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The revised patient satisfaction questionnaire (PSQ-R): validity, reliability, equivalence, and network analysis among hospitalized patients in the Chinese population

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Abstract

Objectives The study of comprehensive satisfaction with healthcare is still limited due to nonstandard measurement tools of patient satisfaction for the Chinese population. Therefore, the present study aimed to verify the validity, reliability, and measurement invariance of the revised Patient Satisfaction Questionnaire (PSQ-R) and conducted network analysis among a sample of the Chinese population.

Methods A cross-sectional study using telephone surveys was conducted from April 2022 to August 2022. A total of 1377 participants who had been hospitalized completed the survey (481 males [34.9%], mean age = 49.4 years [SD ± 19.0]).

Results Four factors ('satisfaction with medical staff', 'satisfaction with hospital', 'satisfaction with medical costs', and 'satisfaction with medical insurance premiums'), were verified through confirmatory factor analysis (CFA) and had good equivalence across genders. The 'satisfaction with medical staff' and 'satisfaction with hospital' factors had the strongest edge intensity in the factor-level network.

Conclusions The 18-item (four-factor) PSQ-R has good validity, reliability, and measurement invariance. The four dimensions appear to describe patient satisfaction well among the Chinese population who had been hospitalized. To effectively enhance patient satisfaction, the quality of healthcare service and medical staff skills should both be improved, medical insurance premiums should be increased, and medical costs should be decreased.

Keywords Patient satisfaction questionnaire, Validity and reliability, Equivalence, Network analysis

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Introduction

Patient satisfaction is viewed as an important indicator of the quality of healthcare services, which contributes to maintaining patients' rights and enhancing the patient-practitioner relationship [1]. Patient satisfaction is also considered a direct and simple measurement of the effectiveness and function of hospitals [2, 3]. Moreover, patient satisfaction depends on the consistency of real experiences and expectations for health services [4]. Some scholars posit that patient satisfaction is based on whether patients' expectations of what should happen are met [5, 6], which may indicate patient fulfilment in terms of medical costs, accessibility to health services, and/or subjective wellbeing [7]. Therefore, patient satisfaction is not only an emotional or affective evaluation of health services based on individuals' cognitive processes through expectations, but also an overall evaluation of various aspects of health services [8, 9]. To date, patient satisfaction lacks a common definition and an effective measurement tool due to different theories and contexts [5]. A comprehensive patient satisfaction questionnaire may contribute to clarifying reasons for patient dissatisfaction (e.g., complaints regarding medical staff, hospital, medical costs and medical insurance premiums) and enhancing the quality of health services.

The value expectancy model developed by Linder-Pelz asserts that expectancy is the most important determinant of patient satisfaction [10]. Health quality theory indicates that patient satisfaction originates from interpersonal care [11]. In addition, need theory [12], attitude theory [13], and economic theory [14] explain patient satisfaction based on single dimension (i.e., needs, attitudes, or economic factors). These theories are not supported by empirical studies, which suggests that patient satisfaction is a multidimensional outcome of healthcare and should be assessed in terms of various aspects across cultures and contexts. Patients' conditions, perceptions, attitudes, religious beliefs, demographics, socioeconomic situations, and personality traits may interact to influence patient satisfaction and expectancy [5]. A systematic review reported that determinants of patient satisfaction vary depending on measurement tools and cultures [15].

Some patient satisfaction psychometric instruments have been developed based on specific contexts and cultures [16–21]. For example, the Hospital Patient Satisfaction Questionnaire comprises six factors ('information and medical care', 'nursing care', 'comfort', 'visiting', 'privacy', and 'cleanliness'). It assesses satisfaction with medical and surgical services and was developed with a Spanish population, and reported 'privacy' (i.e., *'privacy during examination or tests'* and *'privacy on the way to testing'*) as the factor having the highest satisfactory mean score [16]. The short-form seven-factor Patient Satisfaction Questionnaire (PSQ-18) comprising seven factors ('general satisfaction', 'technical quality', 'interpersonal manner', 'communication', 'financial aspects', 'time spent with doctor', and 'accessibility and convenience') was developed in the US and UK, and also assesses patient satisfaction [17, 18]. In addition, a 12-item two-factor Patient Satisfaction Questionnaire (including 'satisfaction with general practitioner (GP) services' and 'contextual patient dissatisfaction') was developed by the Institute of Public Health of the Republic of Serbia and reported a good validity and reliability [19]. Cole et al. investigated the telemedicine satisfaction among US patients with opioid use disorder using the five-factor Patient Satisfaction Survey (PSS) (comprising 'communication', 'privacy', 'patient perception', 'technology utilization' and 'treatment access') and found telemedicine was a feasible method that increased patient satisfaction in rural areas [20]. Another study used the eight-item Client Satisfaction Questionnaire (CSQ) comprising a single factor to assess outpatient satisfaction of mental health services received in Ethiopia and found more than a quarter of outpatients were dissatisfied with mental health services [21]. Moreover, a patient satisfaction review using data collected from *Facebook* concluded that service attributes of 'waiting time', 'treatment', 'communication', 'environment', 'diagnosis', 'cost', and 'incident type' (i.e., emergency, surgery or birth) were the most associated with patient satisfaction [22]. The aforementioned studies demonstrate that the findings regarding patient satisfaction were not consistent each other in different cultures and contexts.

