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Psychometric properties of the Chinese version of the SF-36v2 in patients with severe mental illnesses in China: factor structure, reliability, and validity

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Abstract

Objective Patients with severe mental illnesses(SMIs) often experience a diminished quality of life(QOL), and a validated tool to assess their QOL remains lacking. This study aimed to evaluate the psychometric characteristics of SF-36v2 among Chinese SMIs patients to determine its suitability for assessing their QOL.

Methods We conducted a cross-sectional study involving 924 randomly selected SMIs patients from 23 community health centers in Nanjing, China. The reliability of the SF-36v2 was assessed by Cronbach's alpha and split-half reliability. Factor structure was examined by exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Convergent validity was evaluated using average variance extracted (AVE) and composite reliability (CR).

Results The SF-36v2 scale demonstrated good internal consistency, with a Cronbach's alpha of 0.941 and split-half reliability of 0.965. A slight ceiling effect was observed in the Social Function dimension (17.6%). CFA confirmed the acceptability of the hypothesized model, with the measurement model meeting all relevant fit metrics (X^2/df = 1.552, $p < 0.05$, RMR = 0.037, GFI = 0.950, AGFI = 0.942, CFI = 0.984, NFI = 0.955, RMSEA = 0.024). For each dimension, AVE > 0.5 and CR > 0.7, indicating good convergent validity of the scale. The square root of the AVE from the variables was greater than the correlation between the dimensions in the model, supporting the scale's discriminant validity. Additionally, the PCS (43.74 ± 10.28) and MCS (43.74 ± 10.28) scores of patients with SMIs were significantly lower than the Chinese general population norm ($p < 0.001$).

Conclusions The SF-36v2 demonstrated robust psychometric properties, making it a reliable and valid tool for assessing QOL in SMIs patients. Its application can facilitate an objective evaluation of QOL in this population and inform treatment decisions accordingly.

Highlights

- Due to the challenges in effectively curing severe mental illnesses（SMIs）, the objective of patients engaging in healthcare services is no longer the complete eradication of their illness, but rather the pursuit of

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relative health, such as improving the quality of life. The SF-36v2 scale as a tool for assessing quality of life, has not yet been validated for its psychometric properties within populations with SMIs.
- According to our analyses, the SF-36v2 showed satisfactory reliability as well as an appropriate factor structure (Cronbach's alpha = 0.941) in patients with SMIs, with no ceiling/floor effect in all dimensions except for the social functioning dimension, which showed a slight ceiling effect.And the quality of life of patients with SMIs was significantly lower than the norm in the SF-36v2 scale.
- The SF-36v2 scale has demonstrated strong psychometric properties in patients with SMIs and can be used as a reliable assessment tool for quality of life in patients with SMIs.

Keywords Severe mental illnesses, Quality of life, SF-36v2, Psychometric properties

Introduction

Severe mental illnesses (SMIs) refer to a group of mental health conditions with severe symptoms that significantly impact patients' lives. 'The Norms for the Management and Treatment of Severe Mental Illnesses' classify SMIs into six categories: schizophrenia, schizoaffective disorder, paranoid psychosis, bipolar disorder, mental disorder in epilepsy, and mental retardation with mental disorders [1]. In recent years, the prevalence of SMIs has been increasing. By 2021, the cumulative number of registered SMIs cases in China had reached approximately 6.6 million, an increase of nearly 200,000 cases from 2020 [2].

SMIs are characterized by a long duration and a high recurrence rate [3]. Consequently, the primary goal for patients seeking treatment often shifts from complete to achieving relative health, such as improving the quality of life [4, 5]. Given the nature of these conditions, quality of life decreases significantly at all stages of the disease [6]. While it may improve after treatment and control, it remains lower than the general population [7, 8].

Quality of life is broadly defined as an individual's perception of their physical, psychological, and social well-being [9]. It is widely recognized as a fundamental assessment of patients' self-reported health outcomes [10]. There are numerous tools to assess quality of life, including the 36-item Short Form Health Scale (SF-36), the WHO Quality of Life Scale (WHOQOL I-100), the European Quality of Life Scale (EQ-5D), etc [11]. As the most widely used generalized health-related quality of life instrument, the SF-36v2 (formerly SF-36) has been used in quality of life studies in a variety of populations [12]. The SF-36v2 contains a moderate number of items that effectively mitigate ceiling and floor effects, thereby enhancing its sensitivity to changes in health status [13]. In addition, the SF-36v2 demonstrates robust measurement breadth and depth, enabling a thorough and precise evaluation of quality of life [14]. The items evaluating perceived health changes reflect longitudinal dynamic variations compared to the previous year. Additionally, the SF-36v2 contains standardized normative scores that can be used as a "standardized control" for the health status of specific populations. Localized population norms for the SF-36v2 have been established in several countries [15, 16]. Among these, the standardized norms derived from 1998 data of the U.S. general population are the most widely utilized [17]. In China, scholars Jiang Minmin et al. utilized the normative scoring rules of the SF-36v2 to construct a standardized normative scale that is applicable to the general population, which provided a valuable reference for the subsequent use of SF-36v2 in Chinese population [18]. These features contribute to the instrument's comprehensive assessment of quality of life, sensitivity to changes in health status, and improved clinical interpretability through norm-based scoring [19].

