widely used by researchers in the field of low vision. It was translated and validated in many languages like Chinese, Thai, Turkish, and Spanish (Pérez-Maná, 2022). Furthermore, LVQOL assesses different aspects of visual function by 25 items (approximately with half of the VA LV VFQ items) that can be a useful option for low vision patients who are usually old, with some background diseases that make them impatient and sensitive. These positive features assure us to choose this instrument.

LVQOL was developed in 4 dimensions including 25 items. The questionnaire assesses distance vision, mobility and lighting, adjustment, reading and fine work and activities of daily living. The higher the score obtained from this questionnaire, the higher quality the life is. The LVQOL takes 5 to 10 minutes to be fulfilled and would therefore put no stress on a person with low vision. The average LVQOL score (approximately 60 out of 125) shows that a low vision patient has a markedly impaired functional status and quality of life (Wolffsohn & Cochrane, 2000).

In the current Standards for Psychological and Educational Testing, validity refers to the “degree to which evidence and theory support the interpretations of test scores for proposed uses of tests. Validity is, therefore, the most fundamental consideration in developing tests and evaluating tests” (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999) Factor analysis is a multivariate statistical method used to evaluate relationships among a set of observed variables. The method was developed in the early 1900s by Charles Spearman. Two popular applications of factor analysis called Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are commonly used to assess and establish the psychometric qualities of scores from sets of items (Sellbom & Tellegen, 2019). EFA is used to explore the factor structure of a test or instrument. It shows the number and types of factors that explain correlations among the items and how these factors relate to one another

(Schreiber, 2021). CFA is a latent variable modeling method that assumes scores on sets of related questionnaire items show a common complex, unobservable phenomenon (construct) (Bean & Bowen, 2021). In this study we aimed to translate the LVQOL questionnaire into the Persian language and apply EFA and CFA techniques to validate the questionnaire.

Methods

This research was reviewed by an independent ethical review board and conforms to the principles and applicable guidelines for the protection of human subjects in biomedical research. The strategy of translation and adjustment a comprehensive English language low vision related quality of life instrument, LVQOL, was chosen to develop a Persian culturally specific quality of life measurement for low vision people.

Two important principles of making replication being close to the original version and cultural adaptation were considered during translation. Forward translation (from English to Persian) was done at first. Then an expert committee comprised of methodologists, health professionals, language professionals, and the translators checked for the cultural adaptation. The expert committee assessed if a word or several words reflect the same ideas or subjects in both the original and adapted versions of the questionnaire. A second forward translation was performed. Then a backward translation (from Persian to English) and the third forward translation were accomplished. In the first stage the LVQOL questionnaire was independently translated into Persian by three optometrists whose mother tongue was Persian and who had advanced levels English knowledge. These three translations investigated in a meeting consisting of optometrists and ophthalmologists. Necessary corrections were made and the first Persian version of the questionnaire was prepared. It was agreed to add the option of reading Short Message Service (SMS) to the item of “reading your letters and mail” in the Reading and Fine Work part of the questionnaire. In the second phase, the first Persian version was translated into English by two English native people who knew advanced levels of Persian. These two translations were compared to the original version of the LVQOL questionnaire and necessary modifications were done. At last this English version of the questionnaire was sent to JS Wolffsohn by an Email and he confirmed that this version is similar to the original version in terms of content and concept. In the patient testing phase, the translated questionnaire was administered to 10 normal vision and 10 low vision subjects whose mother tongue were Persian. The problems with its application were reviewed through face to face interviews with mentioned subjects. The final version of the questionnaire was administered to the study and control groups that were matched by age, gender and level of education.