In China (where the present study was carried out), total healthcare expenditure has increased rapidly over the past two decades [23], which is related to the 'fee-for-service' (FFS) payment method [24]. The FFS incentivized medical staff to prescribe expensive drugs and tests to patients for higher profit and rewards, which exacerbated the conflict between medical staff and patients, and decreased patient satisfaction and the quality of healthcare services [25]. Following this, the prospective 'capitation' payment method 'capitation' (i.e., medical insurance institutions pay to relevant medical institutions in advance according to the number of patients they have) was introduced as part of the Chinese healthcare service reform [24]. A study conducted by Yip et al. reported that China's healthcare reform (from 2009 to 2012) was commendable, but that work was needed to further improve quality of care and patient satisfaction, and to reduce patients' financial burden [25]. Another Chinese study investigating the determinants of patients' satisfaction from 17 hospitals ($n=1287$ patients) indicated that the reduced cost and convenience (e.g., 'less waiting time') significantly improved patient satisfaction [26].

Although patient satisfaction regarding healthcare has been studied in terms of various aspects across cultures

and contexts, the study of comprehensive satisfaction with healthcare is still limited due to nonstandard measurement tools (e.g., use of non-Likert scales or instruments with factors of less than three items) [27, 28] and has mainly concentrated on nursing satisfaction among the Chinese population [29, 30]. Moreover, Chinese special medical insurance policies (e.g., medical expenditures are reimbursed in different proportions based on region and amount of medical insurance payments) should also be considered in the study of patient satisfaction. Based on the aforementioned issues, a more comprehensive measurement tool of patient satisfaction including satisfaction with medical staff, hospital, medical costs and medical insurance premiums should be developed, which also need to suit China's conditions.

The Patient Satisfaction Questionnaire (PSQ) is an eight-item scale developed by the municipal Healthcare Security Administration based on the Guidelines for Hospital Management Evaluation (2008 Edition) issued by the Ministry of Health of the People's Republic of China [31]. It assesses patients' satisfaction with medical healthcare services. Six items assess satisfaction with the hospital, one item assesses satisfaction with medical costs, and one item assesses satisfaction with medical staff. The PSQ does not include any items assessing satisfaction with medical insurance premiums, and items are scored in different ways (e.g., some items are rated from 1 [*agree*] to 3 [*disagree*], while the item assessing medical costs is rated 'high' or 'low'). Based on literature research and to ensure satisfaction regarding medical insurance premiums was included, 12 items were added and two were deleted from the scale by three experts from healthcare and psychology fields. The revised 18-item Patient Satisfaction Questionnaire (PSQ-R) comprises four factors ('satisfaction with medical staff', 'satisfaction with hospital', 'satisfaction with medical costs', and 'satisfaction with medical insurance premiums').

In recent years, the network analysis approach has been widely applied in social science research. The resulting visualized networks can clearly display the studied variables and their statistical relationship through nodes and edges that is not possible with other types of analysis. Moreover, some scholars have used network analysis to examine the internal structure and core items of questionnaires or scales. For instance, Lecuona et al. used network analysis to explore the structure of the five-facet Mindfulness Questionnaire (FFMQ), which identified the stable structure of FFMQ [32]. In addition, a 28-item General Health Questionnaire (GHQ) was also examined through network analysis, which displayed the symptoms structure of the GHQ and better provided the comorbidity analysis [33]. Moreover, the network comparison test (NCT) can be used examine differences of network structure and global strength between gender, which may better clarify more visually than traditional statistics (e.g., *t*-tests, ANOVAs, chi-square tests) if there is gender difference in patient satisfaction (i.e., nodes of variables and edges between variables).

Given the lack of psychometric evaluation of the PSQ-R, the aims of the present study were to (i) verify the revised four-factor Patient Satisfaction Questionnaire (PSQ-R) through item analysis, structure validity, and reliability among a sample of the Chinese hospitalized patients; (ii) perform equivalence measurement among a sample of the Chinese hospitalized patients; and (iii) conduct a network analysis for the PSQ-R and compare the network structure and global strength between genders.

Methods

Participants

A cross-sectional study using telephone surveys was conducted in one city of Jiangxi Province across 14 counties, an area that had a total population of more than 9.8 million in 2022. The sample of the telephone survey was collected based on medical institution category which were provided by municipal Healthcare Security Administration (i.e., 619 total medical institutions, including 11 'AAA' hospitals, 93 'AA' hospitals, and 515 'A' hospitals). Of the 619 total medical institutions, all of 11 'AAA' hospitals were selected, as well as 45 'AA' hospitals and 80 'A' hospitals. (In China, there are three levels of hospital: 'AAA' is the highest level of hospital, 'A' is the lowest level of hospital and 'AA' is in the middle level, based on medical resource allocation, such as medical staff, equipment and funding). Every 'AAA' hospital randomly selected 10 patients, the 'AA' hospital randomly selected 20 patients, and the 'A' hospital randomly selected 30 patients. Consequently, 3410 patients were selected as potential participants in the present study. Just over one-third of those contacted (36.2%) did not answer the telephone. The reasons for this are unknown but some may not have been at home at the time of the call, some may have screened their calls and not wanted to talk to the caller, and others may not have wanted to talk to someone they did not know. Moreover, just under a quarter of those contacted (23.4%) said they did not want to participate in the study. Again, the reasons for this are unknown but some may have thought it would take too much of their time or were not interested in the focus of the research and/or did not want to disclose any personal information. Therefore, a total of 1377 participants (481 males, 34.9%, mean age = 49.4 years [SD ± 19.0]) completed the survey. The length of hospital stay ranged from one day to 365 days (median = 13 days). Of the 1377 participants, 51 patients were hospitalized in 'AAA' hospitals, 525 in 'AA' hospitals, and 801 in 'A' hospitals.