The psychometric properties of the SF-36v2 have been validated in the Chinese general population and various clinical settings (including breast cancer, hereditary angioedema, etc.) [20, 21]. These studies affirm the scale's validity and reliability within this context. However, while the SF-36v2 has shown strong reliability and validity across different populations, its effectiveness among patients with SMIs remains unclear, which is the focus of the present study. Therefore, it is crucial to validate the SF-36v2's measurement properties specifically in patients with SMIs, particularly within Chinese populations. This validation will enhance our understanding of quality of life outcomes for patients with SMIs and reveal potential differences between the quality of life of patients with SMIs and the general population.

The purpose of this study was to examine the psychometric properties of the Chinese version of the SF-36v2 in a sample of Chinese patients with SMIs, including factor structure, reliability, and validity. While the SF-36v2 has been used in various clinical settings [22, 23], there remains a need for rigorous psychometric evaluation within specific populations. This study aims to provide robust evidence supporting the use of the Chinese version of the SF-36v2 for assessing quality of life in Chinese patients with SMIs, addressing a critical gap in the literature and informing clinical practice in this specific context. Furthermore, we conducted a comparative analysis between the quality of life of SMIs patients and the norms of the Chinese general population to investigate potential disparities between the two populations.

Materials and methods

Study design and participants

We conducted a cross-sectional study of patients with SMIs from January to July 2022 in 23 community health centers in Nanjing, China. These community health service centers provide patients with SMIs (Mainly includes the six major categories of the Chinese Norms for the Chinese Management and Treatment of Serious Mental Illnesses(2018 Edition): schizophrenia, schizoaffective disorder, paranoid psychosis, bipolar disorder, epilepsy-related mental disorder, and mental retardation with mental disorder) with filing management and community rehabilitation services [24]. The inclusion criteria were: (1) Diagnosed with a SMI by attending psychiatrists according to the diagnostic criteria of the ICD-10, and classified according to the Chinese Norms for the Management and Treatment of Serious Mental Illnesses (2018 Edition); (2) total illness duration ≥ 3 years; (3) aged ≥ 18 years; (4) the patient's condition is stable, with no severe psychotic symptoms or violent behavior for at least three months. We excluded participants with (1) severe cardiovascular, cerebrovascular, hepatic, renal, or other debilitating physical conditions that could significantly impact their ability to participate in the study; (2) a history of drug dependence or addiction; (3) non-cooperation or withdrawal from the study; (4) data incomplete. We used the study design checklist and terminology guide developed by the COSMIN Consortium in the design and reporting of this study [25, 26].

We randomly selected 50 patients in each community health center using a random number table method($n = 1150$). We rigorously screened patients according to the aforementioned exclusion criteria and excluded those who did not meet the requirements ($n = 42$), resulting in 1108 patients with SMIs completing the SF-36v2 assessment.

The COSMIN guidelines recommend that factor analyses require a minimum sample size of seven times the number of scale entries and that internal consistency tests require a sample size greater than 100 [25]. To ensure the persuasiveness of the study results, we calculated based on a standard of 15 participants per item. The SF-36v2 comprises 36 items, estimating a minimum sample size of 540 patients, and our sample size meets this criterion.

Ethical approcal was obtained for this study, all community health service centers provided ethical approval. All participants were provided with detailed information about the study and signed a written informed consent form. Researchers employed a standardized protocol to explain the purpose of the survey and the filling requirements to participants, emphasizing the accuracy of data. Each item of the SF-36v2 was explained by researchers, who assisted participants in completing the questionnaire independently. If participants were unable to complete the questionnaire independently, researchers conducted the filling process by inquiring about each item sequentially. To ensure data accuracy and completeness, trained research staff reviewed all completed questionnaires for missing data, inconsistencies, and potential errors. This process helped minimize data entry errors and ensured the reliability of our findings. Data quality control measures included pre-survey training for all researchers, multiple data entries, and strict accuracy checks.

