

Development and Validation of a Health-Related Social Capital Instrument for Older People

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Background: Health-related social capital refers to the social resources that individuals can obtain in social networks that affect health behaviors and outcomes. Social capital significantly influences health and is linked to health outcomes in older adults. However, there are few social capital scales to capture the resources of health in older people.

Objective: This study aims to develop and validate a health-related social capital scale for older people, with initial development and testing conducted in the Chinese sample.

Methods: The scale was developed through a multi-stage process. First, a systematic literature review of social capital and aging literature combined with the focus group discussion informed the generation of an initial 33-item pool. Two rounds of consultation with a panel of 14 experts (in health policy and health management, health behavior, sociology, and public health) refined these items for relevance and clarity, comprising four dimensions with 26 items. A validation study was then conducted to finalize the instrument. A web-based cross-sectional study was conducted in Shanxi Province from December 2022 to February 2023. A total of 505 participants were recruited, and 473 valid questionnaires were retained. Participants' mean age was 66.73 (SD=6.81) and around half of the sample was female (52.60%). Classical Test Theory (CTT) including item analysis, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and reliability (Cronbach's α , McDonald's ω and composite reliability (CR)) and validity (convergent, discriminant, external, content) test were used to select items and evaluate the measurement properties of the final instrument.

Results: The final health-related social capital scale consists of 12 items across four dimensions: social network, participation, trust, and support. Each dimension demonstrated strong reliability, with Cronbach's α , McDonald's ω , and composite reliability all exceeding 0.7, with social trust dimension demonstrating the highest reliability. EFA revealed that these four factors explained 60.215% of the variance. CFA confirmed the scale's structural validity and model fit. The Average Variance Extracted (AVE) ranged from 0.538 to 0.629, indicating good convergent validity, while Heterotrait-Monotrait ratio of correlations (HTMT) between 0.174 and 0.397 suggested acceptable discriminant validity. Regression analyses supported the scale's external validity. Content validity was strong, with item-level indices (I-CVI) from 0.923 to 1.00 and scale-level indices (S-CVI/UA of 0.800 and S-CVI/Ave of 0.958).

Conclusion: This scale is reliable, valid, and can effectively assess older people's social capital related to health. Although developed and initially validated in China, its theoretical dimensions are designed to be cross-culturally relevant. Further studies are recommended to test and adapt the scale in diverse cultural and geographical settings.

Keywords: aged, social capital, health, scale development, reliability, validity

Introduction

The global percentage of older adults is projected to increase from 12% in 2015 to 22% by 2050, reaching more than two billion individuals.¹ China's aging process is accelerating, with 260 million elderly people making up 18.7% of the population, according to the latest census.² Enhanced healthcare and social security have raised health awareness, and as life expectancy exceeds 80 years, the growing elderly population will increasingly strain societal support resources.³ The



WHO's Decade of Healthy Aging 2020–2030 emphasizes enhancing the functional abilities of the elderly population to promote healthy aging.⁴ Active and healthy ageing have become national strategies for coping with the ageing population.⁵ Studies have found that increasing social capital among older people is an approach to facilitating active and healthy aging.⁶

Social capital is a complex and multifaceted concept encompassing several related constructs.^{7–9} The foundational perspectives from pioneers such as Bourdieu initially introduced the concept of social capital, defining it at an individual level as “the accumulation of social networks and resources, which encompass a range of actual or potential assets shared by groups and their members.”¹⁰ Coleman built upon and advanced Bourdieu's social capital theory as a form of social structural resources.¹¹ Social capital can be categorized into two distinct dimensions: cognitive social capital, which includes the norms, beliefs, and values that foster mutual benefit, and structural social capital, which refers to the externally observable aspects of social organization and social networks.^{8,12} While social capital can be operationalized in several ways, there is a consensus that it represents the resources mobilized through individuals' networks.^{13,14} Key attributes universally recognized in this context include social networks, social participation, social trust, and social support.^{15–17}

Social capital is a significant social determinant of health and its influence on health and health behaviors among older people is well-documented.^{18–21} The presence of cognitive social capital for the elderly tends to mitigate the impact of life stressors, relieve loneliness, and enhance social integration to slow the decline in functional ability and support continued community living.^{14,22,23} Conversely, structural social capital has the potential to rapidly diffuse health information and healthy norms of behavior, reduce the frequency of minor ailments, and provide care during medical emergencies and illnesses.^{24,25} These dimensions of social capital have been found to positively influence older individuals' mental and physical well-being, as indicated by various studies.

However, the field of social capital and health research is undergoing critical reflection. Scholars have highlighted that core concepts such as social capital, community, and trust often carry an insufficiently examined ideological load.^{26–28} This can lead to a tendency to idealize “community” while ignoring potential “dark side”, such as exclusion and power imbalances.^{29–31} A prominent critique urges quantitative research to move beyond oversimplistic operationalization and engage more deeply with social theory that is sensitive to ideology, power, and multidimensionality.²⁸ This theoretical critique highlights significant limitations in existing measurement approaches.

A manifestation of such oversimplification is the frequent reliance on single-item proxies in large-scale surveys to represent complex social capital constructs, an approach that inherently fails to capture their multidimensionality.^{32,33} While existing scales provide reliable measures of general social capital,^{34–37} they are not optimized to assess its health-related dimensions in the context of aging and community life.^{38–40} Furthermore, in the limited studies on health-related social capital scale for the elderly, the reported reliability and validity were not particularly outstanding.⁴¹ Consequently, prevailing approaches may not yield accurate or comprehensive information regarding social capital in health-specific contexts.

In direct response to this call for more theoretically engaged measurement, the present study aims to develop and validate a health-related social capital scale for older adults. We define health-related social capital as the social resources individuals obtain from their social networks that influence health behaviors and outcomes. This instrument is designed to be more suitable for older populations by explicitly incorporating community context and health-related resources into its framework.

Methods

This study was performed in line with the principles of the Declaration of Helsinki. This study was approved by the Research Ethics Committee of the School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology (2023/S065). The patients/participants provided their informed consent to participate in this study.