Procedure

The municipal Healthcare Security Administration provided all data for 619 local medical institutions and 353,468 patients as of December 24, 2021. This information included categories of medical institution (i.e., 'AAA' hospital, 'AA' hospital and 'A' hospital), patients' gender and age, their telephone number, length of hospital stay, and medical cost. The telephone survey was conducted by ten trained investigators using the PSQ-R. Data were collected from April 5, 2022, to August 31, 2022. The inclusion criterion was that all participants had to be patients on the list of the municipal Healthcare Security Administration, while the exclusion criteria were being an individual that did not answer the telephone or did not want to participate in the study.

The total participants ($N=1377$) were divided randomly into two subsamples (Sample 1=666 for exploratory factor analysis [EFA], Sample 2=711 for confirmatory factor analysis [CFA]). The total sample was used for the reliability testing, measurement invariance testing, and network analysis. There were no significant differences between subsamples on age ($t=0.62$), gender ($\chi^2=0.17$), or the total patient satisfaction score on the PSQ-R ($t=0.26$) (all $p>0.05$).

Ethics

Ethical approval (Ref: 2021822) was obtained from the first author's institutional Research Ethics Committee and informed consent was provided verbally by participants (or their parent or legal guardian in the case of children under 16 years). The aim of the study and the principles of voluntary participation and withdrawal were also explained to participants.

Measures

The PSQ-R contains 18 items and four dimensions: satisfaction with medical staff, satisfaction with the hospital, satisfaction with medical costs, and satisfaction with medical insurance premiums (i.e., medical costs were paid to the hospital, while medical insurance premiums were paid by the municipal Healthcare Security Administration in China). The dimensions of satisfaction with medical staff (e.g., "*How satisfied are you with the patience of the medical staff when explaining the information of the diagnosis and treatment plan?*"), satisfaction with the hospital (e.g., "*How satisfied are you with the service of this hospital? [including the medical care and nonmedical care procedure of providing a diagnosis, picking up medicine at the pharmacy]*"), and satisfaction with medical costs (e.g., '*How satisfied are you with the degree of compliance charges? [overcharges, repetitive payments]*) are each assessed with five items, while the dimension of satisfaction with medical insurance premiums is assessed with three items (e.g., "*How satisfied are you with the level of payment of medical insurance premiums?*"). Each item is responded to on a five-point scale from 1 (*strongly unsatisfied*) to 5 (*strongly satisfied*). Higher scores indicate higher levels of patient satisfaction. The Cronbach's alpha and McDonald's ω values of the total PSQ-R were 0.87 (CI: 0.86, 0.88) and 0.87 (CI: 0.85, 0.88), and for the four factors, the values were 0.89 (CI: 0.88, 0.89) and 0.88 (CI: 0.87, 0.89) [satisfaction with medical staff], 0.87 (CI: 0.85, 0.88) and 0.87 (CI: 0.86, 0.88) [satisfaction with the hospital], 0.68 (CI: 0.66, 0.71) and 0.69 (CI: 0.66, 0.72) [satisfaction with medical costs], 0.68 (CI: 0.65, 0.71) and 0.69 (CI: 0.66, 0.72) [satisfaction with medical insurance premiums].

Statistical analysis

Descriptive statistics of the patient satisfaction score and demographic information (e.g., gender, age, and the length of hospital stay) were conducted to provide means, standard deviations, frequencies, and percentages of the key variables. These variables were analyzed using SPSS 20.0. Item analysis was conducted to evaluate the quality of individual items in the PSQ-R. Exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and equivalence measurement were conducted to examine the construct validity of the PSQ-R. These analyses were performed using Mplus 9.0. Cronbach's alpha and McDonald's ω were calculated to examine the internal consistency of the PSQ-R. These analyses were performed using JASP 0.16.1.0. Network analysis was conducted to compare the difference of network structure between responses provided by males and females. This analysis was performed using R 4.2.2.

Skewness (<2) and kurtosis (<7) were calculated to check if there was normal data distribution [34]. The independent sample t-test ($p<0.05$) was used to assess patient satisfaction between genders. Item analysis was conducted through item-total correlations (>0.3) and alpha if item deleted. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy (>0.80) and Bartlett's test of sphericity ($p<0.05$) were used to check the data's suitability for factor analysis [35]. EFA with the robust maximum likelihood estimator (MLR) was conducted. The data-model fit of CFA included the Tucker–Lewis Index (TLI) and comparative fit index (CFI) (both >0.90), root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) (both <0.08) [36, 37]. Measurement equivalence on gender was assessed through configural, metric, scalar, error variance, factor variance and factor covariance, and latent mean equivalence [38].