Instruments

The present study utilized the Chinese version of the SF-36v2 scale, which was provided by Zhejiang University. The scale was developed by researchers from Zhejiang University based on the original SF-36v2 instrument, which has been localized and refined through extensive adjustment [27]. It has now been applied in various studies across multiple populations in China [28, 29]. The scale adopts a standard recall format (past 4 weeks) and utilizes a Likert rating scale, consisting of 36 items. For example, Item 13 assesses respondents' physical functioning by asking, "During the past four weeks, how much time have you reduced work or other activities due to physical health reasons?" The response options are categorized into five levels: all of the time, most of the time, some of the time, a little of the time, none of the time. And item 2 was used to assess the change in health status over the past year by asking the respondent, "How do you feel about your current health status compared to 1 year ago?" (Responses were categorized as excellent, very good, good, fair, poor) to assess changes in their health status over the past year. Except for item 2, is not included in the total score, the other 35 items are categorized into 8 dimensions to reflect the respondents' quality of life: Physical Function (PF), Role Physical (RP), Bodily Pain (BP), General Health (GH), Vitality (VT), Social Function (SF), Role Emotional (RE), and Mental Health (MH) [30]. The dimensions of PF, RP, BP, and GH are categorized into the Physical Component Summary (PCS) domain, while the dimensions of VT, SF, RE, and MH are categorized into the Mental Component Summary (MCS) domain. The SF-36v2 uses a standard scoring algorithm for each item [31], and the scale scores are linearly transformed to a score of 0 ~ 100, with higher scores indicating better quality of life. Standardized scores were calculated based on SF-36v2 normative data (mean 50, standard deviation 10). The original version of the SF-36v2 has demonstrated good reliability and validity [17]. In the Singaporean Asian population, the Chinese version of the SF-36v2 (Cronbach's α: 0.68–0.91) exhibited similar internal consistency to the original version (Cronbach's α: 0.71–0.95) [32].

Sociodemographic questionnaire

In this study, a sociodemographic questionnaire was used to collect basic information about the participants to describe the basic characteristics of the participants. Including gender (male or female), age (recorded as actual age), marital status (categorized as unmarried, married, divorced or widowed), education (categorized as elementary or below, middle school, college or higher), employment status (including unemployed or employed), and type of diagnosis mainly includes the six major categories of the Chinese Norms for the Chinese Management and Treatment of Serious Mental Illnesses(2018 Edition): schizophrenia, schizoaffective disorder, paranoid psychosis, bipolar disorder, epilepsy-related mental disorder, and mental retardation with mental disorder.

Chinese general population normals for SF-36v2

We also compared the quality of life of patients with SMIs to the normative data from the general population in China to identify any differences between the two groups. The normative data was established by researchers from Zhejiang University based on a sample of 4,251 individuals from the Chinese population. This sample encompasses six major regions of China, including North China, South China, East China, West China, Central China, and Northeast China, thereby accurately reflecting the quality of life in the Chinese population [33].

Statistical analysis

All survey data were checked and verified for double entry into EpiData, and the entered data were cleaned and organized in SPSS 26.0, multiple interpolation is applied to the missing data.

According to the scoring rules of the SF-36v2 scale [34], the original scores and converted scores of each dimension were calculated. Measures with normal distribution in descriptive analysis were expressed as mean ± standard deviation (M ± SD), and count data were expressed as percentage (%). Two independent samples t-test was used in inferential analysis to compare the difference between the quality of life scores of patients with SMIs and the norms of the Chinese general population.

We conducted an internal consistency evaluation in the reliability assessment of the SF-36v2 using Cronbach's alpha coefficient and split-half reliability. A Cronbach's alpha coefficient ≥ 0.7 indicates a high level of internal consistency reliability among the items of the scale, with higher values suggesting greater reliability [35]. Using the Spearman-Brown formula to calculate split-half reliability [36]. The scores closer to 1 demonstrate higher internal consistency reliability of the scale.

To further assess the measurement precision of the SF-36v2, the Standard Error of Measurement (SEM) was calculated for each dimension. SEM quantifies the extent to which an observed score deviates from an individual's true score due to measurement error, providing an estimate of the scale's precision. SEM is calculated by multiplying the standard deviation (SD) by the square root of (1 - reliability coefficient) [37, 38], where the reliability coefficient is represented by Cronbach's alpha. A lower SEM value indicates higher measurement precision. Generally, an SEM value less than 10% of the total score range is considered acceptable [39]. Floor and ceiling effects for all items are calculated using the total number and percentage of patients achieving the lowest and highest possible scores, respectively, both of which should be less than 15%.

Structure validity, convergent validity, and discriminant validity were used to assess the validity of the SF-36v2. The factor structure and validity of the SF-36v2 were assessed through both exploratory factor analysis(EFA) and confirmatory factor analysis (CFA) [40].

Kaiser - Meyer - Olkin (KMO) is a measure that has been intended to measure the suitability of data for factor analysis. KMO > 0.5 indicates that the existing variables are appropriate for conducting factor analysis on our sample size. Bartlett's sphere test was used to assess the probability of a high correlation between the items of the scale, with $p < 0.05$ indicating that the correlation between the factors was sufficient to support the reasonableness of the factor analysis [41]. For EFA, items with factor loadings > 0.40 in the factor structure were evaluated using the varimax rotation method based on principal component analysis. CFA was conducted to assess the fit of the SF-36v2. If the fit indices (CFI, GFI, AGFI) in the CFA model are all above 0.90, and the root mean square error of approximation (RMSEA) is ≤ 0.05, it indicates a relatively good fit of the model, demonstrating good structural validity.