Study Design

This research seeks to develop and validate a scale to measure health-related social capital in older adults through a four-phase process. First, Phase I was scale development. A systematic literature review and focus group discussions were conducted to identify four key dimensions: social networks, social participation, social trust, and social support. The

Delphi method was then used to consult experts for content validity and applicability. Following this was Phase II sampling and data collection. The preliminary questionnaire was pilot tested and revised for clarity based on participant feedback. In the main study, a multi-stage stratified random sampling method was employed to select a representative sample from urban and rural areas in four cities in Shanxi Province, ensuring population diversity. Phase III was item reduction. The dataset collected in Phase II was used for item reduction analysis, refining the questionnaire to its most effective form. Finally, reliability and validity checks were conducted to evaluate the scale's psychometric properties (Phase IV Scale Validation).

Phase I: Scale Development

Systematic Literature Review and Dimensional Identification

A systematic literature review was conducted by Suyi Song, Fang Tan, and Zhanchun Feng searching the databases PubMed, Web of Science, Medline, and Embase. A comprehensive set of keywords related to social capital was employed, including definition, concept, framework, conceptual framework, theory, dimension and model. These search terms, connected using logical operators, covered the period from January 2000 to February 2022, and the search was limited to articles published in English or Chinese. The detailed search strategy is provided in [Appendix 1](#). The inclusion criteria were: 1) relevance to the concept of social capital in health, 2) a clear discussion on the concept, and 3) contribution to its development, measurement, or critique beyond direct application. The exclusion criteria were: 1) irrelevance to this concept, 2) lack of elaboration on this concept, and 3) studies that only applied the concept without theoretical discussion. Initially, 2147 records were identified, from which 465 were excluded due to inconsistencies and duplicates. The remaining documents were screened based on their abstracts and keywords, resulting in 146 full-text articles being assessed for eligibility, of which 30 met the research criteria. A flowchart of the literature selection process is presented in [Figure 1](#).

Thematic analysis of both existing literature and qualitative data revealed four core dimensions of social capital that are particularly salient to health among older adults: 1) social networks; 2) social participation; 3) social trust, and 4) social support. For the social networks dimension, we used Snijders and Van Der Gaag's resource generator approach to ask the participants how long they had contact with their friends, relatives, and family members who are healthcare professionals.^{42,43} Social trust was defined to encompass interpersonal trust in healthcare professionals and trust in healthcare organizations, reflecting the health-specific focus of our scale. Social participation and support items were adapted to include health behaviors and local practices, such as participation in community fitness activities and seeking health advice from neighbors.

Initial Item Generation via Focus Group Discussion

Based on these core attributes, along with existing literature and measurement tools, a preliminary pool of items was constructed through a focus group discussion. The focus group method was specifically employed to generate the initial item pool and to ensure its relevance and comprehensibility from multiple stakeholder perspectives. The focus group comprised 12 participants who were distinct from the later Delphi expert panel. Participants were purposively selected to represent a range of perspectives relevant to social capital and aging in China, including specialists in sociology, gerontology, and public health. The group consisted of both the internal university scholars and external stakeholders such as community health workers and social workers who directly serve older adults. The session was moderated by an experienced qualitative researcher using a semi-structured guide to explore social capital aspects relevant to older adults in China. Participants engaged in open discussions and structured ranking exercises, which were recorded, transcribed, and analyzed to identify recurring and salient themes that informed item generation. These items were refined through discussions with the university scholars and stakeholders, resulting in a preliminary set of 33 items. The items' details are in [Appendix 2](#).

Initial Item Refinement via Delphi Expert Consultation

We employed a two-round Delphi method to obtain structured expert consensus on the initial item pool. The Delphi method was selected for its particular effectiveness in refining complex, multidimensional constructs like social capital. Its anonymous, iterative feedback process minimizes group dominance and encourages independent judgment. A panel of 15 experts was invited, and 14 (93.33% response rate) completed both rounds. Experts were selected based on the following criteria: 1) backgrounds in

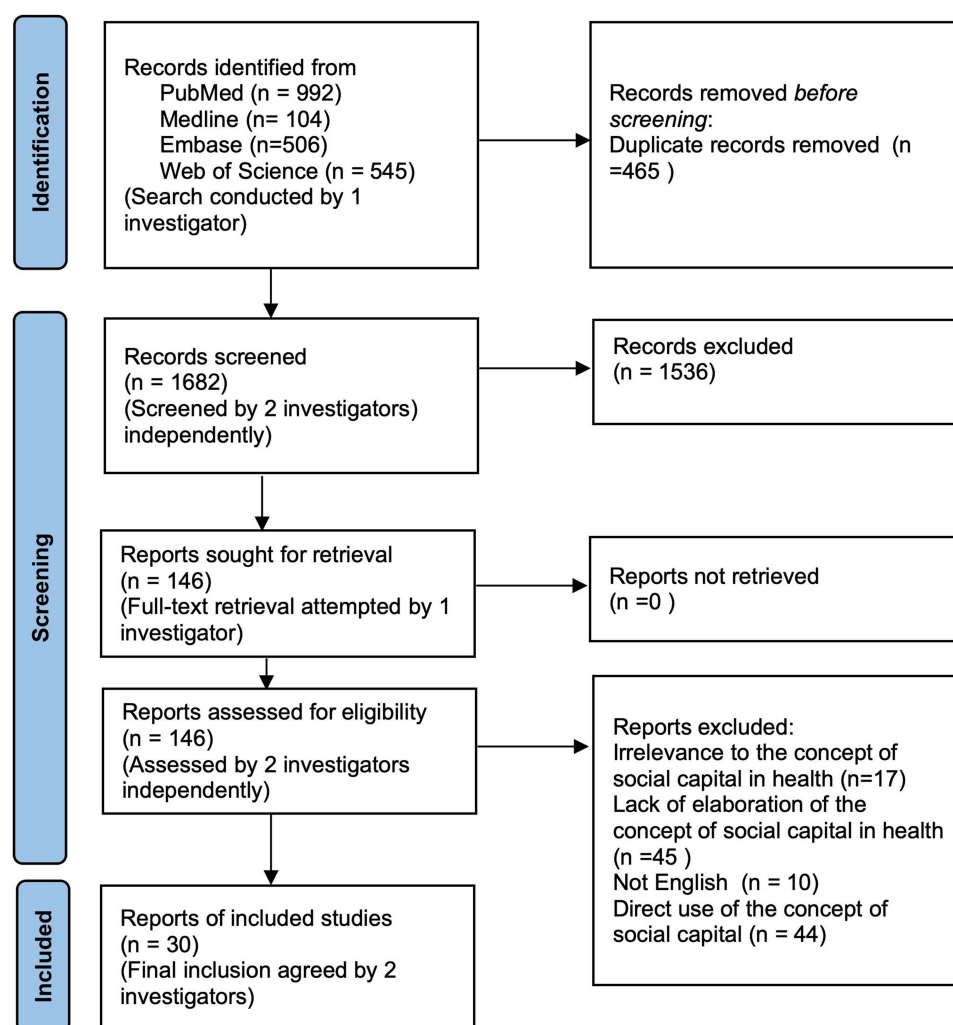


Figure 1 Flow Diagram of Study Selection Process in Scale Development.