Network analysis was conducted to obtain a more conservative network through the extended Bayesian information criterion (EBIC) graphic LASSO model [39, 40]. The edge-weight accuracy (using nonparametric

Table 1 Sociodemographic characteristics and patient satisfaction scores (mean [± SD], *N* = 1377)

Variables	Total (*N* = 1377)	Male (*N* = 481)	Female (*N* = 896)	*t*	*p*	Cohen's *d*
Age	49.4 ± 19.0	52.2 ± 17.5	47.9 ± 19.6	4.03	< 0.001	0.228
Satisfaction with medical staff	19.34 ± 1.93	19.40 ± 1.90	19.31 ± 1.94	0.84	0.404	0.047
Satisfaction with hospital	18.31 ± 2.69	18.26 ± 2.67	18.34 ± 2.71	0.54	0.588	-0.031
Satisfaction with medical costs	19.50 ± 1.43	19.58 ± 1.40	19.45 ± 1.45	1.60	0.111	0.090
Satisfaction with medical insurance premiums	11.87 ± 1.50	11.87 ± 1.44	11.87 ± 1.54	0.03	0.974	-0.002
Total score of patient satisfaction	76.53 ± 5.76	76.59 ± 5.65	76.49 ± 5.81	0.29	0.775	0.016

Table 2 Data-model fit of SAS items in EFA and CFA and gender equivalence

Model	χ^2	df	TLI	CFI	AIC	BIC	SRMR	RMSEA (90% CI)
18-item, one-factor EFA (*N* = 666)	1596.71	135	0.43	0.50	15203.61	15446.68	0.116	0.128 (0.122, 0.133)
18-item, two-factor EFA (*N* = 666)	1038.09	118	0.59	0.68	14053.92	14373.51	0.085	0.108 (0.102, 0.114)
18-item, three-factor EFA (*N* = 666)	637.95	102	0.72	0.82	13239.84	13631.45	0.076	0.089 (0.082, 0.095)
18-item, four-factor EFA (*N* = 666)	358.84	87	0.84	0.91	12752.97	13212.10	0.045	0.068 (0.061, 0.076)
18-item, four-factor CFA (*N* = 711)	507.04	122	0.92	0.94	13290.84	13596.81	0.046	0.067 (0.061, 0.073)
Second-order model 18-item, four-factor CFA (*N* = 711)	512.73	124	0.92	0.94	13292.53	13589.37	0.048	0.066 (0.060, 0.072)
Male (*N* = 481)	412.77	122	0.91	0.93	9139.71	9419.49	0.050	0.070 (0.063, 0.078)
Female (*N* = 896)	483.62	122	0.95	0.96	16562.52	16883.98	0.043	0.058 (0.052, 0.063)
Configural equivalence (*N* = 1377)	542.42	244	0.95	0.96	25702.23	26402.74	0.046	0.042 (0.037, 0.047)
Metric equivalence (*N* = 1377)	564.83	258	0.95	0.96	25733.48	26360.80	0.051	0.042 (0.037, 0.046)
Scalar equivalence (*N* = 1377)	584.52	272	0.95	0.96	25718.01	26272.14	0.051	0.041 (0.036, 0.045)
Error variance equivalence (*N* = 1377)	565.27	290	0.96	0.96	25795.81	26255.85	0.053	0.037 (0.033, 0.042)
Factor variance and factor covariance equivalence (*N* = 1377)	590.10	282	0.95	0.96	25716.96	26218.81	0.053	0.040 (0.035, 0.044)
Latent mean equivalence (*N* = 1377)	596.63	286	0.95	0.96	25714.20	26195.15	0.054	0.040 (0.035, 0.044)

bootstrap), centrality stability (using case-dropping subset bootstrap), and testing for significant differences in nodes and edges were assessed to reflect the network accuracy [41]. The node centrality stability was assessed by the correlation stability coefficient (*CS*-coefficient, at least ≥ 0.25) [42]. Stronger node connections are indicated by thicker edges. The network comparison test (NCT) was conducted to examine the structure and global strength of the network between genders [43].

Results

Descriptive analysis of variables

The total score of the PSQ-R was 76.53 (SD 5.76) in the present study. The length of hospital stay was classified into less than one week (*N* = 492, 35.7%), between one week and one month (*N* = 382, 27.7%), and more than one month (*N* = 503, 36.5%), and there was no gender difference ($\chi^2 = 1.45$, $p > 0.05$). There were also no statistically significant differences in the total score or factors of patient satisfaction between genders (all $p > 0.05$, Cohen's $d < 0.2$) (Table 1).

Data distribution and item analysis

Some items' skewness and kurtosis were more than 2 (i.e., Items 7–11, 16, 18), and some were more than 7 (i.e., Items 7–12, 16–18) (Appendix S1). Therefore, the item data were regarded as non-normally distributed, and the robust MLR was utilized. Moreover, every item of the PSQ-R had good item-total correlation (all > 0.3) and the 'alpha if item deleted' coefficients were good. All 18 items were then subjected to EFA.

Construct validity

The 18-item PSQ-R's KMO was 0.86, and Bartlett's test of sphericity was 12532.34 ($p < 0.001$), which indicated the 18-item PSQ-R was suitable for factor analysis. EFA was conducted using the MLR method, and the factor number was extracted from one to four through Mplus 9.0. The four-factor PSQ-R displayed the best fitting indices ($\chi^2 = 358.84$, df = 87, TLI = 0.84; CFI = 0.91; SRMR = 0.045; RMSEA = 0.068) (Table 2). The four factors included five items for 'satisfaction with medical staff', five items for 'satisfaction with hospital', five items for 'satisfaction with medical costs', and three items for 'satisfaction with medical insurance premiums' (Table 3).