The study was accomplished by 100 low vision in the optometry clinic of Mashhad University of Medical Sciences Mashhhad, Iran (MUMS) between December 2020 and May 2021. According to the patients' documentations available in an eye hospital in Mashhad, Those who were diagnosed as low vision were contacted if they wanted to participate in the study. The guidelines of the declaration of Helsinki was considered in this study. The Ethics Committee of MUMS approved the study protocol by the code of 991701 and all patients gave written informed consent to participate in the study. Inclusion criteria included patients with corrected visual acuity of 0.5 logMAR (6/60) or less or visual field less than 20 degrees in the better eye as low vision definition by WHO, age of 18 and older and ability of reading or hearing. Patients who wre not Persian native were excluded from the study.

All participants were asked to complete the questionnaire. Like the original version, the Persian translation contained 25 items which were rated from 1 to 5 (1: always, 2: usually, 3: sometimes, 4: rarely and 5: never have problem due to their vision). EFA and CFA techniques were incorporated to fit the data by R software (v.3.5.1). As a first step, we started an EFA by choosing a number of factors that we wanted to explore (original 4 dimensions). A variety of software packages are available for fitting EFA. We used maximum likelihood methods in R, with functions from the base and epmr packages. CFA extends EFA by providing a framework for proposing a specific measurement model, fitting the model, and then testing statistically for the appropriateness or accuracy of the model given our instrument and data. For demonstration purposes, we examined CFA in R using the lavaan package.

Results

The final version of the translated LVQOL questionnaire was administered to 100 low vision patients with a mean age of 45.06 ± 16.38. The socio-demographic characteristics of the subjects were presented in table 1 [table 1 near here]. Of 100 low vision patients, 26% had media opacity, 36% had retinopathy, 12% had macular disease and 26% had glaucoma.

EFA factor loadings of the 25 items based on the original 4 dimensions (4 factors) are shown in table 2 [table 2 near here]. By default, values below 0.1 are not displayed when the matrix of factor loadings is printed to the R console. The first six items in the table load strongest on factor 2, with loadings of 0.54, 0.71, 0.64, 0.70, 0.33 and 0.40. The next three items load strongest on factor 1, with loadings of 0.56, 0.84, and 0.51 and vice versa. If we consider a cutoff of 0.3 for factor loadings, items 15, 16, and 21 show lower loadings in each factor.

Next, we can look at the eigenvalues for the factors, to determine the amount of total score variability they each capture. 3.38, 2.47, 2.32 and 2.07 were the eigenvalues of the factor 1-4 respectively. We can visually compare eigenvalues across factors using what's called a *scree plot*. In the plot, factors are listed out on the x-axis, and eigenvalues are compared vertically in terms of their magnitude on the y-axis. As figure 1 shows, the line connecting the eigenvalues across factors resembles a precipice that sharply declines and then leaves a pile of scree or rubble at the bottom [figure 1 near here]. The eigenvalues are all above 1, which is sometimes used as a cutoff for acceptability.

In our final demonstration, we fitted a CFA to the LVQOL. Our first factor structure was similar to what we explored previously via EFA. However, here, our items were only allowed to load on their intended factors. The results are shown in table 3 [table 3 near here]. Model fit is not as strong as we would hope. The Comparative Fit Index (CFI) was 0.44 and the Root Mean Square Error of Approximation (RMSEA) was 0.14. So we came back to the EFA results and made the suggested modifications in the model. Following the EFA results, we omitted items 15, 16 and 21 duo to their low factor loadings and created a new model with a new order of remaining items. New model CFA results are shown in table 4 [table 4 near here]. The CFI and RMSEA were 0.89 and 0.06 respectively. They show good model fit. The new model presented better fit indices from the previous one.

