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Self-concealment scale (SCS) in middle-aged people: psychometric features and cross-age equivalence test

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Abstract

Background Individuals' concealment of negative information and privacy may lead to impaired social interactions and threatened health conditions. This study aimed to investigate the effectiveness of the Self-Concealment Scale (SCS) in the middle-aged Chinese population and to examine the equivalence of the SCS among different age groups.

Methods The current research adopted the SCS, Distress Disclosure Index (DDI), Revised Cheek and Buss Shyness Scale (RCBS), Social Interaction Anxiety Scale (SIAS), Social Phobia Scale (SPS), UCLA Loneliness Scale (ULS-8), and Kessler Psychological Distress Scale (K10) to survey 1124 middle-aged people. To explore the factor structure of the SCS, the study employed exploratory factor analysis and confirmatory factor analysis. The reliability of the SCS was measured based on Cronbach's α coefficients, McDonald's Omega coefficients, and split-half reliability. Correlation analysis was applied to examine the relationship between SCS and RCBS, SIAS, SPS, ULS-8, and K10. Moreover, this study recruited 1458 emerging adults and 1104 older adults to identify the cross-age invariance of the SCS.

Results Exploratory factor analysis of the middle aged adults' data supported a single factor model. The factor loadings of SCS items ranged from 0.62 to 0.73, the commonality ranged from 0.39 to 0.53, and the single-factor model fitted well. The scale showed a Cronbach's α coefficient value of 0.895, McDonald's Omega coefficient of 0.893, and a split-half reliability coefficient value of 0.861. In addition, the SCS demonstrated invariance in emerging adults, middle-aged adults, and older adults. Further analysis showed that the scores of the SCS ($F = 3.55, p = 0.029$) among emerging adults ($M = 26.43, SD = 7.96$) were significantly higher than among middle-aged ($M = 25.77, SD = 7.79$), and older cohort ($M = 25.69, SD = 7.91$).

Conclusion The SCS revealed favorable psychometric characteristics among the middle-aged Chinese population. The degree of self-concealment among emerging adults was higher than that of middle-aged and older people.

Keywords Middle-aged people, Self-concealment, Reliability, Validity, Equivalence

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Introduction

Self-concealment is a common and well-known human experience that anyone who has ever suffered from embarrassment, unpleasantness, or pain is aware of it. However, individuals significantly differ in their feeling of self-concealment. This displays as different levels of concealment of personal information [1]. Self-concealment is perceived as a relatively stable personality trait in that individuals are consciously inclined to conceal painful memories, traumatic experiences, or negative emotions [2]. What constitutes self-concealment is made up of different components, including a tendency to keep secrets, reluctance to share agonizing details with others, and concerns about privacy breaches [3].

Researchers, hitherto, have developed several scales to assess the construct of self-concealment. For instance, Larson and Chastain developed the 10-item Self-Concealment Scale (SCS) based on a systematic elaboration of the concept of self-concealment and related theories [2]. It was found that the SCS could serve as a valid tool for assessing an individual's general self-concealment tendency due to its favorable psychometric characteristics. Moreover, the study further highlighted that although self-concealment and self-disclosure are correlated to a certain extent, they do not share an identical psychological structure. In ensuing related studies, researchers also examined the validity of the SCS several times among people characterized by diverse countries, ages, and occupations [7]. Scholars have adopted the SCS to measure self-concealment in their studies among Japanese, Nigerian, Asian, and African-American populations [4–7]. At present, the SCS has become the most widely used scale for evaluating self-concealment.

Although the SCS is developed based on U.S. residents, it also possesses certain cross-cultural applicability. The other language versions of the SCS still demonstrated good reliability and validity, i.e., the Turkish version and the Chilean version [8, 9]. In addition, prospective quantitative and cross-cultural comparative studies of self-concealment among Chinese people require a valid assessment tool. To this end, Chinese scholars have attempted to translate the English version of the SCS into Chinese and to conduct reliability and validity tests. In particular, Wang revised the Chinese version of the SCS for the first time in a population of secondary school students [10], which concluded that the Chinese version was consistent with the original scale in terms of the number of items and the dimensions, and demonstrated favorable internal consistency reliability and split-half reliability. Moreover, Fan et al. re-verified the validity of the SCS in the Chinese older population [11]. The above two studies indicate that the SCS is applicable in the Chinese social context.

