

Assessment of Health-Related Quality of Life in Rural Population Health Research: Using Classical and Modern Psychometric Approaches

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Abstract Health-related quality of life (HRQOL) is an outcome measure of growing interest in public health research and is concerning a person's perceived health. Population health research often has the goal of administering large questionnaires to large numbers of participants, emphasizing the need for small scales. Furthermore, many existing national surveys administer standard health-related questions which, if validated properly, could be used to assess HRQOL. The aim of this study was to develop and validate a short HRQOL scale for rural adults using both classical and modern psychometric methods. This study analyzed data from 2,430 rural adults participating in the 2012 Montana Behavioral Risk Factor Surveillance System (BRFSS). Three self-reported items (physical health, mental health, & general health) and one constructed index for a total of four items were used to assess HRQOL. Results from factor analysis indicated a single factor model accounting for 53.5% of the total variance. Factor loadings ranged from .48 to .82 with the mental health item contributing the least to the factor. The internal consistency analysis showed that the four-item scale was moderately reliable (KR20 = .70), however could improve (KR20 = .75) if the mental health item was dropped. The Rasch assessment confirmed dropping the mental health item due to an Outfit MnSq statistic greater than 1.50. A final three-item Rasch assessment indicated good model fit, item separation, and item reliability. This study provides psychometric evidence for the use of a three-item (physical health, general health, & healthy days) HRQOL scale (HRQOL3) with rural adults. The simplicity of the scale and the widespread use of its items make the HRQOL3 a viable choice for rural population health research.

Keywords: health-related quality of life, population health, rural health, psychometrics

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1. Introduction

The use of health-related quality of life (HRQOL) as an outcome measure has increased dramatically in public health research and currently serves as a new topic area in *Healthy People 2020* [1]. HRQOL is a multidimensional concept that generally includes dimensions of physical and mental health perceptions [2]. HRQOL has also been shown to be a strong predictor of health status, predicting such events as the number of physician visits, hospitalization events, and mortality among adults [3]. Because HRQOL is such a diverse health measure, it has become a standard variable in public health research [4].

Population health research often has the goal of administering large questionnaires to large numbers of survey respondents, emphasizing the need for small scales. Furthermore, many existing national surveys administer standard health-related questions which, if validated properly using psychometric theory, could be used to assess HRQOL.

Item response theory (IRT) is considered a modern approach to psychometrics, as compared to classical test theory (CTT) [5]. Where CTT focuses on an individual's test score, IRT focuses on each item by examining the response of an individual at a specific ability level and the characteristics of that item [6]. An IRT analysis that is only concerned with an item's difficulty level (b-parameter) and the individuals' ability (θ), is considered a 1-parameter model, and commonly called a Rasch measurement model [7]. Rasch analysis can easily be applied to health and behavioral assessments containing dichotomous response (yes/no) items [8].

Given the overwhelming attraction to use HRQOL as a measure in public health research, as well as a need for short scales in population-level research, there is a strong need for a better understanding of the measurement properties of HRQOL assessments commonly used in rural population health research. Therefore, the purpose of this study was to develop and validate a short HRQOL scale for rural adults using both classical and modern psychometric methods.

2. Materials and Methods

2.1. Participants

Data for this study came from the 2012 Montana Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is an annual state-based cross-sectional survey of non-institutionalized U.S. adults 18 years of age and older [9]. A total of 2,430 adults who indicated residing in a rural county were used in the analysis [10].

2.2. Main Measures

Three self-reported items (physical health, mental health, & general health) and one constructed index (CDC Healthy Days) [11] for a total of four items were used to initially assess HRQOL. The first was a single 5-category item that asked about self-perceived general health. Those responding as “fair” or “poor” were considered to have poor HRQOL and those responding “excellent”, “very good”, or “good” were considered to have good HRQOL. The second and third items were specific questions asking participants about their physical (physical illness and injury) and mental health (stress, depression, and emotional problems), respectively. These questions asked respondents to report the number of days (out of the previous 30 days) that their physical (or mental) health was not good. Those reporting 14 days or more were considered to exhibit poor physical (or mental) health and those less than 14 days were considered to exhibit poor health [12]. The last item was a computed index that was constructed from the physical and mental health questions regarding the previous 30 days. This measure was used to assess the overall number of unhealthy days due to physical and/or mental health, not to exceed 30 days. Those responding 14 days or more were considered to have poor HRQOL and those less than 14 days considered to have good HRQOL. Each item was dichotomized so that 1 represented “good” HRQOL and 0 represented “poor” HRQOL.

