


RESEARCH ARTICLE



Reliability and validity of the Geriatric Self-Care Scale among Chinese older adults

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ABSTRACT

Background: Although the Geriatric Self-Care Scale (GSS) has been widely used in community investigations in China, its reliability and validity have yet to be analyzed.

Objectives: This study aimed to examine the reliability and validity of the GSS in community-dwelling Chinese older adults.

Methods: This prospective observational study included 29428 older adults. Content validity was analyzed using the Content Validity Index (CVI). Reliability analysis included internal consistency and test-retest reliability. Differences in participants who could live independently versus those who could not were analyzed for discriminant validity. The Barthel Index was used as the gold standard. Spearman's correlation and Receiver Operating Characteristic (ROC) analysis were used to assess convergent validity.

Results: The CVI for the GSS was 0.920, with CVI values of 1.000, 0.900, 1.000, 0.800 and 0.900. The Cronbach's alpha for the GSS was 0.869 (for all participants) and 0.867 (for participants aged ≥ 65 years) and the item Cronbach's alpha coefficients were all >0.8 . The Pearson and intraclass correlation coefficients for both the scale and each item were greater than 0.8. There were significant differences ($p < 0.05$) between participants who could live independently and those who could not. There were significant correlations ($p < 0.05$) between the GSS and Barthel Index for each item and the total score. ROC analysis revealed that all areas under the curve were greater than 0.8, with a sensitivity and specificity exceeding 0.8.

Conclusions: The GSS showed good reliability and validity among community-dwelling older adults in China.

Abbreviations: BADL: Basic Activities of Daily Living; AUC: Area Under Curve; BMI: Body Mass Index; CVI: Content Validity Index; GSS: Geriatric Self-Care Scale; ROC: Receiver Operating Characteristic

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1. Introduction


Ageing presents a challenge to public health due to strains on service demand versus resources [1]. In 2022, the global population of people aged ≥ 65 years exceeded 759 million, accounting for approximately 9.4% of the total population. By 2050, this number and proportion are projected to be over 1.6 billion and 16%, respectively [2]. Currently, the degree of ageing in China exceeds the global average. In 2023, the number of older residents in China reached 216.76

million, accounting for 15.4% of the total population [3]. Due to its large population base, China's ageing problem is considered quite serious.

Ageing increases the risk of chronic diseases and causes muscle strength and cognitive decline. This potentially affects their ability to perform basic activities of daily living (BADL) [4]. A decline in BADL can negatively impact the quality of life and mental health of older adults and increase the burden on their family members and society [5]. However, this process is

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usually insidious in its onset, slowly progressive, and difficult to perceive [6]. To take timely interventions to help affected individuals against potential challenges, it is crucial to assess BADL in older adults [7].

Currently, the Katz and Barthel indices are widely used to assess BADL [8]. The Katz Index assesses a person's ability to perform six basic self-care activities: bathing, dressing, toileting, transferring, continence and feeding. This tool is primarily designed for severely ill older patients and has been reported to lack sensitivity in mildly disabled populations in the Chinese context [9,10]. In contrast, the Barthel Index distinguishes between bowel and bladder control and includes grooming, mobility and stair climbing. It has been translated into multiple languages, and its cross-cultural adaptability has been validated in numerous studies [11]. Both the Barthel and Katz Index assessments are typically completed by healthcare professionals. Additionally, the Barthel Index includes 10 items, and the entire assessment takes approximately 5 min [12]. Given the substantial number of older individuals in China, the manpower and time consumption affect its general applicability [10].

To address these issues, the Geriatric Self-Care Scale (GSS) was developed and introduced by the Chinese Medical Academy [13]. It consists of five items: eating, grooming, dressing, toileting and mobility. Each item consists of four levels, with each assigned a different score. A higher total score indicates poorer BADL. Unlike the Barthel Index, the GSS is a self-administered questionnaire with each option described succinctly in a single sentence. Reduced text is expected to enhance accessibility and feasibility, thereby promoting more inclusive participation among a wider population facing common barriers to engaging in self-reported measures. Additionally, the scale includes fewer items than the Barthel Index, which can potentially reduce the time consumption. Given the global trend of population ageing, these minor adjustments are expected to save considerable manpower, material, and financial resources.