Although the SCS has been employed to explore the characteristics, detrimental effects, and the influencing factors of self-concealment among middle-aged Chinese adults [12, 13], the psychometric properties of the SCS in the Chinese middle-aged population are still speculative. The original version of the scale was developed mainly based on middle-aged adults in different occupations, such as nurses, physical therapists, social workers, and volunteers in social service agencies [3]. Two existing studies on the psychometrics of the Chinese version of the SCS, however, were only conducted in adolescent and older adult populations, not involving middle-aged adults.

Middle-aged people normally represent the nucleus of a family and the main financial contributor. Not only do they deal with the pressure of work, but also they bear the family responsibilities of raising and educating children and supporting parents. This group of people frequently suffer from mounting pressure from work and family, especially in the modern industrialized society [14]. As emphasized by psychologists, people's disclosure of their negative feelings, depressed thoughts, and intense sorrow is with the intention of accumulating social support and reducing psychological distress [15]. However, middle-aged adults may resort to hide painful feelings and negative messages with the purpose of protecting self-esteem and avoiding disappointment, contempt, and irritation from others [16]. In addition, individuals who fear public exposure of painful matters may lead to negative effect on others or impedance in problem-solving may tend to conceal themselves [17].

Therefore, this study, while following the psychometric requirements, was designed to examine the applicability of the Chinese version of the SCS in the middle-aged population, to provide a valid tool for processing related studies. Furthermore, as is apparent in available literature, no studies have examined the cross-age consistency of the SCS. The measured equivalence of the scale in different cohorts is a prerequisite for variance analyses. Therefore, the study further examined the cross-cohort consistency of the SCS in emerging adults, middle-aged adults, and older adults, analyzing age differences.

To examine the criterion validity of the SCS, the current study included the Distress Disclosure Index (DDI), Kessler Psychological Distress Scale (K10), Revised Cheek and Buss Shyness Scale (RCBS), Short Forms of the Social Interaction Anxiety Scale (SIAS), and the Social Interaction Anxiety Scale (SIAS). Self-concealment can induce negative emotional experiences that directly or indirectly threaten an individual's health and well-being [18]. Cruddas et al. found that self-concealment was significantly and positively associated with low self-disclosure, negative social comparison, anxiety, depression, and stress [19]. In addition, the conservation

of resources theory (COR) suggests that resources are highly valued in human survival and development and that people are inclined to strive to retain and maintain existing resources and continue to acquire and cultivate new resources [20]. If individuals fail to effectively prevent resource depletion or obtain beneficial resources promptly, a loss spiral will be formed and poses a serious threat to mental health [21]. Self-concealment is a stressor that can lead to ongoing resource depletion. Concurrently, self-concealment also impedes the acquisition of resources by diminishing an individual's willingness to express and reducing the opportunity to acquire assistance and obtain social support [22]. Therefore, self-concealment may be significantly and negatively associated with self-disclosure and mental health status.

Self-concealment has a destructive effect on the maintenance and development of interpersonal and intimate relationships [23]. According to the Social Anxiety Cognitive Model, individuals with high social anxiety tend to anticipate others' negative responses towards themselves and internalized self-protection behavior patterns i.e. concealment and avoidance, experiencing intense loneliness [24]. It is evident that self-concealment manifests itself as a predictor of social anxiety, social phobia, loneliness, and low self-esteem [25]. In Akdoğan et al.'s study, it was found that self-concealment and loneliness play a mediating role in the effect of low self-esteem on well-being [26]. Thus, self-concealment may be significantly and positively associated with social anxiety, social phobia, loneliness, and shyness.

In the wake of the discussion mentioned above, this study hypothesized that the SCS would exhibit favorable reliability and validity in the middle-aged Chinese population, which can be used as a valid instrument to assess self-concealment tendency. Moreover, it further hypothesized that the SCS total score would be significantly positively correlated with the K10, RCBS, SIAS, SPS, and ULS-8 total scores and that the SCS total score would be significantly negatively correlated with the DDI total score. Another hypothesis was that the SCS had measurement equivalence in diverse age groups.

