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The Chinese version of the stigma of loneliness scale in people with chronic diseases: an assessment of psychometric characteristics

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Abstract

Background Loneliness is prevalent in patients with chronic diseases and can threaten their health status, treatment process and quality of life. The stigma of loneliness stems from a derogatory and stigmatizing label that individuals possess towards loneliness with the possibility of being socially disadvantaged, which exacerbates the negative impact of loneliness on patients with chronic diseases and jeopardizes social support. However, few studies focused on this theme in patients with chronic diseases. This study aimed to assess the psychometric characteristics of the Chinese version of the Stigma of Loneliness Scale (SLS) among patients with chronic diseases, to provide a validated tool for related research.

Methods The current study consisted of a two-phase questionnaire survey of 704 patients with chronic diseases. Sample 1 comprised 318 patients (Age:40.87 ± 18.55) with chronic diseases, and the data obtained were used for item analysis and exploratory factor analysis. Sample 2 included 386 patients (Age:40.65 ± 17.08) with chronic diseases, and the resulting data were of use for confirmatory factor analysis, criterion validity, incremental validity, and Cronbach's α coefficient test. Moreover, in Sample 2, the equivalence of SLS in male and female cohorts and in outpatient and inpatient groups was further examined.

Results In the exploratory factor analysis, two dimensions were extracted: Self-Stigma of Loneliness (SSL) and Public Stigma of Loneliness (PSL). The confirmatory factor analysis revealed that the first-order two-factor model demonstrated good fit indices (χ^2/df = 2.754, RMSEA = 0.067, SRMR = 0.023, CFI = 0.988, IFI = 0.989, TLI = 0.983, PNFI = 0.677, PCFI = 0.681), and it was superior to both the one-factor model and the two-factor orthogonal model. The criterion validity test indicated that the SLS scores were significantly positively correlated with the scores of UCLA Loneliness Scale, Brief Illness Perception Questionnaire, Self-Concealment Scale, Social Interaction Anxiety Scale, Social Phobia Scale, Acceptance and Action Questionnaire-Second Edition, Kessler Psychological Distress Scale-6 scores. The Cronbach's α coefficient values for the SLS, SSL, and PSL were 0.961, 0.949, and 0.960, respectively. The results of the incremental validity tests indicated that stigma of loneliness and loneliness differ in psychological construct.

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In addition, the SLS showed measurement equivalence in populations of patients with chronic diseases of different genders, as well as ways of seeking medical care.

Conclusions The Chinese version of the SLS showed favorable reliability and validity in patients with chronic disease populations, which can provide instrumental endorsement for recognition and intervention studies of stigma of loneliness.

Keywords Patients with chronic diseases, Stigma of loneliness, Reliability, Validity

Introduction

Loneliness is seen as one of the most common negative psychological feelings experienced by patients with chronic diseases during long-term treatment and recurrent episodes of the disease [1]. Previous studies revealed that loneliness threatens to impair sleep quality, mental health, and well-being in patients with chronic diseases, decreasing treatment adherence and health service utilization, as well as aggravating the severity of symptoms [2, 3]. Besides, loneliness can be a risk factor for poor prognosis and adverse health conditions of patients with chronic diseases, even contributing to an increased mortality risk [4, 5].

Although loneliness significantly and negatively affects the therapeutic outcome and recovery process of chronic diseases, physicians and nurses have not prioritized but underestimated and mischaracterized patients' feelings of loneliness [6]. In a qualitative study, it was noted that the failure of medical staff to meet the interpersonal needs required by hospitalized patients may result in patients exposing themselves to intense feelings of loneliness and distress [7].

Different perceptions and attitudes towards loneliness may exacerbate or weaken the negative consequences of loneliness [8]. In general, individuals perceive loneliness as a distressing and aversive psychological feeling, assuming that lonely people lack meaningful social connections and are socially disconnected [9]. To this end, such perception may call forth denial, concealment, and stigmatization towards feelings of loneliness and more negative evaluation of people who feel lonely [10].

Stigma is a subjective inference and assumption; in this case, lonely people are often seen as unpopular or with negative characteristics [11]. Researchers have defined stigma of loneliness as the derogatory and stigmatizing negative labels that individuals possess towards loneliness, which in turn leads to perceived discrimination, exclusion, denial, and injustice as results of their loneliness [12]. For instance, previous research discovered that common stigmatizing labels of loneliness encompass lack of social skills, unpopularity, low enthusiasm, insincerity, and weakness [13].

It is acknowledged that stigma of loneliness is strongly associated with loneliness. Tsai et al. found that not only do people negatively evaluate lonely people, but lonely people also engage in negative self-evaluation and social evaluation [14]. People characterized by high levels of loneliness are more sensitive to stigmatizing information which is also more prone to internalizing it as a self-stigma of loneliness. Also, there is evidence that loneliness could impair cognition and judgment of illness in people with chronic diseases [15]. Consequently, patients with high loneliness tend to have higher stigma of loneliness and more negative perceptions of their illness.

The progressive model of self-stigma suggests that the formation of self-stigma undergoes the perception, identification, and application of stereotypes, and that the results can contribute to a decrease in self-esteem and self-efficacy [16]. The most common stereotypes of loneliness are lack of social skills and interpersonal difficulties [13]. Individuals with high SLS, who are identified with stereotypes related to loneliness, may trigger skepticism and lack of self-confidence in their interpersonal skills, which in turn may lead to avoidance, withdrawal, and anxiety about social interactions [17]. In addition, The progressive model of self-stigma emphasizes that individuals with high stigma tend to conceal information about themselves from others and reveal their inner feelings less often [18]. In a qualitative study, stigma was found to disrupt social interactions, trigger loneliness, social disconnection, communication barriers, increase self-concealment, and decrease willingness to seek help [19].