The convergent validity of the SF-36v2 was measured by the average variance extracted (AVE) and the composite reliability(CR) as a way of explaining the covariance among the factors, and when the AVE value was > 0.5 and the CR>0.7, it was considered to have good convergent validity [42]. For discriminant validity, it was evaluated by the coefficients obtained by dividing the covariance of each factor with the other factors by the square root of the AVE of this factor, and if the absolute value of the coefficients obtained is less than 1, it indicates that the factor has good discriminant validity [43].

All data analyses were conducted using SPSS 26.0 and AMOS 26.0, and statistical significance was considered when $p < 0.05$.

Results

Demographic data

Questionnaires were administered to 1108 patients with SMIs, of which 184 were deemed invalid due to missing

Table 1 Demographic characteristics($N = 924$)

Variable	*N*/M	%/SD
Gender		
Male	350	37.9
Female	574	62.1
Age(years, M ± SD)	51.86	13.45
Marital status		
Unmarried	214	23.2
Married	600	64.9
Divorced or widowed	110	11.9
Education		
Elementary or below	483	52.3
Middle school	402	43.5
College or higher	39	4.2
Employment		
Unemployed	107	11.6
Employed	797	86.3
Retired	20	2.2
Diagnosis		
Schizophrenia	576	62.3
Schizoaffective disorder	6	0.6
Paranoid psychosis	3	0.3
Bipolar disorder	200	21.6
Mental disorder in epilepsy	62	6.7
Mental retardation with mental disorders	77	8.3

Notes: N,Number; M, Mean; SD, standard deviation

Table 2 Reliability results of the SF-36v2 scale in patients with SMIs

Dimension	Cronbach's α	Spearman-Brown	Floor effect(%)	Ceiling effect(%)	SEM
Physical Function	0.911	0.903	28(3.0)	26(2.8)	4.31
Role Physical	0.841	0.834	18(1.9)	103(11.1)	5.18
Bodily Pain	0.751	0.751	43(4.7)	93(10.1)	5.49
General Health	0.878	0.877	13(1.4)	51(5.5)	3.39
Vitality	0.862	0.855	34(3.7)	122(13.2)	3.74
Social Function	0.736	0.736	57(6.2)	163(17.6)	6.08
Role Emotional	0.820	0.820	60(6.5)	130(14.1)	6.01
Mental Health	0.924	0.915	39(4.2)	135(14.6)	2.63
Total	0.941	0.965			

SEM: Standard Error of the Measurement

data. Eventually, 924 valid questionnaires were completed, resulting in an effective response rate of 83.4%. The demographics of the participants are detailed in Table 1. 62.1% of the patients were female and the mean age of the patients was 51.86 ± 13.45 years. Schizophrenia patients were predominant, representing 62.3%, followed by bipolar affective disorder. The majority of patients(86.3%) were currently employed, while smaller proportions were unemployed (11.6%) or retired (2.2%) patients.

Reliability

Results for reliability are presented in Table 2. The total scale of Cronbach's alpha was 0.941, and the range of Cronbach's alpha for the eight dimensions was 0.736 to 0.924. All items of the SF-36v2 scale were divided into two parts according to the odd and even numbers, and the Spearman-Brown split-half coefficient was calculated respectively. The split-half coefficient of the total scale was 0.965, and the split-half coefficient of the eight dimensions ranged from 0.736 to 0.915. In addition, the SEM scores for the eight dimensions ranged from 2.63 to 6.08, all falling within the acceptable range. Except for the slight ceiling effect in the SF dimension (17.6% > 15%), there was no ceiling effect and floor effect in other dimensions.

Structure validity/factor analysis

The sample of 924 cases was randomly divided into two parts for EFA and CFA. The KMO test value obtained before EFA was 0.861, and Bartlett's sphericity test was statistically significant ($p < 0.001$). The above results support the development of factor analysis. The results of the EFA indicated that all item factor loadings for the SF-36v2 scale were greater than 0.4. After principal component extraction and variance-maximizing orthogonal rotation, two common factors were generated, which explained a total of 69.49% of the variance.

