



Exploring the Latent Trait and the Measurement Properties of Korean World Health Organization Quality of Life-BREF Measure Applied to Cancer Survivors

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Background: In general, measurement qualities of cross-culturally adapted quality of life (QOL) measures are altered in many aspects, although versions of them are well-validated measures. The latent trait and measurement qualities of the QOL measures for cancer-related samples should be considered when developing cross-culturally adapted measures.

Objects: To investigate the latent trait of the translated into Korean World Health Organization Quality of Life-BREF (WHOQOL-BREF) administered to different cancer survivors who had palliative rehabilitation care service (PRCS).

Methods: A cross-sectional study with 139 cancer survivors who had an experience of cancer survivorship with PRCS were conducted with a two-step analytic procedure including exploratory factor analysis (EFA) to confirm the latent trait and Rasch rating scale modeling to investigate the measurement qualities of the cross-culturally adapted WHOQOL-BREF measure.

Results: While the original WHOQOL-BREF measure constitutes a 4-latent trait, the EFA reveals that 24 items constitute six substantial factors. The item loadings are predominantly spread over factors 1 through 4 in a mixed manner of the latent traits, while the loadings of 'physical health' and 'environmental health' latent traits show similarity to what the original measure intended to assess. The latent trait of the cross-culturally adapted WHOQOL-BREF measure administered to different cancer survivors is likely to reveal more dimensions than the original WHOQOL-BREF measure. Person reliability (i.e., analogous to Cronbach's alpha) and separation are measured with 0.92 and 3.48, respectively. All items except the one item (medical treatment item) fit the Rasch rating model.

Conclusion: Findings suggest that the latent trait and the measurement qualities of the cross-culturally adapted WHOQOL-BREF measure should be taken into consideration when applying versions of it to various populations.

INTRODUCTION

Cancer-related prevalence has statistically increased over the last few decades and is considered a life-threatening disease worldwide. Globally, the mortality rate skyrocketed by 10 million deaths in 2020 [1]. Health statistics in Korea estimated that nearly 37 percent of Korean will have a cancer condition sometime in their lifetimes [2]. Although the overall cancer incidence rates increase globally, the mortality rates of global countries decline and the survival rates improve as progress has been made in early detection and palliative rehabilitation care service (PRCS) for cancer survivors [2]. These transitions may allow the majority of cancer-related people to remain

in their society and guide them into looking for professional helps to improve overall health. Thus, the PRCS plays a primary role in cancer rehabilitation during such difficult experiences. The PRCS may improve the quality of life of the cancer survivors and care givers who are in charge of palliative cares either at home or professional institutions [1,3-5]. In the context of measuring the health status of the survivors resulting from PRCS, it is essential to determine how PRCS impacts the status of quality of life (QOL) and optimally assess it recurrently in an appropriate fashion during cancer survivorship [6].

For acceptable QOL measurement, most measures, if not all, focus on the individual's perception of satisfaction levels and overall health-related status from either general or specific



health conditions of them [6-8]. Both types of measurement, so-called generic and cancer-specific assessments, have been applied to varied samples with different cancer diagnostic groups. Of the generic QOL measures in relation to health-related status, the World Health Organization (WHO) established QOL group and the group developed a 100 item-multi-dimensional measurement with 4 latent traits such as physical, psychological, social, and environmental health domains [1]. It is now applicable across a broad range of different diagnostic groups. The WHOQOL is considered a well-established measure dealing with emphasizing on comprehensive aspects of individual's overall status and known for suitable to apply across various population groups [7-9]. To meet the need for international use with simple and easy to use, the QOL group developed a short-form type measurement with the same 4 latent traits and 26 items (i.e., World Health Organization Quality of Life-BREF [WHOQOL-BREF]). Later, the short-form type measurement was translated into more than 15 international languages. It is now considered the most reliable and valid measurement applicable worldwide across all disease-related populations [9].

Although the WHOQOL-BREF measure has already been known for a well validated measurement with proven proper reliabilities over time, the latent traits of the cross-culturally adapted WHOQOL-BREF are commonly altered compared to the latent trait that was intended to be measured. That is, while designed to capture the level of QOL, scores obtained from a translated version of it often may not be comparable to its original version [10]. In the context of the latent trait being measured, the latent trait of a measure commonly changes between the versions with unacceptable measurement qualities. Consequently, results from the measure are not comparable to one another, although items of the measure are supposed to assess the same latent trait. That is, a measure that generates consistent results all the time can be reliable for the latent trait [11,12]. This characteristic of consistency between the original and a cross-culturally adapted version do not occur when versions of it are optimally applied to different samples or populations [13].