The GSS has been widely used in China and was adopted as a unified standard by the Standardization Administration of China in 2022 [14]. Nevertheless, due to the top-down promotion, there is still a need to analyze its reliability and validity. Therefore, this study was carried out with the objective to validate the GSS.

2. Methods

2.1. Study design

This prospective study followed the Helsinki Declaration and aimed to analyze the reliability and validity of the

GSS among community-dwelling older adults in mainland China. Before the investigation began, relevant authorities approved the study. This study was approved by the Ethics Committee of Zhengzhou University on 21 July 2022 (ZZUIRB2022-07). All individuals involved in the study provided written informed consent. The family members of participants suspected of having cognitive impairments were required to provide informed consent.

2.2. Subjects

This study was part of the 2022 Henan Province Community Physical Examination Program for Older Adults. In this program, community healthcare institutions invited all older individuals in Henan (≥ 60 years old) to undergo physical examination at the designated community healthcare facilities. The notification methods included phone calls, posters, home visits, and community outreach. Since the health information of older individuals is stored in the database, family members of those with cognitive impairments or mobility difficulties were notified to accompany the older adults for physical examination. Community staff (independent of this study) were also requested to assist older individuals who hoped to come but had personal issues such as mobility difficulties or cognitive impairments.

We divided Henan Province into five regions based on geographical location. Within each region, we randomly selected five county-level administrative regions, and within each selected county-level administrative region, we randomly selected one street/township as the study centre. At each centre, we used a convenience sampling method to enrol 2% of the older population as study participants. These selected candidates were informed about the study before they came. The questionnaire and study introduction were posted at the entrance of the community healthcare facilities, allowing older individuals to decide whether to participate in the study or only in the physical examination after reading the questionnaire and its introduction.

The inclusion criteria were as follows: (1) Aged ≥ 60 years. (2) Able to communicate and read in Chinese Mandarin. (3) Conscious. The exclusion criteria were as follows: (1) Uncooperative. (2) Severe mental disorders (e.g. psychotic disorders, delirium). (3) Individuals who have not resided continuously in mainland China for at least 2.5 years at the time of the survey.

2.3. Barthel Index

The Barthel Index is a tool for assessing BADL, first proposed by German psychiatrist Mahlon R. Barthel in 1965 [15]. It includes 10 items including feeding,

grooming, bathing, dressing, bowel control, bladder control, toilet use, transfers, mobility, and stairs. Scores are assigned based on the degree of independence and assistance required. The total score ranges from 0 to 100, with higher scores indicating greater independence. Generally, thresholds of 60 and 80 are commonly used to distinguish whether BADL are impaired.

2.4. Geriatric Self-Care Scale

The GSS was first proposed by the Chinese Medical Academy in 2015 and was adopted as a standard in China in 2022 [14]. Currently, the GSS is widely used in physical examinations, community surveys, and clinical research [16]. The GSS has been translated into English unofficially by this study for clarity, as shown in the Appendix. A higher total score indicates poorer BADL.

2.5. Procedures

In 2022, we conducted a pre-survey in a community in Zhengzhou to determine the approximate time required to complete the GSS. The selection criteria for the pre-survey and the formal investigation were the same. 236 participants were included, and the time taken to complete the GSS was 2 (1–4) min. At least 50 participants were required based on the sample size estimation. This study belonged to a large project. Therefore, far more participants were included. A formal investigation was conducted using on-site questionnaires. The invited participants were unaware of the topic until they temporarily consented to participate. The staff were allowed to explain the contents of the items to the participants and were trained before the study to ensure that the explanations did not lead participants in any way. When distributing the GSS questionnaire, the staff recorded the distribution timepoint on the front page of the questionnaire. After submission by each participant, the staff immediately conducted a preliminary check to ensure that the questionnaire was fully completed. The participants who submitted incomplete questionnaires were instructed to finish the study. If they refused, they were excluded and considered as failing to pass the quality control. Questionnaires that successfully passed quality control had the submission timepoint recorded by the staff to facilitate the subsequent analysis of the completion time. A double entry was used to ensure accuracy. All participants were required to complete the questionnaire within 5 min. Subsequently, all participants were instructed to undergo the Barthel Index assessment after a short rest. Assessors were rigorously trained before the study to ensure objectivity and