CFA was then conducted to verify the construct validity of the 18-item and four-factor PSQ-R through modification of items' residual correlations, which showed good model fits in Sample 2 (*N* = 711, $\chi^2 = 507.04$, df = 122, TLI = 0.92; CFI = 0.94; SRMR = 0.048; RMSEA = 0.066), in the second-order model (*N* = 1337, $\chi^2 = 512.73$, df = 124, TLI = 0.92; CFI = 0.94; SRMR = 0.050; RMSEA = 0.070), among males (*N* = 481, $\chi^2 = 412.77$, df = 122, TLI = 0.91; CFI = 0.93; SRMR = 0.050; RMSEA = 0.070), and among

Table 3 Factor loading of the 18-item patient satisfaction in four factors by CFA

Number	F1	F2	F3	F4
How satisfied are you with the timely and adequate information provided by the doctors on diagnosis, treatment and medication? (15)	0.93			
How satisfied are you with the patience of the medical staff when explaining the information of the diagnosis and treatment plan? (14)	0.88			
How satisfied are you with the carefulness and seriousness of medical staff behaviour? (18)	0.82			
How satisfied are you with the medical staff's ethics? (17)	0.81			
How satisfied are you with the behaviour of medical staff to protect privacy and respect individuality? (16)	0.75			
How satisfied are you with the treatment effect? (4)		0.88		
How satisfied are you with the technical level of diagnosis and treatment in this hospital (doctors and nurse technical competence, communication skills, humaneness, knowledge of problem and care, and so on)? (2)		0.86		
How satisfied are you with the quality of medical and nonmedical services delivered (including treatment effect, pain relief, symptom removal, comfort level, recovery of physiological function indicators, and so on.)? (5)		0.85		
How satisfied are you with the diagnostic instruments and medical inspection equipment/devices? (3)		0.81		
How satisfied are you with the service of this hospital (including the medical care and nonmedical care procedure during the diagnosis, picking up medicine at the pharmacy)? (1)		0.47		
How satisfied are you with appropriateness of drug prescribing (prescribing unnecessary, ineffective, outdated drugs, unapproved and investigational drug, overprescribing)? (8)			0.80	
How satisfied are you with the reasonable degree of inspections and treatments (including over-examination, re-examination, over-treatment and so on.)? (7)			0.78	
How satisfied are you with the degree of compliance charges (overcharges, repetitive payments)? (9)			0.69	
How satisfied are you with the range of medicines? (10)			0.52	
How satisfied are you with the price of medicines? (11)			0.50	
How satisfied are you with the health insurance reimbursement ratio? (13)				0.83
How satisfied are you with the time, attitude, and convenience of medical insurance reimbursement? (12)				0.81
How satisfied are you with the level of payment of medical insurance premiums? (6)				0.76

F1 = satisfaction with medical staff, F2 = satisfaction with hospital, F3 = satisfaction with medical costs, and F4 = satisfaction with medical insurance premiums

females (N=896, χ^2=483.62, df=122, TLI=0.95; CFI=0.96; SRMR=0.043; RMSEA=0.058) (Table 2).

Reliability

The Cronbach's alpha and McDonald's ω values of the 18-item PSQ-R were both 0.87. The composite reliabilities (i.e., the value of omega) of the four factors were 0.90, 0.87, 0.71 and 0.74, respectively. The two-week test-retest reliability (i.e., Cronbach's alpha) of the PSQ-R was 0.82 in the present study based on 83 patients randomly sampled from the original participant population (N=1377).

Measurement equivalence

The 18-item and four-factor PSQ-R had no significantly different fitting indices between genders ($\triangle\chi^2$=70.85, $\triangle df$=0, p>0.05). Equivalence measurement included configural, metric, scalar, error variance, factor variance and factor covariance, and latent mean equivalence, all of which displayed good fitting indices (all TLI and CFI≥0.95, SRMR and RMSEA<0.08) (Table 2). These results indicated good measurement equivalence of the PSQ-R across genders.

Network analysis

As shown in Fig. 1, the EBICglasso networks of the 18-item PSQ-R included the total sample, males and females (Figure A-C: item-level, Figure D-F: factor-level]). For the item-level network of 1377 participants, Item 14 (*'How satisfied are you with the patience of the medical staff when explaining the information of the diagnosis and treatment plan?'*) and Item 15 (*'How satisfied are you with the timely and adequate information provided by the doctors on diagnosis, treatment and medication?'*) had the strongest edge intensity (r=0.802) (Appendix S2). For the factor-level network, F1 (*'satisfaction with medical staff'*) and F2 (*'satisfaction with hospital'*) had the strongest edge intensities among the total sample (r=0.348), males (r=0.379) and females (r=0.333) (Appendices S6 and S12).