Prior studies have extensively discussed the prevalence of loneliness and the underlying factors that may affect loneliness in patients with chronic illnesses, with corresponding interventions proposed [20]. However, few studies have focused on the stigma of loneliness in patients with chronic illness. Compared to the general population, loneliness in patients with chronic illness is not only influenced by real-life interpersonal interactions or psychological factors but may also result from physical limitations and long-term medical dependency [21]. Furthermore, patients with chronic illness may suffer from a "double stigma," encompassing both disease-related stigma and loneliness-related stigma [22].

Due to stigmatized attitudes toward their illness, those patients may actively reduce social interactions, conceal their emotional experiences, and more frequently resort to maladaptive coping strategies, such as rejecting care

and concern from family or friends, which can further exacerbate feelings of loneliness and negative evaluations of loneliness [23, 24]. For instance, Hanna et al. found that patients were less likely to express their loneliness to others because they perceived it as a weakness and a burden, which could adversely affect their treatment process [25]. Furthermore, evidence suggests that a decrease in stigma of loneliness and an increase in social support are equally important in diminishing loneliness and its negative effects in chronically ill patients [26].

Stigma of loneliness is prevalent in different countries and is mediated by cultural factors. Typically, in collectivist cultures, public stigma tends to elicit more severe self-stigma and has a more obvious impact on an individual's health and well-being [27]. For instance, Barreto et al. found that in collectivist cultures, individuals tend to perceive loneliness as manageable and have higher stigma of loneliness [10]. As we all know, the United States is a typical country with an individualistic culture, while China is a typical country with a collectivistic culture. Concretely, the Chinese people establish and develop interpersonal relationships based on kinship and geographical proximity, with no clear-cut boundary between oneself and others [28].

Interpersonal relationships not only reflect the degree of harmony between the parties involved but also indicate an individual's popularity and social standing within their group or social network [29]. Loneliness signifies that an individual is marginalized and overlooked, with limited influence within the group and insufficient access to social support and resources. For patients with chronic disease in China, social support not only provides emotional, financial, and practical assistance but also suggests that they are still welcomed by family or friends instead of being perceived as a burden or liability [30].

Currently, a variety of scales are available to assess loneliness in different demographics; however, few instruments have been specifically designed to measure stigma of loneliness [31]. To enable the measurement of the construct of stigma of loneliness, Ko et al. developed the Stigma of Loneliness Scale (SLS) among American college students [12]. The scale consisted of 10 items divided into Self-Stigma of Loneliness (SSL) and Public Stigma of Loneliness (PSL) dimensions. In the study by Ko et al., it was found that the factor structure of the two-factor model demonstrated better fit indices compared to the one-factor model and the two-factor orthogonal model, and the scale exhibited good structural validity, construct validity, internal consistency reliability, and test-retest reliability [12]. The validity of the SLS has not only been confirmed among U.S. college students but has also been widely used to explore the relationships between stigma of loneliness and mental health, loneliness, self-concealment, and interpersonal interactions among adults, older adults, or international students across different socio-cultural contexts [32–35].

To examine the applicability of the SLS in the Chinese population, Fan et al. translated the scale into Chinese and tested its reliability among Chinese college students [36]. It was found that the Chinese version of the SLS showed good psychometric characteristics. Notably, the psychometrics of both of these SLS were studied in college students. At present, no studies have examined the applicability of the SLS to other populations. But, previous research has revealed that college students exhibit characteristics that differ from other adult populations in terms of the degree and type of stigma of loneliness [37].

In addition, people with chronic illness often experience loneliness and have a stronger sense of need for support from family or those around them [38]. However, the applicability of SLS in the population of chronically ill patients is unclear. Besides, cross-group equivalence implies that individuals from different cohorts will understand and interpret questionnaire items in the same way. So, differences can only be analyzed when the measurement tool SLS shows invariance across cohorts. Notably, previous research has found that individuals of different genders differ in the prevalence of loneliness and attitudes toward loneliness [39]. Moreover, gender differences have been found in stigma-related studies [40]. In addition, hospitalized patients showed inconsistencies with outpatients in terms of their need for interpersonal relationships and their experience of loneliness [41]. To account for potential differences in SLS across gender and in patient populations with different modes of attendance, studies also need to examine the cross-group consistency of the scale.

By examining the psychometric properties of the SLS within the Chinese patients with chronic diseases, this study can provide valuable insights into the characteristics and detrimental effects of stigma of loneliness in the context of Chinese socio-cultural background, thereby effectively enriching the existing literature. Given that the SLS is primarily designed to measure individuals' negative cognitions and evaluations of loneliness without addressing the sources or extent of loneliness, and the language used is not specifically tailored for college students, the SLS can serve as a potentially effective tool for assessing stigma of loneliness among patients with chronic illness. Hence, this study aims to examine the psychometric properties of the SLS within the patients with chronic illness population to provide a reliable instrument for relevant empirical research. The present study hypothesizes that the SLS will demonstrate good reliability and validity among patients with chronic illness and exhibit measurement invariance across different genders and treatment modalities.

Methods

Procedures and study design

This study employed a cross-sectional research design, utilizing a convenience sampling approach for data collection. Following medical consultations, the research team provided eligible patients with detailed information regarding the study's objectives and the assurance of anonymity. Patients who voluntarily agreed to participate in the survey were required to sign informed consent forms before receiving the paper-based questionnaires. Participants were instructed to complete the questionnaires independently, based on their genuine perceptions and experiences, ensuring the authenticity and reliability of the collected data. To allow for a test of the stability of the SLS factor structure across samples, the current study conducted data collection in two stages. Phase 1 was completed in June-July 2023, and Phase 2 was completed in August-September 2023 for the survey. To improve the representativeness of the sample, the investigators surveyed 11 hospitals in 5 provinces in China. Four hospitals in Jilin Province were selected in Northeast China, two hospitals in Henan Province in Central China, three hospitals in Tianjin and Guangdong Province in East China, and two hospitals in Hainan Province in the southernmost part of China. Among them, 6 hospitals were Western medicine hospitals, and 5 hospitals were Chinese medicine hospitals.

