RESEARCH ARTICLE

Instrument development and validation of the comprehensive ability of older people assessment scale

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Abstract

Aim: The study is aimed to develop and psychometrically test the Comprehensive Ability of Older People Assessment scale and classify the ability grades.

Design: A cross-sectional design was used for instrument development.

Method: The Comprehensive Ability of Older People Assessment scale was developed by a sample of 971 older people from 4 long-term care institutions in China. The data were collected between April 2018 and March 2020. One-way analysis of variance and multiple regression analysis was used to screen scale items, while focus group interviews were used to integrate the subjective and objective items. Confirmative factor analysis and expert judgment were applied to explore construct validity. Reliability was explored through internal consistency estimation using Cronbach's alpha and homogeneity evaluation using corrected item-total correlations. Cluster analysis and discriminant analysis were used to segment the comprehensive ability assessment scores and discriminant function was established to determine the boundary value of each segment, using correlation analysis to perform reverse verification.

Results: Factor analysis yielded 40 items with six dimensions, including "mentation and cognitive," "perception and communication," "emotional problems," "mental and behavioural problems," "daily life and social participation," and "skin and oral status." The Cronbach's α was 0.951, while the dimensions showed Cronbach's α values ranging from 0.760–0.946. The rationality and scientificity of this scale were proved by the correlation analysis of reverse validation.

Conclusion: The 4-grade Comprehensive Ability of Older People Assessment scale is proved to be with good validity and reliability and should be considered for institutional assessors.

Impact: Assessors can accurately evaluate older people's health status and nursing needs through this scale in long-term care institutions, communities and hospitals, so as to provide accurate and high-quality nursing services. It will become a scientific basis for the government to offer accurate pension subsidies, purchase pension

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services scientifically for older people and establish third-party objective evaluation and supervision.

1 | INTRODUCTION

The trend of population ageing began in Europe in the middle of the 19th century. Since the 1970s, it has gradually spread to countries in North America and Asia. The proportion of older people and over-aged population and the dependency ratio of older people have always been rising, which has become a global issue affecting human development (Chen, 2021). Population ageing is a universal, natural, sustained and inevitable phenomenon, which has an impact on older people themselves also the country where they are living. The phenomenon of ageing not only brings physiological changes to older people, but also leads to emotional, cognitive and social changes (Cardoso et al., 2018). If there is no way to actively deal with ageing and accurately assess and pay attention to the health status of older people, the contradiction of ageing will become more prominent, and there will be more adverse social, economic and political consequences in near future (Álvarez-García et al., 2018).

The active ageing policy is based on meeting the nursing needs of older people and maintaining their good physical, psychological and intellectual conditions (Walker, 2015), so as to prevent or delay the adverse physiological, psychological or social changes of older people, eliminate the marginalization and morbidization of older people and transform older people from concentrators of social problems to solvers and creators of promoting sustainable development (Pérez-Cuevas et al., 2015). The older people have strong heterogeneity such as the coexistence of multiple diseases, multiple drug using, the decline of physiological and cognitive ability, weakness and so on, which easily leads to adverse clinical outcomes such as falls, incontinence and delirium and may have huge economic and social needs due to long-term care. However, due to the limited resources, it is necessary to scientifically evaluate and reasonably plan the ability and nursing needs of older people, so as to make a more reasonable allocation of medical and social resources (Frijters et al., 2013).

For these reasons, it is the fundamental solution and premise to evaluate the physiological, social, functional and other dimensions of older people effectively and comprehensively for dealing with the future crisis and ageing of disabled older people. Compared with traditional medical assessments, it has been found that comprehensive geriatric assessment (CGA) can improve older people's activity of daily living and cognitive function, improve quality of life, reduce medical demands and expense and save health resources at the same time (Tobis et al., 2017). At present, there are many assessment tools for older people recognized both domestically and internationally (Craig et al., 2015, Li and Xu, 2018), most of which were developed abroad and assessed physical function, activities of daily living, cognitive ability and mental health. Only a few scales have assessed the

nutrition and illness of the older people. Due to the time-consuming assessment, they were not widely used (Li and Xu, 2018). Compared with foreign countries, the development of older people nursing needs assessment instruments in China is quite different in assessment mode, assessment standard and dimension refinement. Some scales are too miscellaneous, and the assessment time is too long to be implemented on a large scale. It is difficult to adapt to the increasingly diversified nursing needs of older people and the requirements of fine management of institutions. The quality of nursing service in China's long-term care institutions is uneven, and there is still a lack of a unified tool for assessing the ability of older people (Zhang et al., 2019). Therefore, the establishment of a comprehensive and effective Comprehensive Ability of Older People Assessment Scale can objectively and multi-dimensionally assess the risks and adverse outcomes of older people, so as to provide the basis for medical staff to better formulate care programmes and allocate resources (Beswick et al., 2008; Li et al., 2021, Wu et al., 2021).