While the original version of WHOQOL-BREF is developed to assess the influence on a broad range of QOL status, results obtained from cross-culturally adapted WHOQOL-BREF measures are likely to be sensitive to only groups with particular QOL status. This type of measurement deficits, in general,

stem from applying a challenging measure to sample group with a low level of the status or vice versa. This measurement property often results in typically either ceiling or floor effects in which most classical test theory (CTT)-based QOL measures may only be able to sensitive to a sample group with particular capability with respect to the latent trait being measured. Hence, to overcome those measurement deficits of CTT-based measure, several authors advocate for investigating the measurement quality of individual items with modern test theory models rather than focusing on a group with particular capability [14-16].

By using Rasch rating scale model focusing individual item characteristics rather than a test as a whole, the shortcomings such as the properties of incomparable and variable scores resulting from different samples can be overcome. Based on a probabilistic formula focusing on: 1) the ratio of a probability of getting success and failure on a particular test item for individuals and 2) logarithmic transformation of the ratio obtained from the mathematical formula (i.e., logits), it provides both person ability and item difficulty estimates. These estimates represent a unit of measurement and provide an invariable scale that remains the same unit of measurement regardless of what type of samples are being measured and what type of measurements are being applied to the samples. With these two invariable measurement properties, one can investigate how well item measures corresponds to person ability measures in terms of item difficulty calibrations. The Rasch model also generates conventional measurement properties such as person reliability and separation scores of most CTT-based measurements provide to test overall performances of the measure [10].

The purposes of this study are to investigate: 1) the latent trait of cross-culturally adapted WHOQOL-BREF measure administered to different cancer survivors and 2) how the measurement qualities of the measurement were performed using the Rasch rating scale model.

MATERIALS AND METHODS

1. The WHOQOL-BREF Assessing the Influence on the Status of Quality of Life

A translated into Korean WHOQOL-BREF was adopted for the present study due to its popularity and one of well-established patient-reported outcome measures that have

been developed for assessing the global health status of individuals. The original WHOQOL-BREF measure is known for having good measurement qualities across four health-related latent traits with 24 items and is available in more than 15 international languages worldwide [1,6]. For the 4 latent traits being measured, the measure contains four health-related latent traits representing physical (7 items), psychological (6 items), social relationships (3 items) and environmental health (8 items). Category responses for all items are rated with a 5-point Likert type scale based on how frequently experienced on particular items for the past two weeks. For the individual item comparisons based on item difficulty calibrations, the command of 'REVERSE SCORE' was used for the negatively phrased items. After the series of Rasch analyses, scores represent that higher score indicates better the status of QOL latent traits. The measure validated by Min et al. [17] was used for the present study. The measure as well as other measures were provided to the survivors upon the completion of the health care institution visit for PRCS.

2. Recruitment of the Cancer Survivors

Data were retrieved from a larger project to conduct the present study. The project was based on data collected as part of the primary clinical test of PRCS. The PRCS was provided from an oriental medicine and two rehabilitation hospitals and between April 16, 2018 and October 11, 2019. The PRCS provided by the institutions contain: 1) an initial consultation regarding an overall current health status, potential risks of the PCRS, and possible side effects that may be caused by the PCRS, and 2) the individualized PRCS as indicated for the survivors. After advertising a recruitment notice at those institutions and obtaining the informed consent form signed, any cancer survivors who underwent cancer-related medical treatments, determined medically stable by their physicians, and completed PCRS at the institutions were included for the study. However, cancer survivors who were not recommended for the PCRS by their physicians were excluded for the study. Upon completing at least two sessions of PCRS, the survivors were asked to fill out the WHOQOL-BREF measure. The study is approved by the Institutional Review Board of College of Health and Welfare, Woosong University (IRB no. 1041549-190114-SB-70). The flowchart of the study as well as the detail procedures are presented in Figure 1.