Method

Procedure and participants

No consensus has been reached by different researchers on the criteria used to classify the age ranges of emerging adults, middle-aged people, and older people. In a review study, it was noted that the majority of researchers cited 35 to 65 years of age and 40 to 60 years of age as the two most widely used criteria for classifying the age range of middle-aged people [27]. Moreover, the National Bureau of Statistics of China classifies the population aged 65 and above as older adults. Therefore, this study divides the population aged 34 and below into emerging adults,

the population aged 35 to 64 into middle-aged people, and the population aged 65 and above into older people.

Recruitment of middle-aged and older people was carried out using convenience sampling and snowball sampling. The survey was conducted by systematically trained students who visited their home communities or rural areas during holidays. The research was based on a one-to-one basis and participants completed the responses independently after obtaining informed consent. In addition, at the end of the survey, the respondents would recommend potential participants to expand the scope of the survey. It's worth noting that the data for older adults in this study consisted of two parts. First, data from older adults obtained in the previous study was included, totaling 1085 people [11], which means that the current study included former research data. Second, in this survey, 19 respondents who are over 65 years old were not deleted but added to the data for the older cohort. The discrepancy from previous studies on self-concealment among older Chinese people is that the current study examined the effectiveness of SCS in the middle-aged population, and the equivalence and variance of SCS in the three populations of emerging, middle-aged, and older adults. Previous findings underpin the actualization of the current study. Therefore, there are significant differences between the two studies in terms of the targeted population and corresponding conclusions.

In the study, convenience sampling was adopted to collect data from emerging adults by distributing questionnaires to undergraduate and postgraduate students in three universities. The respondents consisted of undergraduate and graduate students majoring in medicine, nursing, education, and language-related fields. Before starting the survey, the investigators explained in detail the purpose, confidentiality, anonymity, and voluntary nature of the survey to different age groups. Only after obtaining informed consent from the respondents did the survey begin. The study followed the Declaration of Helsinki and was approved by the Ethics Committee of Jilin International Studies University (approval number: JY202211003). There was a total of 3686 valid data obtained for the study (see Table 1). Among them, there were 1458 emerging adults, 1124 middle-aged people, and 1104 older people.

Instrument

Self-concealment scale (SCS)

There are 10 items comprising the SCS, which is structured as a one-dimensional scale [3]. Item example "If I shared all my secrets with my friends, they'd like me less." The scale is rated on a 5-point scale ranging from 1 "strongly disagree" to 5 "strongly agree". The scale is rated on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree". All items are positively scored. The

Table 1 Socio-demographic characteristics

	Emerging Adults (N=1458)		Middle-aged Adults (N=1124)		Older Adults (N=1104)	
	N	%	N	%	N	%
Gender						
Male	434	29.77	523	46.53	532	48.19
Female	1024	70.23	601	53.47	572	51.81
Age (Mean, SD)	21.74	(3.10)	46.68	(4.54)	74.05	(5.49)
Learning Phase						
Graduate student	469	32.17	-	-	-	-
Undergraduate	989	67.83	-	-	-	-
Education						
Bachelor's degree & above	-	-	217	19.31	44	3.99
College	-	-	148	13.17	39	3.53
High school or technical secondary school	-	-	285	25.36	139	12.59
Junior high school	-	-	331	29.45	281	25.45
Elementary school	-	-	143	12.72	601	54.44
Marital status						
Unmarried	1421	97.46	40	3.56	9	0.82
Married	37	2.54	1072	89.77	984	89.13
Divorced or widowed	0	0	12	1.07	111	10.05
Ethnic group						
Han majority	1323	90.74	1009	89.77	1004	90.94
Ethnic minority	135	9.26	115	10.23	100	9.06
Only child or not						
Only Child	741	50.82	287	25.53	171	15.49
Non-only Child	717	49.18	837	74.47	933	84.51

higher the total score, the higher the tendency of the individual to hide his/her negative feelings, thoughts, and information from others.

Distress disclosure index (DDI)

To use the DDI to assess an individual's propensity to conceal psychological distress [28]. The scale consists of 12 items and is scored on a 5-point scale. An example of an item is "When I am in a bad mood, I talk about it with my friends." where items 2, 4, 5, 8, 9, and 10 are reverse scored. The higher the total score, the stronger the individual's willingness to reveal psychological distress. The Cronbach's alpha coefficient for the scale in this study was 0.83.