2 | BACKGROUND

After a systematic review of recent developments in comprehensive geriatric assessment instruments in long-term care institutions, there are 8 comprehensive assessment tools for the older people in long-term care institutions (Zhang et al., 2019). WHOQOL-BREF is a concise scale based on the World Health Organization Quality of life scale (WHOQOL-100) (Hoben et al., 2016). It includes four dimensions: physiology, psychology, society and environment. The total score is 0–100. The higher the score is, the better the quality of life of the subjects is. Although WHOQOL-BREF has been used to evaluate the quality of life of older people with different diseases, it is rarely used to evaluate older people in long-term care institutions. SF-36 HRQOL is a universal tool for measuring health status, including the assessment of physical and mental factors. The total score is 0–100, the higher the score indicates the better the health-related quality of life of the subjects (Bunevicius, 2017). NHP was produced in Britain in 1970 and is one of the most widely used health-related quality of life scales. The scale is mainly used to measure the emotional, social and physical health problems of older people and the impact of these problems on activities of daily living. It is better to use NHP to evaluate older people with chronic diseases and cognitive impairment (Tabali et al., 2012). CARE is a scale created by the centre for medical insurance and Medicaid in the United States. It includes four dimensions: medical status, functional status, cognitive status and social support factors. Its reliability and validity needed to be further determined (Tobin et al., 2012). BGA was compiled by

Xie et al. (2016) including body, self-care ability, social function and mental evaluation of four dimensions, 37 items, which has not been applied in long-term care institutions. The comprehensive evaluation scale for health function of the older people was developed by Hu et al. (2013) through literature review and Delphi method. It includes three dimensions: life function health status, psychological health status and social status. At present, the scale has not been applied to other studies.

According to criteria for selecting health measurement tools based on consensus, the reliability of the International Resident Assessment Instrument-Long-term care facilities (InterRAI-LTCF) (Hjaltadóttir et al., 2011) and the Ability assessment questionnaire for older people (abbreviation: AAQ)(China Social Welfare Association et al., 2013) are higher. Our research team found that the InterRAI-LTCF and the AAQ scale have formed a mature system, and these two comprehensive assessment tools are worth popularizing in the long-term care institutions of our country in the future.

Our research team used these two scales in the actual investigation of long-term care institutions and found some problems. InterRAI-LTCF was originated from the minimum data set (MDS) developed by the American government in 1987 to unify the evaluation standards of long-term care institutions (Hjaltadóttir et al., 2011). As a scale consisting of 196 items in 14 dimensions, the assessment contents of InterRAI-LTCF mainly include identity information, cognitive ability, communication and vision, emotion and behaviour, social and psychological health, physical function, self-control of urination and defecation, disease diagnosis, health status, oral and nutritional status, skin condition, recreational activities and social participation. InterRAI-LTCF assessment data are mainly obtained through observation, which is less invasive, and it has been used as a standardized comprehensive assessment tool for assessing the disability status of older people in more than 40 countries and regions, which is proved to have good reliability and validity (Morris et al., 2011). However, some of the items in InterRAI-LTCF are not closely related to the nursing care of older people.

At present, the research on the application of InterRAI-LTCF in long-term care institutions is insufficient. Boorsma et al. (2013) tried to implement InterRAI-LTCF in 10 long-term care institutions in the Netherlands, and they found the management methods and financial support of long-term care institutions needed major changes; and at the same time, sufficient personnel and computer equipment were warranted to support the implementation of InterRAI-LTCF. In the investigation phase, it was also found that InterRAI-LTCF was time-consuming and had too many items. Due to the lack of resources in long-term care institutions, it is difficult to implement this scale.

The other available instrument is AAQ, implemented by the Chinese Ministry of Civil Affairs in 2013 to evaluate the older people's grade of ability. This is a 40-item scale with a 4-grade assessment of 4 dimensions, including older people's activities of daily living (ADL), spiritual cognition, perception and communication, and social participation. According to the results of this questionnaire evaluation, the ability of daily life of the older people can be divided into 4 grades: intact ability, mild disability, moderate disability and severe disability. The Cronbach's α coefficient of the questionnaire is 0.725 (Guo et al., 2017). We found that the focus of this scale is ability classification which does not include the illness condition of older people, and the number of items in the questionnaire is too simple to affect the accuracy of the assessment (Ding and Xu, 2016). In conclusion, the two available instruments at present do not have universality in China's long-term care institutions (Zhang et al., 2019).

3 | THE STUDY

3.1 | Aim

The study is built on the two current scales (InterRAI-LTCF and AAQ) aiming to develop a new instrument, the Comprehensive Ability of Older People Assessment scale (CAOPAs), also to test the psychometric characteristics and classify the ability grades of CAOPAs.

3.2 | Methodology

A cross-sectional study is carried out to validate CAOPAs developed to measure the comprehensive ability and nursing needs of older people. Using convenience sampling method, 725 older people from three long-term care institutions were investigated in Jiangsu Province of China. The content validity was assessed by the expert judgment method, factor analysis was used to assess construct validity and Cronbach's α was used to test internal consistency. Using cluster sampling method, the k-means algorithm and Fisher linear discriminant analysis were used to segment the comprehensive ability evaluation scores of 246 older people in long-term care institutions, and the ability grades of CAOPAs were classified.

3.3 | Participants

From April 2018 to September 2019, the research team recruited 725 older people from three long-term care institutions in China in accordance with convenience sampling method for investigation. After the scale was formed and the reliability and validity were tested, 246 older people were recruited from the fourth pension institution for reverse validation and grading from January 2020 to March 2020.

Inclusion criteria included (1) signed written informed consent; (2) Age ≥60 years old; (3) stay in the long-term care institutions for more than 3 months; (4) volunteer for the research group study; and (5) older people or their caregivers, such as nursing staff and nurses, have the ability to accept the questions on the questionnaire from the assessors and answer the relevant questions correctly;

Three instructions of CAOPAs are as follows: (a) People with cognitive dementia or mental illness will improve their original ability by one level (the nursing staff of long-term care institutions or family members of the older people answer assessment questions); (b)

Those who have fallen, choked, committed suicide or got lost two or more times in 3 days shall be improved by one level on the original ability level; and (c) Being in a coma is directly assessed as grade 3 (severe disability).