The current study used 10 times the number of questionnaire items and a total of not less than 300 as the minimum sample size calculation criteria [42]. The inclusion criteria for participants were (1) age ≥ 18 years; (2) voluntary consent to participate in this survey; (3) diagnosed with chronic diseases such as diabetes mellitus, coronary artery disease, tumors, hypertension, and strokes; Exclusion criteria: (1) the presence of language or communication barriers; (2) the presence of serious mental illness and cognitive impairment; (3) history of dementia; (4) poor health, not suitable for questionnaire survey judged by doctors.

Participants

A total of 704 valid questionnaires were returned in the current study. Of these, sample 1 surveyed 318 chronic disease patients and sample 2 surveyed 386 chronic disease patients. In the total sample, the minimum age of participants was 18 years old, the maximum age was 86 years old, and the mean age was 40.75 years old (SD = 17.75); in sample 1, the minimum age of participants was 18 years old, the maximum age was 86 years old, and the mean age was 40.87 (SD = 18.55); and in sample 2, the participants had a minimum age of 18, a maximum age of 85, and a mean age of 40.65 (SD = 17.08). Detailed sociodemographic information for each sample is shown in Table 1.

Measures

Stigma of loneliness scale (SLS)

The SLS was selected as a scale to assess stigma of loneliness in patients with chronic diseases [12]. The Chinese version of the scale, SLS, was revised in a population of Chinese college students and showed good psychometric characteristics [36]. The SLS consists of 10 items and is scored on a 5-point scale, being divided into Self-Stigma of Loneliness (SSL) and Public Stigma of Loneliness (PSL) dimensions. Higher scores indicate a greater level of stigma of loneliness in individuals.

UCLA loneliness scale (ULS-8)

The UCLA Loneliness Scale is the most commonly used instrument for measuring loneliness in individuals, and a short version of the questionnaire with different numbers of items was developed. The ULS-8 exhibits a high degree of reliability and simplicity, and has been widely used in rapid measuring for loneliness [43]. The Chinese version of the ULS-8 demonstrates good psychometric properties [44]. The ULS-8 has a unidimensional structure and is scored on a 4-point scale. The higher the total score of the scale, the higher the level of loneliness of the individual. The Cronbach's alpha coefficient for the scale in this study was 0.76.

Brief illness perception questionnaire (BIPQ)

The BIPQ was selected to assess the individual's feelings and perceptions of the disease they suffer from [45]. The Chinese version of the BIPQ is an effective tool for assessing patients' perceptions, understanding, and emotional responses to their illness [46]. The scale consists of 9 items on a 10-point scale. Among these, item 3, item 4 and item 7 are reverse scored and the rest of the items are positively scored. Item 9 is mainly used to measure the patient's perception of etiology and is not involved in scoring. The higher the total score, the higher the individual's negative perception of the disease and the higher the perceived severity of the disease. The Cronbach's alpha coefficient for the scale in this study was 0.87.

Self-Concealment scale (SCS)

The SCS was chosen to assess an individual's psychological tendency to conceal negative information and distressing feelings [47]. The validity of the Chinese version of the SCS has been confirmed across different age groups [48]. The SCS comprises 10 items in a unidimensional structure. The scale is scored on a 5-point scale, from 1 (strongly disagree) to 5 (strongly agree). A higher total score indicates that the individual's tendency to self-conceal is also higher. The Cronbach's alpha coefficient for the scale in this study was 0.93.

Table 1 Sociodemographic characteristics

	Entire sample (*n* = 704)		Sample 1 (*n* = 318)		Sample 2 (*n* = 386)	
	N	%	*N*	%	*N*	%
Age						
18 ~ 35	316	44.89	151	47.48	165	42.75
36 ~ 59	255	36.22	102	32.08	153	39.64
60 ~ 86	133	18.89	65	20.44	68	17.62
Gender						
Male	313	44.46	135	42.45	178	46.11
Female	391	55.54	183	57.55	208	53.89
Age (Mean, SD)	40.75	(17.55)	40.87	(18.55)	40.65	(17.08)
Types of illnesses						
Diabetes mellitus	169	24.01	71	22.33	98	25.39
Coronary artery disease	120	17.05	57	17.92	63	16.32
Tumors	89	12.64	46	14.47	43	11.14
Hypertension	213	30.26	92	28.93	121	31.35
Strokes	113	16.05	52	16.35	61	15.80
Way of seeking medical care mode						
Outpatients	438	62.22	174	54.72	264	68.39
Inpatients	266	37.78	144	45.28	122	31.61
Nationality						
Han Chinese	629	89.35	290	91.19	339	87.82
Minority	75	10.65	28	8.81	47	12.18
Residence						
City	518	73.58	232	72.96	286	74.09
Country	186	26.42	86	27.04	100	25.91
Education						
Elementary school and below	64	9.09	32	10.06	32	8.29
Junior high school	117	16.62	53	16.67	64	16.58
High/vocational secondary school	107	15.20	57	17.92	50	12.95
Junior college	101	14.35	52	16.35	49	12.69
Undergraduate	276	39.20	109	34.28	167	43.26
Post-graduate	39	5.54	15	4.72	24	6.22
Marital status						
Unmarried	255	36.22	122	38.36	133	34.46
Married	410	58.24	181	56.92	229	59.33
Divorced	14	1.99	5	1.57	9	2.33
Widowed	16	2.27	5	1.57	11	2.85
Remarried	9	1.28	5	1.57	4	1.04
Number of children						
None	277	39.35	128	40.25	149	38.60
One	221	31.39	87	27.36	134	34.72
More than one	206	29.26	103	32.39	103	26.68

Social interaction anxiety scale (SIAS) and social phobia scale (SPS)

The SIAS and SPS were adopted to measure the level of anxiety and fear of social activities in individuals. Fergus et al. developed a shortened version of the scale consisting of 12 items [49]. The Chinese versions of the SIAS and SPS exhibit good psychometric properties and demonstrate cross-cultural measurement invariance [50]. Both the SIAS and the SPS consist of 6 items each, which are scored on a 5-point scale. The validity of the scales has been validated in both the general population and in populations with social anxiety disorders. Higher total scores indicate that individuals also have higher levels of social anxiety and fear. The Cronbach's alpha coefficients for the SIAS and SPS in this study were 0.94 and 0.95, respectively.