health policy, management, social capital, and aging; 2) at least two years of relevant experience; 3) at least a deputy senior title; 4) affiliated with institutions in China. The expert panel comprised senior scholars from leading universities and research institutions in China. Their primary expertise spanned health policy and management (n=10), public health and chronic disease management (n=2), sociology (n=1), and health behavior (n=1), with an average of 15 years of professional experience. The details of the experts are included in [Appendix 3](#).

The Delphi process was conducted anonymously. In each round, experts independently rated the items without knowing the identities or responses of other panel members. In the first round, we gathered qualitative insights and preliminary scores to pinpoint ambiguous or low-consensus items. Experts received a package containing the definitions of the four theoretical domains and the initial 33 items. They were asked to rate the relevance of each item on a 4-point Likert scale (1 = Not relevant, 4 = Highly relevant) and to provide qualitative comments and suggestions for rewording, elimination, or addition of items for each rating.

The content validity of the final instrument was assessed using the Content validity index (CVI),⁴⁴ including item-level CVI (I-CVI) and scale-level CVI (S-CVI). The S-CVI includes S-CVI/UA (universal agreement) and S-CVI/Ave (averaging calculation) by the expert panel. Decision rules for item retention or deletion were pre-specified before the first Delphi round.^{45,46} I-CVI was calculated after each round. A consensus threshold ranging from 51% to 80% is widely used in Delphi studies across various disciplines.⁴⁷ In this study, items failing to achieve a pre-defined consensus threshold of $\geq 78\%$ agreement were removed.⁴⁸

The second round focused on re-evaluating revised items with controlled feedback to reach a stable consensus.⁴⁹ Experts received a revised questionnaire. For each modified item, they were provided with a summary of the first-round statistics (I-CVI) and the anonymized qualitative comments that justified the revision. They were then asked to re-rate the revised items. Consensus was pre-defined primarily as an I-CVI ≥ 0.78 . Based on the first round of expert feedback, three items (Q8, Q16, Q20) were deleted and eight items (Q4, Q5, Q6, Q13, Q15, Q19, Q24, Q30) were revised. In the subsequent second round, a further four items (Q9, Q11, Q12, Q26) were deleted. After two rounds, the health-related social capital scale for older adults was finalized, comprising four dimensions with 26 items. The 26 items demonstrated good content validity at the whole-scale level (S-CVI/UA of 0.846, S-CVI/Ave of 0.981), and the I-CVI ranging from 0.786 to 1.000. Further details of the Delphi method are included in [Appendices 4–7](#).

Phase II: Sampling and Data Collection

Pilot Study

A pilot study was conducted in November 2022 as part of the cross-sectional survey to prepare for the main study. Using a convenience sampling method, we recruited 15 community-dwelling older adults, operationally defined as individuals aged 60 years or older. Participants were selected based on the following criteria: 1) aged 60 or older; 2) residents of the sampled community for over half a year; 3) possessing normal reading, writing, and communication ability 4) providing informed consent voluntarily. Immediately after completion, we conducted brief, semi-structured cognitive interviews with each participant. These interviews focused on: 1) their overall understanding of the questionnaire's purpose; 2) the clarity and wording of each item (e.g., “What did you think this question was asking?”); and 3) the appropriateness and difficulty of the response scale. Participants were encouraged to verbalize any confusion or suggestions. All feedback was recorded in detailed notes. The qualitative feedback was analyzed thematically by two researchers. Issues were categorized (e.g., “ambiguous terminology”, “complex sentence structure”). Respondents' questions and areas of difficulty were documented, leading to the revision of specific items (Q14 and Q15).

Main Study

Participants Recruitment

A cross-sectional web-based survey study was conducted from December 2022 to February 2023. Shanxi Province, located in northern China, comprises 11 prefecture-level cities. Four cities (Taiyuan, Jinzhong, Linfen, and Shuozhou) were selected through stratified purposive sampling to represent diverse geographic, economic, and social characteristics while ensuring research feasibility. One city, one urban, and one rural community were selected in each city. Participants were selected based on the following criteria: 1) aged 60 or older; 2) residents of the sampled community for over half a year; 3) possessing normal reading, writing, and communication ability; 4) providing informed consent and participating voluntarily. Community centers serve as vital social hubs and resource centers for older adults in urban China. To address challenges in web-based surveys with older adult participants, we used Questionnaire Star for its user-friendly interface and collaborated with local community centers to offer on-site assistance. Feedback from the pilot study was used to simplify the survey and enhance its accessibility for older participants, aiming to improve their experience and boost participation rates.

Sample Size

According to Rouquette and Falissard, for Exploratory Factor Analysis (EFA), the participant count should be 10 times the number of questionnaire items.⁵⁰ For Confirmatory Factor Analysis (CFA), the sample size should be 10 times the number of freely estimated parameters.⁵⁰ Our initial instrument had 26 items, requiring a minimum of 260 participants. Accounting for an estimated 10% rate of invalid responses, we aimed to recruit at least 289 participants (260/0.9). A total of 505 questionnaires were ultimately returned, and 473 valid questionnaires were retained, resulting in a valid response rate of approximately 93.66%. This dataset served as the study sample for item reduction analyses (Phase III), and the validation sample to test the final instrument (Phase IV).