Exclusion criteria included (1) those who fill in the form incorrectly or incompletely; (2) those who are unable to continue the investigation due to sudden emergency during the research process; and (3) the older people who leave the institution and live outside during the investigation.

3.4 | Instrument

In the early stage, our research team established the scale system of CAOPAs according to the research purpose, the scale items were selected based on the results of literature reading, field investigation (InterRAI-LTCF and AAQ) and focus interviews.

3.5 | The validity

The content validity is assessed by the expert judgment method, including content validity of the item (Item-level CVI, I-CVI) and content validity index of scale grade (Scale-level CVI, S-CVI) (Wang et al., 2011). The evaluation method sets the option to four grades: 1 = irrelevant; 2 = weak correlation; 3 = strong correlation; and 4 = very relevant. Count the number of experts with "3 points = strong correlation" and "4 points = very relevant" for each item, and divide the number of experts counted by the total number of experts participating in the evaluation to get the corresponding I-CVI. I-CVI is required to be no less than 78 if the number of experts is more than 6. S-CVI/UA is the percentage of all items whose scores are 3 or 4. We can indicate the content validity of the scale is good if S-CVI/UA is more than 80%. S-CVI/Ave is expressed by the I-CVI mean of all items of the scale, and when the S-CVI/Ave value of the scale is >0.9, indicating that it meets the requirements. At the beginning of this study, the theoretical framework has been established, and the scale items were selected based on the results of literature reading, field investigation (InterRAI-LTCF and AAQ) and focus interviews. It is generally believed that exploratory factor analysis is not necessary in the development of the scale on the basis of previous studies and conclusions (Zhu & Q, 2018). The construct validity of CAOPAs was assessed through confirmative factor analysis (CFA). SPSS 22.0 software (SPSS, Inc.) was used for all statistical analysis except for CFA, where the Mplus 7.1 software (Muthén) was used. Spearman correlation analysis was adopted to perform reverse verification of the scale.

3.5.1 | Confirmative factor analysis

The standard of good fit varies, namely the model fit for the CFA considered chi-square, the comparative fit index (CFI) (values >0.95

indicated a good fit), the root mean square error of approximation (RMSEA) (values <0.06 indicated a good fit), the normed fit index or the Tucker Lewis index (TLI) (values ≥0.95 indicated a good fit) and the standardized root mean square residual (SRMR) (values <0.08 indicated a good fit).

3.5.2 | Reverse verification

For reverse verification, whether the results assessed by the ability grade of older people of CAOPAs are more convincing than AAQ's was verified. This study used CAOPAs and AAQ to evaluate the same group of older people, and there are differences in the results of the two scales in evaluating the ability level of the same older people. We selected 63 older people with different ability levels for analysis and comparison. Spearman correlation analysis was conducted between the grades (1, 2, 3, 4) and body mass index, cognitive score, activities of daily living, depression score, pain score, communication score and pressure sore score of 63 older people in InterRAI-LTCF, whose results showed that the correlation coefficient of CAOPAs was higher than that of AAQ, which meant that CAOPAs was more related to the ability and health status of older people. The correlation coefficient of CAOPAs and body mass index (r = .263) was higher than that of AAQ and body mass index (0.124) ($p < .01$). The correlation coefficient of CAOPAs and cognitive score (r = .535) was higher than that of AAQ and cognitive score (0.018) ($p < .01$). The correlation coefficient of CAOPAs and activities of daily living (r = .511) was higher than that of AAQ and activities of daily living (0.045) ($p < .01$). The correlation coefficient of CAOPAs and pain score (r = .340) was higher than that of AAQ and pain score (0.169) ($p < .01$). The correlation coefficient of CAOPAs and pressure ulcer score (r = .490) was higher than that of AAQ and pressure ulcer score (0.039) ($p < .01$). Thus, the results and scale classification were more convincing.

3.6 | The reliability

CAOPAs was tested for internal consistency with Cronbach's α. For internal consistency, a coefficient α of 0.70 or greater was used as standard (Ganesh et al., 2016). For external consistency, which was measured by half-reliability, the judgment standard can be compared with the measurement standard of α reliability coefficient.

3.7 | Scale classification

For the classification of CAOPAs, K-means algorithm and Fisher linear discriminant analysis were used to classify the samples. The clustering results were evaluated by four validity indexes, within-cluster sum of squared errors (*SSE*), single side band (SSB), intra-cluster part of dispersion (IntraDPS(K)) and inter-cluster part of dispersion (InterDPS(K)), so as to establish the best K value and update the

values of each cluster centre step by step and get the best clustering results according to the evaluation results (Shi, 2017).

3.8 | Measurement of nursing working hours

Nursing workload measurement can objectively reflect the nursing needs of patients, and nursing working hours measurement is currently considered to be the most commonly used and classic scientific method in nursing workload measurement. (Lopetegui et al., 2014). The investigators who have received formal assessment training used "nursing time measurement table for older people nursing service projects" (Wang, 2019) and the information chemical time measurement platform to measure the nursing working hours. Specifically, the day shift (6:00 ~ 18:00) was observed and recorded by the investigator, while the night shift (18:00 ~ 6:00) was self-recorded by the nursing staff through the project sheet.