Acceptance and action questionnaire-second edition (AAQ-II)

The AAQ-II was adopted to measure the degree of experiential avoidance and psychological rigidity in

individuals [51]. The Chinese version of AAQ-II is an useful self-report measure of experiential avoidance [52]. The scale is composed of 7 items with a unidimensional structure. The AAQ-II is scored on a 7-point scale and all items are positively scored. The higher the total score, the higher the level of individual's feelings of pain and one's control and avoidance of the impulses and emotions, and the higher the level of psychological rigidity. The Cronbach's alpha coefficient for the scale in this study was 0.95.

Kessler psychological distress scale (K10)

The K10 scale has been extensively used to assess the mental health status of different populations and has demonstrated good psychometric characteristics [53]. The Chinese version of K10 has good validity and reliability [54]. The K10 consists of 10 items and is scored on a 5-point scale. A higher total score indicates that the individual has a higher level of anxiety and depression and is more likely to suffer from mental illness. The Cronbach's alpha coefficients for the scales in this study were 0.97.

Statistical analysis

Descriptive statistical analysis was conducted on the data, and the mean, standard deviation, skewness, and kurtosis of all items in the SLS were reported. If the absolute skewness value is less than 3 and the absolute kurtosis value is less than 10, it indicates that the data generally conforms to a normal distribution [55]. Item analysis and EFA were performed on the data from Sample 1 using SPSS 20.0. The item analysis aims to examine the degree of differentiation between the items [56].

First, independent samples *t*-tests were performed by setting the first 27% of the total SLS score as the high group and the second 27% as the low group. If $p > 0.05$, the item was deleted. Second, Pearson correlation analysis was taken to decide the deletion of items with correlation less than 0.40 by calculating the correlation between each item and the total SLS score. Third, a significant increase in the Cronbach's alpha coefficient value after removal of any item indicated that the item should be rejected due to its poor degree of consistency with other items.

The results of the original scale study showed that the explanatory rates for the two dimensions were 49.64% and 12.57%, respectively [12]. However, in the revision of the Chinese version of the SLS by Fan et al., the explanatory rate for the first dimension was found to be 63.48%, significantly higher than that in the original study, while the explanatory rate for the second dimension was 11.12%, which is consistent with the original findings [36]. Compared to the second dimension, the first-dimension accounts for the majority of the total variance, making it the primary dimension of the SLS. In other words, the Chinese version of the SLS exhibits a trend toward a unidimensional structure.

Therefore, this study employed both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to examine the factor structure of the SLS and constructed one-factor model and two-factor orthogonal model for comparison with the two-factor model. The EFA included data from Sample 1, and CFA uses data from Sample 2. In EFA, Principal Axis Factor Analysis (PAFA) stood out as the method of factor extraction, and Promax as the method of factor rotation. If the factor loading value of an item is less than 0.40 or commonality is less than 0.30, the item needs to be removed.

CFA was performed on the data in Sample 2 using AMOS 24.0. The criteria for good model fit were: $\chi^2/df < 3$, RMSEA < 0.08, SRMR < 0.05, CFI, IFI, TLI > 0.90, PNFI, PCFI > 0.50 [57]. Moreover, to explain the convergent validity and discriminant validity of the scale, this study calculated composite reliability (CR), average variance extracted (AVE), maximum reliability (MaxR(H)), and heterotrait-monotrait ratio (HTMT). If the CR value exceeds 0.70 and the AVE value is greater than 0.50, it indicates that the SLS has good convergent validity [58]. If the square root of the AVE for a dimension is greater than the correlations between dimensions, and the HTMT ratios are below 0.85, it suggests that the data exhibit good discriminant validity [59]. Additionally, if the MaxR(H) of the SLS is greater than 0.80, it demonstrates a high level of internal consistency among the items [60].

The reliability and validity tests based on Sample 2 are to analyze the validity of the SLS for the criterion-related validity and incremental validity. The correlation between the SLS and the validity instrument was calculated by Pearson correlation analysis to examine the criterion-related validity of the scale. Incremental validity of the SLS adopted Hierarchical Regression Analysis, which examined the role of the SLS in predicting the BIPQ, SCS, SIAS, SPS, AAQ-II, and K10 beyond a measure of loneliness [61].

In the entire sample, this study further explored the equivalence of SLS in male and female patient populations and in outpatient and inpatient populations [62]. First, the present study constructed Configural Invariance (M1) with no restrictions added to the model. Second, the current study constructed Weak Invariance model (M2), which set the factor loadings of different groups to be equal. Again, this study constructed the strong invariance model (M3), and the M2 model was based on setting the intercepts of the different groups to be equal. Finally, the Strict Invariance Model (M4) was constructed based on the M3, setting the residuals of different groups to be equal. The differences in CFI between M2 and M1, M3 and M2, and M4 and M3 were

Table 2 The results of descriptive statistical analysis ($N = 704$)

Item	Skewness	Kurtosis	Mean	SD
1	0.76	-0.33	2.16	1.15
2	0.74	-0.40	2.21	1.18
3	0.74	-0.40	2.18	1.16
4	0.67	-0.59	2.23	1.20
5	0.78	-0.22	2.18	1.16
6	0.47	-0.85	2.36	1.20
7	0.57	-0.63	2.29	1.17
8	0.52	-0.69	2.36	1.18
9	0.60	-0.52	2.24	1.13
10	0.55	-0.61	2.33	1.18

compared sequentially to determine whether the corresponding models were valid. A criterion for the validity of the model is $\Delta CFI < 0.01$ [63, 64].