Discussion

Most of the visual quality assessment questionnaires are in English (WHOQoL Group, 1993; Zou et al. 2005; Yingyong, 2007). There are some translated or developed quality of life questionnaires about general health or some special eye diseases like cataract, dry eye and glaucoma in Persian. Furthermore the NEI- VFQ- 39 was translated and validated in Persian years ago that is used for the general assessment of visual function (Asgari, 2011). None of the low vision related quality of life questionnaires have been translated or developed in Persian. In this study we aimed to translate and assess the validity and model fit of the Low Vision Related Quality of Life (LVQOL) questionnaire in Persian. A single questionnaire can never include the whole range of quality-of-life features in visual impairment for everyone. However, the LVQOL presents useful clinical information about the various aspects of visual function, such as visual acuity, contrast sensitivity, and visual field, and the visual status description of an individual. This information can be used to assess the outcome of low-vision rehabilitation to improve the quality of life of an individual. This instrument evaluates distance vision, mobility, lighting, general adjustment to life, reading and fine work, and activities of daily living of low vision people (Wolffsohn & Cochrane, 2000).

In this study we aimed to assess the LVQOL model by factor analysis. In the Spanish version, authors claimed that IRT analysis evidenced the need to structure the questionnaire in two or three well-defined subscales and to reconsider including certain items that may be unable to provide significant discrimination (Pérez-Maná et al. 2022). As a first step EFA was done on the original version of the Persian translated LVQOL. The term factor is synonymous with construct, and refers to an underlying and unobservable trait, characteristic, or attribute assumed to cause or give rise to the observable behavior we measure and score using test items (Bedford & Speklé, 2018). Some questions we might ask about the Persian LVQOL questionnaire that can be answered with EFA. As the original LVQOL was created based on 4 dimensions and Pérez-Maná et al. (2022) concluded, LVQOL is a multidimensional questionnaire, we have done four-factor EFA. The presence of four factors on the LVQOL suggests that sub scores based on each factor may provide more detailed information about where an individual's visual function problems lie. These differences are not evident in a single total score. Factor analysis suggests that sub scores interpretations in cases may be justified. The EFA model estimates the relationships between each item on our test and each factor that the model extracts. These relationships are summarized within a factor loading matrix (Schreiber, 2021). Loadings closer to 0 indicate small or negligible relationships, whereas values closer to 1 indicate strong relationships (Sellbom & Tellegen, 2019). Most of the loadings were between 0 and 0.80 in this study. As a general rule of thumb, loadings of 0.30 or higher may merit further interpretation, whereas loadings below 0.30 may not (Sellbom & Tellegen, 2019). By default, values below 0.1 are not displayed when the matrix of factor loadings is printed to the R console. Variability explained for a given factor can be indexed using its standardized eigenvalue. An eigenvalue of 1 tells us that a factor only explains as much variability, on average, as a single item (Schreiber, 2021). Larger standardized eigenvalues are better, as they indicate stronger factors that better represent the correlations in scores. Smaller eigenvalues, especially ones below 1, indicate factors that are not useful in explaining variability. Eigenvalues, along with factor loadings, can help us identify an appropriate factor structure for our test. All of our model Eigenvalues were above 1. The item error terms summarize the unexplained variability for each item. Items with larger factor loadings will have lower errors, and vice versa. The EFA pointed us in the right direction in terms of finding a suitable number of factors for our test, and determining how our items load on these factors. However, because EFA does not involve any formal hypothesis testing, the results are merely descriptive. The EFA led us to conclude first that items 15, 16 and 21 had low factor loadings and should be omitted from the scale. It also showed that the order of items did not appear to be appropriate and the number of factors needed to adequately capture certain percentages of the variability in scores.

Zou et al. (2005) determined the Chinese LVQOL scales according to the VARIMAX rotation factor analysis results. Four principal factors were identified. They also found out that the order should be different in each 4 scales from the original one.

In the Thai LVQOL study, the factor analysis showed the need for questions 4, 7, 11, 12, 16 to be deleted as factor loading was less than 0.70. They concluded that these questions were not important for the patients' lives (Yingyong, 2007).

CFA extends EFA by providing a framework for proposing a specific measurement model, fitting the model, and then testing statistically for the appropriateness or accuracy of the model given our instrument and data (Orçan, 2018). In CFA, we hypothesized that four factors will be sufficient for explaining the correlations among items in the LVQOL. We first considered the original model was appropriate and then compared it with the modified one based on EFA.

