Postprint: Latent Class Analysis of Cognitive Function and Influencing Factors in Community-Dwelling Elderly with Chronic Diseases

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Abstract

Background: Elderly community residents with chronic diseases are at higher risk of cognitive impairment, which seriously threatens their quality of life. While improving cognitive function is an important means to enhance their quality of life, there exists heterogeneity in the patterns of cognitive impairment among elderly community populations with chronic diseases and different characteristics. How to effectively improve their cognitive function remains to be further explored.

Objective: To explore the latent classes of cognitive function among elderly community residents with chronic diseases and analyze the influencing factors of different classes, in order to provide references for formulating targeted strategies to improve cognitive function.

Methods: Using convenience sampling method, from September to December 2022, community-dwelling elderly patients with chronic diseases who visited Baokang Hospital Affiliated to Tianjin University of Traditional Chinese Medicine were surveyed using a General Information Questionnaire, Mini-Mental State Examination (MMSE), Activities of Daily Living Scale (ADLS), Social Support Rating Scale (SSRS), and Cognitive Reserve Questionnaire (CR). Mplus 8.3 was used to conduct latent class analysis and establish subgroup models. Univariate analysis and unordered multivariate Logistic regression analysis were performed to explore the influencing factors of cognitive function among elderly community residents with chronic diseases in different classes.

Results: A total of 526 questionnaires were distributed in this study, and 502 valid questionnaires were recovered, with an effective recovery rate of 95.44%. The cognitive function of 502 elderly community residents with

chronic diseases could be divided into three classes: high cognition-recall impairment group (n=253), medium cognition-attention disorder group (n=158), and low cognition-general poor group (n=91). The results of unordered multivariate Logistic regression analysis showed that, compared with the low cognition-general poor group, elderly community residents with chronic diseases aged 60-74 years (OR=2.315, 95%CI=1.163-4.608, P=0.017), with 2 chronic diseases (OR=4.105, 95%CI=1.807-9.327, P=0.001), normal blood pressure (OR=2.763, 95%CI=1.414-5.400, P=0.003), normal blood lipids (OR=2.016, 95%CI=1.014-4.008, P=0.046), higher CR total score (OR=1.031, 95%CI=1.005-1.057, P=0.018), and higher SSRS total score (OR=1.031, 95%CI=1.007-1.105, P=0.023) were more likely to be in the high cognition-recall impairment group, while elderly residents with higher ADLS total score (OR=0.920, 95%CI=0.885-0.957, P<0.001) were more likely to be in the low cognition-general poor group. Compared with the low cognition-general poor group, elderly community residents with chronic diseases with 2 chronic diseases (OR=2.862, 95%CI=1.254-6.529, P=0.012), normal blood pressure (OR=2.655, 95%CI=1.350-5.225, P=0.005), normal blood lipids (OR=2.310, 95%CI=1.147-4.652, P=0.019), and higher SSRS total score (OR=1.077, 95%CI=1.027-1.129, P=0.002) were more likely to be in the medium cognition-attention disorder group, while elderly residents with higher ADLS total score (OR=0.948, 95%CI=0.913-0.984, P=0.005) were more likely to be in the low cognition-general poor group.

Conclusion: Cognitive function among elderly community residents with chronic diseases exhibits distinctly different classification characteristics. Age, number of chronic diseases, blood pressure, blood lipids, cognitive reserve, social support, and activities of daily living are influencing factors of their cognitive function latent classes. Medical staff should actively identify the cognitive function characteristics of different classes of elderly community residents with chronic diseases and provide timely effective interventions to improve the cognitive function level of elderly community residents with chronic diseases.

Full Text

Latent Class Analysis and Influence Factors Study of Cognitive Function among Older People with Chronic Diseases in Community

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Abstract

Background Older adults with chronic diseases in community settings face elevated risks of cognitive impairment, which severely threatens their quality of life. While improving cognitive function represents a crucial means to enhance their well-being, heterogeneity exists in the manifestation of cognitive impairment across different subgroups of community-dwelling elderly with chronic conditions. Effective strategies for cognitive enhancement require further exploration tailored to these distinct patterns.

Objective To identify latent classes of cognitive function among community-dwelling older adults with chronic diseases and analyze the influencing factors associated with each class, thereby providing evidence for developing targeted cognitive improvement strategies.