Final Questionnaire

The questionnaire comprised two sections: 1) Sociodemographic characteristics, including age, sex, education level,

residence, living situation, monthly income, and health status. 2) The health-related social capital measurement instrument for older adults, with 26 items scored on a six-point Likert scale from 1 to 6.

Phase III: Item Reduction

Item Analysis

Item analysis was based on the following analyses: 1) the distribution of scores of each item was analyzed, including Mean, standard deviation (SD), Skewness statistic, Kurtosis statistic, and Shapiro–Wilk (SW) statistic; 2) the correlation coefficient method evaluates the homogeneity between the item and the total score (item-total correlations); 3) the homogeneity-reliability test involved assessing whether Cronbach's alpha increased after removing an item from the scale, if so, then the item was considered for deletion; and 4) the homogeneity-reliability test: the communality. Items were retained based on the following criteria: Items with SD more than 1,⁵¹ item-total correlations of at least 0.40, a decrease in Cronbach's α value upon item deletion,⁵² and communality of at least 0.2.⁵³ Items were considered for deletion if they failed to meet one-item analysis indicators.

Exploratory Factor Analysis

We used EFA to reduce items and identify the underlying factor structure. Before conducting the EFA, the dataset's univariate characteristics were assessed. The SW test was used to check univariate normality. We also assessed sampling adequacy with the Kaiser-Meyer-Olkin (KMO) measure (>0.7) and confirmed the usefulness of factor analysis with the Bartlett's test of sphericity ($p < 0.05$).⁵⁴

Principal axis factoring (PAF) was chosen due to the ordered categorical nature of the scoring. Oblique rotation was used, as we expect the factors to be correlated due to the social capital theory. The number of factors for the scale was determined by eigenvalues greater than 1 and aided by the scree plot.^{55,56} To ensure item differentiation, questions were selected based on the factor loading of each item in each common factor: items with a factor loading of 0.4 or above were retained to ensure identification of the item, which helped distinguish scale structure more clearly. Items with a communality of less than 0.4 were excluded. Each chosen factor needed to explain over 5% of the total variance, and all selected factors together should account for more than 50% of the total variance.⁵⁷ Cross-loading items were excluded for a simpler structure.

Confirmatory Factor Analysis

Following the EFA, CFA was performed on the remaining 18 items to rigorously assess its structural validity and model fit. A model fit was evaluated by $\chi^2/df < 3$,^{58–60} CFI ≥ 0.9 ,^{61,62} TLI ≥ 0.9 ,^{61,62} SRMR < 0.08 ,⁶³ and RMSEA < 0.06 .^{64,65}

Phase IV: Scale Validation

Reliability

The reliability was assessed using Cronbach's alpha (α), McDonald's omega (ω) and composite reliability (CR). A threshold of 0.70 for these coefficients were considered appropriate.^{66–68}

Validity

CFA assessed structural validity, with a model fit indicated by $\chi^2/df < 3$ (^{58–60}), CFI ≥ 0.9 ,^{61,62} TLI ≥ 0.9 ,^{61,62} SRMR < 0.08 ,⁶³ and RMSEA < 0.06 .^{64,65}

Convergent validity defined as measures of the same construct should be highly intercorrelated among themselves and uniform in the pattern of intercorrelations.^{69,70} Convergent validity of the scale was evaluated using average variance extracted (AVE), with an AVE ≥ 0.50 indicating acceptable validity.⁷¹

Discriminant validity defined as cross-construct correlations among measures of empirically associated variables should correlate at a lower level than the within-construct correlations.^{69,70} Discriminant validity was assessed using the Heterotrait-Monotrait ratio of correlations (HTMT), with a threshold of <0.85 considered satisfactory.^{70,72}

External validity of the final scale was used multiple linear regression model. The model examined the associations between the four dimensions and total scale and key available attributes: sex, age, education level, monthly income, residence, living arrangement, and self-rated health status.

Content validity, as detailed in the Delphi method section, was assessed using CVI, including I-CVI and S-CVI. S-CVI includes S-CVI/UA and S-CVI/Ave by the expert panel. The criteria for a satisfactory CVI were: I-CVI ≥ 0.78 ; S-CVI/UA ≥ 0.8 ; and S-CVI/Ave ≥ 0.9 .^{73–75}

Data Analysis Software

CFA, CR, AVE, and multiple linear regression model were conducted using R4.2.1 (macOS), while other analyses were done with SPSS 26.0 (macOS). A p-value <0.05 was considered statistically significant.

Results

Sample Characteristics

Among the 473 participants, the majority (70.2%) were aged 60–69 years, and 52.6% were female. Approximately one-third had an education level of high school. Around half of the sample were living in urban (48.40%), and living with partners only (48.00%). About one-third of the samples had a monthly income of more than 4000 Yuan. 45.24% of the samples reported good health status (see Table 1).

Table 1 Sample Characteristics (n =473) in Phase II Sampling and Data Collection

Variables	Group	N (%) / Mean (SD)
Age (years)	60-69	332(70.20)
	70-79	114(24.10)
	≥ 80	27(5.70)
		66.73(6.81)
Sex	Male	224(47.40)
	Female	249(52.60)
Education level	Illiteracy	30(6.30)
	Primary school	93(19.70)
	Middle school	88(18.60)
	High school	156(33.00)
	College and above	106(22.40)
Residence	Urban	229(48.40)
	Town	120(25.40)
	Rural	124(26.20)
Living arrangement	Living alone	49(10.40)
	Living with partner only	227(48.00)
	Living with children's family only	56(11.80)
	Living with partner and children's family	118(24.90)
	Other	23(4.90)
Monthly income	<1000	109(23.00)
	1000~2000	82(17.40)
	2001~3000	69(14.60)
	30,001~4000	79(16.70)
	>4000	134(28.30)
Health status	Very poor	14(2.96)
	Poor	61(12.90)
	Fair	145(30.66)
	Good	214(45.24)
	Excellent good	39(8.25)

Item Reduction

Initial Item Analysis (26 to 22 Items)

Item analysis was conducted on the initial 26 items. The mean scores ranged from 2.05 to 4.61, with SD between 0.97 and 1.73. Skewness, kurtosis, and the SW test indicated significant deviations from normality for all items (SW range 0.74–0.93, $p < 0.001$). Item-total correlations ranged from 0.379 to 0.564. Items Q1, Q3, and Q19 were removed due to low item-total correlations (< 0.40). Item Q27 was removed because its standard deviation was below 1.0. Finally, 22 items were retained after item analysis. (see [Table 2](#)).