After conducting EFA, CFA was performed on the SF-36v2 scale using the maximum likelihood method in AMOS. A second-order factor model was constructed according to the theoretical structure of the SF-36v2 scale, with 35 items as measured variables, 8 dimensions as first-order factors, and PCS and MCS as second-order factors. The CFA results showed that all model fit indices met the acceptability criteria. $2/df = 1.552$ ($p < 0.05$, the chi-square value becomes larger by the sample size, this indicator is acceptable), $RMR = 0.037 < 0.05$, $GFI = 0.950 > 0.9$, $AGFI = 0.942 > 0.9$, $CFI = 0.984 > 0.9$, $NFI = 0.955 > 0.9$, $RMSEA = 0.024 < 0.05$ (Fig. 1). Furthermore, the standardized factor loadings for all items are greater than 0.40. The t-test for the unstandardized factor loadings indicates that all loading coefficients are statistically significant at the 0.001 test level (Table 3). The standardized factor loadings from the first-order factors to the second-order factors for each dimension are all greater than 0.40. The t-test for the unstandardized factor loadings indicates that these loading coefficients are statistically significant at the 0.001 test level (Table 3). This enhances the reliability of the factor analysis results.

Convergent validity

Convergent validity was estimated from the average variance extracted (AVE) and composite reliability. Except for the four entries of the PF dimension (PF3: Lift or carry

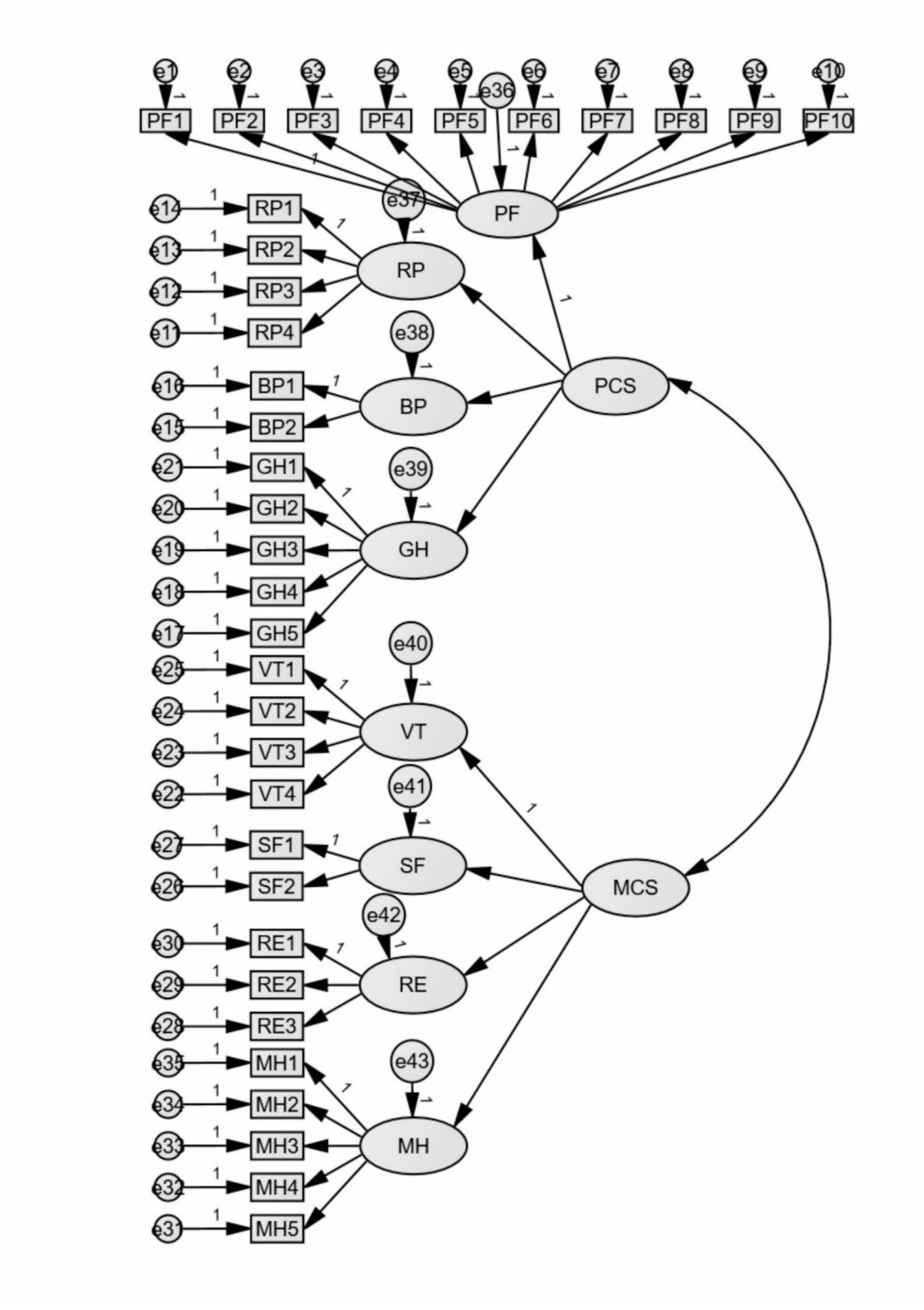

Fig. 1 The SF-36v2 second-order factorial model plot

Table 3 CFA second-order factor analysis results for the SF-36v2 scale

Second-order factor	First-order factor	UFL	SE	t***	SFL
PCS	Physical Function	1			0.756
	Role Physical	1.798	0.115	17.174	0.869
	Bodily Pain	2.215	0.132	16.229	0.826
	General Health	1.903	0.113	17.135	0.864
MCS	Vitality	1			0.929
	Social Function	0.85	0.049	19.719	0.887
	Role Emotional	0.866	0.052	20.053	0.88
	Mental Health	0.902	0.048	19.985	0.811