3.9 | Ethical considerations

This study was approved by Nanjing University of Chinese Medicine Ethics Committee. Before data collection, the research team signed the "Contract for Scientific Research Entrustment of Nanjing University of Chinese Medicine" with four long-term care institutions and obtained their permission, we also signed informed consent obtained from all participants. Based on the ethical principles of informed consent, respect, beneficence and confidentiality, as honoured by the research team, all participants were informed about the aims and the method of the study. In the case of older people with cognitive decline, the legal guardian or representative to provide consent to participate in our study. The benefits and possible risks associated with this study were also explained to the participants. Besides, all data were collected anonymously and archived in a password-protected computer. Only the primary investigator and research team members have access to the data.

4 | RESULTS

4.1 | Participant characteristics

In this study, a total of 775 older people from three long-term care institutions in China were included. Seven hundred and twenty-five questionnaires were collected for the first time, of which 25 were discharged because 3 died and 22 were transferred to hospital for treatment. The effective recovery rate is 93.5%. The average age of sample is 84.6 (SD 9.2) (Table 1). The statistics of chronic diseases are hypertension (53.7%), diabetes mellitus (23.4%), coronary heart disease (17.9%) and cerebrovascular disease (35.2%). Among the 725 interviewees, 126 older people with dementia, accounting for 17.4%. 48 older people suffer from mental illness (6.6%). Mild disability and severe disability account for a relatively high proportion in the ability

TABLE 1 Older people's socio-demographic characteristics

Characteristics	Older people (N = 725)(%)
Age(years old), N (%)	
60 ~ 69	39 (5.4)
70 ~ 79	160 (22.0)
≥80	526 (72.6)
Gender, N(%)	
Male	279 (38.5)
Female	446 (61.5)
Marital status, N (%)	
Unmarried	26 (3.6)
Married	326 (45.0)
Widowed	352 (48.6)
Divorced	2 (0.3)
No statement of marital status	19 (2.6)
Degree of education, N (%)	
Junior high school and below	281 (38.8)
High school / vocational high school	146 (20.1)
University and above	175 (24.1)
Unknown	123 (17.0)
Medical expense	
Part of the expenses	708 (97.66)
All at one's own expense	14 (1.93)
All public expenses	3 (0.41)
Dementia	
Yes	126 (17.38)
No	599 (82.62)
Number of chronic diseases	
0	138 (19.0)
1	221 (30.5)
≥2	366 (50.5)

grade of older people, with the percentages of 40.8% and 40.7% (Non-zero p-values<.001) (Table 2).

4.2 | Item screening and initial scale formation

4.2.1 | Screening results of InterRAI-LTCF scale items

Taking the nursing working hours of older people as dependent variables, 196 items of InterRAI-LTCF as independent variables, 154 items with statistical significance in the one-way ANOVA were used as independent variables, and the multiple regression analysis was performed by setting (α) in = 0.05and (α) out = 0.10. The results show that 17 items could jointly explain 78.10% of the variance of nursing time (Table 3).

| Ability grades | long-term care facilities | | | Total [N (%)] |
	1[N,(%)]	2[N,(%)]	3[N,(%)]	
Ability intact	16 (8.5)	40 (11.7)	0 (0.0)	56 (7.7)
Mild disability	81 (42.9)	204 (59.6)	11 (5.7)	296 (40.8)
Moderate disability	23 (12.1)	36 (10.5)	19 (9.8)	78 (10.6)
Severe disability	79 (36.5)	62 (18.1)	164 (84.5)	295 (40.7)
Total	189 (26.1)	342 (47.1)	194 (26.8)	725 (100.0)

TABLE 2 Ability grades of the older people

TABLE 3 Screening results of InterRAI-LTCF scale items($N = 725$)

Dimension	Items	B	SD	Beta	t	p value
	Constant	149.948	143.953		1.042	.298
Communication and Vision	Listening	−98.597	43.114	0.047	2.287	.023
Emotion and behaviour	Always complaining and worrying	186.790	62.619	0.057	2.983	.003
Mental health	Telling or hinting being lonely	251.279	100.946	0.048	2.489	.013
Functional condition	Lower body dressing ability	176.025	43.273	0.207	4.068	.000
	Using of bathrooms	184.065	35.033	0.253	5.254	.000
	Bed activity	84.892	40.627	0.094	2.090	.037
	Eating	167.764	38.839	0.167	4.319	.000
	Time out of residence in the last 3 days	106.799	38.624	0.063	2.765	.006
Self-control	Controlled defecation	126.243	36.476	0.118	3.461	.001
Disease diagnosis	Hemiplegia	389.993	121.416	0.060	3.212	.001
	Pneumonia	331.227	150.510	0.043	2.201	.028
Skin condition	Foot problem	94.233	47.939	0.039	1.966	.050
Treatment	Respirator or ventilator	860.899	282.062	0.059	3.052	.002
	Wound care	325.900	95.046	0.064	3.429	.001
	Doctor's advice	504.089	112.103	0.084	4.497	.000
Social participation	Living ability	277.054	52.950	0.210	5.232	.000
	Time / space orientation	84.635	40.670	0.067	2.081	.038

Note: $R^2 = 0.781$, $\triangle R^2 = 0.776$, $p < .001$.
Abbreviations: B, partial regression coefficient; Beta, standard regression coefficient; SD, standard deviation.

4.2.2 | Screening results of AAQ scale items

Taking the nursing working hours of older people as dependent variables, 40 items of AAQ as independent variables and 32 items of statistical significance in single-factor analysis of variance as independent variables. Also, 24-hr nursing working hours of older people was taken as dependent variable, and the multiple regression analysis was performed by setting (α) in = 0.05and (α) out = 0.10. The results show that 9 items of the scale entered the regression equation ($F = 131.210$, $p = .000$). These nine factors could explain 82.60% of the variation of nursing working hours (Table 4).