Methods Using convenience sampling, we conducted a survey from September to December 2022 among community-dwelling older adults with chronic diseases attending Tianjin University of Traditional Chinese Medicine Affiliated Baokang Hospital. Participants completed the General Information Questionnaire, Mini-Mental State Examination (MMSE), Activity of Daily Living Scale (ADLS), Social Support Rating Scale (SSRS), and Cognitive Reserve Questionnaire (CR). Latent class analysis was performed using Mplus 8.3 to establish subgroup models. Univariate analysis and unordered multinomial logistic regression were employed to examine factors influencing cognitive function across different classes.

Results Of 526 questionnaires distributed, 502 valid responses were collected (effective response rate: 95.44%). Cognitive function among the 502 community-dwelling older adults with chronic diseases clustered into three distinct classes: high cognition with memory impairment (n=253, 50.4%), moderate cognition with attention impairment (n=158, 31.5%), and low cognition with overall impairment (n=91, 18.1%). Unordered multinomial logistic regression revealed that, compared to the low cognition group, individuals aged 60-74 years (OR=2.315, 95%CI=1.163-4.608, P=0.017), with two chronic diseases (OR=4.105, 95%CI=1.807-9.327, P=0.001), normal blood pressure (OR=2.763, 95%CI=1.414-5.400, P=0.003), normal blood lipids (OR=2.016, 95%CI=1.014-4.008, P=0.046), higher CR scores (OR=1.031, 95%CI=1.005-1.057, P=0.018), and higher SSRS scores (OR=1.031, 95%CI=1.007-1.105, P=0.023) were more likely to belong to the high cognition with memory impairment group. Conversely, higher ADLS scores (OR=0.920, 95%CI=0.885-0.957, P<0.001) increased likelihood of membership in the low cognition group. Similarly, compared to the low cognition group, those with two chronic diseases (OR=2.862, 95%CI=1.254-6.529, P=0.012), normal blood pressure (OR=2.655, 95%CI=1.350-5.225, P=0.005), normal blood lipids (OR=2.310, 95%CI=1.147-4.652, P=0.019), and higher SSRS scores (OR=1.077, 95%CI=1.027-1.129,

P=0.002) were more likely to belong to the moderate cognition with attention impairment group, while higher ADLS scores (OR=0.948, 95%CI=0.913-0.984, P=0.005) predicted membership in the low cognition group.

Conclusion Community-dwelling older adults with chronic diseases exhibit distinct cognitive function profiles. Age, number of chronic diseases, blood pressure, blood lipids, cognitive reserve, social support, and activities of daily living significantly influence latent class membership. Healthcare providers should actively identify cognitive characteristics across these classes and implement timely, effective interventions to improve cognitive function in this population.

Keywords Chronic disease; Cognition; Community; Aged; Latent class analysis; Root cause analysis

Introduction

The seventh national census revealed that China had 264 million people aged 60 years and older in 2020, a figure projected to exceed 500 million by 2050 [1]. Population aging has led to a rapid increase in chronic disease prevalence, with approximately 86.3% of community-dwelling older adults in China living with chronic conditions [2,3]. Compared with healthy peers, older adults with chronic diseases face higher risks of cognitive impairment [4], defined as subjective or objective decline in one or more cognitive domains including perception, attention, memory, and language [5]. As a prodromal symptom of dementia [6], cognitive impairment severely impacts quality of life, triggers long-term care needs, and increases societal healthcare burdens [7].

Previous research indicates that cognitive function is influenced by multiple factors including disease status, physical function, cognitive reserve, and social support [8-10], suggesting that cognitive impairment patterns may vary across different subgroups of older adults with chronic diseases. However, existing studies typically evaluate cognitive function using total scale scores without considering individual differences in cognitive performance profiles. Latent class analysis can identify subgroups of older adults with similar cognitive patterns, enabling exploration of population heterogeneity and provision of targeted support [11]. Therefore, this study employed latent class analysis to examine cognitive function profiles among community-dwelling older adults with chronic diseases and analyze class-specific influencing factors to inform tailored cognitive enhancement strategies.

Methods

Study Subjects

We used convenience sampling to recruit 526 community-dwelling older adults with chronic diseases attending Tianjin University of Traditional Chinese Medicine Affiliated Baokang Hospital between September and December 2022.

Inclusion criteria: (1) age $\geq$ 60 years; (2) community residence $\geq$ 6 months; (3) diagnosis of at least one chronic disease by a secondary-level or higher hospital; (4) adequate reading and communication abilities; (5) informed consent.