EFA (22 to 18 Items)

The 22-item set was suitable for factor analysis (KMO = 0.852, Bartlett's test of sphericity: $\chi^2 = 4385.794$, $df = 231$, $p < 0.001$).⁷⁶ According to the results, item 2 was dropped due to factor loads lower than 0.4, and item 17, 18, 21 with loads of 0.35 and higher on multiple factors were also discarded. Finally, 18 items were retained after EFA. (see [Table 3](#)).

The EFA results identified four factors with rotation sums of squared loadings of 3.890, 2.875, 2.352, and 2.649, respectively, collectively explaining 54.170% of the variance, surpassing the 50% threshold for effective information extraction. Factor 1 relates to social support (25.886% variance), Factor 2 to social participation (12.914%), Factor 3 to social networks (8.208%), and Factor 4 to social trust (7.162%). Each factor explained more than 5% of the total variance.

Table 2 Item Analysis Summary in Phase III Item Reduction

Item	Mean	SD	Skew	Kurtosis	SW Statistic	Item-Total Correlation	Cronbach's α Value After Item Deletion	Communality	Substandard Index	Note
Q1	2.30	1.22	0.61	-0.54	0.86***	0.380**	0.868	0.472	1	Delete
Q2	2.43	1.38	0.64	-0.47	0.86***	0.424**	0.868	0.757	0	Retain
Q3	2.22	1.24	0.78	-0.10	0.85***	0.389**	0.867	0.395	1	Delete
Q4	3.68	1.40	-0.30	-0.61	0.92***	0.500**	0.865	0.473	0	Retain
Q5	3.53	1.36	-0.24	-0.57	0.93***	0.508**	0.864	0.758	0	Retain
Q6	3.50	1.39	-0.21	-0.65	0.93***	0.443**	0.866	0.589	0	Retain
Q7	2.13	1.17	0.98	0.75	0.84***	0.474**	0.865	0.453	0	Retain
Q11	2.22	1.18	0.96	0.75	0.85***	0.464**	0.865	0.516	0	Retain
Q13	2.74	1.73	0.62	-0.88	0.85***	0.500**	0.866	0.427	0	Retain
Q14	2.07	1.47	1.25	0.54	0.74***	0.473**	0.866	0.537	0	Retain
Q15	2.05	1.30	1.24	0.91	0.79***	0.450**	0.865	0.527	0	Retain
Q17	4.14	1.12	-0.75	0.74	0.87***	0.431**	0.865	0.416	0	Retain
Q18	4.33	1.00	-0.61	1.17	0.86***	0.451**	0.865	0.659	0	Retain
Q19	4.61	1.09	-0.57	0.78	0.84***	0.379**	0.866	0.541	1	Retain
Q21	4.19	1.08	-0.70	0.97	0.87***	0.430**	0.864	0.51	0	Retain
Q22	4.02	1.18	-0.58	0.38	0.90***	0.515**	0.863	0.625	0	Retain
Q23	3.87	1.23	-0.44	-0.12	0.92***	0.504**	0.863	0.708	0	Retain
Q24	3.99	1.14	-0.52	0.39	0.90***	0.509**	0.862	0.561	0	Retain
Q25	4.28	1.03	-0.45	1.14	0.84***	0.466**	0.864	0.428	0	Retain
Q27	4.42	0.97	-0.36	1.23	0.83***	0.515**	0.862	0.495	1	Delete
Q28	4.49	1.10	-0.42	0.42	0.86***	0.474**	0.864	0.535	0	Retain
Q29	4.35	1.15	-0.60	0.77	0.87***	0.564**	0.861	0.541	0	Retain
Q30	4.44	1.13	-0.62	0.89	0.86***	0.487**	0.863	0.57	0	Retain
Q31	4.39	1.11	-0.42	0.40	0.87***	0.540**	0.862	0.5	0	Retain
Q32	4.18	1.22	-0.40	0.08	0.89***	0.537**	0.862	0.588	0	Retain
Q33	4.43	1.08	-0.42	0.62	0.86***	0.557**	0.861	0.596	0	Retain
Judgment criteria	/	>1	/	/	/	≥ 0.4	≤ 0.869	≥ 0.2	≤ 1	/

Note: ** $p < 0.01$, *** $p < 0.001$. SD < 1 , item-total correlations < 0.40 are in bold. The full text of all items is available in [Appendix 2](#).

Abbreviations: SD, Standard Deviation; SW, Shapiro–Wilk test of normality; Cronbach's α , Cronbach's alpha.

CFA (18 to 12 Items)

A CFA was performed on the 18-item, four-factor model derived from the EFA. The 18-item four-factor model did not yield satisfactory fit indices ($\chi^2/df = 3.744$, CFI = 0.880, TLI = 0.899, SRMR = 0.06, RMSEA = 0.076). Therefore, using some of the suggested modifications to improve model fit, item 7,13,25,28,29,30 were removed.

Since the CFA led to the further elimination of items, an additional EFA was performed to validate the final 12-item instrument. The final 12-item instrument is in the [Appendix 8](#). This EFA perfectly replicated the factor structure of the CFA (see [Appendix 9](#)). The solution explained 60.215% of the cumulative variance, and no cross-loading items.

Validation of the 12-Item Scale

Reliability

The final 12-item scale and its four subscales demonstrated strong internal consistency. The Cronbach's α for the total scale and each dimension ranged from 0.761 to 0.832, the McDonald's ω from 0.773 to 0.835, and CR of the domain ranges from 0.773 to 0.835 (see [Table 4](#)).

Validity

Structural Validity. The 12-item four-factor was then modeled using the R program, with an excellent fit: RMSEA=0.042 (≤ 0.06), $\chi^2/df=1.815$ (< 3), SRMR=0.036 (< 0.08), CFI=0.982 (≥ 0.90), IFI=0.982 (≥ 0.90), TLI= 0.975 (≥ 0.90) (see [Table 5](#) and [Figure 2](#)).