Notes: PCS, Physical Component Summary; MCS, Mental Component Summary
UFL, unstandardized factor loadings; SFL, standardized factor loadings
CFA, confirmatory factor analysis
***All t-tests for unstandardized factor loading coefficients $p < 0.001$

miscellaneous objects; PF4: Climb several flights of stairs; PF7: Walk more than 1,500 m; PF10: Bathe or dress oneself), the factor loadings of each dimension corresponding to each entry were all greater than 0.7. This indicates that, overall, the items in the SF-36v2 adequately represent their corresponding dimensions, demonstrating good convergent validity of the scale. The AVE for each dimension exceeded 0.5, and the CR exceeded 0.7, overall, the model had good convergent validity (Table 4).

Discriminant validity

The correlation coefficients between the dimensions in the SF-36v2 scale were less than 0.7. The AVE square root values for eight dimensions were greater than the correlation coefficients between that dimension and the rest of the dimensions, implying high discriminant validity of the model (Table 5).

Comparison of quality of life between patients with SMIs and general population norms in China

The scores of patients with SMIs in all dimensions were lower than the normative values of the Chinese general population ($p < 0.001$), and the total scores of the PCS and the MCS were significantly different from the normative values of the Chinese general population ($p < 0.001$). The results are shown in Table 6.

Discussion

Quality of life is an important concern for patients with SMIs, as these conditions can have a profound impact on their physical, psychological, and social functioning [44, 45]. However, the lack of validated measures in this population limits our ability to assess such outcomes effectively. This study evaluated the psychometric properties of the Chinese version of the SF-36v2 among patients with SMIs in China and compared their quality of life with normative data from the general Chinese population. The findings provide new insights into the applicability and reliability of this tool in this unique clinical context.

Our study demonstrates that the SF-36v2 has acceptable psychometric properties in the measurement of quality of life in patients with SMIs. The internal consistency reliability coefficients and split-half reliability coefficients for each dimension exceeded the acceptable threshold (0.70), suggesting that the SF-36v2 scores are consistent across time and context. In addition, the SEM for each dimension was within the acceptable range, which further validates the reliability of the SF-36v2 in this population. This is consistent with the previous studies on the scale's reliability in populations with atrial fibrillation and hereditary angioedema [13, 46]. Importantly, the present study extends the evidence for the robustness of the SF-36v2 psychometric properties in patients with SMIs, which has been underrepresented in previous studies.

The ceiling effect observed in the SF dimension (17.6%) warrants further discussion. In psychometric properties assessments, ceiling effects may reduce the ability of instruments to detect meaningful differences or changes in high-functioning individuals [47]. For patients with SMIs in China, cultural values and the influence of free treatment programs may interfere with their reflections on the SF dimensions. Specifically, the collectivist cultural norms in China often emphasize the importance of family and social support, which may lead to inflated self-reported SF scores, even among patients with SMIs [48, 49]. In this study, patients with SMIs participated in a free treatment program designed to promote their recovery by providing comprehensive rehabilitation services, such as free medication and health check-ups [50]. This initiative may alleviate some of the economic and social barriers typically associated with accessing treatment, resulting in a positive impact on their perceived social roles. However, this interpretation requires caution and further empirical investigation, as there is currently no direct evidence to support these claims. Future research should examine how specific cultural and economic factors influence responses to the SF-36v2, particularly in the SF dimension, to ensure the sensitivity and validity of the tool in different populations.

Our findings support the two-factor structural model of the SF-36v2 (PCS and MCS), which collectively explained 69.49% of the total variance. This is consistent with the theoretical assumptions and similar to the findings of Wang et al. [51]. Interestingly, while a Japanese study suggested that a three-factor model of PSC, MCS, and role-social could result in more favorable factor loadings for PCS and MCS [52], all eight dimensions of these two factors showed higher factor loadings in our study. Differences in factor structure across studies may reflect differences in sample characteristics or the unique

Table 4 Factor analysis results and convergent validity of the model fitted to the SF-36v2 scale