independence. After assessments, both assessors and participants were required to answer a question: Do you think the participant can take care of himself independently? If both the participant and the corresponding assessor chose 'yes', the participant was classified into the positive group. If both chose 'no', the participant was classified into the negative group. A follow-up was conducted 3 months after the initial survey, and 5296 participants were randomly invited to complete the GSS again. Any questions that arose during the completion of the questionnaire were answered on-site. Participants could choose to voluntarily participate in the survey or withdraw from the study without affecting others. Baseline information obtained through self-reporting or on-site measurements included: gender, age, resident type, ethnicity, educational level, marital status, Body mass index (BMI), smoking, and alcohol intake. We collaborated with local primary healthcare institutions. They were responsible for providing the participants' medical histories, including hypertension, type II diabetes, cerebrovascular diseases, kidney diseases, heart diseases, and eye diseases. Missing data were not included in the final analysis.

2.6. Statistical analysis

Continuous data following a normal distribution are presented as mean \pm standard deviation, whereas data following a skewed distribution are presented as medians and quartiles. Categorical data are presented as number of cases and percentages. Content validity was analyzed using the Content Validity Index (CVI). This study included 10 independent academics with over 5 years of background in geriatrics or public health. There were five levels in CVI scoring: Lv.5 indicated very relevant; Lv.4 indicated quite relevant; Lv.3 indicated somewhat relevant; Lv.2 indicated irrelevant and Lv.1 indicated irrelevant. The CVI for each item was (the number of professors who gave \geq Lv.3)/10. A CVI \geq 0.8 indicated good content validity [17]. Cronbach's α was used to analyze internal consistency. The Cronbach's α coefficient >0.8 indicated good internal consistency [18]. Pearson correlation and Intraclass Correlation Coefficient (ICC) two-way random effects model, single measures, and absolute agreement were used to analyze the test-retest reliability. An ICC >0.75 indicated high consistency [18]. Discriminant validity was assessed using two methods. First, we compared the GSS scores of the positive and negative groups. Based on the Barthel Index, the top 33% and bottom 33% of all the participants were selected. Their GSS scores were compared. Spearman's correlation analysis

was used to investigate convergent validity by comparing each item and the total score of the GSS versus the Barthel Index. Receiver Operating Characteristic (ROC) analysis was used with the GSS scores as the independent variable and cutoff points of 60 and 80 for the Barthel Index as the dependent variables. An Area Under Curve (AUC) > 0.7 was considered good [19]. A p -value < 0.05 was considered statistically significant and SPSS 21.0 was used for statistical analysis.

3. Results

3.1. Baseline information

A total of 35274 older adults participated in the physical examination program at the research centres. Among them, 297 were excluded due to compliance during the examination, 588 were excluded due to severe mental disorders, and 385 were excluded for not having resided for at least 2.5 years. Ultimately, 34004 participants met the inclusion criteria, among which 3712 older individuals declined to participate in the study. Totally, 30292 questionnaires were distributed and 29428 were ultimately included in the analysis, with an effective rate of 97.15%. Excluded cases either dropped out of the study midway ($n=727$), or failed to pass the quality control ($n=137$). A total of 5886 participants were randomly selected and invited to participate in the follow-up after 3 months. 5721 cases were included in the final analysis. The excluded participants either did not respond or declined the invitations. More than 80% of the participants completed the GSS in approximately 3 min, with over 95% finishing it within 5 min. There were 20973 participants aged 65 years and 3631 of them were included in the second test. Baseline information for all participants is shown in Table 1.

3.2. Content validity

The CVI was divided into five levels: A level ≥ 3 was considered acceptable. The CVI for scales was the average of the corresponding items. The CVI of the GSS was 0.920, and the CVI values of each item were 1.000, 0.900, 1.000, 0.800 and 0.900, respectively. This indicated good content validity.

3.3. Reliability

There were no significant differences at baseline between all participants and those who participated in the follow-up tests. For all participants, the Cronbach's alpha for the total GGS score was 0.869 for all

participants and 0.867 for those aged ≥ 65 years. The Cronbach's alpha did not increase after each item was deleted, all > 0.8. The correlation coefficient for the retest total score was 0.952 for all participants and 0.954 for those aged ≥ 65 years, and for each item, it was 0.833, 0.912, 0.903, 0.916 and 0.965 for all participants and 0.954, 0.837, 0.915, 0.901, 0.924 and 0.967 for those aged ≥ 65 year ($p < 0.001$). The ICCs for the total score and each item were all > 0.8, as shown in Table 2. The Basel index was 100.00 (95.00, 100.00) for all participants and 100.00 (90.00, 100.00) for those aged ≥ 65 years.