Convergent validity. AVE ranges from 0.538 to 0.629 indicating good validity (see [Table 6](#)).

Discriminant validity. All HTMT values range from 0.174 to 0.397, which are substantially below the conservative threshold of 0.85, were shown acceptable discriminant validity (see [Table 6](#)).

External Validity. Regression analyses confirm the external validity of the health-related social capital scale. Monthly income was positively associated with the total social capital score, social networks, and social participation ($p < 0.05$). Rural residence was also positively associated with the total social capital score and social participation ($p < 0.05$; Ref:

Table 3 Exploratory Factor Analysis in Phase III Item Reduction

Item	Communalities	Factor 1	Factor 2	Factor 3	Factor 4
Q4	0.455	0.271	0.197	-0.680	0.145
Q5	0.592	0.146	0.282	-0.857	0.182
Q6	0.475	0.101	0.265	-0.742	0.146
Q7	0.433	0.160	0.674	-0.193	0.182
Q11	0.455	0.102	0.713	-0.237	0.130
Q13	0.391	0.207	0.633	-0.083	0.213
Q14	0.506	0.090	0.730	-0.211	0.183
Q15	0.468	0.073	0.704	-0.246	0.225
Q22	0.525	0.327	0.179	-0.097	0.795
Q23	0.556	0.253	0.229	-0.116	0.844
Q24	0.463	0.291	0.232	-0.193	0.728
Q25	0.339	0.605	0.140	-0.064	0.214
Q28	0.519	0.717	0.076	-0.039	0.294
Q29	0.546	0.735	0.192	-0.054	0.366
Q30	0.525	0.752	0.107	-0.010	0.285
Q31	0.504	0.691	0.152	-0.282	0.241
Q32	0.537	0.668	0.119	-0.383	0.248
Q33	0.566	0.726	0.208	-0.323	0.228
Rotation Sums of Squared Loading		3.890	2.875	2.352	2.649
% of variance		25.886	12.914	8.208	7.162

Note: Principal axis factoring with Oblique rotation was conducted. Factor loadings with an absolute value ≥ 0.40 are in bold. Factor labels were assigned based on item content and theoretical alignment: Factor 1 = Social Support, Factor 2 = Social Participation, Factor 3 = Social Networks, Factor 4 = Social Trust. Communalities represent the proportion of each item's variance explained by the common factors.

Table 4 The Reliability of the Scale and Its Dimension in Phase IV Scale Validation

Dimension	Number of Items	Cronbach's α	McDonald's ω	CR
Social Networks	3	0.812	0.819	0.819
Social Participation	3	0.761	0.773	0.773
Social Trust	3	0.832	0.835	0.835
Social Support	3	0.826	0.829	0.829
Total scale	12	0.797	0.791	0.791

Note: Reliability was assessed using three complementary indices to evaluate the internal consistency of the total scale and its subscales: Cronbach's alpha (α), a classic measure of inter-item correlation and scale homogeneity; McDonald's omega (ω), which is more appropriate for multidimensional scales as it accounts for factor loadings and is less sensitive to the number of items; and Composite Reliability (CR), which estimates the reliability of a latent construct in factor models. The states the common acceptability threshold (≥ 0.70).

Table 5 Structural Validity of the Four-Factor Model, Goodness-of-Fit Indices from CFA in Phase IV Scale Validation

Model	χ^2/df	TLI	CFI	IFI	GFI	AGFI	SRMR	RMSEA with 95% CI
Structural model	3.948(509.317/129)	0.873	0.893	0.894	0.878	0.838	0.060	0.079 (0.072,0.086)
Modified structural model	1.815(87.112/48)	0.975	0.982	0.982	0.970	0.952	0.036	0.042 (0.027,0.055)
Recommended value	≤ 3	≥ 0.90	≥ 0.90	≥ 0.90	≥ 0.90	> 0.80	< 0.08	≤ 0.05

Notes: Model fit indices for the confirmatory factor analysis: χ^2/df = normed chi-square with its 95% CI (Confidence Interval).

Abbreviations: TLI, Tucker-Lewis Index; CFI, Comparative Fit Index; IFI, Incremental Fit Index; SRMR, Standardized Root Mean Square Residual; RMSEA, Root Mean Square Error of Approximation.

urban). The categories of living arrangement (with partner only, with children's family, or with both) were negatively associated with social trust compared to living alone ($p < 0.05$). The categories of living arrangement (with partner only, and with children's family) were negatively associated with the total social capital score compared to living alone ($p < 0.05$). Social trust was positively associated with reporting poor and excellent good self-rated health ($p < 0.05$; Ref: very poor) (see [Appendix 10](#)).

Content Validity. The items show good content validity at both the whole-scale level (S-CVI/UA of 0.800, S-CVI/Ave of 0.958) and at the individual item level CVIs ranging from 0.923 to 1.00 (see [Table 7](#)).

The complete path of item reduction from the initial 26 to the final 12 items is summarized in [Table 8](#).

Discussion

This study developed and validated the first 12-item scale specifically designed to measure health-related social capital among older adults, covering social networks, participation, trust, and support. The instrument was developed through a rigorous mixed-methods process that integrates qualitative insights with quantitative validation.

Psychometric Properties

In scale development and psychometric evaluation, classical test theory (CTT) methods like item analysis, EFA, and CFA are commonly used due to their simplicity. We reduced the initial 26 items to 12 items based on CTT. The psychometric evaluation confirmed the scale's robustness. It demonstrated high internal consistency, as evidenced by strong Cronbach's α , McDonald's ω and CR. Construct validity was firmly supported. EFA and CFA upheld a stable four-factor structure, aligning with the theoretical dimensions of social capital, and model fit indices were excellent. Furthermore, the scale showed good convergent and discriminant validity, and its content validity was established through rigorous expert consultation.