Revised cheek and buss shyness scale (RCBS)

The level of shyness in individuals was measured by the RCBS [29]. The scale consists of 13 items and is scored on a 5-point scale. An example of an item is "If I shared all my secrets with my friends, they'd like me less." Items 3, 6, 9, and 12 are reverse scored, and the rest are positive scored. The higher the total score, the higher the level of shyness experienced by the individual in interpersonal interactions. The Cronbach's α coefficient for the scale in this study was 0.84.

Short forms of the social interaction anxiety scale (SIAS)

Social interaction anxiety and social phobia are the two dimensions that make up social anxiety. The SIAS consists of 6 items scored on a 5-point scale [30]. Take "Nervous mixing with people when don't know well." as an example, each item is positively scored. The higher the total score, the higher the level of anxiety experienced by the individual in social interactions. The Cronbach's α coefficient for the scale in this study was 0.89.

Short forms of the social phobia scale (SPS)

The social phobia is one of the dimensions that make up social anxiety. The SPS consists of 6 items scored on a 5-point scale [30]. An item example is "Worry head will shake or nod in front of other people". Each item is positively scored. The higher the total score, the higher the individual's fear of social interaction. The Cronbach's α coefficient for the scale in this study was 0.90.

UCLA loneliness scale (ULS-8)

The ULS-8 is a shortened version of the ULS-20, and the Chinese version of the ULS-8 has demonstrated good reliability and validity [31]. The ULS-8 consists of 8 items and is scored on a 4-point scale. An item example is "People are around me but not with me." Among them, items 3 and 6 are reverse-scoring questions. The higher the total score, the stronger the perceived loneliness of

the individual. The Cronbach’s α coefficient for the scale in this study was 0.79.

Kessler psychological distress scale (K10)

The K10 is widely recognized as a tool for assessing the mental health status of people of all ages [32]. The scale consists of 10 items rated on a 5-point scale. For example, the item “About how often did you feel so restless you could not sit still?” is positively scored. The higher the total score, the more psychological distress the individual experiences and the worse the mental health status. The Cronbach’s α coefficient for the scale in this study was 0.93.

Statistical analysis

To examine the differentiation of the items, the study undertook an independent samples t-test to analyze the differences between the items in the high and low subgroups. In this case, the top 27% of the total score was defined as a high subgroup, and the bottom 27% was defined as a low subgroup. Moreover, to examine the homogeneity of the items, the study utilized the item-total correlation and Cronbach’s α coefficient test. If the correlation coefficient between the items and the total score is lower than 0.40, or if there is an increase in the Cronbach’s α coefficient value of the scale after the deletion of an item, then it means that the homogeneity is poor and should be deleted [33]. Based on previous studies, the data were randomly divided into two groups, one group of data for exploratory factor analysis ($n=562$) and the other group of data for confirmatory factor analysis ($n=562$) [34]. In exploratory factor analysis, the maximum likelihood method was employed for factor extraction. Statisticians recommend the orthogonal rotation method when it is assumed or found that the items are not correlated, while oblique rotation methods should be used when there is a correlation between the items.

Since there is a correlation among the items, this study conducted oblique rotation using the Promax method (oblique rotation) [35].

For validity testing, the study conducted confirmatory factor analysis, and criterion-related validity. In confirmatory analysis being estimated by maximum likelihood, the criterion for model fitting well include that $\chi^2/df < 3$, RMSEA < 0.08 , SRMR < 0.05 , CFI, IFI, TLI > 0.90 , PNFI, PCFI > 0.50 [36]. As to the reliability test, Cronbach’s α coefficient value, McDonald’s Omega coefficient, and the split-half reliability value of the SCS were calculated. If these are greater than 0.70, the SCS has good reliability [37]. To measure the equivalence of SCS across gender and age groups, the study compared four nested models: Configural Invariance model (M1), Weak Invariance model (M2), Strong Invariance model (M3), and Strict Invariance model (M4) [38]. Compare the difference in CFI and RMSEA between M2 and M1, M3 and M2, and M4 and M3 in turn. If both ΔCFI and $\Delta RMSEA$ are less than 0.01, then equivalence holds.