Path	UFL	SFL	SE	t***	AVE	CR
PF→PF1	1.000	0.786			0.508	0.911
PF→PF2	0.942	0.739	0.039	23.891		
PF→PF3	0.842	0.690	0.038	21.994		
PF→PF4	0.859	0.696	0.039	22.231		
PF→PF5	0.955	0.750	0.039	24.341		
PF→PF6	0.894	0.715	0.039	22.974		
PF→PF7	0.781	0.629	0.040	19.732		
PF→PF8	0.860	0.707	0.038	22.637		
PF→PF9	0.901	0.714	0.039	22.908		
PF→PF10	0.864	0.689	0.039	21.964		
RP→RP1	1.000	0.715			0.570	0.841
RP→RP2	1.094	0.771	0.051	21.441		
RP→RP3	1.086	0.760	0.051	21.170		
RP→RP4	1.101	0.772	0.051	21.487		
BP→BP1	1.000	0.776			0.602	0.752
BP→BP2	0.970	0.776	0.049	19.921		
GH→GH1	1.000	0.729			0.591	0.878
GH→GH2	1.058	0.805	0.045	23.541		
GH→GH3	1.019	0.761	0.046	22.273		
GH→GH4	1.040	0.781	0.045	22.855		
GH→GH5	1.021	0.765	0.046	22.377		
VT→VT1	1.000	0.832			0.613	0.864
VT→VT2	0.958	0.793	0.035	27.384		
VT→VT3	0.897	0.749	0.035	25.326		
VT→VT4	0.916	0.755	0.036	25.619		
SF→SF1	1.000	0.734			0.584	0.737
SF→SF2	1.049	0.793	0.050	20.900		
RE→RE1	1.000	0.740			0.602	0.819
RE→RE2	1.034	0.780	0.048	23.038		
RE→RE3	1.106	0.806	0.046	22.369		
MH→MH1	1.000	0.873			0.709	0.924
MH→MH2	0.909	0.800	0.029	30.839		
MH→MH3	0.992	0.854	0.029	34.672		
MH→MH4	0.957	0.838	0.029	33.497		
MH→MH5	0.979	0.843	0.029	33.828		

Notes: PF, Physical Function; RP, Role Physical; BP, Bodily Pain; GH, General Health; VT, Vitality; SF, Social Function; RE, Role Emotional; MH, Mental Health

UFL, unstandardized factor loadings; SFL, standardized factor loadings; AVE, average variance extracted; CR, composite reliability

***All t-tests for unstandardized factor loading coefficients $p < 0.001$

psychological and social correlates of SMIs [53–55]. It is worth noting that although cultural and healthcare system differences undoubtedly play a significant role [56, 57], the interpretation of the factor structure should take into account the specific background of the study population. Future research should integrate both qualitative and quantitative methods to explore the underlying reasons for these differences and to understand how patients with SMIs perceive and respond to items in the SF-36v2.

The results of the CFA showed strong correlations between the first-order factors and their respective second-order factors, validating the construct validity of SF-36v2, which consistent with previous research in other populations [58, 59]. Although some of the items in the PF dimension had standardized factor loadings < 0.7, suggest that these items may be less relevant for patients with SMIs, but these values are still within the acceptable range [60]. Patients with SMIs often experience functional limitations and reduced engagement in physical activities due to symptoms such as fatigue, medication side effects, or social withdrawal [61, 62]. In addition, the item "walk more than 1500 m" may not be universally understood due to its specific reference distance, which may lack practical application to this population. Future research should explore whether adapting these items to better reflect the daily lives and experiences of patients with SMIs could improve the overall applicability of the SF-36v2.

Table 5 Discriminant validity of the SF-36v2 scale

PCS	Physical Function	Role Physical	Bodily Pain	General Health
Physical Function	0.713			
Role Physical	0.560**	0.755		
Bodily Pain	0.536**	0.573**	0.776	
General Health	0.585**	0.649**	0.564**	0.769
MCS	**Vitality**	**Social Function**	**Role Emotional**	**Mental Health**
Vitality	0.783			
Social Function	0.663**	0.764		
Role Emotional	0.692**	0.591**	0.776	
Mental Health	0.664**	0.614**	0.624**	0.842

Notes: PCS, Physical Component Summary; MCS, Mental Component Summary

** represents $P<0.01$ for the inter-dimensional correlation coefficient; the Bolded font indicates the AVE square root value for that dimension

Table 6 Comparison of quality of life between Chinese patients with SMIs and SF-36v2 norms(M ± SD)

Dimension	SMIs ($N=924$)	Norms($N=4251$)	t***
Physical Function	40.32 ± 14.42	87.6 ± 16.8	-99.684
Role Physical	37.17 ± 13.15	83.0 ± 20.7	-105.948
Bodily Pain	48.03 ± 11.01	83.3 ± 19.7	-97.424
General Health	42.15 ± 9.05	68.2 ± 19.4	-87.454
Vitality	38.95 ± 10.00	70.1 ± 16.8	-94.658
Social Function	40.63 ± 11.73	84.8 ± 16.6	-114.454
Role Emotional	35.33 ± 15.05	85.3 ± 17.7	-100.939
Mental Health	39.67 ± 9.68	78.8 ± 15.4	-122.809
Physical Component Summary	43.74 ± 10.28	85.8 ± 13.5	-124.382
Mental Component Summary	38.27 ± 10.60	67.5 ± 12.9	-83.798