4.2.3 | Initial scale formation

The research team selected 8 nursing management experts in the field of nursing care for older people to conduct focus interviews.

The following are the central results of the focus interview (1)Put the "height and weight" of InterRAI-LTCF into the basic data section, so that interviewees can more intuitively understand the body shape of the older people; (2) Add the items of "easy distraction" and "speech confusion" of InterRAI-LTCF; Move the "time / space orientation" and "character orientation" of the social participation part of AAQ to this dimension; (3) Add InterRAI-LTCF communication and vision, which can be divided into "expression ability" and "understanding ability"; (4) In the third dimension, the item of InterRAI-LTCF emotion and behaviour is used to remove aggressive behaviour and depression in AAQ, and the interviewees said that the item of InterRAI-LTCF is more detailed than AAQ and can reflect more emotional and mental problems and nursing needs; (5) Increase the number of items in InterRAI-LTCF: "full-bed slides with open beds on both sides," "torso restraint device" and "seats to prevent getting up"; (6) In the fifth dimension, the items of "skin pressure sore" and "oral / dental" in InterRAI-LTCF could reflect the condition of older people.

TABLE 4 Screening results of AAQ scale items (N = 725)

Dimension	Items	B	SD	Beta	t	p value
	Constant	4,436.539	231.340		19.178	.000
Disease diagnosis	Dementia	154.512	44.595	0.080	3.465	.001
Activities of daily life	Eating	80.597	16.744	0.159	4.813	.000
	Making up	119.477	30.238	0.137	3.951	.000
	Dressing	78.106	21.409	0.162	3.648	.000
	Stool control function	41.768	16.153	0.080	2.586	.010
	Bathroom usage	88.547	24.809	0.178	3.569	.000
	Indoor movement	32.943	13.794	0.096	2.388	.017
Social participation	Time / space orientation	118.066	36.303	0.092	3.252	.001
	Living ability	223.464	46.010	0.156	4.857	.000

Note: $R^2 = 0.826, \triangle R^2 = 0.824, p < .001$

Abbreviations: AAQ, ability assessment questionnaire for older people; B, partial regression coefficient; Beta, standard regression coefficient; SD, standard deviation.

Combined with the objective screening method and focus interview method, the qualified parts of each scale are selected as scale items, and a scale was initially formed with a total of 6 dimensions, namely "mentation and cognitive, perception and communication, emotional problems, mental and behavioural problems, daily life and social participation, skin and oral status," a total of 42 items, including 24 items of InterRAI-LTCF scale and 18 items of AAQ.

4.3 | The validity

4.3.1 | Content validity

In this study, seven experts related to nursing care service for older people research in Nanjing were invited to judge the scale and items, respectively. The recovery rate and expert coefficient were 100%. The expert's judgment on the problem was based on (Ca) of 0.86, the familiarity of (Cs) of 0.83 and the authority coefficient of (Cr) of 0.85. These experts are highly authoritative in nursing care for older people. There were options of a four-grade score set in the letter table, among which 1 = irrelevant, 2 = weak correlation, 3 = strong correlation and 4 = very relevant. The percentage of S-CVI/UA (universal agreement) was 87.5% > 80%, which indicated that the content validity of the scale was good. The S-CVI/Ave value of the scale was 0.982 > 0.9, which met the requirements.

4.3.2 | Construct validity: Confirmative factor analysis

We tested the model with the six dimensions formed in the previous stage. The item factor loading results showed that the factor load of the two items, T27 "time to get out of residence in the last 3 days" and T40 "the family maintains a strong relationship of mutual assistance," were less than 0.4 and negative for the first analysis,

so we deleted the two items. After deleting these two items, the CFA model reached a good fit, with $\chi^2 = 6,434.051$, df 725, p < .01; CFI = 0.970; TLI = 0.953; RMSEA = 0.043; and SRMR = 0.061. After the modification of the model, each index showed that the modified model fitted well with the actual data model. The secondary order factor was good for every dimension (Figure 1).

4.3.3 | The reliability

The reliability coefficient alpha was 0.951 for the entire scale, and for each factor, the coefficients were 0.906 for "mentation and cognitive," 0.849 for "perception and communication," 0.763 for "emotional problems," 0.768 for "mental and behavioural problems," 0.946 for "daily life and social participation" and 0.760 for "skin and oral condition," respectively.

4.4 | Scale classification

4.4.1 | Establishment of the best K value

Matlab 2015b is used as a statistical tool, and the results of the comprehensive evaluation of 246 older people collected for the second time was used as a data set. K values were randomly assigned 2–10 to classify the data set to calculate the four validity indicators of different classification results (Table 5, Figure 2).