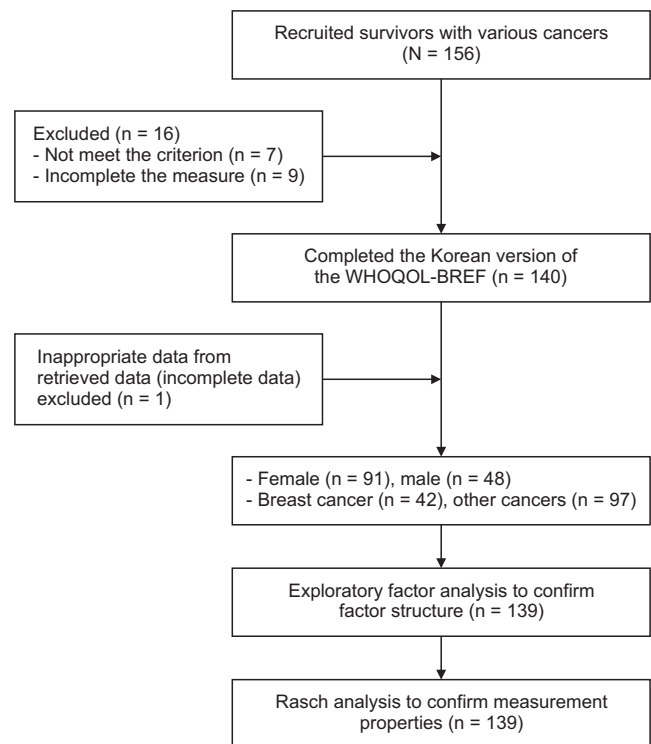


Figure 1. Flowchart of the study. WHOQOL-BREF, World Health Organization Quality of Life-BREF.

3. Data Analysis

As an initial means of exploring the underlying latent traits of the WHOQOL-BREF measure, principal component analysis method with exploratory factor analysis (EFA) was used. The EFA extracts maximum common variance from all items within the measure and puts them into a common score. The unweighted least squared method for estimates and varimax rotation method was used. Missing data were placed with mean values. The number of retained factors was determined by: 1) eigenvalues greater than 1, 2) factors explaining greater than 5% of the variance, and 3) scree test where the slope changes substantially below the eigenvalues graph [18]. A significant loading of EFA was determined with a criterion of greater than 0.46, which was suggested by researchers [19]. The IBM SPSS (ver. 27.0; IBM Co.) was used to conduct the EFA.

Rasch rating scale model (1-parameter item response theory model) provides estimates of person ability and item difficulty in a log-odd unit (i.e., logit). The logit values generated from Rasch rating model can be presented in a logarithmically transformed scale based on the probability of getting success and failure, where the ratio of two odds were ranging from 0 to 1. That is, items with higher logits indicate that there will be a greater challenge on those items. Using UMEAN and USCALE

commands of the Winsteps® software program version 3.57.2 (Winsteps.com), the logit value was transformed into 0 to 100 percent scale to aid comparison in the present study.

Rasch rating scale model was applied to determine: 1) the unidimensional latent trait of the measure, 2) goodness of fit statistics representing how well items fit to the unidimensional latent trait, and 3) the item calibrations of the WHOQOL-BREF measure in the order of most challenging to least challenging items in person-item map. The present study used the ranges from 0.6 to 1.4 as Bond and Fox's guidelines for Rasch analysis of clinical survey data [20]. If the mean square values (i.e., fit statistics) of particular items are not between the range, it is considered to be misfit indicating the responses on a particular item are being unexpected way. If that is the case, it means that the survivors may either misinterpret or misunderstand the concept of those items.

RESULTS

The EFA with principal component analysis method was performed to explore the latent trait and the dimensionality of the WHOQOL-BREF measure. The EFA reveals that the factor loadings of 24 items showed six substantial factors. While items loaded on the latent traits of physical (factor 5) and environment health (factor 6) as expected, many items predominantly loaded on factors 1 through 4 in a mixed manner of the latent traits. That is, the latent trait of the translated WHOQOL-BREF measure applied to various cancer survivors is more likely to be different from the original measure. Table 1 presents the factor loadings of the measure with six substantial latent traits in a comparison to the original WHOQOL-BREF measure. The the loadings represent 6 factors, while the original measure has 4 latent traits of health-related quality of life (HRQOL) construct (i.e., physical, psychological, social relationships, and