Results

Item analysis

The results of the item analysis showed (see Table 2) that the scores of the items were significantly higher in the high subgroups than in the low subgroups ($t=13.67-18.93$), and the values of the correlation coefficients of the items with the total scores ranged from 0.68 to 0.75. Furthermore, the Cronbach’s α coefficient value for the SCS was 0.895. After deleting any of the items, the Cronbach’s α coefficient values for the scale ranged from 0.882 to 0.887. During the item analysis phase, all data met the criteria for inclusion and none of the items were deleted.

Exploratory factor analysis

Before conducting exploratory factor analysis, the KMO value of SCS was examined in the study. The results

Table 2 Item analysis results of SCS

Item	Sample (N=1124)		Low subgroup(N=303)		High subgroup(N=303)		t value	Correlation Coefficients	Cronbach’s α coefficient test
	M	SD	M	SD	M	SD			
Item 1	2.67	1.15	1.55	0.67	3.66	0.84	33.99***	0.74***	0.884
Item 2	2.32	0.99	1.52	0.62	3.09	0.97	23.72***	0.68***	0.887
Item 3	2.81	1.16	1.76	0.84	3.71	0.87	28.19***	0.69***	0.887
Item 4	2.36	1.03	1.49	0.58	3.19	0.96	26.41***	0.70***	0.886
Item 5	2.72	1.13	1.67	0.80	3.62	0.82	29.66***	0.69***	0.887
Item 6	2.53	1.09	1.52	0.56	3.52	0.88	33.19***	0.75***	0.883
Item 7	2.64	1.11	1.62	0.71	3.61	0.85	31.17***	0.74***	0.883
Item 8	2.68	1.11	1.64	0.67	3.68	0.82	33.65***	0.75***	0.882
Item 9	2.45	1.05	1.50	0.58	3.38	0.92	30.23***	0.75***	0.882
Item 10	2.59	1.10	1.63	0.72	3.47	0.96	26.70***	0.69***	0.887

Note. *** $p < 0.001$

Abbreviations: M, Mean; SD, Standard Deviation

Table 3 Results of exploratory factor analysis of SCS (N=1124)

Items	Factor loading	Communality
1. I have an important secret that I haven't shared with anyone.	0.65	0.42
2. If I shared all my secrets with my friends, they'd like me less.	0.62	0.39
3. There are lots of things about me that I keep to myself.	0.63	0.40
4. Some of my secrets have really tormented me.	0.63	0.40
5. When something bad happens to me, I tend to keep it to myself.	0.69	0.48
6. I'm often afraid I'll reveal something I don't want to.	0.71	0.51
7. Telling a secret often backfires and I wish I hadn't told it.	0.71	0.50
8. I have a secret that is so private I would lie if anybody asked me about it.	0.73	0.53
9. My secrets are too embarrassing to share with others.	0.71	0.51
10. I have negative thoughts about myself that I never share with anyone.	0.66	0.44

Table 4 Criterion validity test for SCS (N=1124)

	1	2	3	4	5	6	7
1.SCS	-						
2.DDI	0.30***	-					
3.RCBS	0.45***	-0.30***	-				
4.SIAS	0.54***	-0.26***	0.69***	-			
5.SPS	0.51***	-0.28***	0.71***	0.85***	-		
6.ULS-8	0.39***	-0.34***	0.56***	0.58***	0.61***	-	
7.K10	0.55***	-0.31***	0.57***	0.67***	0.70***	0.66***	-
Mean	25.76	38.75	31.77	11.39	15.21	15.55	21.89
SD	7.83	7.60	8.23	4.18	5.80	4.19	7.70

Note. ***p*<0.01;

Abbreviations: SCS, Self-Concealment Scale; DDI, Distress Disclosure Index; RCBS, Revised Cheek and Buss Shyness Scale; SIAS, Social Interaction Anxiety Scale; SPS, Social Phobia Scale; ULS-8, UCLA Loneliness scale; K10, Kessler Psychological Distress Scale; SD, standard deviation

showed that the KMO value was 0.920 and Bartlett's sphericity test value was 2340.01 (df=45, *p*<0.001). The results indicated that the data met the prerequisites for exploratory factor analysis of SCS. In further exploratory factor analysis (see Table 3), only one factor with an eigenvalue greater than 1 explained 51.01% of the total variance. The results of the scree plot showed that it was appropriate to extract one factor. In addition, the factor loading values for all items ranged from 0.62 to 0.73 and the communality ranged from 0.39 to 0.53 (see Table 2). The factor loading values for all items were above 0.40 and the communality was above 0.30 [39]. Therefore, no items were removed from the exploratory factor analysis summary.