4.4.2 | Cluster analysis results

Cluster analysis was conducted according to the scores of each dimension and the total score of CAOPAs, and the comprehensive ability of older people could be divided into four grades. As for the result of test, there were 21 older people in grade 0 (ability intact),
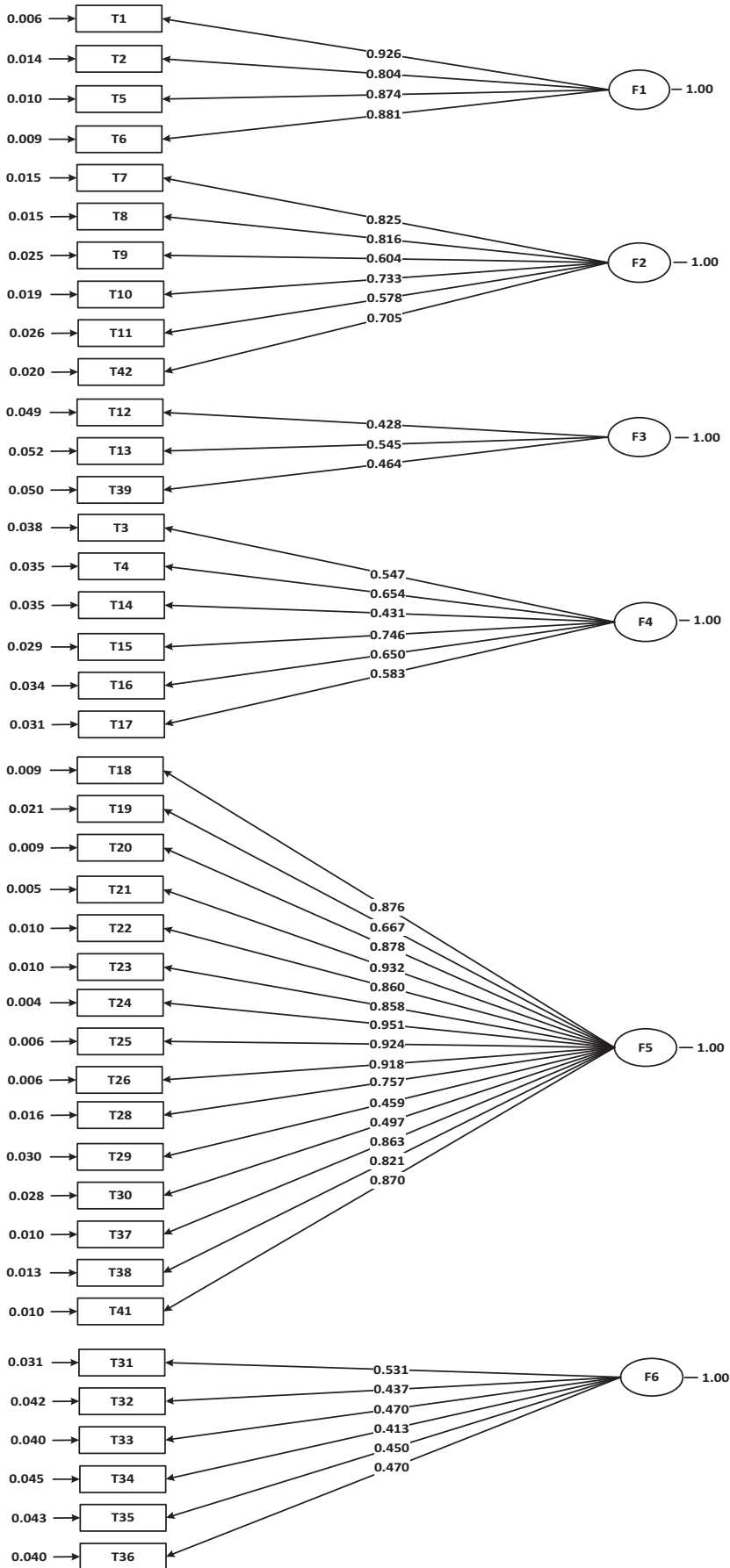
FIGURE 1 Confirmatory Factor Analysis model of CAOPAs. (CAOPAs, Comprehensive Ability of Older People Assessment scale; T, Item; F, Dimension)

52 in grade 1 (Mild disability), 142 in grade 2 (moderate disability) and 31 in grade 3 (severe disability).

4.4.3 | Discriminant analysis results

According to the clustering results, discriminant analysis was carried out on the non-overlapping parts of the comprehensive ability assessment scores of older people, and the discriminant function was established (Table 6). The constructed discriminant function was used in this study to cross verify the non-overlapping data, among which the correct discrimination rates of four grades were 95.2%, 96.2%, 95.8% and 93.5%, indicating that the established discriminant function has good discrimination effect (Table 7). The discriminant function was used to discriminate and analyse the overlapping

data and established the segmentation boundary value of each grade finally (Table 8).

4.5 | Reverse verification

The dimensions of the InterRAI-LTCF are detailed, which can evaluate the health status of older people in many aspects (Ca Rpenter & Hirdes, 2013). Through the systematic review, we know that compared with a single scale, the assessment of InterRAI-LTCF can more accurately assess the ability of older people (Zhang et al., 2019). Moreover, our previous research is based on the InterRAI-LTCF and AAQ, and the reverse verification after the formation of CAOPAs. If we will compare with the grades of AAQ and do the correlation analysis with the ability module of InterRAI-LTCF, the results would be more meaningful. A

TABLE 5 Results of evaluation indicators with different k values ($N = 246$)

Indicators	K = 2	K = 3	K = 4	K = 5	K = 6	K = 7	K = 8	K = 9	K = 10
SSE	991.1484	830.2628	561.5667	531.9026	498.3412	442.3305	396.5902	378.302	334.2205
SSB	723.8516	884.7372	1,153.433	1,183.097	1,216.659	1,272.669	1,318.410	1,336.698	1,380.779
IntraDPS	0.577929	0.484118	0.327444	0.310147	0.290578	0.257919	0.231248	0.220584	0.194881
InterDPS	0.422071	0.515882	0.672556	0.689853	0.709422	0.742081	0.768752	0.779416	0.805119

Note: $p < .001$.