Exclusion criteria: (1) history of diagnosed mental disorders; (2) severe hearing or visual impairments preventing effective participation.

Sample size was calculated using the formula $N = (Z_1\text{-}\alpha/_2/\delta)^2 \times p \times (1\text{-}p)$ [12], with $\alpha = 0.05$ ($Z_1\text{-}\alpha/_2 = 1.96$), allowable error $\delta = 0.05$, and estimated cognitive impairment prevalence $p = 0.19$ [13], yielding a required sample of 237 participants.

Instruments

General Information Questionnaire: Developed through literature review and expert consultation, this questionnaire included: (1) demographics (gender, age, marital status, smoking, alcohol consumption, height, weight); (2) disease characteristics (number of chronic diseases, blood pressure, blood glucose, blood lipids).

Mini-Mental State Examination (MMSE): Developed by Folstein et al. [14] and validated in Chinese by Wang et al. [15], the MMSE assesses cognitive function across five domains: orientation (10 items), memory (3 items), attention and calculation (5 items), recall (3 items), and language (9 items), totaling 30 items. Each item is scored dichotomously (1 = correct, 0 = incorrect), with total scores ranging from 0 to 30 (higher scores indicate better function). Cognitive impairment is defined as scores $\leq$ 17 for less than primary education, $\leq$ 20 for primary education, and $\leq$ 24 for middle school education or higher.

Activity of Daily Living Scale (ADLS): Developed by Lawton et al. [16], the ADLS evaluates physical function through 14 items across two domains: physical self-maintenance (6 items) and instrumental activities of daily living (8 items). Items use a 4-point Likert scale, with total scores ranging from 14 to 56 (higher scores indicate greater impairment).

Social Support Rating Scale (SSRS): Developed by Xiao [17], the SSRS measures social support across three dimensions: subjective support (4 items), objective support (3 items), and support utilization (3 items), totaling 10 items. Except for items 6 and 7 (scored by selected options), all items use a 4-point Likert scale, with total scores ranging from 12 to 66 (higher scores indicate better support).

Cognitive Reserve Questionnaire (CR): Following international practice [10,18-21], cognitive reserve was measured using three proxy indicators: (1) Education level (categorized as "below primary," "primary," "middle school," "high school/technical secondary," "college," and "bachelor' s or above" using a 6-point Likert scale); (2) Occupation type (categorized as "unemployed," "low-skill manual," "skilled manual," "skilled non-manual," "professional," and "high responsibility/intellectual demand" using a 7-point Likert scale); (3) Cognitively stimulating activities (assessed by frequency of participation in physical, intellectual, and social activities using a 4-point Likert scale). Following international methods for calculating cognitive reserve total scores using interquartile ranges as weight coefficients [22], the formula was: CR total = 2 × education level + 3 × occupation type + 4 × cognitive activities. Total scores range from 0 to 64, with higher scores indicating greater cognitive reserve.

Survey Methods and Quality Control

General information and scale data were collected through one-on-one interviews by trained researchers using standardized instructions, with responses recorded accurately. Disease data were measured and recorded by community healthcare professionals according to established guidelines: hypertension (systolic $\geq$ 140 mmHg and/or diastolic $\geq$ 90 mmHg) [23], hyperglycemia (fasting glucose $\geq$ 7.0 mmol/L or random glucose $\geq$ 11.1 mmol/L) [24], and dyslipidemia (total cholesterol $\geq$ 5.18 mmol/L, triglycerides $\geq$ 1.70 mmol/L, LDL cholesterol $\geq$ 3.37 mmol/L, or HDL cholesterol $<$ 1.04 mmol/L) [25].

Statistical Analysis

Data were analyzed using SPSS 26.0 and Mplus 8.3. Latent class models with 1–5 classes were fitted using Mplus 8.3, with optimal model selection based on fit indices [11,26]. Model fit was evaluated using Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample-size adjusted BIC (aBIC), where lower values indicate better fit (BIC is generally preferred for model selection). Entropy assessed classification quality ($\geq$ 0.80 indicates acceptable fit). The Lo-Mendell-Rubin likelihood ratio test (LMR) and Bootstrap likelihood ratio test (BLRT) compared model fit, with significant P-values indicating that a k-class model fit significantly better than a (k-1)-class model.