The edge-weight accuracy are explained through the bootstrapped CIs with the narrow grey area (Appendices S4 and S8). The CS coefficient indicated better centrality stability (CS>0.5) in the item-level network (edge and node strength both $CS_{(cor=0.7)}$=0.75) and the factor-level

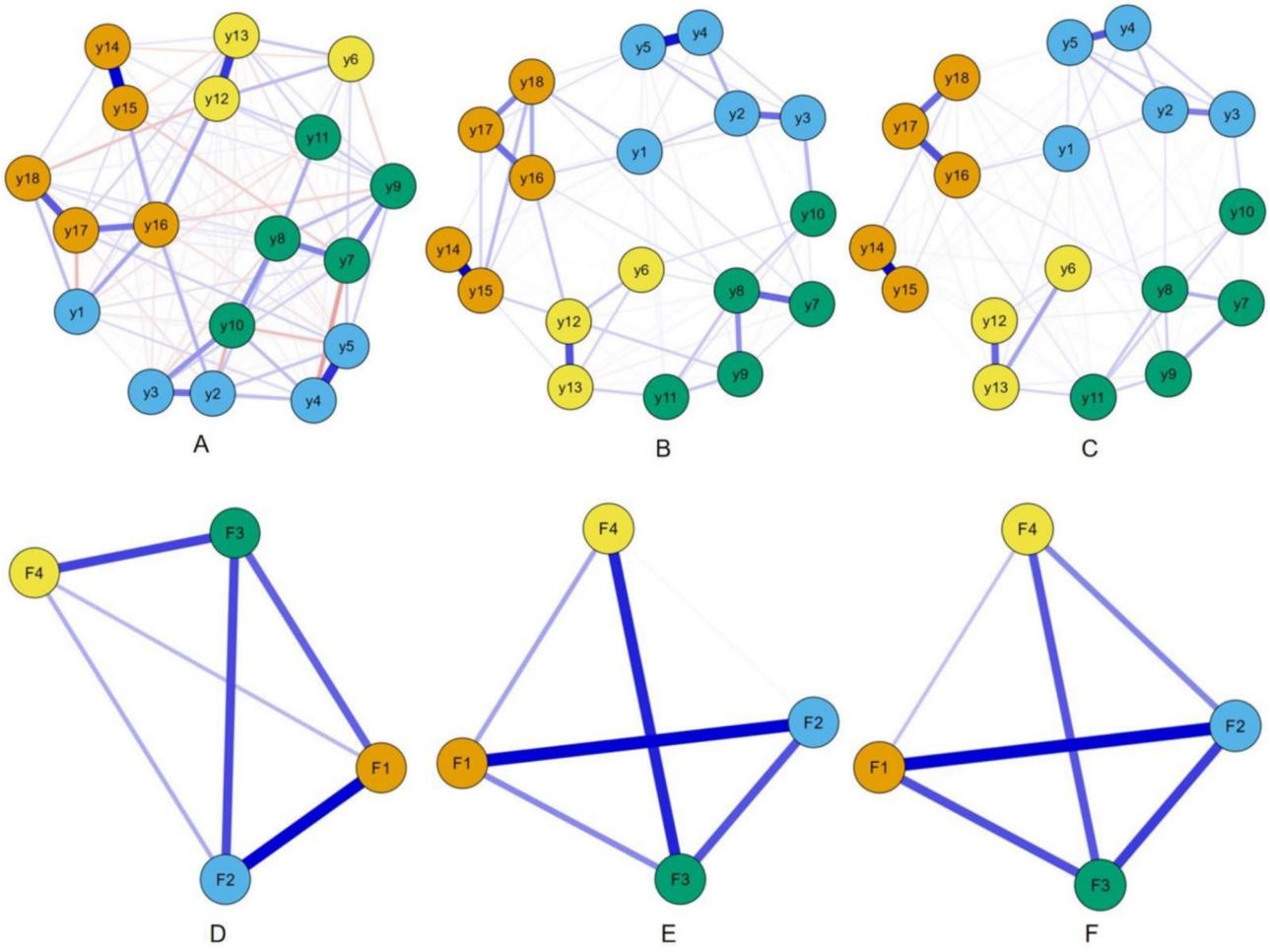

Fig. 1 EBICglasso model based on network analysis according to patient satisfaction among all participants (**A** & **D**), males (**B** & **E**) and females (**C** & **F**). Note: y1 - y18 = items of patient satisfaction, F1 = satisfaction with medical staff, F2 = satisfaction with hospital, F3 = satisfaction with medical costs, and F4 = satisfaction with medical insurance premiums

network (edge $CS_{(cor=0.7)}$=0.75, and node strength $CS_{(cor=0.7)}$=0.672). Moreover, the tests for significant differences indicated that Item 14 (*'How satisfied are you with the patience of the medical staff when explaining the information of the diagnosis and treatment plan?'*) and Item 15 (*'How satisfied are you with the timely and adequate information provided by the doctors on diagnosis, treatment and medication?'*), and Item 4 (*'How satisfied are you with the treatment effect?'*) and Item 5 (*'How satisfied are you with the quality of medical and nonmedical services delivered?'*) were significantly different from each other. All node (i.e., item and factor) strengths were also significantly different (Appendices S5 and S9).

There were no significant differences in the network structure or global strength between males and females at either item-level (M=0.18, p=0.664; 7.72 vs. 8.02, p=0.361) or factor-level (M=0.14, p=0.16; 1.28 vs. 1.27, p=0.935) NCT.

Discussion

The present study examined the validity, reliability, measurement invariance, and network structure of the 18-item and four-factor PSQ-R among a Chinese population of hospitalized patients. The results indicated that the 18-item (four-factor) PSQ-R had good validity, reliability, measurement invariance, and stable network structure. It was found that the PSQ-R had good psychometric characteristics which may contribute to better assessment of patient satisfaction and enhance the quality of healthcare services.