Abbreviations: InterDPS, inter-cluster part of dispersion; IntraDPS, intra-cluster part of dispersion; SSB, single side band; *SSE*, within-cluster sum of squared errors.
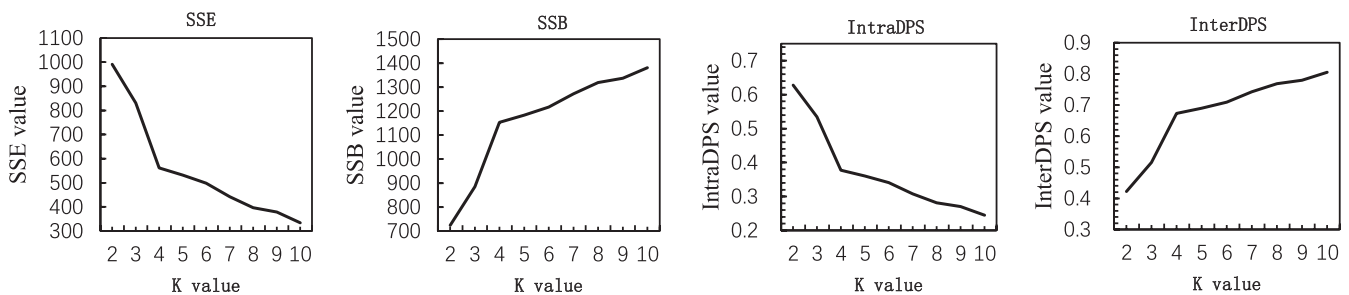

FIGURE 2 Four indicator values corresponding to different k values

TABLE 6 Discriminant function coefficient of comprehensive ability grade

	Discriminant function			
	1	2	3	4
Mentation and cognitive	1.165	1.016	0.161	0.422
Perception and communication	0.196	0.551	−0.06	0.017
Emotional problems	0.758	−0.558	0.29	4.336
Mental and behavioural problems	5.965	1.385	−0.007	−0.47
Daily life and social participation	0.389	0.533	0.119	0.131
Skin and oral condition	0.573	1.237	1.148	2.118
(Constant)	−31.197	−21.487	−2.739	−12.364

Note: $p < .001$.

Grades	Forecast group members				Total
	1	2	3	4	
1	20(95.2%)	1(4.8%)	0	0	21 (100%)
2	2(3.8%)	50(96.2%)	0	0	52 (100%)
3	0	0	136(95.8%)	6(4.2%)	142 (100%)
4	0	0	2(6.5%)	29(93.5%)	31 (100%)

Note: p < .001.

TABLE 8 Classification method of CAOPAs

Grades	Score range
Grade 0 (ability intact)	0–35 points
Grade 1 (Mild disability)	36–51 points
Grade 2 (moderate disability)	52–80 points
Grade 3 (severe disability)	81–110 points

Note: p < .001.
Abbreviations: CAOPAs, Comprehensive Ability of Older People Assessment scale.

total of 246 older people were evaluated by two scales (CAOPAs and AAQ), and 63 of them had different ability grades results. Spearman correlation analysis was conducted to the ability grades (1, 2, 3, 4) of these 63 older people and the ability-related modules (body mass index, cognitive score, activities of daily living, depression score, pain score, communication score, pressure ulcer score, social participation) in InterRAI-LTCF. The results show that the correlation coefficient of CAOPAs is higher than that of AAQ, indicating that CAOPAs is more related to the ability of older people, and thus, the evaluation results and grades would be more convincing (Table 9).

5 | DISCUSSION

We have developed a new instrument for assessing comprehensive ability in older people called CAOPAs and appraised its psychometric characteristics. The theoretical framework considered was the holistic nursing theory, which is guided by modern nursing concept, requiring the best nursing measures for older people's physiological, psychological, social participation, cultural adaptation and other aspects of nursing needs (Chen & Luo, 2016). The instrument showed good validity and reliability. Therefore, it could be used by pension evaluators to assess the comprehensive ability of older people.

5.1 | The Scientific Development of CAOPAs

5.1.1 | This study used mature scales for evaluation, combined with nursing time measurement method for verification

Under the framework of holistic nursing theory and with help of the previous literature research and empirical investigation of our

research team, this scale has been published whether at home or abroad and tested for reliability and validity, and we conducted field surveys in long-term care institutions. InterRAI-LTCF and AAQ were used to assess the ability and nursing needs of the same older people. These two scales are both internationally recognized mature and reliable assessment tools. Each item of the maturity scale has a detailed description as the basis for evaluation and judgment, and they have been used in the population of older people, which conformed to our research purpose and direction. Our pre-research results of the subject, "nursing time measurement table for older people nursing service projects" and the information chemical time measurement platform were used to measure the nursing working hours. In this study, it is the first time that the nursing time measurement method was used to select the scale items to explore the relationship and correlation between the comprehensive ability of older people and the length of nursing working hours, in line with the actual situation of long-term care institutions.

5.1.2 | This study combined quantitative and qualitative methods, as well as reliability and validity testing methods, aiming at making the scale construction more reasonable

We used the data collected from the field survey to initially screen the scale items and then combined the results of focus interview method to test and select the applicability and feasibility of the scale items to form a preliminary table. Based on the combination of qualitative and quantitative methods, the content validity and reliability of CAOPAs were tested. In the content validity assessment, there were deleted items considered not relevant. Then, we obtained a good content validity index, confirming that the remaining items adequately represented the construct. Confirmatory factor analysis was used to judge the structural validity of our scale, to verify the fitting degree of theoretical model and data and to revise the naming and items of factors after confirmatory factor analysis. The results show that the construction of our scale is scientific, reasonable and standardized.