SPSS 26.0 was used for descriptive statistics, chi-square tests for categorical variables, and one-way ANOVA for continuous variables. Unordered multinomial logistic regression identified factors influencing cognitive function class membership, with $P < 0.05$ considered statistically significant.

Results

Survey Results and General Characteristics

We distributed 526 questionnaires and recovered 502 valid responses (effective response rate: 95.44%). Participants ranged in age from 60 to 98 years (mean: 70.3 ± 7.5 years), with 264 males (52.6%) and 238 females (47.4%).

Scale Scores

The mean MMSE total score was 24.78 ± 5.45, with 133 participants (26.50%) showing cognitive impairment. Domain scores were: orientation 8.94 ± 1.72, memory 2.73 ± 0.65, attention and calculation 3.67 ± 1.49, recall 1.90 ± 1.07, and language 7.54 ± 1.90.

The mean ADLS total score was 20.32 ± 8.74 (physical self-maintenance: 7.66 ± 3.08; instrumental activities: 12.66 ± 6.03). The mean SSRS total score was 36.56 ± 8.31 (objective support: 8.83 ± 2.91; subjective support: 20.78 ± 4.65; support utilization: 6.94 ± 2.49). The mean CR total score was 28.97 ± 14.57.

Latent Class Analysis of Cognitive Function

Using the 30 MMSE items as indicators, we fitted 1–5 class models . As class number increased, AIC, BIC, and aBIC decreased, with BIC reaching its minimum at 3 classes. The 3-class model showed Entropy = 0.877, with average classification probabilities of 92.3%–96.8%, indicating high reliability. LMR ($P = 0.002$) and BLRT ($P < 0.001$) were statistically significant, confirming that the 3-class model fit significantly better than the 2-class model. Therefore, the 3-class model was selected as optimal.

Conditional probability distributions across the 30 items for the three classes are shown in [Figure 1: see original paper]. Class 1 (C1) showed relatively high probabilities (> 0.800) across most items, except item 21 in the recall domain (probability = 0.735), and was labeled "high cognition with memory impairment" (n = 253, 50.4%). Class 2 (C2) showed intermediate probabilities (> 0.400) across most items, except item 18 in the attention domain (probability = 0.341), and was labeled "moderate cognition with attention impairment" (n = 158, 31.5%). Class 3 (C3) showed low probabilities (< 0.400) across multiple items in orientation (items 4, 5, 10), attention (items 16, 17, 18), recall (items 19, 20, 21), and language (items 26, 29, 30) domains, and was labeled "low cognition with overall impairment" (n = 91, 18.1%).

Univariate Analysis of Cognitive Function Classes

Significant differences across cognitive function classes were found for age, marital status, number of chronic diseases, blood pressure, blood glucose, blood lipids, ADLS total score, SSRS total score, and CR total score ($P < 0.05$). No significant differences were observed for gender, smoking, alcohol consumption, or BMI ($P > 0.05$) .

Multivariate Analysis of Cognitive Function Classes

Using the low cognition group as reference, unordered multinomial logistic regression was performed with variables significant in univariate analysis (see for coding). Results showed that, compared to the low cognition group, participants aged 60-74 years (OR = 2.315, 95%CI = 1.163-4.608, P = 0.017), with two chronic diseases (OR = 4.105, 95%CI = 1.807-9.327, P = 0.001), normal blood pressure (OR = 2.763, 95%CI = 1.414-5.400, P = 0.003), normal blood lipids (OR = 2.016, 95%CI = 1.014-4.008, P = 0.046), higher CR scores (OR = 1.031, 95%CI = 1.005-1.057, P = 0.018), and higher SSRS scores (OR = 1.031, 95%CI = 1.007-1.105, P = 0.023) were more likely to belong to the high cognition with memory impairment group, while higher ADLS scores (OR = 0.920, 95%CI = 0.885-0.957, P < 0.001) predicted membership in the low cognition group.

Similarly, compared to the low cognition group, participants with two chronic diseases (OR = 2.862, 95%CI = 1.254-6.529, P = 0.012), normal blood pressure (OR = 2.655, 95%CI = 1.350-5.225, P = 0.005), normal blood lipids (OR = 2.310, 95%CI = 1.147-4.652, P = 0.019), and higher SSRS scores (OR = 1.077, 95%CI = 1.027-1.129, P = 0.002) were more likely to belong to the moderate cognition with attention impairment group, while higher ADLS scores (OR = 0.948, 95%CI = 0.913-0.984, P = 0.005) predicted membership in the low cognition group .