3.4. Discriminant validity

When a participant's answer to independent living matched that of the assessor, the participant was categorized into either the positive group (=yes) or negative group (=no). There were significant differences between the two groups in the total score ($p < 0.001$). Based on the Barthel Index, the top 33% and bottom 33% of the participants were selected. There were significant differences in the GSS scores ($p < 0.001$) for both all participants and those aged ≥ 65 years, as shown in Table 3.

3.5. Convergent validity

There were significant correlations (p all < 0.001) between the GSS and Barthel Index for each item and the total score. Each item and the total score of the Barthel Index showed correlation coefficients > 0.7 with the total score of the GSS, except for Bathing ($r = -0.696$), as shown in Table 4.

Participants were divided into two groups using cutoff points of 60 and 80 on the Barthel Index, and ROC analysis was conducted with the GSS score as the independent variable. When the cutoff point was 60 on the Barthel Index, the AUC was 0.914 for all participants and 0.845 for those aged ≥ 65 years. When the cutoff point was 80 on the Barthel Index, the AUC was 0.929 for all participants and 0.925 for those aged ≥ 65 years, as shown in Table 5.

4. Discussion

Screening for BADL contributes to accurate and timely intervention in older adults [20]. Since 2022, the Standardization Administration of China has been promoting the GSS nationwide [14]. Through a large-sample multicentre investigation, this study conducted reliability and validity analyses of the GSS,

Table 1. Baseline information.

Item	All participants (<i>n</i> =29428)	The follow-up participants (<i>n</i> =5721)	<i>p</i>
Gender [<i>n</i> (%)]			0.378
Male	13162 (44.7)	2595 (45.4)	
Female	16266 (55.3)	3126 (54.6)	
Age ($\bar{x} \pm s$)	73.3 \pm 6.7	73.2 \pm 9.8	0.342
Resident type [<i>n</i> (%)]			0.055
Urban	16956 (57.6)	3218 (56.3)	
Rural	12472 (42.4)	2503 (43.7)	
Ethnicity [<i>n</i> (%)]			0.162
Han	27122 (92.2)	5313 (92.9)	
Minority	2306 (7.8)	408 (7.1)	
Educational level [<i>n</i> (%)]			0.079
University and above	482 (1.6)	96 (1.7)	
Senior high school	1567 (5.4)	257 (4.5)	
Junior high school	14507 (49.3)	2841 (69.7)	
Primary school and lower	12872 (43.7)	2527 (44.1)	
Marital status [<i>n</i> (%)]			0.281
Married	21145 (71.9)	4155 (72.6)	
Divorced	2495 (8.4)	497 (8.7)	
Unmarried	1003 (3.4)	173 (3.0)	
Widowed	4785 (16.3)	896 (15.7)	
BMI [<i>n</i> (%)]			0.063
Underweight	3795 (12.9)	704 (12.3)	
Normal weight	14296 (48.6)	2882 (50.4)	
Overweight	10033 (34.1)	1873 (32.7)	
Obesity	1304 (4.4)	262 (4.6)	
Smoking [<i>n</i> (%)]			0.282
Yes	4982 (16.9)	996 (17.4)	
Quit	17735 (60.3)	3481 (60.9)	
Never	6711 (22.8)	1244 (21.7)	
Alcohol intake [<i>n</i> (%)]			0.074
Yes	9923 (33.7)	1958 (34.2)	
Quit	15124 (51.4)	2978 (52.1)	
Never	4381 (14.9)	785 (13.7)	
Hypertension [<i>n</i> (%)]			0.067
Yes	12163 (41.3)	2439 (42.6)	
No	17265 (58.7)	3282 (57.4)	
Type II diabetes [<i>n</i> (%)]			0.235
Yes	7233 (24.6)	1364 (23.8)	
No	22195 (75.4)	4357 (76.2)	
History of cerebrovascular diseases [<i>n</i> (%)]			0.076
Yes	3779 (12.8)	686 (12.0)	
No	25649 (87.2)	5035 (88.0)	
History of kidney diseases [<i>n</i> (%)]			0.087
Yes	672 (2.2)	152 (2.7)	
No	28756 (97.8)	5569 (97.3)	
History of heart diseases [<i>n</i> (%)]			0.115
Yes	1250 (4.3)	217 (3.8)	
No	28178 (95.7)	5504 (96.2)	
History of eye diseases [<i>n</i> (%)]			0.298
Yes	222 (0.8)	51 (0.9)	
No	29206 (99.2)	5670 (99.1)	