Confirmatory factor analysis

The results of the study showed that the fit indices of the one-factor model were $\chi^2/df=3.194$, SRMR=0.031, RMSEA=0.063, CFI=0.971, IFI=0.971, TLI=0.959, PNFI=0.682, PCFI=0.690.

The criterion-related validity test of SCS

Pearson correlation analysis was used to examine the criterion-related validity of the SCS. The results showed (see Table 4) that SCS was significantly and positively correlated with all validity criteria instruments (*r*=0.39

to 0.55), except for the significant negative correlation between SCS and DDI (*r*=-0.30).

Reliability test of SCS

The Cronbach's α coefficient value, McDonald's Omega coefficient, and split-half reliability were included as indicators of SCS reliability. The results showed that the Cronbach's α coefficient value of SCS was 0.895, McDonald's Omega coefficient was 0.893, and the split-half reliability value was 0.861, all of which were higher than the standard of 0.70.

Equivalence test and analysis of variance of SCS in different age groups

In the four models constructed in this study, the Configural Invariance model (M1), Weak Invariance model (M2), Strong Invariance model (M3), and Strict Invariance model (M4), all the fit indices were good, except for the χ^2/df which was higher than 3 (see Table 5). This result fulfills the prerequisites for performing the test of equivalence. In addition, ΔCFI (-0.008 to -0.001) and $\Delta RMSEA$ (-0.002 to 0.003) were less than 0.01 in the comparisons between M2 and M1, M3 and M2, and M4 and M3. All four models were valid, and SCS was equivalent in different age groups.

On this basis, the study examined age differences in self-concealment. The results showed significant

Table 5 Results of equivalence test of SCS

Model	χ^2	χ^2/df	CFI	IFI	TLI	SRMR	RMSEA (90%CI)	Δ CFI	Δ RMSEA
M1	713.39	7.93	0.962	0.963	0.944	0.036	0.043 (0.040~0.046)		
M2	747.44	6.92	0.961	0.962	0.952	0.038	0.040 (0.037~0.043)	-0.001	-0.003
M3	899.10	7.02	0.953	0.964	0.951	0.038	0.040 (0.038~0.043)	-0.008	0.0003
M4	1018.16	6.44	0.948	0.948	0.956	0.041	0.038 (0.036~0.041)	-0.005	-0.002

Abbreviations: M1, Configural Invariance model; M2, Weak Invariance model; M3, Strong Invariance model; M4, Strict Invariance model

variations in self-concealment among emerging adults ($M=26.43$, $SD=7.96$), middle-aged adults ($M=25.77$, $SD=7.79$), and older adults ($M=25.69$, $SD=7.91$) ($F=3.55$, $p=0.029$). Post hoc test analysis revealed that self-concealment was significantly higher in emerging adults than in middle-aged ($p=0.034$) and older people ($p=0.018$), while the difference in self-concealment between middle-aged and older people was not significant ($p=0.810$).

Discussion

The objectives of this study were to analyze the psychometric characteristics of the Self-Concealment Scale (SCS) using data collected from a population of middle-aged Chinese adults. In addition, the study was conducted to analyze the cross-age invariance of the SCS by testing the equivalence of the scale across three samples: emerging adults, middle-aged adults, and older adults. The results of the analysis of the reliability, validity, and equivalence of the SCS were satisfactory. The findings suggest that the Chinese version of the SCS is concise, reliable, and valid, which can be used to assess self-concealment tendencies in middle-aged adults.

Factor structure analysis

The study first examined the quality of the SCS items. Item analyses showed that all items measured the same construct and discriminated well between subjects with different levels of self-concealment. In this regard, the study retained all the items for factor analysis. The findings of the exploratory factor analysis and the confirmatory factor analysis supported the idea that the SCS is a unidimensional construct. The SCS was found to have a unidimensional structure in the English version, the Turkish version, and the Chinese version of the scale [3, 8, 10]. In terms of the way the scale is divided into dimensions and the number of entries, the present study concluded that it is consistent with previous studies.