Table 1. Factor loadings of the Korean WHOQOL-BREF

Factors and items of Korean version of WHOQOL-BREF	Factor loading					
	1	2	3	4	5	6
Factor 1 Physical/Social/Psychological						
3 Pain and discomfort (P)	-0.164	-0.146	-0.355	0.090	-0.663	-0.051
4 Medical treatment (P)	-0.339	-0.001	-0.240	0.245	-0.587	0.409
16 Sleep (P)	0.132	-0.115	0.110	0.447	0.494	0.023
21 Social support (S)	0.017	0.421	0.161	0.076	0.463	0.268
26 Negative feelings (Psy)	-0.045	-0.058	0.029	-0.161	-0.665	-0.194
Factor 2 Psychological/Environmental						
5 Positive feeling (Psy)	0.299	0.481	0.006	0.399	0.141	0.372
13 Opportunities for acquiring new skills (E)	0.176	0.693	0.294	0.150	0.030	0.253
14 Participation in and opportunities for recreation/leisure (E)	0.288	0.772	0.022	0.148	0.092	0.069
Factor 3 Psychological/Environmental						
6 Self-esteem (Psy)	0.195	0.201	0.114	0.286	0.056	0.581
19 Satisfy with you (Psy)	0.325	0.206	0.116	0.194	0.494	0.526
20 Personal relationship (S)	0.301	0.182	0.273	0.098	0.268	0.574
22 Sexual activity (S)	0.118	0.104	0.416	-0.181	0.067	0.694
Factor 4 Psychological/Environmental						
7 Thinking, learning, memory, and concentration (Psy)	0.316	0.115	0.220	0.706	-0.022	0.032
8 Freedom, physical safety, and security (E)	0.152	0.474	0.038	0.603	0.237	0.162
9 Physical environments (E)	0.055	0.447	0.471	0.555	0.097	-0.078
11 Bodily image and appearance (Psy)	0.187	0.343	0.237	0.593	0.048	0.224
Factor 5 Physical						
10 Energy for daily life (P)	0.622	0.153	0.219	0.366	0.054	0.249
15 Discomfort (P)	0.775	0.311	0.164	0.072	0.160	0.094
17 Ability to perform daily living activities (P)	0.707	-0.019	0.122	0.276	0.408	0.287
18 Capacity for work (P)	0.703	0.339	0.093	0.211	0.102	0.168
Factor 6 Environmental						
12 Financial resources (E)	0.302	0.441	0.545	0.228	-0.144	0.017
23 Home environments (E)	0.079	0.055	0.719	0.137	0.183	0.145
24 Health and social care (E)	0.238	-0.046	0.662	0.129	0.145	0.367
25 Transport (E)	0.071	0.265	0.650	0.237	0.238	0.182

WHOQOL-BREF, World Health Organization Quality of Life-BREF; P, physical health; S, social health; E, environmental health; Psy, psychological health.

environmental health).

In attempt of determining the unidimensional latent trait with goodness of fit statistics, and item difficulty calibrations of the translated WHOQOL-BREF, a series of Rasch analyses was conducted. All items, except one item (medical treatment item), exhibit acceptable fit statistics and fit to the Rasch model. Table 2 represents the Item difficulty calibrations falling between 42.27 and 56.59.

Overall, Person reliability (i.e., analogous to Cronbach's alpha) and person separation were measured with 0.92 and 3.48. The mean square (MnSq) values of infit and outfit were 1.02 and 1.03, respectively. After transforming logit values into 0 to 100 percent logits, Items anchored to 50 for mean value. Overall, items were well-spread around the mean value with minor ceiling effects. The item difficulty calibrations in the order of the most to the least challenging is visually investigated using item-person map. The mean value of item difficulty calibrations of the WHOQOL-BREF measure targeted the survivors well throughout the survivors' HRQOL level with some ceiling and minor floor effects (Figure 2).

DISCUSSION

The study investigated how the individual items of the translated into Korean WHOQOL-BREF measure administered to people who underwent palliative rehabilitation care services at three health care institutions. Whether or not the latent trait of the Korean WHOQOL-BREF measure was performed as the 24 items of the original measure were intended to assess was confirmed. This property was a critical issue in which the translated version would be an acceptable measure that generates consistent results as originally designed. In an attempt to determine the underlying latent traits with 24 items of the translated measure [21,22], the EFA with principal component analysis method was applied. The results revealed that 24 items yielded 6 factors instead of 4-latent traits of the original measure. This result with an increased number of factors is of concern. First, why is there a discrepancy across the original and the translated into Korean QOL measures and if such a discrepancy exists, which measure is more valid, the original measure or the translated measure? This discrepancy is commonly a function of different perspectives on the latent trait