Results for the first CFA showed poor fit. The discouraging CFA results inspired us to modify our factor structure in hopes of improving model fit. Potential changes included the removal of items 15, 16 and 21 with low factor loadings, and change of items ordered. Having fit multiple CFA models, we can then compare fit indices and look for relative improvements in fit for one model over another.

In the Turkish LVQOL study, to test whether there was a relationship between the items and their corresponding dimensions, confirmatory factor analysis (CFA) for categorical data was applied. The items with factor loadings below 0.40 were eliminated (item 16). The goodness-of-fit statistics were TLI=0.951, CFI=0.878 and RMSEA=0.097 for the remaining items indicating an acceptable fit to the model (Idil et al. 2011).

Of these two fit comparison statistics, we focused on Akaike (AIC) and Bayesian (BIC). The AIC and BIC both decreased from the original model to the modified model (AIC of 6593.039 and BIC of 6738.929 in the original model changed to 5818.004 and 5948.263 in the modified one respectively). Taken together, the results of these CFA suggest that the modified four-factor model is appropriate for the Persian LVQOL.

There are some advantages of factor analysis such as the identification of groups of inter- related variables which show us how the variables are related to each other. Factor analysis can be used to identify the hidden dimensions which may or may not be apparent from the direct analysis. It is not extremely difficult to do, inexpensive and accurate. These assure us to encourage other researchers to complete factor analysis during their psychometric quality assessments.

In conclusion, after appropriate modifications, the Persian adaptation of the LVQOL has been shown to be valid and suitable for use in Persian low vision practices to assess visual function and quality of life of patients with visual impairment.

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Tables

Table 1. socio-demographic characteristics of the subjects

Characteristic	Patients
Gender	
Male	**66**
Female	**34**
Age	
18-39	**43**
40-59	**33**
≥60	**24**
Level of education	
Primary school	**2**
High school	**29**
Graduated	**54**
Post graduated	**15**
Job	
Housewife	**20**
Working	**35**
Unemployed	**7**
Retried	**25**
student	**13**

Table 2. factor loadings based on EFA

Item	Factor 1	Factor 2	Factor 3	Factor 4	Error
1	0.17	0.54		0.23	0.63
2	- 0.21	0.71	0.10		0.43
3	0.17	0.64	0.28		0.48
4	0.43	0.70	0.21		0.29
5	0.28	0.33	- 0.16		0.78
6	0.12	0.40		0.28	0.75
7	0.56	0.23	- 0.15		0.61
8	0.84	0.20	- 0.11		0.25
9	0.51			0.35	0.61
10	0.11		0.19	0.70	0.45
11	0.11	0.34		0.82	0.20
12				0.69	0.51
13	0.48		0.11	0.15	0.73
14	0.46		0.27		0.72
15	0.19		0.14		0.94
16			-0.29	-0.19	0.86
17	0.57	0.32	0.40		0.42
18	0.13	0.14	0.33		0.85
19		0.18	0.83	0.14	0.27
20			0.67		0.53
21	0.21	-0.27	0.28		0.80
22	0.34	0.13	0.30	- 0.10	0.77
23	0.49		0.37	0.23	0.56
24	0.45		0.40		0.64
25	0.52	0.16	0.11		068