Results

Descriptive Statistical Analysis.

In Table 2, the mean, standard deviation, skewness, and kurtosis of all items in the SLS are provided to illustrate the distribution characteristics of the data. The results show that the skewness values range from 0.47 to 0.78, and the kurtosis values range from – 0.22 to -0.85.

Item analysis

Item analysis was performed in Sample 1. The results of the independent samples *t*-test showed (see Table 3) that among the items, the scores of the high subgroups were significantly higher than those of the low subgroups ($t = 18.53$ to 29.26, $p < 0.001$). Correlation analysis showed that the correlation between each item and the total score ranged from 0.81 to 0.88, which was greater than the criterion of 0.40. The Cronbach's alpha coefficient value for all items was 0.958, and after deleting any item, the Cronbach's alpha coefficient value ranged from 0.953 to 0.956.

Exploratory factor analysis(EFA)

EFA was performed on the data from Sample 1. The results showed a KMO value of 0.932 and a Bartlett's test of sphericity value of 3413.05 ($df = 45$, $p < 0.001$). The KMO value was greater than 0.70, which indicated that the data were suitable for EFA. ln the EFA (see Table 4), the factor loadings for each of the items were in the range of 0.709 to 0.967, and the coefficients of the items were in the range of 0.699 to 0.857. All items met the retention criteria.

The number of factors was determined by the eigenvalue greater than 1 and combined with the scree

Table 3 The result of item analysis of SLS

Item	Entire Sample ($N = 318$)		Low Subgroup ($N = 86$)		High Subgroup ($N = 86$)		t-value	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
	M	SD	M	SD	M	SD			
1	2.06	1.08	1.08	0.28	3.21	1.02	18.70^{***}	0.81^{***}	0.956
2	2.08	1.07	1.03	0.19	3.19	1.00	19.62^{***}	0.81^{***}	0.956
3	2.10	1.10	1.05	0.21	3.40	0.97	21.86^{***}	0.87^{***}	0.953
4	2.14	1.17	1.05	0.21	3.53	0.90	24.87^{***}	0.86^{***}	0.954
5	2.09	1.09	1.03	0.19	3.22	1.08	18.53^{***}	0.83^{***}	0.955
6	2.35	1.20	1.06	0.24	3.66	0.79	29.26^{***}	0.88^{***}	0.953
7	2.23	1.12	1.05	0.21	3.49	0.85	25.84^{***}	0.88^{***}	0.953
8	2.28	1.15	1.05	0.21	3.48	0.88	24.97^{***}	0.86^{***}	0.954
9	2.20	1.11	1.02	0.15	3.43	0.91	24.08^{***}	0.88^{***}	0.953
10	2.27	1.15	1.07	0.30	3.49	0.90	23.56^{***}	0.85^{***}	0.954

Note: $^{***}p < 0.001$; SD, standard deviance

Table 4 The result of exploratory factor analysis of SLS($N = 318$)

Item	SSL	PSL	Commonality
1. I would never tell another person that I am lonely because I would feel ashamed.	**0.967**	-0.060	0.756
2. Being lonely would mean something is wrong with me.	**0.911**	0.019	0.782
3. If I were lonely, I would feel ashamed.	**0.886**	0.003	0.777
4. I would judge myself negatively if I were lonely.	**0.797**	0.127	0768
5. Being lonely would be embarrassing.	**0.717**	0.206	0.699
6. Others would assume that I do not have any friends if I were lonely.	-0.072	**0.936**	0.857
7. Others would assume that I am not very good at talking to people if I were lonely.	-0.055	**0.909**	0.776
8. If I were lonely, others would assume that I had not made enough of an effort to not feel this way.	0.147	**0.762**	0.852
9. Others would assume it was my fault if I were lonely.	0.190	**0.731**	0.803
10. If I were lonely, others would assume that I do not have social skills.	0.161	**0.709**	0.789

Note: the bold part is the factor and the factor load value of the project; SSL, Self-Stigma of Loneliness; PSL, Public Stigma of Loneliness

Table 5 Confirmatory factor analysis and competitive model fitting index($N = 386$)

Competing Model	χ^2/df	RMSEA	CFI	IFI	TLI	PNFI	PCFI	SRMR
two-factor model	2.754	0.067	0.988	0.989	0.983	0.677	0.681	0.018
one-factor model	26.65	0.258	0.826	0.827	0.755	0.584	0.587	0.084
two-factor orthogonal mode	12.221	0.171	0.924	0.924	0.893	0.653	0.657	0.432

Note: RMSEA: root mean square error of approximation; CFI: comparative fit index; IFI: incremental fit index; TLI: Tucker-Lewis index; PNFI: parsimonious normed fit index; PCFI: Parsimonious Comparative Fit Index; SRMR: standardized root mean square residual

Table 6 The criterion-related validity test of SLS($N = 386$)

	1	2	3	4	5	6	7	8	9	10
1.SLS	-									
2.SSL	0.93**	-								
3.PSL	0.93**	0.74**	-							
4.ULS-8	0.59**	0.57**	0.54**	-						
5.BIPQ	0.37**	0.32**	0.37**	0.20**	-					
6.SCS	0.62**	0.59**	0.56**	0.46**	0.31**	-				
7.SIAS	0.69**	0.63**	0.64**	0.68**	0.26**	0.61**	-			
8.SPS	0.68**	0.64**	0.63**	0.67**	0.25**	0.58**	0.91**	-		
9.AAQ-II	0.66**	0.60**	0.62**	0.72**	0.39**	0.55**	0.71**	0.70**	-	
10.K10	0.66**	0.62**	0.61**	0.76**	0.33**	0.52**	0.78**	0.77**	0.84**	-
Mean	23.16	11.39	11.77	17.21	47.56	24.67	14.66	14.15	15.19	25.28
SD	10.42	5.61	5.56	4.40	15.22	9.33	6.27	6.25	5.32	10.09