Theoretical and Contextual Implications of the Findings

The distinction between cognitive and structural social capital is fundamental in social capital theory.⁷⁷ EFA and CFA revealed components of structural social capital (social network and social participation) and cognitive social capital

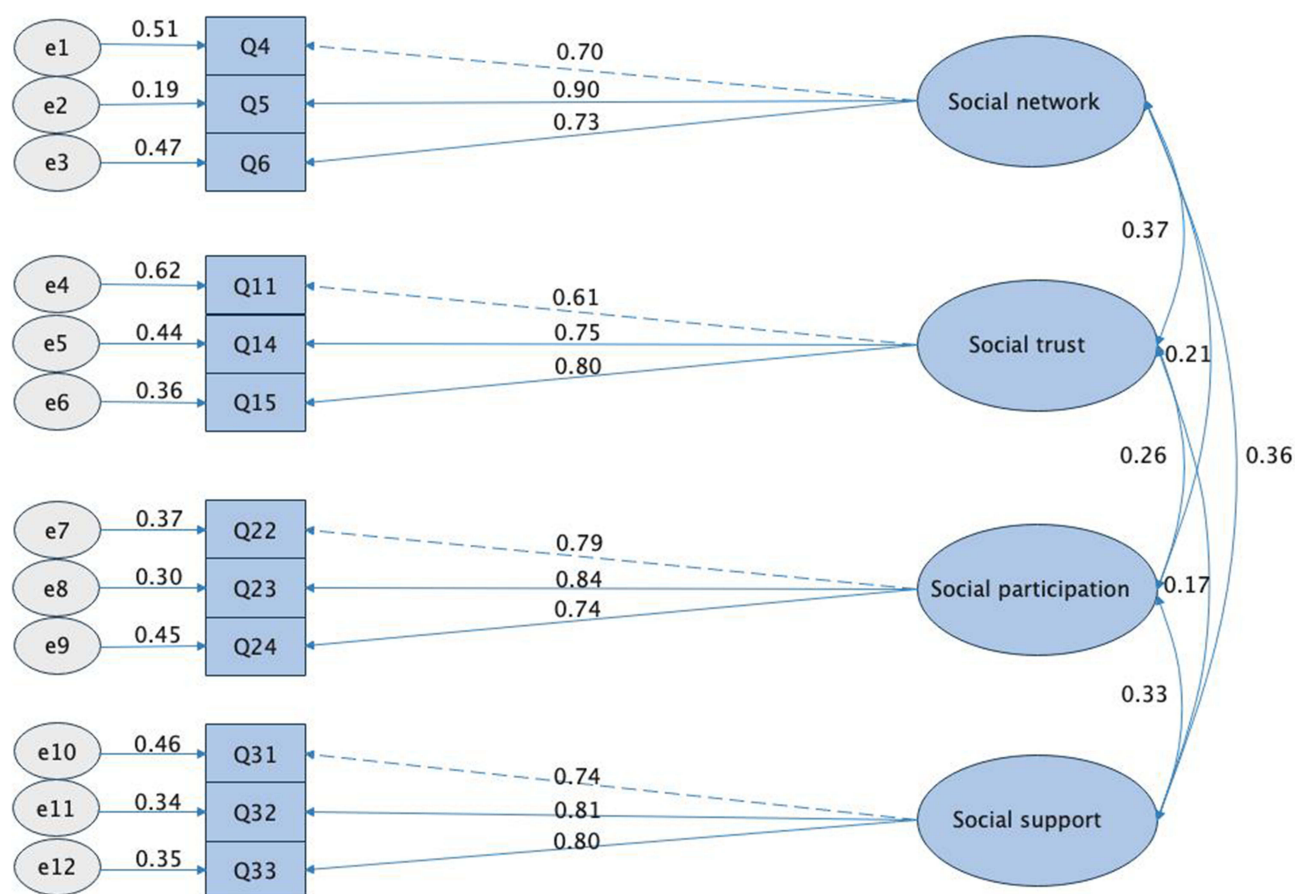


Figure 2 Structural Equation Model of the Health-related Social Capital in Phase IV Scale Validation.

(social trust and social support), aligning with theoretical expectations. From our health-related social capital concept framework, four universal dimensions align with Wang Hui's research,⁷⁸ but we integrate social ties into social networks, reducing redundancy between social networks and social support. Individual-level community-based social participation which is one of the dimensions is vital for older adults' health and well-being.⁴¹ This focus differs from approaches like the Japanese JAGES program, which treats individual and community-level participation separately,^{41,79} such a distinction was not feasible in our study due to sample size limitations at the community level.

While well-established scales such as the Personal Social Capital Scale (PSCS) are valuable for assessing general social capital and demonstrate good reliability,^{34–37} they are not optimized to capture the health-specific dimensions crucial for aging populations. For instance, their measurement of social networks often focuses on kinship ties, potentially overlooking the critical role of healthcare professionals within an older adult's support system.³⁸

Table 6 Convergent Validity and Discriminant Validity in Phase IV Scale Validation

Dimension	AVE	HTMT			
		Social Networks	Social Participation	Social Trust	Social Support
Social Networks	0.604	I			
Social Participation	0.538	0.397	I		
Social Trust	0.629	0.174	0.361	I	
Social Support	0.620	0.337	0.222	0.254	I

Abbreviations: AVE, Average Variance Extracted (measure of convergent validity; AVE ≥ 0.50 indicates acceptable validity). HTMT, Heterotrait-Monotrait ratio of correlations (measure of discriminant validity; HTMT < 0.85 indicates acceptable discriminant validity).

Table 7 Content Validity by the Expert Consultation in Phase IV Scale Validation

Item	Experts in Agreement (N)	I-CVI
Q4	14	1.000
Q5	14	1.000
Q6	14	1.000
Q11	14	1.000
Q14	13	0.923
Q15	13	0.923
Q22	14	1.000
Q23	14	1.000
Q24	14	1.000
Q31	14	1.000
Q32	14	1.000
Q33	14	1.000
S-CVI/Ave		0.958
S-CVI/UA		0.800

Notes: Common acceptability criteria are: I-CVI ≥ 0.78 , S-CVI/Ave ≥ 0.90 , S-CVI/UA ≥ 0.80 .

Abbreviations: I-CVI, Item-level Content Validity Index; S-CVI/Ave, Scale-level Content Validity Index based on the averaging method; S-CVI/UA, Scale-level Content Validity Index based on Universal Agreement.