5.2 | The rationality of the classification of CAOPAs

In this study, through a large sample survey, cluster sampling method, cluster analysis, discriminant analysis and the establishment of the best K value were used to divide the scores of comprehensive ability

TABLE 9 Spearman correlation analysis results(N = 63)

	CAOPAs	AAQ
CAOPAs	1.000	0.138
AAQ	0.138	1.000
Body mass index	−0.263**	−0.124
Cognitive score	0.535**	0.018
Activities of daily living	0.511**	0.045
Depression score	−0.075	0.085
Pain score	−0.340**	−0.169*
Communication score	0.453**	−0.071
Pressure ulcer score	0.490**	0.039
Social participation	−0.277**	0.025

Note: *p < .05. **p < .01.

Abbreviations: AAQ, ability assessment questionnaire for older people; CAOPAs, Comprehensive Ability of Older People Assessment scale.

assessment of older people by sections and to establish the boundary value of each segment. The best clustering number (K value) was 4. Combined with the suggestions of older people care service experts and the requirements of national policy documents, the comprehensive ability assessment of older people in long-term care institutions is divided into four grades: Grade 0 (ability intact), Grade 1 (Mild disability), Grade 2 (moderate disability) and Grade 3 (severe disability). Therefore, the ability of 246 older people was divided into four grades, including 21 older people in Grade 0, 52 in Grade 1, 142 people in Grade 2 and 31 in Grade 3. According to the results of cluster analysis, discriminant analysis was carried out on the non-overlapping part of CAOPAs, and the discriminant function was established. By using the established discriminant function to the known overlapping sample data, the correct discrimination rate of the four grades are 95.2%, 96.2%, 95.8% and 93.5%, which shows that the established discriminant function has good discrimination effect and the final threshold value of each segment of the grading level is reasonable and reliable.

5.3 | The feasibility of application of CAOPAs

The empirical study was carried out after the formation of the final version of CAOPAs, and the analysis of variance between different grades of older people and nursing time was carried out. The results were in line with the actual situation of the older people's nursing needs. It could be seen that there were differences in the length of nursing time for older people of different ability grades with discrimination. The correlation analysis between the comprehensive ability assessment score of older people and nursing time showed that r = .358 and p < .05. The results show that the longer the nursing working hours are, the higher the comprehensive ability evaluation scores of older people are, and the higher the ability level of older people is. This shows that the nursing workload of long-term care institutions is related to the ability level of older people. Therefore, CAOPAs conforms to the actual situation of long-term care institutions, and it is feasible in long-term care institutions.

5.4 | Limitations

There are some limitations on this study. Firstly, the traceability of the older people may have influenced the answers to the questionnaire. Secondly, the adjustment of the structural validity of CAOPAs is a long-term process. In this study, two values of confirmatory factor analysis are close to the standard of good fitness, indicating that our scale needs to be revised and improved in practice. In addition, due to the limited time of the survey, only four long-term care institutions were selected in this study, and thus, the results may only be the representation of the local reality. We need to consider future evaluations of the psychometric characteristics of CAOPAs to confirm our results. However, as the first study that is carried out in long-term care institutions and taking the screening of scale items and nursing working time into account in the comprehensive ability assessment of older people, this study is still commendable.

5.5 | Future research plans

1. In the future, the research sites will be further expanded, and the mature paths and methods explored in this study will be used to investigate and study the nursing care needs of family and community-based care for the older people, so as to form suitable assessment tools according to the situation of different places and institutions (Xu, 2019).

2. We will continue to explore the relevant mechanisms among the comprehensive ability score, nursing grade and nursing service items of older people, build a hierarchical network platform for elderly care (Gui, 2019), communicate with product developers, combine the characteristics of nursing specialty and the needs of elderly care and explore the in-depth application of Internet technology in the pension service industry.

3. Based on the talent training module of the platform, the practical work of the training system of nursing service personnel for older people will be carried out to train diversified nursing personnel for the long-term care institutions, universities, communities and hospitals,optimize the talent allocation.

4. According to the nursing operation items and nursing working hours of long-term care institutions, we will evaluate the workload of nursing staff (Wang, 2019) and construct a nursing manpower cost accounting mode to improve the supportability of long-term care institutions as the mainline to ensure that everyone could enjoy nursing service.

6 | CONCLUSION

The CAOPAs (40-item and 4-grade) could accurately and comprehensively assess the older people's ability and nursing needs, whose results indicate that CAOPAs have good validity and reliability, as well as good usability and utility. The research results provide a reference basis for older people's nursing needs assessment and may

help to deepen the reform of pension services. In addition, CAOPAs monitoring can be useful for evaluating the effect of different nursing measures or pension service support over time and improve quality in nursing care for older people.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

ETHICAL APPROVAL

This study was approved by Nanjing University of Chinese Medicine Ethics Committee. Before data collection, the research team signed the "Contract for Scientific Research Entrustment of Nanjing University of Chinese Medicine" with four long-term care institutions and obtained their permission, we also signed informed consent was obtained from all participants.

STATEMENT OF HUMAN AND ANIMAL RIGHTS

This paper does not contain any experiments involving human participants or animals performed by any of the authors.

INFORMED CONSENT

Informed consent was obtained from all individual participants included in the study.

DATA AVAILABILITY STATEMENT

The raw/processed data required to reproduce these findings cannot be shared at this time as the data also forms part of an ongoing study.

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