Table 2. Fit statistics of the Korean WHOQOL-BREF in descending order of difficulty

Item number and name of Korean WHOQOL-BREF	Difficulty	Infit MnSq	Infit ZSTD	Outfit MnSq	Outfit ZSTD
4 Medical treatment (P)	56.59	1.59	4.7	1.89	6.4
21 Social support (S)	56.40	0.98	-0.1	1.03	0.3
18 Capacity for work (P)	54.94	0.88	-1.1	0.84	-1.4
14 Participation in and opportunities for recreation/leisure (E)	54.74	1.10	0.9	1.08	0.7
12 Financial resources (E)	53.69	1.08	0.7	1.13	1.0
16 Sleep (P)	53.29	1.30	2.6	1.43	3.4
11 Bodily image and appearance (Psy)	52.51	0.93	-0.6	0.93	-0.6
5 Positive feeling (Psy)	52.00	0.86	-1.3	1.03	0.3
10 Energy for daily life (P)	51.98	0.82	-1.6	0.80	-1.6
13 Opportunities for acquiring new skills (E)	51.28	0.96	-0.3	0.95	-0.4
17 Abilities to perform daily living activities (P)	50.88	0.70	-3.0	0.73	-2.6
8 Freedom, physical safety, and security (E)	50.37	0.82	-1.5	0.81	-1.5
23 Home environments (E)	50.16	1.02	0.2	1.05	0.5
19 Satisfy with you (Psy)	50.08	0.70	-2.8	0.70	-2.8
15 Discomfort (P)	49.13	0.87	-1.2	0.84	-1.3
9 Physical environments (E)	49.04	0.92	-0.6	0.90	-0.7
22 Sexual activity (S)	47.22	1.16	1.3	1.16	1.2
7 Thinking, learning, memory, and concentration (Psy)	46.71	1.07	0.6	1.06	0.5
3 Pain and discomfort (P)	46.59	1.22	1.8	1.41	2.7
20 Personal relationship (S)	45.42	0.81	-1.6	0.81	-1.6
6 Self-esteem (Psy)	45.10	1.09	0.8	1.07	0.5
26 Negative feeling (Psy)	43.67	1.30	2.1	1.56	3.3
24 Health and social care (E)	42.83	0.95	-0.3	0.93	-0.5
25 Transport (E)	42.27	0.88	-0.9	0.88	-0.9

WHOQOL-BREF, World Health Organization Quality of Life-BREF; P, physical health; S, social health; E, environmental health; Psy, psychological health; MnSq, mean square standardized residuals; ZSTD, Z score standardized.

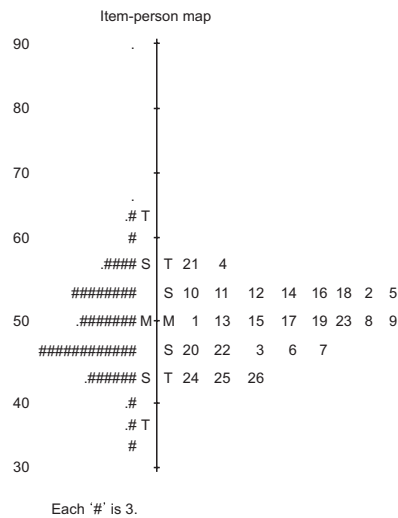


Figure 2. Item-person map of the Korean WHOQOL-BREF. The graph represents item difficulty calibrations on the right side of the map with a 0–100 converted score, and person ability scores on the left side of the map following the Rasch analysis. Each analysis is anchored on the average item difficulty calibration to 50. The 'M' represents the average item calibrations for the WHOQOL-BREF measure. WHOQOL-BREF, World Health Organization Quality of Life-BREF.

being measured in the context of cultural interpretations of particular items [23]. In a review of the items' factor loadings on the 6 substantial factors, the present study identified 6 distinct latent traits, with item loading on: 1) factor 1 all related to physical/social/psychological dimension, 2) factor 2 related to psychological/environmental, 3) factor 3 related to psychological/environmental, 4) factor 4 psychological/environmental, 5) factor 5 physical, and 6) factor 6 related to environmental health latent traits. In general, a factor can be defined as a theoretical latent trait with meaningful loadings of more than one [19,20,22]. Since more stringent guidelines of the factor loadings for determining the distinct relationships were used for the study, this would have resulted in more factors. In addition, few authors proposed that translated measures strongly emphasized on cultural background, contextual factors, and different languages to be used in various countries, challenges always lie in balancing conceptual meanings to allow comparability and being culturally consistent outcomes [23–26]. In this context, translated sentences or phrases used in the Korean WHOQOL-BREF may vary significantly when applying to the survivors with Korean cultural background.