Table 3. CFA analysis of the original LVQOL						
Latent variables						
Items	estimate	Std.Err	Z- value	P(>|z|)	Std.lv	Std.all
Factor 1 1	0.577	0.103	5.605	0.000	0.577	0.560
2	0.390	0.090	4.359	0.000	0.390	0.451
3	0.700	0.099	7.050	0.000	0.700	0.675
4	0.923	0.111	8.348	0.000	0.923	0.767
5	0.248	0.079	3.124	0.002	0.248	0.332
6	0.409	0.090	4.546	0.000	0.409	0.468
7	0.451	0.105	4.300	0.000	0.451	0.445
8	0.604	0.122	4.964	0.000	0.604	0.505
9	0.364	0.101	3.605	0.000	0.364	0.379
10	0.507	0.138	3.666	0.000	0.507	0.385
11	0.710	0.136	5.218	0.000	0.710	0.528
12	0.346	0.136	2.548	0.011	0.346	0.273
Factor 2 13	0.506	0.115	4.386	0.000	0.506	0.472
14	1.030	0.135	7.644	0.000	1.030	1.011
15	0.479	0.117	4.103	0.000	0.479	0.437
16	- 0.109	0.101	-1.072	0.284	- 0.109	- 0.107
Factor 3 17	0.683	0.121	5.646	0.000	0.683	0.572
18	0.312	0.079	3.953	0.000	0.312	0.415
19	0.580	0.063	9.171	0.000	0.580	0.877
20	0.408	0.070	5.846	0.000	0.408	0.590
21	0.090	0.037	2.444	0.015	0.090	0.263
Factor 4 22	0.492	0.110	4.452	0.000	0.492	0.479
23	0.641	0.109	5.863	0.000	0.641	0.610
24	0.765	0.111	0.882	0.000	0.765	0.702
25	0.582	0.121	4.811	0.000	0.582	0.513
Covariances						
Factor 1						
Factor 2	0.258	0.106	2.432	0.015	0.258	0.258
Factor 3	0.441	0.103	4.271	0.000	0.441	0.441
Factor 4	520	0.108	4.827	0.000	0.520	0.520
Factor 2						
Factor 3	0.254	0.107	2.372	0.018	0.254	0.254
Factor 4	0.516	0.111	4.655	0.000	0.516	0.516
Factor 3						
Factor 4	0.621	0.100	6.217	0.000	0.621	0.621

Table 4. CFA analysis of the modificated LVQOL

Latent variables						
Items	estimate	Std.Err	Z- value	P(>|z|)	Std.lv	Std.all
Factor 1						
8	0.851	0.112	7.629	0.000	0.851	0.712
17	0.867	0.110	7.851	0.000	0.867	0.727
7	0.675	0.103	4.590	0.000	0.475	0.675
25	0.661	0.112	5.928	0.000	0.661	0.683
9	0.457	0.098	4.673	0.000	0.457	0.476
23	0.593	0.104	5.684	0.000	0.593	0.563
13	0.553	0.108	5.132	0.000	0.553	0.517
14	0.521	0.103	5.079	0.000	0.521	0.512
24	0.585	0.109	5.365	0.000	0.585	0.537
22	0.556	0.106	4.318	0.000	0.456	0.544
Factor 2						
2	0.451	0.087	5.168	0.000	0.451	0.521
4	1.026	0.107	9.577	0.000	1.026	0.853
3	0.760	0.097	7.835	0.000	0.760	0.732
1	0.545	0.104	5.267	0.000	0.545	0.529
6	0.451	0.091	4.860	0.000	0.351	0.501
5	0.369	0.078	3.436	0.001	0.269	0.461
Factor 3						
19	0.728	0.101	7.203	0.000	0.728	1.100
20	0.370	0.079	4.705	0.000	0.370	0.536
18	0.372	0.078	4.484	0.000	0.372	0.462
Factor 4						
11	1.233	0.127	9.689	0.000	1.233	0.917
10	0.891	0.129	6.929	0.000	0.891	0.677
12	0.835	0.124	6.740	0.000	0.835	0.660
Covariances						
Factor 1						
Factor 2	0.594	0.086	6.908	0.000	0.594	0.594
Factor 3	0.441	0.101	3.702	0.002	0.441	0.441
Factor 4	0.387	0.109	3.624	0.009	0.387	0.387
Factor 2						
Factor 3	0.315	0.101	3.109	0.002	0.315	0.315
Factor 4	0.398	0.103	3.865	0.000	0.398	0.398
Factor 3						
Factor 4	0.199	0.097	2.043	0.041	0.199	0.199

Figures

Fig 1. The eigenvalues of factors based on EFA.