Furthermore, they may not fully conceptualize the community-based, individual-level resources, such as access to local health services and amenities, that are vital for the health and well-being of older adults who are often deeply embedded in their community contexts.^{39,40}

Our findings offer nuanced insights into the nature of social capital among older adults in China. The scale shows known-groups validity through significant associations with socio-economic factors. Rural residents reported higher social participation and capital than urban residents, reflecting strong community dynamics in rural areas and indicating the scale's effectiveness in capturing the social capital.^{80–82} Additionally, a positive link between monthly income and social capital suggests that financial resources may enhance social connections.²⁵ The scale partially relates to health outcomes, with social trust significantly linked to better self-rated health,⁸³ supporting its external validity. Although other dimensions were not statistically significant, their positive trends suggest a broader relationship.

Practical Application and Interpretation of the Scale

The scale developed in this study measures the older adults' access to health-related social resources and assesses social capital among elderly, explicitly highlighting its link to health. Its brevity and reliability make it a valuable tool for surveys and targeted interventions for older adults. For research and community practice, regular assessment using this tool can help identify effective social networks and support systems, informing the design or adaptation of community activities to strengthen these connections. For instance, expanding social networks through structured programs, intergenerational activities, or technology-based initiatives can help build social capital, connecting older adults to diverse information and support beyond immediate family, thereby improving access to health resources and enhancing well-being. Furthermore, assessing health-related social capital facilitates the identification of disparities and requirements among diverse groups of elderly individuals concerning their levels of social capital. This information empowers researchers and policymakers to develop tailored interventions for healthy ageing. For example, it can inform the provision of support services to individuals experiencing significant loneliness or the implementation of educational initiatives for those lacking awareness of healthcare practices. This scale primarily targets researchers studying social capital's role in healthy aging. With further validation, it could also help clinicians and community health workers identify social capital deficits. Due to its complexity, it should be administered by trained professionals, not older adults themselves.

Table 8 Path of Item Reduction from Initial Pool to Final Scale

Phase	Stage	Number of items	Method	Number of Items Removed	Reason for Items Removed	Number of Items Remaining
Phase I: Scale Development	Item Generation	33	Literature review/A focus group discussion	–	(Item generation, no removal)	33
	Expert Consultation (Round 1)	33	The Delphi method	3	Q8,Q16,Q20 (Expert Agreement rates<78%)	30
	Expert Consultation (Round 2)	30	The Delphi method	4	Q9,Q10,Q12,Q26 (Expert Agreement rates<78%)	26
Phase II: Sampling and Data Collection	Pilot Study	26	Cross-sectional survey	-	Wording of Q14, Q15 modified	26
	Main Study	26	Cross-sectional web-based survey	-	(Data collection for analysis)	26
Phase III: Item Reduction	Statistical Analysis	26	Item Analysis	4	Q1,Q3,Q19(Item-total correlations<0.4) Q27(SD <1)	22
		22	Exploratory Factor Analysis	4	Q2 (factor loading< 0.4) Q17,Q18,Q21 (loads of 0.35 and higher on multiple factors)	18
		18	Confirmatory Factor Analysis	6	Q7,Q13,Q25,Q28,Q29,Q30(Low factor loadings and model fit improvement)	12
Phase IV: Scale Validation	Final scale	12	Reliability test Validity test	0	Final scale validated	12

Abbreviation: SD, Standard Deviation.

Limitations and Future Directions

This study is notable for creating a health-related social capital scale for elderly. While designed for broad relevance, its initial validation was conducted within a specific socio-cultural context (Shanxi Province, China), which presents several limitations that also inform future research. First, the reliability assessment was confined to internal consistency (Cronbach's α , McDonald's ω and CR), which was robust. However, we did not evaluate test-retest reliability to establish the temporal stability of the scale scores over time. Future studies should administer the scale to the same participants over a 2-to-4-week interval to confirm its stability. Second, the external validation of the scale was conducted using available socio-demographic and self-rated health variables. While some expected patterns emerged (e.g., with income and residence), the associations with specific, objective health outcomes (e.g., morbidity, healthcare utilization, functional status) remain unexamined. The absence of these external health measures limits our understanding of the scale's predictive validity. Future research should integrate such health proxies to fully establish the tool's criterion validity. Furthermore, the current validation lacked a direct comparison with established scales measuring similar or related constructs (eg, general social capital scales and loneliness scales). Third, the scale requires validation in broader and more diverse populations. Although cognitive testing included urban and rural participants, the initial psychometric validation within a single provincial context means its generalizability to other regions and cultures is not yet established. Future research should prioritize cross-cultural and multi-regional validation studies. Finally, we recognize a fundamental limitation inherent in our quantitative methodological approach. The process of distilling complex, socially-constructed, and ideologically-laden concepts, such as social capital, community, trust, and tradition into a 12-item scale necessarily involves simplification and carries the risk of inadvertently perpetuating some of the implicit normative assumptions embedded within these multifaceted terms.^{29,30,84,85} While the scale measures accessible resources, it might not fully capture the complexity, power dynamics, or negative aspects of social relations. Future research should use qualitative or mixed methods to explore these dimensions in depth and enhance our findings.

Conclusions

This study developed a scale to assess the health-related social capital among elderly individuals, comprising 12 items assessing social networks, social participation, social trust, and social support. Our study demonstrates that this instrument is valid for assessing health-related social capital in older adults. This scale contributes to the existing body of research by emphasizing health-related social capital among older adults. It builds on previous instruments by incorporating the roles of healthcare professionals in social networks and community health resources, which are crucial for promoting the well-being of the elderly. It can help public health officials create customized interventions that reflect the specific level of social capital available in a given region. We encourage its application in diverse contexts to generate evidence that is both methodologically rigorous and theoretically informed, ultimately supporting policies and programs for healthy aging.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work the authors used ChatGPT in order to improve the readability and language of the manuscript. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

Data Sharing Statement

The datasets from this study are not publicly available due to ethical restrictions and participant confidentiality concerns, as they contain sensitive information about elderly adults. However, de-identified data can be requested from the corresponding author. All analysis materials are available upon request to the corresponding author.

Ethics Approval and Consent to Participate

This study was performed in line with the principles of the Declaration of Helsinki. This study was approved by the Research Ethics Committee of the School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology (2023/S065). The patients/participants provided their informed consent to participate in this study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no competing interests in this work.

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