BMI was classified according to the consensus. Smoking: Smoking at least one cigarette per day for at least 4 days a week, continuously for over 6 months, was considered as Yes. Having smoked in the past but not for at least 6 months was considered Quit. Alcohol intake: Drinking alcohol at least once a day, for at least 4 days a week, continuously for over 6 months, was considered Yes. Having consumed alcohol in the past but not for at least 6 months was considered Quit.

BMI: body mass index.

using the Barthel Index as the gold standard. In geriatric medicine and public health, the popularization of this scale is expected to reduce resource consumption and enhance regional comparability.

Validity analysis indicates the extent to which a scale can precisely assess its target content. The GSS had a scale CVI of 0.920, which was above 0.8. All individual items had a CVI above 0.78. This indicated that the content validity of the scale was good. However, the CVI for the toileting item was only 0.8. The main reason was that some experts believed that the terms

for urination and defaecation differed across the regions. The use of a standardized term may be obscure for some users [21]. Therefore, especially in regions where dialects are widely used, it is recommended to adjust expressions for urination and defaecation according to local customs. A study on content validity in English indicated that the Barthel Index needs revisions in terms of language, clarity, content completeness, and appropriateness [22]. A comparative analysis has also reported there remains conceptual issues in the Katz Index [23]. Considering that the GSS was

Table 2. Reliability of the GSS.

All participants (<i>n</i> = 29428)				
Item	Cronbach' α	GSS scores	Test-retest reliability (<i>n</i> = 5721)	
			Pearson correlation coefficient	ICC (95%CI)
Total	0.869	0.00 (0.00, 2.00)	0.952***	0.975 (0.973, 0.976)
Eating	0.856 if deleted	0.00 (0.00, 0.00)	0.833***	0.898 (0.892, 0.903)
Grooming	0.822 if deleted	0.00 (0.00, 0.00)	0.912***	0.904 (0.821, 0.949)
Dressing	0.822 if deleted	0.00 (0.00, 0.00)	0.903***	0.951 (0.949, 0.954)
Toileting	0.841 if deleted	0.00 (0.00, 0.00)	0.916***	0.954 (0.952, 0.957)
Mobility	0.860 if deleted	0.00 (0.00, 1.00)	0.965***	0.982 (0.981, 0.983)
Participants aged 65 years and above (<i>n</i> = 20973)				
Item	Cronbach' α	GSS scores	Test-retest reliability (<i>n</i> = 3631)	
			Pearson correlation coefficient	ICC (95%CI)
Total	0.867	0.00 (0.00, 2.00)	0.954***	0.976 (0.974, 0.977)
Eating	0.855 if deleted	0.00 (0.00, 0.00)	0.837***	0.900 (0.893, 0.907)
Grooming	0.821 if deleted	0.00 (0.00, 1.00)	0.915***	0.953 (0.950, 0.956)
Dressing	0.819 if deleted	0.00 (0.00, 0.00)	0.901***	0.947 (0.943, 0.950)
Toileting	0.839 if deleted	0.00 (0.00, 0.00)	0.924***	0.959 (0.956, 0.962)
Mobility	0.857 if deleted	0.00 (0.00, 1.00)	0.967***	0.983 (0.982, 0.984)

****p* < 0.001.

ICC: Intraclass Correlation Coefficient; GSS: Geriatric Self-Care Scale; CI: Confidential Interval.

Table 3. Discriminant validity [M (*Q*₁, *Q*₃)].