Rasch fit statistics allow investigators to determine how well test items fit to a unidimensional latent trait of a measure. Researchers also propose that the unidimensional latent trait can be assessed using varied multivariate analysis methods

such as principal component analysis as a classical test theory-based approach and Rasch fit statistics as a modern test theory [21]. The present study used both methods to compare which measurement properties are more optimal. With an exception of 'medical treatment' item, items of the WHOQOL-BREF in the present study were fit to a unidimensional latent trait of a translated WHOQOL measure. This would indicate that that the cancer survivors' responses to 'medical treatment' item is not as predictable as expected. Thus, to further examine whether or not to include the translated WHOQOL measure as a valid measurement reflecting all aspects of the latent trait of QOL measure. In addition, the item represented as the most difficult item with high fit statistics as can be seen in the Table 2. That is, the survivors are likely to regard the item as the most difficult in the context of a property of the item that describes how much knowledge is required to answer the item [22]. Authors reported the similar results on the latent trait of physical health as the most challenging latent trait in their study of the WHOQOL-BREF measure [27]. In the present study, the survivors had a tendency to rate the 'transport' item as the least challenging. This may indicate that the attribute of the item from environmental latent trait would not be a primary factor in the course of the cancer survivorship.

Additionally, the measurement qualities of the translated WHOQOL-BREF measure was examined using a modern test theory (i.e., Rasch analysis). Person reliability (i.e., analogous to Cronbach's alpha) and separation values were found to be acceptable (i.e., 0.92 and 3.48, respectively) for measuring the latent trait of the translated WHOQOL measure applied to cancer survivors in Korea. If a Cronbach's alpha internal consistency reliability values are ranging from 0.70 to 0.95, one can determine it as acceptable. However, if the value is too high, it may suggest that some items are redundant as they are testing the same items but in a different guise [27].

Using the person-item map for the visual inspecting individual's responses, it can be predicted that particular items may be more or less challenging with respect to item locations in the map. The map presents test items with person ability (i.e., the level of QOL in the present study) as well as item locations in the order of the mean square values (i.e., item difficulty) in the linear continuum (Figure 2). Overall, item locations are well-spread manner around the whole QOL levels with redundancy in terms of item difficulty. The redundancy, several items with similar item difficulties, is not of concern in the present

study since those items may have relevant concept in relation to 4 latent traits of the measure. In addition, most items target most cancer survivors well with some ceiling and minor floor effects. However, the most challenging 2 items, medical treatment and social support items, was not successfully able to target the survivors with high level of QOL. In general, ceiling and floor effects are common in developing CTT-based measures because both the item difficulty and person ability are not considered at the same time [28]. The investigation on the latent traits of the measure in the study was able to provide the insight into those two measurement qualities (i.e., item difficulty and person ability) of a modern test theory in which the survivors response to hierarchically ordered individual items considering the survivor's status of QOL during cancer survivorship experience was considered in a linear continuum.

The limitations of the study were: 1) relatively small sample size for the factor analysis when each factor is defined by several items. In the present study, most factors were defined by only three to five items. A factor with fewer than three items is generally known as a weak and unstable measurement. With an optimal sample size from various populations, future studies can provide a better insight into latent traits of the translated QOL measure. 2) Not all cancer survivors equally experience the same perception to particular items in the course of cancer survivorship. There may be more of a heterogeneous sample-related reason. This would prompt further investigations to clarify it.

CONCLUSIONS

The present study is primarily focused on determining the latent trait and measurement qualities of a translated WHOQOL-BREF for cancer survivors who underwent palliative rehabilitation care services at health care institutions. Findings suggest that the latent trait and the measurement qualities of the WHOQOL-BREF measure should be taken into consideration when applying a translated version of it to cancer survivors.

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CONFLICTS OF INTEREST

No potential conflicts of interest relevant to this article are reported.

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