However, notably, in Larson and Chastain's definition of self-concealment, it is considered not as a unidimensional structure, but as a multidimensional structure consisting of three components [3]. Furthermore, in the

Working Model proposed by Larson et al., it is stated that self-concealment is a complex trait-like motivational construct and insecure attachments, trauma incidence, and social-evaluative concerns and social-evaluative concerns are its potential precursors [2]. Therefore, it is unclear whether a unidimensional construct is optimal for the SCS and whether the SCS reflects the full range of self-concealment. Moreover, the scale only assessed the individual's propensity for self-concealment and did not address the antecedent and outcome variables of self-concealment. More empirical evidence is needed to validate the dimensional structure of the SCS more prudently in the future. Concurrently, researchers may also consider revising the SCS again by incorporating the latest research findings on self-concealment. By modifying, deleting, and adding items, the scale items correspond more to the characteristics of contemporary middle-aged adults and also respond more comprehensively to the definition of self-concealment.

Criterion validity analysis

The results of the criterion validity analyses demonstrated that self-concealment can affect an individual's social interactions and psychological well-being. Specifically, individuals with high self-concealment tended to have higher levels of shyness, loneliness, social anxiety, and social phobia, were less likely to reveal their distress to others, and had worse mental health. Self-concealment has been found to lead to negative outcomes such as increased psychological distress, deteriorated mental health, and disrupted interpersonal interactions in most previous studies [40–42]. Moreover, in the Working Model of self-concealment, it is also pointed out that the most direct harm caused by self-concealment is the impact on the individual's interpersonal behavior and mental health [2]. As the result of this study, the Working Model is validated and expanded. In addition, grounded in resource preservation theory, research has viewed self-concealment as a stressor that is considered to have a destructive effect on an individual's social support, which can result in both the depletion of resources and the acquisition of effective resources [43]. The preliminary

validation of this viewpoint by the findings of the present study contributes to a better understanding of how self-concealment affects mental health from the perspective of resource preservation theory.

Cross-group invariance analysis

The present study is the first to examine the measurement equivalence of the SCS across age groups. The fact that the scale has equivalence across cohorts is a prerequisite for the analysis of variance between group comparisons. The study found that SCS has measurement equivalence across young, middle-aged, and older age groups. On this basis, the study further examined age differences in self-concealment. It was found that middle-aged and older adults had a significantly higher tendency to conceal than emerging adults. Previous studies have found that individuals of different ages do not conceal different types of information to the same extent [44]. For instance, O'Connor et al. found that individuals' concealment of COVID-19 information was decreasing with increasing age, and their attitudes toward concealment were more negative [45]. The present study reached discrepant conclusions. The reason for this may be analyzed because the present study mainly examined individuals' general tendency to self-conceal rather than concealment of specific information. Compared to emerging adults, middle-aged and older adults are more concerned and worried about the potential negative consequences of information disclosure, fearing that it will affect their image [46]. Therefore, middle-aged and older adults have a higher propensity for self-concealment.

Some theoretical significance is attached to this study. The study analyzed the reliability and validity of the SCS in a middle-aged Chinese population, which provided empirical evidence for evaluating the psychometric characteristics of the Chinese version of the scale. At present, when researchers revise the different language versions of the SCS, it is mainly done based on the youth population. As can be seen from the analysis of the existing literature, this study is the first to examine the validity of the SCS in a non-Western middle-aged population. In addition, the findings enrich the literature on self-concealment. Previous studies have mainly explored the negative effects of self-concealment on emerging adults and older adults, while less attention has been paid to middle-aged adults [47, 48]. Moreover, the study's analysis of the criterion validity not only helps to better understand the effects of self-concealment on the interpersonal and psychological health of middle-aged adults but also is an effective expansion of the theory of resource preservation. The study views self-concealment as a stressor that can lead to the depletion of individual resources and impede the acquisition of valuable resources. The study introduces resource preservation theory to the field of

self-concealment to explain its harms, which provides new perspectives for related research. Notably, this study is the first to examine cross-cohort consistency in SCS among emerging adults, middle-aged adults, and older adults, which enriches and adds to the existing literature.