All participants (<i>n</i> = 29428)			
Item	The positive group (<i>n</i> = 13740)	The negative group (<i>n</i> = 7798)	<i>p</i>
Total scores	0.00 (0.00, 0.00)	3.00 (1.00, 6.00)	<0.001***
Item	The top 33% participants (<i>n</i> = 9809)	The bottom 33% participants (<i>n</i> = 9809)	
Total scores	0.00 (0.00, 0.00)	3.00 (1.00, 5.00)	<0.001***
Participants aged 65 years and above (<i>n</i> = 20973)			
Item	The positive group (<i>n</i> = 8927)	The negative group (<i>n</i> = 5611)	<i>p</i>
Total scores	0.00 (0.00, 0.00)	4.00 (2.00, 10.00)	<0.001***
Item	The top 33% participants (<i>n</i> = 6991)	The bottom 33% participants (<i>n</i> = 6991)	
Total scores	0.00 (0.00, 0.00)	4.00 (2.00, 10.00)	<0.001***

****p* < 0.001.

developed in Chinese, and the developers share a linguistic and cultural background with the Chinese older population, this can reduce potential conceptual conflicts and enhance its applicability. However, it should be noted that the content validity was appraised only by academics and not by lay representatives, who are more important candidates in this domain.

The Cronbach's alpha in the GSS for all participants and those aged ≥ 65 years was both above 0.8, which is consistent with the reliability study of the Barthel Index reported by Thygesen [24]. If any item was deleted, the Cronbach's alpha coefficient of the scale decreased. This indicated that no item should be removed and the GSS had good internal consistency. We chose a 3-month interval to assess the test-retest reliability. This minimized bias caused by memory effects and ensured that there were no significant changes in participants' BADL. The GSS demonstrated satisfactory test-retest reliability. This study included older individuals from both urban and rural areas with

a wide disparity in educational levels. The high reliability of the GSS can be attributed to its concise and user-friendly design. In regions with a large older population or a shortage of medical personnel, the GSS might help reduce the burden on staff and hence improve the efficiency of resource allocation.

The GSS demonstrated significant differences between older adults with and without BADL disabilities. A previous study has shown that the Barthel Index has relatively high sensitivity and relatively low floor and ceiling effects and can well assess the BADL disability of the elderly [25]. In this regard, the GSS shares a common advantage with the Barthel Index. However, the Barthel Index has demonstrated high applicability and discrimination in stroke patients, suggesting that further research is needed for the GSS in this population [26]. This study employed two methods to analyze discriminant validity. The determination of the BADL was influenced by subjective perceptions and objective evaluations [27]. Therefore, in the first method, every participant and his/her assessor were required to evaluate BADL. A case was included in the analysis only when the assessor and participant held the same viewpoints. In the second method, we selected one-third of the participants with the highest and lowest Barthel Index scores for analysis. The results indicated that the GSS demonstrated good discriminant validity for both the methods. Therefore, the scale was considered effective in distinguishing older adults who could live independently from those who could not.

The Barthel Index was used as the gold standard to assess the convergent validity of the GSS. Significant correlations were observed between all items of the GSS and the Barthel Index. Additionally, the total

Table 4. Comparison between the GSS and Barthel Index.

GSS	Barthel Index										
	Total	Feeding	Grooming	Bathing	Dressing	Bowel control	Bladder control	Toilet use	Transfers	Mobility	Stairs
Total	−0.792***	−0.746***	−0.714***	−0.696***	−0.730***	−0.792***	−0.745***	−0.766***	0.794***	−0.813***	−0.759***
Eating	−0.729***	−0.823***	−0.577***	−0.512***	−0.559***	−0.493***	−0.568***	−0.471***	−0.680***	−0.676***	−0.571***
Grooming	−0.744***	−0.610***	−0.866***	−0.738***	−0.702***	−0.518***	−0.487***	−0.638***	−0.733***	−0.624***	−0.493***
Dressing	−0.673***	−0.600***	−0.719***	−0.761***	−0.834***	−0.532***	−0.552***	−0.495***	−0.582***	−0.681***	−0.506***
Toileting	−0.707***	−0.576***	−0.646***	−0.603***	−0.618***	−0.849***	−0.876***	−0.903***	−0.606***	−0.752***	−0.642***
Mobility	−0.688***	−0.456***	−0.635***	−0.652***	−0.597***	−0.711***	−0.734***	−0.692***	−0.839***	−0.894***	−0.785***

Note: *** $p < 0.001$.

Table 5. ROC analysis.