2.3. Other Variables

Health status variables such as heart attack, stroke, COPD, arthritis, and depression were self-reported and used to validate the new HRQOL scale. Each participant was categorized as either having been afflicted by the health condition (i.e., yes) or not (i.e., no). Covariates such as age, sex, and income were assessed by self-reported items and used in the main analyses to control for their confounding effects.

2.4. Statistical Analysis

The following analysis plan was followed: 1) factor analysis, 2) internal consistency reliability analysis, 3) Rasch analysis, 4) development of the new HRQOL ability score, 5) descriptive statistics of the new HRQOL measure, and 6) validation of the new HRQOL measure by comparison with known health status groups [8]. All analyses were performed using the Complex Samples Module of the SPSS system version 16.0 and Winsteps version 3.65 [13]. All p-values are reported as 2-sided and statistical significance level was set at .05.

3. Results

A total of 2,430 participants (Mean [SD] age = 57.4 [16.4] years) indicated resided in a rural county and completed the HRQOL assessments. Of which 70.9% self-reported good HRQOL (see Table 1). Among males and females, 65.6% and 74.6% reported good HRQOL, respectively. For age, 88.7%, 87.9%, 81.5%, 69.2%, 70.8%, and 57.2% of adults reported good HRQOL in the 18-24, 25-34, 35-44, 45-54, 55-64, and 65+ year groups, respectively. Across race/ethnicity, White, American Indian, Hispanic, Multiracial, and Other groups reported 72.1%, 59.1%, 82.6%, 56.5%, and 94.5% good HRQOL, respectively. Finally, when considering household income (US \$), the lowest prevalence of self-reported good HRQOL was seen in those with less income (< \$10,000). While the greatest prevalence of self-reported good HRQOL was seen in those with higher incomes (> \$50,000).

Table 1. Prevalence of HRQOL status by demographic category, 2012

	Good HRQOL		Poor HRQOL		p
	%	SE	%	SE	
Overall	70.9	1.3	29.1	1.3	< .001
Gender					.001
Male	65.6	2.2	34.4	2.2	
Female	74.6	1.6	25.4	1.6	
Age Group (yr)					< .001
18-24	88.7	4.8	11.3	4.8	
25-34	87.9	3.6	13	3.6	
35-44	81.5	3.6	18.5	3.6	
45-54	69.2	3.2	30.8	3.2	
55-64	70.8	2.5	29.2	2.5	
65+	57.2	2.3	42.8	2.3	
Race/Ethnicity					.004
White	72.1	1.4	27.9	1.4	
American Indian	59.1	4.2	40.9	4.2	
Hispanic	82.6	9.1	17.4	9.1	
Multiracial	56.5	8.4	43.5	8.4	
Other	94.5	3.8	5.5	3.8	
Income (US \$)					< .001
< 10,000	39.8	4.8	60.2	4.8	
10-14,999	55.1	4.9	44.9	4.9	
15-19,999	53.8	4.7	46.2	4.7	
20-24,999	55.8	4.5	44.2	4.5	
25-34,999	66.8	4.5	33.2	4.5	
35-49,999	77.5	3.1	22.5	3.1	
50-74,999	89.2	2.2	10.8	2.2	
75,000+	85.4	2.7	14.6	2.7	

Note. p-values are for the Rao-Scott chi-square statistic. HRQOL is measured from self-reported general health item.

Results from factor analysis indicated a single factor model accounting for 53.5% of the total variance (see Table 2). Factor loadings ranged from .48 to .82 with the mental health item contributing the least to the factor. The internal consistency analysis showed that the four-item scale was moderately reliable (KR20 = .70), however could improve (KR20 = .75) if the mental health item was dropped.

Table 2. Results of both classical and modern psychometric approaches by stage of analysis

Results	Analysis Stage	
	First	Second
Descriptives		
No. of Items	4	3
Mean	1.75	1.35
SD raw score	1.07	0.93
Rasch Analysis		
% Person Fit	89.4	91.5
% Item Fit	75	100
Item Separation	8.96	11.22
Item Reliability	0.99	0.99
Misfit Statistics	1	0
rRM	-0.95	-0.99
Classic Analysis		
KR20	0.70	0.75
% Variance	53.5	66.7
LFL	0.48	0.79

Note. r_{RM} is the correlation between raw HRQOL scores and Rasch ability scores. LFL is the lowest factor loading.

The Rasch assessment confirmed dropping the mental health item due to an Outfit MnSq statistic greater than 1.50 [14]. A final three-item Rasch assessment indicated good model fit, item separation, and item reliability. The Rasch HRQOL ability scores for individuals were transformed to T-scores for ease of interpretation, where larger scores indicated better HRQOL.