Note: $^{**}p < 0.01$; SD, standard deviation; SLS, Stigma of Loneliness Scale; SSL, Self-Stigma of Loneliness; PSL, Public Stigma of Loneliness; ULS-8, UCLA Loneliness Scale; BIPQ, Brief Illness Perception Questionnaire; SCS, Self-Concealment Scale; SIAS, Social Interaction Anxiety Scale; SPS, Social Phobia Scale; AAQ-II, Acceptance and Action Questionnaire-Second Edition; K10, Kessler Psychological Distress Scale

plot. The results showed that a total of 2 factors were extracted, cumulatively explaining 82.81% of the variance of the total variance. Item 1 to item 5 were attributed to factor 1, and item 6 to item 10 were attributed to factor 2. Since the number of items and their attribution were consistent with the original scale, the two factors were named Self-Stigma of Loneliness (SSL) and Public Stigma of Loneliness (PSL), respectively.

Confirmatory factor analysis(CFA)

The CFA was performed in sample 2 and the results showed good model fit indices: $\chi^2/df = 2.754$, RMSEA = 0.067, SRMR = 0.023, CFI = 0.988, IFI = 0.989, TLI = 0.983, PNFI = 0.677, and PCFI = 0.681. This study constructed separate one-factor model and two-factor orthogonal mode as competitive models respectively. The results showed (see Table 5) that the two competing models had poorer fit indices for each of the fit indices. Therefore, the two-factor structure was the optimal model.

Criterion-related validity test

In Sample 2, Pearson correlations were performed to calculate the correlations of the SLS and the SSL and PSL dimensions with the criterion instruments using Pearson correlations. The results showed (see Table 6) that SLS total scores and dimension scores were significantly and positively correlated with total scores on the ULS-8, BIPQ, SCS, SIAS, SPS, AAQ-II, and K10.

Table 7 The results of incremental validity test of SLS($N = 386$)

Dependent variable	Independent variable	First floor		Second floor	
		ΔR^2	β	ΔR^2	β
BIPQ		0.13**		0.16**	
	ULS-8		0.36**		0.22**
	SLS				0.24**
SCS		0.21**		0.39**	
	ULS-8		0.46**		0.14**
	SLS				0.54**
SIAS		0.46**		0.58**	
	ULS-8		0.68**		0.42**
	SLS				0.44**
SPS		0.44**		0.57**	
	ULS-8		0.67**		0.41**
	SLS				0.44**
AAQ-II		0.52**		0.60**	
	ULS-8		0.72**		0.52**
	SLS				0.35**
K10		0.57**		0.64**	
	ULS-8		0.76**		0.57**
	SLS				0.32**

Note: $^{**}p < 0.01$; SLS, Stigma of Loneliness Scale; ULS-8, UCLA Loneliness Scale; BIPQ, Brief Illness Perception Questionnaire; SCS, Self-Concealment Scale; SIAS, Social Interaction Anxiety Scale; SPS, Social Phobia Scale; AAQ-II, Acceptance and Action Questionnaire-Second Edition; K10, Kessler Psychological Distress Scale

Incremental validity test

The results of the Hierarchical Regression Analysis (see Table 7) showed that the standardized regression coefficients (β) and the increased amount of explained

Table 8 The results of the equivalence analysis of the SLS (*N* = 386)

Model		χ^2/df	CFI	IFI	TLI	SRMR	RMSEA (90%CI)	ΔCFI
Gender equivalence test	M1	4.142	0.976	0.976	0.965	0.026	0.067 (0.059 ~ 0.076)	
	M2	3.720	0.976	0.976	0.969	0.027	0.062 (0.054 ~ 0.070)	0.005
	M3	3.641	0.974	0.974	0.970	0.028	0.061 (0.054 ~ 0.069)	0.001
	M4	3.480	0.970	0.970	0.972	0.029	0.059 (0.053 ~ 0.066)	0.002
Equivalence test of the ways of seeking help	M1	4.510	0.973	0.973	0.961	0.023	0.071 (0.062 ~ 0.079)	
	M2	4.107	0.973	0.973	0.966	0.024	0.067 (0.059 ~ 0.075)	0.0001
	M3	3.755	0.973	0.973	0.970	0.024	0.063 (0.055 ~ 0.070)	0.0004
	M4	3.670	0.969	0.968	0.970	0.048	0.062 (0.055 ~ 0.069)	0.004

Note: M1, Configural Invariance model; M2, Weak Invariance model; M3, Strong Invariance model; M4, Strict Invariance model; RMSEA: root mean square error of approximation; CFI: comparative fit index; IFI: incremental fit index; TLI: Tucker-Lewis index; PNFI: parsimonious normed fit index; PCFI: Parsimonious Comparative Fit Index; SRMR: standardized root mean square residual

variance(ΔR^2) reached a significant level, which represent the predictive effect of SLS on BIPQ, SCS, SIAS, SPS, AAQ-II, and K10 after controlling for ULS-8.

Convergent and discriminant validity tests

Convergent and discriminant validity were tested using the entire sample. The results showed that the composite reliability (CR) values for Self-Stigma of Loneliness (SSL) and Public Stigma of Loneliness (PSL) were 0.95 and 0.96, respectively, while the average variance extracted (AVE) values were 0.79 and 0.83, respectively. The maximum reliability (Max H) values were 0.95 and 0.96, respectively, indicating good convergent validity of the scale. Additionally, the square roots of the AVE for SSL and PSL were 0.89 and 0.91, respectively, which are greater than the correlation coefficient between the two dimensions ($r = 0.75$). Furthermore, the heterotrait-monotrait ratio (HTMT) was 0.79, demonstrating good discriminant validity of the scale.

Reliability test

In the entire sample, Cronbach's alpha coefficients for the SLS and the SSL and PSL dimensions were calculated to explain the reliability of the scale. The results showed that the Cronbach's alpha coefficient values for the SLS and the SSL and PSL dimensions were 0.961, 0.949, and 0.960, respectively.