In the present study, there were no gender differences in the lengths of hospital stay. The lengths of hospital stay as a single factor or interaction with other factors (e.g., severity of disease and effective treatment) may be examined in future studies. There were also no statistically significant differences in the total score of the PSQ-R or factors of patient satisfaction between genders. Previous research has indicated that there are gender differences

in practitioners' communication styles [43–45]. In addition, some studies have reported weak gender differences of patient satisfaction for specific diseases (e.g., lumbar spinal stenosis) and the quality of nursing care among patients aged less than 35 years old [46–48].

The data distribution test and item analysis showed that the 18-item (four-factor) PSQ-R was appropriate for factor analysis using the MLR method due to the nonnormal distribution of some items. The four-factor PSQ-R was tested and verified through EFA and CFA. The second-order model and equivalence measurement were also performed to verify the good structural validity of the PSQ-R and its applicability across genders. The internal consistency and test-retest reliability demonstrated the good reliability of the PSQ-R.

The four factors of PSQ-R mainly assessed the satisfaction with medical staff (e.g., communication between patient-practitioner, respect and medical ethic), hospital (e.g., medical inspection equipment/devices and hospital's services quality), medical cost (e.g., cost of inspections and treatments), and medical insurance premiums (e.g., payment of Healthcare Security Administration and convenience of medical insurance reimbursement). In a Serbian study [19], patient satisfaction comprised two dimensions ('satisfaction with medical staff' and 'indicative of contextual patient dissatisfaction'), which was somewhat similar to the present study involving medical staff.

In China, healthcare reform is a topical issue for individuals' livelihood [49, 50]. Due to disparities in medical resources between regions, disparities in medical insurance coverage across income groups, and disparities in the employment sector (i.e., state-owned vs. nonstate-owned) [49], inequality in healthcare has seriously influenced individuals' quality of life [51]. The phenomenon of being in poverty or returning to poverty can occurs due to severe diseases with large medical expenditures, which can also decrease patient satisfaction. Consequently, the Chinese government actively carried out healthcare reform to improve these medical issues and mainly concentrated on the expansion of medical insurance and public hospitals, strengthening primary care, resulting in the 'Health China 2030' blueprint (i.e., which set the goals of providing universal health security for all citizens by 2030) in 2016 [50]. The PSQ-R includes important issues that Chinese healthcare reform focused on, that is, satisfaction with medical insurance premiums, satisfaction with medical costs, and satisfaction with hospital. In addition, the attributes of medical staff (e.g., their professional abilities, communication skills, and attitudes towards patients) may affect patient satisfaction. Therefore, the four-factor PSQ-R was selected and verified as a suitable measurement tool for patient satisfaction among a sample of the Chinese hospitalized population.

Mark and Wan [52] used measurement invariance to examine the perception of patient satisfaction using a 10-item Patient Satisfaction Questionnaire (i.e., where every item represented a separate variable, from working together of medical staff to sharing patients' concern with the nurses) between gender, race, and two time points (twice in six months). The results indicated good equivalence across time but not gender or race. Strong equivalence across genders, ages, and tumor location were also found among patients with cancer using the Satisfaction With Life Scale (SWLS), which includes five items and one factor assessing the individual's comprehensive judgement on life satisfaction [53]. In addition, the nine-item Chinese Patient Satisfaction Questionnaire (ChPSQ-9) with two dimensions ('satisfaction with doctors' services' and 'satisfaction with nurses' services') has been tested for factorial invariance among patients with breast or lung cancer, and showed evidence of longitudinal factorial invariance [54]. In the present study, the measurement invariance between genders indicated that the PSQ-R had the same meaning and function and is suitable for both males and females.

Previous studies of patient satisfaction questionnaires have mostly conducted EFA, CFA, reliability tests, and equivalence measurements, but few have performed network analysis. Network analysis was utilized to better describe the internal relationships among items and among factors through graphs. For example, Shim et al. identified a dominant item (i.e., concern about the illness) of the Brief Illness Perception Questionnaire (BIPQ) among patients with specific illnesses (i.e., those with rheumatic diseases, HIV [human immunodeficiency virus] infection and AIDS [acquired immune deficiency syndrome]) through network analysis [55]. A 39-item Parkinson's Disease Questionnaire (PDQ-39) was used to examine the validity and most influential items through network analysis and reported a close connection between symptoms (e.g., 'depressive mood' and 'feeling isolated') [56]. Network analysis has been more widely used in social, psychological, and medical fields [57].

In the present study, Item 14 (*'How satisfied are you with the patience of the medical staff when explaining the information of the diagnosis and treatment plan?'*) and Item 15 (*'How satisfied are you with the timely and adequate information provided by the doctors on diagnosis, treatment and medication?'*) had the strongest edge intensity, which indicated that medical staff's professional skills and communication abilities are considered the core components of patient satisfaction. Zhang et al. (using random forest algorithms and logistic regression) also reported that treatment outcome was the strongest predictor for patient satisfaction, followed by communication between medical staff and patients [58].