Table 3 contains descriptive statistics of the new HRQOL measure constructed from the Rasch measurement analysis. Male respondents ($M = 49.1$, $SD = 10.36$) had significantly lower HRQOL than female respondents ($M = 50.6$, $SD = 10.36$, $p < .001$). And a significant negative linear trend was seen across age groups, with the greatest HRQOL seen in the 18-24 year age group ($M = 54.9$, $SD = 5.97$) and the lowest HRQOL seen in the 65+ year age group ($M = 47.9$, $SD = 10.50$, $p < .001$).

Table 3. Description of Rasch HRQOL scores by sample characteristics

Characteristic	N	M	SD	p
Overall	2430	50	10	
Gender				<.001
Male	878	49.11	10.36	
Female	1514	50.57	9.75	
Age Group (yr)				<.001
18-24	74	54.91	5.97	
25-34	185	53.93	7.19	
35-44	259	53.35	7.84	
45-54	441	50.08	10.16	
55-64	614	49.65	10.24	
65+	819	47.92	10.50	

Note. HRQOL scores are T-transformed. Age group is significant for linear trend.

Table 4. Construct validity of new Rasch HRQOL measure by comparison of known group differences

Groups	N	M	SE	p
Heart Attack				<.001
No	2173	51.31	0.28	
Yes	190	43.61	1.02	
Stroke				<.001
No	2243	51.20	0.27	
Yes	120	42.04	1.44	
COPD				<.001
No	2070	51.74	0.28	
Yes	293	43.04	0.97	
Arthritis				<.001
No	1258	53.43	0.31	
Yes	1105	47.23	0.45	
Depression				<.001
No	1673	52.00	0.30	
Yes	690	48.00	0.60	

Note. HRQOL scores were T-transformed. Higher T-scores represent better HRQOL.

All p-values are ANCOVA adjusted for age, sex, and income.

Table 4 contains construct validity evidence for the new HRQOL measure by comparing the new score between groups with known differences in HRQOL. Adults who had suffered either a heart attack [M (SE): 43.6 (1.02) vs. 51.3 (0.28)], stroke [M (SE): 42.0 (1.44) vs. 51.2 (0.27)], COPD [M (SE): 43.0 (0.97) vs. 51.7 (0.28)], arthritis [M (SE): 47.2 (0.45) vs. 53.4 (0.31)], or depression [M (SE): 47.4 (0.60) vs. 52.0 (0.30)] had significantly lower HRQOL (p 's < .001) as compared to their healthier counterparts.

4. Discussion

The purpose of this study was to develop and validate a short HRQOL scale for rural adults using both classical and modern psychometric methods. Results from the CTT analysis showed that three original items, commonly found in many large-scale surveys, and one constructed index, making a 4-item HRQOL scale was improved by dropping the mental health item. The new 3-item HRQOL scale (HRQOL3) showed acceptable construct validity and internal consistency. Results from the Rasch analysis confirmed development of the HRQOL3. The percentage of participants fitting the Rasch measurement model was improved in the HRQOL3 as compared to the original 4-item scale. As well, item separation increased substantially in the HRQOL3 analysis.

The results of this study also clearly showed that the new HRQOL ability measure possesses adequate construct validity by the comparison of known group differences examination. HRQOL was significantly greater among adults with better health status profiles. Those who had no history of heart attack, stroke, COPD, arthritis, and depression had greater Rasch ability scores than their less healthy counterparts. Similar group differences in HRQOL have been noted by others in adults having a heart attack [15], stroke [16], COPD [17], arthritis [18], and depression [19].

There are many strengths associated with the results of this study. First, the large sample size was useful and necessary for proper Rasch parameter estimates and fit statistics. Samples of size 200 and greater are suggested for proper estimation [20]. Another strength of this study is the use of the Rasch measurement analysis to allow for the evaluation of both properly fitting participants as well as properly fitting items to the model [8]. A final strength of this study was the use of modern psychometric methods in conjunction with CTT.

This study is not without its limitations. One limitation is the use of rural county residence as criteria for rural adult status. It is possible that adults residing in rural counties may possess sociodemographic characteristics similar to urban adults (and vice versa) and therefore account for an amount of misclassification error. A second limitation to these findings is the self-report nature of the study. It should be noted that the original HRQOL items used in this study were self-reported, however, HRQOL is a latent construct of self-perceived health and therefore may not be limiting as self-reported health behavior.

5. Conclusion

This study provides psychometric evidence for the use of a three-item (physical health, general health, & healthy

days) HRQOL scale (HRQOL3) with rural adults. The simplicity of the scale and the widespread use of its items make the HRQOL3 a practical choice for rural population health research.

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