Equivalence test for SLS in a gender-specific patient population

The results of the multiple group analysis showed (see Table 8) that the Configural Invariance (M1), weak invariance model (M2), strong invariance model (M3), and Strict Invariance Model (M4) had good model fit indices. The prerequisites for conducting cross-gender consistency tests were satisfied. The CFI comparison of the four models sequentially revealed that the ΔCFIs were 0.005, 0.001, and 0.002, respectively, which were all less than the 0.01 criterion. This indicates that the factor loadings, intercepts, and residuals of SLS in the patient population of different genders are equivalent and can be compared by gender.

Independent samples *t*-tests were taken to analyze the gender differences in SLS total scores and scores of each dimension. The results showed that the total SLS score was higher in male patients(M = 24.59, SD = 10.46) than in female patients (M = 20.91, SD = 9.46) and the difference was significant ($t = 4.90$, $p<0.001$). SSL score was higher in male patients (M = 12.08, SD = 5.65)than in female patients (M = 10.10, SD = 4.88) and the difference was significant (t = 4.98, $p<0.001$). In addition, PSL score was higher in male patients (M = 12.52, SD = 5.56) than in female patients (M = 10.82, SD = 5.22) and the difference was significant (t = 4.17, $p<0.001$).

Equivalence test of SLS in outpatient and inpatient populations

The results of the multiple group analysis showed (see Table 8) that the four models had good fit indices and could be tested for cross-group consistency. In the comparative analysis of the different models, it was found that the ΔCFI were 0.0001, 0.0004, and 0.004, respectively, which were all less than the 0.01 criterion. This indicates that the SLS has factor loadings, intercepts, and residual equivalence in the outpatient and inpatient populations.

Independent samples *t*-tests were taken to analyze the differences between outpatients and inpatients SLS total scores and scores on each dimension. The inpatient SLS total score (M = 23.81, SD = 10.96) was higher than the outpatient (M = 21.79, SD = 9.43) and the difference was significant (t = 2.50, $p = 0.013$). Inpatient SLS scores (M = 11.64, SD = 5.76) were higher than outpatients (M = 10.58, SD = 5.01) and the difference was significant (t = 2.49, $p = 0.013$). In addition, PSL scores were higher for inpatients (M = 12.17, SD = 5.78) than for outpatients (M = 11.21, SD = 5.20) and the difference was significant as well (t = 2.22, $p = 0.027$).

Discussion

This study tested the reliability and validity of the Chinese version of the Stigma of Loneliness Scale (SLS) in 704 patients with chronic diseases. It was discovered that the scale was consistent with the original English scale in terms of the number of items and the way the dimensions were divided. In addition, the SLS demonstrated favorable construct validity, criterion validity, and internal consistency reliability, while the scale had measurement equivalence in both male and female, and in outpatient and inpatient populations. The findings suggest that the SLS is a valid tool for assessing stigma of loneliness in patients with chronic illness.

In the exploratory factor analysis (EFA), two dimensions, Self-Stigma of Loneliness (SSL) and Public Stigma of Loneliness (PSL), were extracted, cumulatively explaining 82.81% of the total variance. To examine the rationality of the two-factor structure, this study conducted a validated factor analysis (CFA) and a competing model test. As the results showed, the two-factor model was superior to the one-factor model and the two-factor orthogonal mode. The original English scale as well as the Chinese version of the scale were developed or revised in the college student population [12, 65]. In both studies, the SLS was found to be composed of two dimensions, SSL and PSL.

In addition, in previous studies of different types of stigma, such as mental illness stigma and seeking help stigma, they were similarly categorized into public stigma and self-stigma [66, 67]. The present study reached similar conclusions in a population of people with chronic illness. The findings may provide empirical evidence to better understand the psychological structure of stigma of loneliness.

The distinction between public stigma and self-stigma is primarily based on the difference in the source of stigma [27]. PSL originates from the external environment as the negative perceptions held by the majority of people in society about lonely people and the consequent emotional reactions of aversion and fear, as well as behavioral reactions of discrimination, alienation, and avoidance [68]. SSL stems from inside the individual as a result of the lonely person's perception of, identification with, and applications of stigmatizing information, which can lead to negative consequences of self-depreciation and self-discrimination [69]. To a large extent, the formation of SSL is affected by PSL [70].

When individuals perceive stigmatizing information related to loneliness, it can lead to SSL formation if they identify with it and incorporate it into their self-concept [71]. Individuals with high SSL may experience more significant feelings of rejection and social alienation and more intense negative emotions when experiencing loneliness. To better elucidate how external stigmatizing information affects an individual's self-stigma, a follow-up approach could be taken in prospective studies so as to provide an in-depth analysis of the relationship between the two.

It was revealed that the total SLS score and the dimension scores were significantly and positively correlated with the scores of the validity scale instrument. In other words, chronic disease patients with high stigma of loneliness tend to exhibit higher levels of psychological rigidity, concern about disease, and loneliness, and worse mental health. SLS also undermines patients' interpersonal interactions and increases levels of social anxiety, social phobia, and self-concealment.

The results of this study not only show that SLS has good criterion validity, but also extends the progressive model of self-stigma [16]. The progressive model of self-stigma emphasizes that an individual's identification with and application of stigmatizing information can lead to negative psychological outcomes. The present study suggests that stigma of loneliness has a negative impact on patients' perception patterns, disease process, mental health, and social interactions. In addition, the results of incremental validity analyses indicated that the stigma of loneliness is a psychological construct distinct from loneliness. Loneliness is a negative psychological experience due to the fact that the quantity or quality of interpersonal relationships does not meet an individual's expectations [72]. Stigma of loneliness, on the other hand, is a social evaluation of loneliness and how individuals perceive and comment on loneliness.