Age group	Dependent variable	Area under curve	Specificity	Sensitivity	Confidential interval
All participants	Barthel Index > 60 = 1	0.914	0.816	0.897	0.896, 0.932
	Barthel Index > 80 = 1	0.929	0.918	0.818	0.914, 0.944
Participants aged ≥ 65	Barthel Index > 60 = 1	0.845	0.806	0.894	0.890, 0.926
	Barthel Index > 80 = 1	0.925	0.830	0.888	0.909, 0.940

scores of each scale showed correlation coefficients of > 0.6 with the items of the other scales. Furthermore, there were similarities in some items between the two scales such as eating (feeding), grooming, and mobility. The correlation coefficients for these items were greater than 0.8. This potentially contributes to the satisfactory convergent validity of the GSS. Subsequently, ROC analyses were conducted on the GSS using cutoff points of 60 and 80 for the Barthel Index. These cut-off points are commonly used thresholds in various studies to assess the degree of BADL disability. Both ROC analyses demonstrated an AUC exceeding 0.9, indicating that GSS had excellent diagnostic value. Moreover, the sensitivity and specificity of both analyses were above 0.8, indicating that GSS can identify positive and negative conditions with high accuracy and reliability.

As the global ageing trend intensifies, the growth of the older population has become a social challenge [28]. Therefore, it is important to conduct assessments and provide personalized care services [20]. Among the key indicators for evaluating the health of older adults, BADL have gained increasing attention [29]. The simplicity and efficiency of the GSS can reduce job stress for medical workers. In some places, such as medical facilities and nursing homes, healthcare staff need to assess the BADL of many older individuals. The GSS does not require one-on-one assessments and can be completed by the users themselves in most cases. This can simplify and accelerate the assessment process and save time and manpower. For older

adults, simple and understandable assessment tools can reduce their anxiety and discomfort [30]. These characteristics make the promotion of GSS particularly significant for the vast older population in China.

In this study, the primary source of missing data was incomplete questionnaires. This might be related to poor compliance and applicability of the GSS. Therefore, this source of missing data cannot be considered random missingness. In this case, imputation might introduce bias, so missing data were excluded. Since certain population characteristics are more commonly associated with missing data, this might imply the limited representativeness of the study. One possible recommendation is to include a follow-up survey with drop-out participants in future research to understand the reasons and improve the questionnaire. Additionally, this study had some limitations. First, community surveys required participants to come to the investigation centres. Therefore, those with severe frailty or cognitive impairment might be excluded. This limited the representativeness of the sample. Second, we did not include hospitalized older individuals. Therefore, caution should be exercised when using the GSS in these populations. Lastly, while a set of grading criteria was published with the GSS to classify participants into different levels of BADL [14], we did not validate these cutoff points. In addition, it should be noted that the version in the Appendix was translated for convenience of communication and did not strictly adhere to the five-step translation process [31]. Therefore, studies in other languages should translate it anew from the original version.

5. Conclusion

This study demonstrated that the GSS is a reliable and valid self-administered questionnaire for assessing BADL among older individuals in China.

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Ethical approval

This study was approved by the Ethics Committee of Zhengzhou University on July 21, 2022 (ZZUIRB2022-07). All individuals involved in the study provided informed written consent.

Consent to publish

I have obtained consent to publish from the participants to report individual patient data.

Authors contributions

All authors have made substantial contributions to this work and have approved the final version of the manuscript. Concept and design: Hongji Zeng, Weijia Zhao, Rui Wang, Xin'ao Wang, Pengchao Luo, Xuyang Zhang, Xi Zeng; Acquisition of data: Hongji Zeng, Weijia Zhao, Rui Wang, Xi Zeng; Statistical analysis: Hongji Zeng, Weijia Zhao, Rui Wang, Xin'ao Wang, Pengchao Luo, Xuyang Zhang; Data interpretation: Hongji Zeng, Weijia Zhao, Rui Wang; Authorship of the original draft: Hongji Zeng; Review and editing: Hongji Zeng, Weijia Zhao, Rui Wang, Xin'ao Wang, Pengchao Luo, Xuyang Zhang, Xi Zeng; Funding: Xi Zeng.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The datasets generated and/or analyzed during the current study are not publicly available due to confidentiality requirements but are available from the corresponding author on reasonable request.

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