Notes: M, Mean; SD, standard deviation

SMIs: severe mental illnesses

***All t-tests for unstandardized factor loading coefficients $p<0.001$

The SF-36v2 demonstrated strong convergent and discriminant validity, with CR values exceeding 0.70 and AVE values greater than 0.50 across all dimensions. These results are consistent with previous validation studies in general and clinical populations [63]. This indicates that the SF-36v2 is capable of capturing different but interconnected aspects of quality of life in patients with SMIs, making it a reliable tool for this population. However, the interplay between physical and mental health dimensions warrants further investigation, particularly in patients with SMIs, where psychological distress often exacerbates physical health challenges [64].

The PCS and MCS scores in this study were significantly lower than the SF-36v2 norms for the Chinese general population. Similar trends have been reported in other studies, reflecting the profound impact of SMIs on both physical and mental health [65]. This difference may be attributed to the prolonged duration of illness, stigma, and reduced access to preventive healthcare services in patients with SMIs [66, 67]. Furthermore, the quality of life scores for patients in this study were lower than those reported for patients with SMIs in Japan and the United States [68, 69]. This may reflect systemic differences in mental health service delivery. For example, Japan and the United States have established comprehensive community-based mental health programs that prioritize early intervention, stigma reduction, and patient empowerment [70, 71]. In contrast, mental health services in China are still underdeveloped, community-based rehabilitation programs are limited, and the community-based mental rehabilitation service system still needs to be further developed [72]. These systemic differences, combined with the older age and high prevalence of comorbidities in our sample, likely contributed to the observed quality of life disparities.

Limitations

This study has several limitations. First, as a community-based study, it excluded hospitalized patients and patients without access to medical care, which may limit the generalizability of the findings. Second, the older age of the participants and the prevalence of chronic comorbidities may have affected the results of the study, making it unrepresentative of younger patients with SMIs [73]. Third, although we explored cultural and healthcare resource factors that influence quality of life, our interpretations remain speculative due to a lack of direct evidence. Fourth, this study employed a cross-sectional design, which did not allow for repeated measurements. As a result, the SF-36v2 was administered only once, making it impossible to evaluate certain important psychometric properties, such as retest reliability and responsiveness. Additionally, this study did not collect specific data on participants' comprehension of individual items in the Chinese version of the SF-36v2, which limits the direct assessment of its content validity. However, given that the majority of participants reported understanding the items in the Chinese version of the SF-36v2 and were able to respond accurately during the survey process, it is reasonable to generalize our findings to this population. Future studies should include longitudinal and multicenter designs to validate psychometric properties of SF-36v2 in more diverse patients with SMIs and to examine causal relationships between disease characteristics, quality of life, and different cultural backgrounds. Additionally, qualitative approaches could provide deeper insights into how patients perceive and respond to SF-36v2 items, informing culturally sensitive adaptations of the scale.

Conclusion

Overall, the Chinese version of the SF-36v2 demonstrates robust reliability and validity in assessing the quality of life of Chinese patients with SMIs, making it a valuable

tool for both clinical practice and research, but the applicability of the PF and SF dimensions should be noted. Importantly all participants expressed understanding of the questions in the scale, which highlights its cultural adaptability and accessibility, addressing a critical gap in validated quality of life assessment tools for Chinese patients with SMIs. Finally, the SF-36v2 facilitates clinicians in regularly assessing the quality of life of patients with SMIs in China, reflecting changes in their health status, and allowing for timely adjustments to treatment management strategies. Future studies should consider utilizing the SF-36v2 in conjunction with other disease-specific scales for a more comprehensive evaluation. In addition, this study found that patients with SMIs generally have a lower quality of life, underscoring the need for greater attention to the health status of this population in the future.

Supplementary Information

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Supplementary Material 1

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Author contributions
YW and HF participated in the conception and design of the study; YW and ZX analyzed and interpreted the data and wrote the manuscript; JJD and JXL participated in the formal analysis; YZ and JXZ participated in the results visualization; JF and JWZ contributed to the interpretation of the results; SZW and XZ took part in the investigation and data curation; HF, LW and DJL coordinated and supervised data collection; HF critically reviewed and revised the manuscript and obtained funding. All authors have read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study was conducted in adherence to the local and international ethical principles including those in the Declaration of Helsinki. The study was approved by the Ethics Committee of Nanjing Medical University (approval number 2023-047). Written informed consent was obtained from a legally authorised representative for anonymised patient information to be published in this article.

Consent for publication
The findings described in this document have not been previously published, and none of the authors are currently submitting them to another publisher for consideration.

Competing interests
The authors declare no competing interests.

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