Strengths

The present study encompasses practical value. Self-concealment is prevalent for all ages and negatively affects individuals' wellbeing in the aspect of psychology, emotion, and behavior. The SCS represents an effective tool for assessing self-concealment in middle-aged adults, which can be applied to various areas of scientific research, mental health education, and psychotherapy. For concealing certain specific information, self-concealment is significantly higher in middle-aged adults than in other age groups [44]. In this regard, the SCS is suitable to identify and evaluate the self-concealment tendency of middle-aged people and to screen key populations in need of intervention. Furthermore, there is evidence that self-concealment adversely affects the establishment of the counseling relationship and therapeutic outcomes in psychotherapy [49]. In both family therapy and couples therapy, it is emphasized that visitors should be encouraged to disclose secrets with the aim of reducing self-concealment, thereby promoting intimacy [50]. Therefore, psychotherapists can employ the scale revised in this study to evaluate therapeutic outcomes.

Limitations and future research

Although the Chinese version of the Self-Concealment Scale (SCS) was found to encompass favorable applicability in the middle-aged population in this study. Nevertheless, some limitations may impact the reliability of the study's findings. First, the study did not adopt a strictly random sampling approach, but rather convenience sampling and snowball sampling. Limitations in the research design could reduce the representativeness of the samples and the accuracy of the findings. In prospective studies, on the one hand, a more rigorous sampling approach could be adopted; on the other hand, further testing of the validity of SCS could be considered among participants with different demographic characteristics, such as different places of residence, economic incomes, occupations, health statuses, ethnicities, and countries. Secondly, the study adopted a cross-sectional questionnaire which could not reflect the stability and validity of the scale across time.

Third, in the criterion validity test, we focused on the effects of self-concealment on individuals' interpersonal and psychological well-being. It has been noted that self-concealment is strongly associated with attachments, trauma incidence, social-evaluative concerns, emotion regulation, mindfulness, psychological flexibility,

help-seeking attitudes, and negative health behaviors [2]. To this end, a more comprehensive examination of the antecedent and outcome variables of SCS is required in future research. Fourth, the SCS was only used to measure an individual's general propensity for self-concealment and did not address what kind of information and content was being concealed. For instance, individuals may not conceal the information about sexual orientation, abuse experiences, illness, and negative evaluations of self to the same degree. Therefore, in ensuing research, self-concealment scales could be specifically designed to assess specific information.

Conclusion

As shown in the obvious study results, the Chinese version of the Self-Concealment Scale (SCS) was identified to be a reliable and valid scale for assessing the tendency to conceal painful information and negative feelings among middle-aged adults. Self-concealment is able to undermine interpersonal interactions, increase loneliness, and threaten mental health status. In addition, the SCS demonstrates measurement equivalence across age groups, facilitating the comparison of age differences. Considering that self-concealment is higher in middle-aged and older adults than in emerging adults, it is pivotal to improve the assessment, intervention, and research on self-concealment in those adults to minimize its potential harm. Therefore, the Chinese version of the SCS is suitable for large-scale investigations and studies of self-concealment in middle-aged adults.

Abbreviations

SCS	Self-Concealment Scale
SD	Standard Deviance
DDI	Distress Disclosure Index
ULS-8	UCLA Loneliness Scale
BIPOQ	Brief Illness Perception Questionnaire
RCBS	Revised Cheek and Buss Shyness Scale
SIAS	Social Interaction Anxiety Scale
SPS	Social Phobia Scale
ULS-8	UCLA Loneliness Scale
K10	Kessler Psychological Distress scale
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
M1	Configural Invariance Model
M2	Weak Invariance model
M3	Strong Invariance model
M4	Strict Invariance model

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Author contributions

ZF, XS, XH, and LL conceived and designed the study. ZF, XS, and XH are responsible for data collection. ZF, XS, XH, and LL provided statistical advice

on study design and participated in data analysis. ZF wrote the main content of the manuscript up. ZF and XS contributed to manuscript preparation and revision. LL contributes to the request for funding of the study. All authors read and approved the final manuscript.

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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 the 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 the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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