Discussion

Heterogeneity in Cognitive Function among Community-Dwelling Older Adults with Chronic Diseases

This study found that 133 participants (26.50%) exhibited cognitive impairment, a higher rate than the 19.0% reported by Shi et al. [13]. Cognitive function among community-dwelling older adults with chronic diseases showed individual variation, clustering into three distinct classes: "high cognition with memory impairment,""moderate cognition with attention impairment,"and "low cognition with overall impairment."

The high cognition group (50.4%) demonstrated the best overall cognitive performance with only mild memory deficits. This may reflect better physical function and adequate social support, providing more opportunities for social connection and interaction that help maintain cognitive health [27,28]. The moderate cognition group (31.5%) showed intermediate overall performance with characteristic attention deficits, possibly due to higher burden of chronic diseases leading to elevated chronic inflammation, fatigue, and frailty that impair attention [29,30]. The low cognition group (18.1%) exhibited poor performance across multiple domains, likely resulting from combined cardiovascular and metabolic diseases affecting cerebral oxygen supply, low cognitive reserve, and reduced capacity to

cope with brain injury [31,32]. Healthcare providers should strengthen regular health screenings, monitor chronic disease management, and encourage participation in leisure and social activities to maintain cognitive function.

Influencing Factors of Cognitive Function Classes

Age, Blood Pressure, Blood Lipids, and Number of Chronic Diseases Age, blood pressure, blood lipids, and number of chronic diseases were identified as risk factors, consistent with previous research [33-35]. Potential mechanisms include: (1) aging-related brain atrophy causing neuronal loss and synaptic dysfunction [33]; (2) blood pressure and lipid abnormalities causing microvascular injury that impairs cerebral blood flow, oxygen supply, and metabolism [36]; and (3) multiple chronic diseases leading to polypharmacy and increased risk of central nervous system adverse effects [37]. Community healthcare providers should closely monitor older adults with chronic diseases, particularly those of advanced age, and develop personalized comprehensive disease management plans addressing medication, diet, and exercise to prevent or delay cognitive impairment.

Activities of Daily Living Impaired activities of daily living emerged as a risk factor, aligning with Ono et al. [38]. Possible explanations include: (1) reduced physical activity limiting neurovascular generation and synaptic plasticity benefits [39]; and (2) decreased social participation and increased social isolation accelerating cognitive decline [40]. Healthcare providers should offer appropriate exercise programs based on physical function levels, encourage physical activity, utilize community activity centers to provide social spaces, and increase opportunities for social participation to protect cognitive function.

Social Support Higher social support served as a protective factor, consistent with Zhang et al. [41]. Mechanisms may involve: (1) enhanced interpersonal interaction increasing cognitive stimulation and brain activity [42]; and (2) greater material assistance and emotional support improving stress coping capacity [43]. Healthcare providers should train family members and caregivers in medication management, monitoring, diet, and exercise to optimize support, and organize regular activities to provide social platforms and help older adults build social support networks.

Cognitive Reserve Higher cognitive reserve was a protective factor, consistent with Li et al. [44]. Potential mechanisms include: (1) maintenance of physiological robustness in brain functional networks [45]; and (2) increased brain-derived neurotrophic factor synthesis enhancing synaptic plasticity and neuroprotection [46]. Since cognitive reserve accumulates through life experiences and activity participation [10], healthcare providers should develop appropriate assessment tools to evaluate cognitive reserve, identify older adults with low reserve, and encourage participation in physical, intellectual, and social activities to enhance reserve and protect cognitive function.

Conclusion

This study identified three cognitive function classes among community-dwelling older adults with chronic diseases: high cognition with memory impairment, moderate cognition with attention impairment, and low cognition with overall impairment. Age, number of chronic diseases, blood pressure, blood lipids, cognitive reserve, social support, and activities of daily living significantly influence class membership. Healthcare providers should recognize these distinct cognitive profiles and implement targeted interventions to protect cognitive function and improve quality of life.

Limitations: This study used convenience sampling, which may introduce selection bias. Additionally, the cross-sectional design precludes observation of longitudinal trends in cognitive function. Future research should employ longitudinal designs to track cognitive trajectories in this population.

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Note: Figure translations are in progress. See original paper for figures.