In addition, it was found that hospitalized patients had significantly higher SLS scores than outpatients. Compared with outpatients, hospitalized patients have a higher severity of illness, suffer more pronounced psychological stress, and are subject to more severe depletion of psychological resources. Interpersonal relationships and social support, as a valuable resource, can help individuals better cope with the negative effects of disease [73]. To avoid continued loss of psychological resources, hospitalized patients tend to be more sensitive, worried and rejected by loneliness and have a higher

demand for social support [74]. Therefore, stigmatized evaluations of loneliness are more severe among hospitalized patients.

This study maintains a certain value. By drawing on the existing literature, this study is basically the first to analyze the psychometric properties of SLS in a patient population. At present, stigma of loneliness has been studied mainly among college students and adults in the community, and no study has specifically explored the stigma of loneliness in patients with chronic illnesses [10]. Furthermore, there is a lack of scales for assessing stigma of loneliness in patients with chronic illnesses in clinical practice and empirical studies. This study can provide a usable measurement tool for the development of relevant empirical research.

In addition, the analysis of the criterion validity can contribute to a further understanding of the implications and detriments of stigma of loneliness. Loneliness is prevalent in different countries as well as in different populations, especially in the patient population [21]. Patients' loneliness and mental health can threaten all aspects of disease treatment. The results of this study suggest that intervening on stigma of loneliness in patients with chronic diseases is helpful in reducing loneliness, decreasing fear and worry about the disease, and improving mental health. Therefore, this study may not only provide instrumental support for evaluating the effectiveness of stigma of loneliness interventions, but also provide new perspectives for improving patients' mental health.

Limitations and future research

This study has some limitations that need to be addressed in future research. First, the current study did not take a strictly random sampling approach and suffers from underrepresentation of participants, which in turn might reduce the applicability of the conclusions. For instance, the number of rural, ethnic minority, and hospitalized patients accounted for 26.42%, 37.78%, and 10.65% of the total number of patients, respectively. In contrast, the place of residence, ethnic culture and severity of disease are potential influential factors of stigma of loneliness in patients with chronic diseases [75]. In this regard, the applicability of SLS in populations of chronically ill patients with different sociodemographic characteristics could be further analyzed in future studies.

Second, compared to college students, patients with chronic illness exhibit unique characteristics in terms of the sources, extent, and consequences, as well as their attitudes and evaluations toward loneliness. This study only examined the reliability and validity of the SLS among patients with chronic illness without developing new items, which may limit the scale's effectiveness. In future research, qualitative methods could be employed to explore the connotations and dimensions of stigma of loneliness within the chronic patient population and to develop specialized assessment tools. Third, this study did not take into account the effects of the course of disease, symptom severity, duration of illness and impairment of body functioning on SLS in chronically ill patients. In prospective studies, the reliability of SLS could be further examined in populations of patients with different types of chronic diseases and at different stages of disease onset.

Fourth, in collectivist societies such as China, where interpersonal relationships are highly valued, family members often exhibit mutual dependence and close emotional bonds. Family members can provide patients with emotional, financial, and practical assistance, which not only helps reduce feelings of loneliness but also holds positive value in mitigating their stigma of loneliness. However, this study did not delve deeply into the impact of family relationships and social support on stigma of loneliness among patients with stigma of chronic illness, which may hinder the accurate interpretation of the antecedent and outcome variables related to stigma of loneliness in this population.

In future research, it would be worthwhile exploring the influence of family factors on stigma of loneliness across different cultural contexts, as well as to further validate the scale's effectiveness among patients with chronic illness who have specific family structures, such as those who are widowed or living alone. Fifth, the current study did not examine the retest reliability of SLS to determine whether SLS is stable across time. A more comprehensive assessment of the psychometric properties of the SLS in patients with chronic diseases, such as retest reliability and empirical validity, is needed in future studies.

Conclusions

In the present study, the psychometric characteristics of the SLS were analyzed in patients with chronic diseases. The SLS revealed favorable reliability and validity in this population and was consistent with the original scale in terms of the number of items and the division of dimensions. These findings indicate that the SLS is a valid tool for assessing stigma of loneliness in patients with chronic diseases. In addition, it was found that stigma of loneliness was higher in males and inpatients than in females and outpatients. In future studies, SLS can be adopted to help figure out the existing situation of stigma of loneliness, its influencing factors, and consequences in patients with chronic diseases. On top of that, the SLS can also serve as a tool for assessing the effectiveness of interventions.

Abbreviations

SLS	Stigma of loneliness scale
SSL	Self-Stigma of Loneliness
SD	Standard deviance
PSL	Public Stigma of Loneliness
ULS-8	UCLA loneliness scale;
BIPQ	Brief Illness Perception Questionnaire
SCS	Self-concealment scale
SIAS	Social interaction anxiety scale
SPS	Social phobia scale
K10	Kessler psychological distress scale
AAQ-II	Acceptance and Action Questionnaire-Second Edition
ACT	Acceptance and commitment therapy
EFA	Exploratory factor analysis
CFA	Confirmatory factor analysis
RMSEA	Root mean square error of approximation
CFI	Comparative fit index
IFI	Incremental fit index
TLI	Tucker-lewis index
PNFI	Parsimonious normed fit index
PCFI	Parsimonious comparative fit index
SRMR	Standardized root mean square residual
HTMT	Heterotrait-monotrait ratio
CR	Composite reliability
AVE	Average variance extracted
MaxR(H)	Maximum reliability
M1	Configural invariance model
M2	Weak Invariance model
M3	Strong Invariance model
M4	Strict Invariance model

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Author contributions
ZF, XS, YL, HC, and HW conceived and designed the study. ZF, XS, HW and YL are responsible for data collection and analysis. ZF, XS, and HW contributed to manuscript preparation and revision.

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Data availability
The data are not publicly available due to privacy or ethical restrictions. If there is a reasonable request, it can be obtained from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study followed Helsinki Declaration, and the research was approved by the Ethics Committee of Jilin International Studies University (JY202211003). All participants received informed consent to participate in this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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