Having an effective treatment to relieve or eliminate pain is the most urgent expectation for patients with various diseases. First, patients try to look for the most reputable medical experts to obtain the right diagnosis and treatment. Next, in the process of medical practice, patients also assess communication with medical staff as one of the important aspects for satisfaction. Therefore, based on high-level professional knowledge and skills, great communication ability may increase patient satisfaction. In contrast, patient satisfaction decreases when there are medical staff-patient conflicts [59]. At the same time, medical staff-patient rapport and trust may also enhance medical staff job satisfaction [60], further improve patient satisfaction.

In the present study, the factors 'satisfaction with medical staff' and 'satisfaction with hospital' had the strongest edge intensity. The skills of medical staff are among the key elements for assessing the quality of healthcare services and determining hospital grades (i.e., in China, the higher the hospital grade, the higher the number of reputable medical staff). Therefore, in the present study, it is not surprising that 'satisfaction with medical staff' and 'satisfaction with hospital' were closely correlated because patient satisfaction with medical staff may increase satisfaction with the hospital. In contrast, satisfaction with the hospital decreases due to dissatisfaction with medical staff [61]. The network accuracy was also verified through the edge-weight accuracy, centrality stability, and nodes and edges' significant differences, which indicated the stable network structure of the PSQ-R.

Regarding the factors 'satisfaction with medical costs' and 'satisfaction with medical insurance premiums', patients also consider the cost medical treatment in addition to the efficacy of treatment. In China, universal health insurance coverage was achieved for 95% of the Chinese population by 2011 [62], and critical illness insurance has also been implemented to reduce the incidence of catastrophic health expenditure since 2012 [63]. However, different diseases require different treatments and result in different expenditures, while some expensive medical expenditures (e.g., imported medicine and medical equipment) may not be allowed in medical insurance reimbursement. Such large medical expenditures are not affordable for most individuals, which seriously affects Chinese individuals' health and decreases the quality of healthcare. Therefore, medical costs and medical insurance reimbursement (i.e., medical insurance premiums) influence patient satisfaction. Overall, effective treatment, effective communication, high-grade hospitals, affordable medical costs, and reasonable medical insurance premiums all contribute towards improved patient satisfaction [50].

The PSQ-R's network structure and global strength had no significant differences across genders, which suggests that the PSQ-R as a suitable tool irrespective of gender. The 18-item (four-factor) PSQ-R is appropriate for use among the Chinese population. The network structure indicated the interaction of factors. For example, dissatisfaction with medical staff may decrease satisfaction with hospitals, and hospitals with a low reputation will have medical staff with decreased job satisfaction, which further negatively influences patient satisfaction, causing a vicious cycle. In contrast, higher satisfaction with medical staff may also emerge through better professional ability and communication skills from medical staff, enhancing hospital reputation and increasing patient satisfaction.

There are several limitations in the present study. Cross-sectional studies and undirected network analysis do not allow the inference of causal relationships. In addition, some researchers have indicated that classical node centrality indices, including betweenness and closeness, are unsuitable as measures of node importance and that the relationship between node centrality and causal influence is not straightforward [64, 65]. Therefore, node centrality was not used in the main body of the present study and was considered only in the supplementary material. In future research, a more suitable study method on node centrality should be used. In addition, telephone surveys of patients rather than face-to-face interviews were used, which may cause a slight bias due to individual factors (e.g., dialect and speaking speed). Although an effort was made to get a representative hospitalized sample, the relatively low response rate may have affected the generalizability and biased the findings. It should also be noted that patients from the three different levels of hospital may have responded to satisfaction questions differently, and that further research examining patient satisfaction at these different types of hospital is needed. Subsequent research should also include comparisons of the PSQ-R between inpatients and outpatients, different age groups (e.g., young vs. old), different occupational status (employed vs. unemployed; retired vs. non-retired), and high vs. low insurance protection. Gender differences in patient satisfaction also need to be examined in future research based on aspects such as age, disease type, and nursing care. Moreover, samples should be enlarged throughout the country and not be limited to a few cities. The determinants of patient satisfaction should also be examined in the future through network analysis of directed acyclic graphs (DAGs), which may better explain the causal relationship of multi-variables.

Conclusion

The 18-item (four-factor) PSQ-R was found to have good reliability, validity, and measurement equivalence. In the network structures, 'satisfaction with medical staff' and 'satisfaction with hospital' had the strongest edge

intensity. The four dimensions of the PSQ-R appears to describe patient satisfaction well among the Chinese population. Therefore, enhancing satisfaction in terms of these four aspects may help in improving healthcare satisfaction among Chinese patients. More specifically, to effectively enhance patient satisfaction, the quality of healthcare service and medical staff skills should both be improved, medical insurance premiums should be increased, and medical costs should be decreased.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-024-11788-1.

Supplementary Material 1.

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Authors' contributions
Conceptualization: ZMN; Data curation: ZMN and LXH; Formal analysis: ZMN and SLM; Funding acquisition: ZMN; Investigation: ZMN and HQH; Methodology: ZMN and SLM; Project administration: ZMN; Software: ZMN; Writing - original draft: ZMN and LXH; Writing - review & editing: ZMN, LL, and MDG.

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Data availability
The datasets for the present study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This research involves human participants and was carried out in accordance with the relevant guidelines and regulations of the Declaration of Helsinki and the present study protocol was approved by the Ethics Committee in Gannan Medical University (Reference number: 2021MY01). Informed consent was obtained from participants or their parent or legal guardian in the case of children under 16 years.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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