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Effect of depression combined with cognitive impairment on dependency risk in rural older adults: analysis of data from the China health and retirement longitudinal study (CHARLS 2020)

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Abstract

Background This study aims to investigate the relationship between cognitive impairment, depressive symptoms, and Activities of Daily Living (ADL)/ Instrumental Activities of Daily Living (IADL) dependency among older people living in rural areas.

Methods We analyzed data from the China Health and Aging Longitudinal Study 2020, focusing on the rural older adults over 60. We identified four groups and constructed three regression models (models 1–3) to investigate the relationship between cognitive impairment or depression and dependency.

Results Based on a logistic regression model, older adults living in rural areas face a sequentially increased risk of dependence on ADL if they in group 2 (OR = 1.33, 95% CI = 1.09–1.63), group 3 (OR = 1.76, 95% CI = 1.43–2.17), or group 4 (OR = 2.38, 95% CI = 1.95–2.91), when compared to a reference group 1. Group 2 (OR = 2.44, 95% CI = 2.03 to 2.93) was more likely to be at risk of IADL dependence than Group 3 (OR = 1.99, 95% CI = 1.64 to 2.43).

Conclusions This study highlights the substantial impact of depression and cognitive impairment on ADL/ IADL dependence among rural older adults, with an especially heightened risk when both disorders are present simultaneously. Moreover, factors such as gender, age, inpatient services, outpatient services, and self-rated health are strongly associated with functional dependence in this population.

Keywords Depression, Cognitive impairment, Dependency, Older adults, Rural

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Introduction

Population aging has become increasingly prevalent worldwide, driven by longer life expectancies and declining fertility rates. As of 2020, 9% of the global population is aged 65 and over, and this figure will rise to 16% by 2050 [1]. This trend has significant implications for public health and policy and is a growing concern.

As the population ages, cognitive impairment and depressive symptoms are increasingly prevalent afflictions [2]. However, the exact nature of the relationship between these two conditions remains unclear. While specific studies suggest that cognitive impairment is a critical component of depression [3], others propose that depression may be an early warning sign of dementia [4, 5]. Moreover, some researchers maintain that the link between depression and cognitive impairment is not causal and that the two conditions are simply independent yet coexisting comorbidities.

Research suggests that local economic development may influence cognitive impairment and depressive symptoms in later life, with low-income individuals more vulnerable than others [6, 7]. In Europe, financial hardship is a common risk factor for cognitive impairment and depressive symptoms in people aged 65 and over [8, 9]. Similarly, in Japan, income class is an important determinant of cognitive impairment and depressive symptoms in older adults [10]. In addition, there are significant differences between urban and rural areas in the incidence of cognitive impairment and depressive symptoms in older adults [11–13]. In a survey of 470 participants in New Taipei City, Taiwan, the prevalence of cognitive impairment was higher in rural than in urban areas (25.1% vs. 10.8%, $p < 0.001$), while the prevalence of depression showed an inverse relationship (rural: 8.2% vs. urban: 13.6%, $p < 0.001$) [14].

Assessing one's capacity for independent living, Activities of Daily Living (ADL) encompass fundamental tasks like bathing, eating, dressing, toileting, and moving. On the other hand, Instrumental Activities of Daily Living (IADL) entail more advanced physical and mental activities and skills, such as food preparation, shopping, financial management, and household chores. These skills are crucial prerequisites for healthy aging, and preserving one's independent functional ability is the primary determinant of their quality of life in old age [15, 16]. As individuals age, their physical and psychological functions may deteriorate, resulting in an increased need for functional dependence [15–17]. Research has shown that functional dependence is linked to economic development, with countries and regions with lower social and economic development levels reporting a higher number of ADL/IADL dependents [18–20]. A six-year follow-up study in Sweden found that 434 (21.0%) of 2,066 subjects developed ADL dependence and 310 (15.0%) developed IADL dependence [21]; another survey of 31,464 older adults over 60 in India found that 23.8% reported ADL dependence and 48.4% reported IADL dependence [22]. In addition, a study of 16,661 Chinese respondents found urban-rural differences in IADL dependence [23]. Several studies have examined the relationship between cognitive impairment and depressive symptoms and ADL/IADL dependency in urban older adults [24–26].

Addressing dependency issues and supporting functional improvements is crucial to ensure that older adults maintain their health as they age. China, with the largest older adults globally and a fast-aging population, is home to many older individuals living in rural areas. Older adults in rural areas are more likely to face cognitive impairment and depression, due to relatively poor economic conditions, limited medical resources, and weak social support networks. Additionally, their quality of life is generally lower, their self-care ability is reduced, and the risk of functional dependence is significantly increased. At the present, there have been few studies conducted on cognitive impairment and depressive symptoms in rural older populations in China, and there is no prior data on the associations between cognitive impairment and depressive symptoms and ADL/IADL dependence in this specific population. Our goal is to evaluate the current state of cognitive impairment and depressive symptoms among rural older individuals in China and explore their correlation with ADL/IADL dependence. Our findings will serve as a scientific reference for improving the health outcomes of this population.

Methods

Study population

We used data from wave 5 of the CHARLS, which is publicly available at http://charls.pku.edu.cn. The CHARLS is a nationally representative survey involving participants aged 45 years or older and their spouses and includes an assessment of community residents' social, economic, and health status [27]. In 2020 CHARLS surveyed a total of 17,708 individuals. Of these samples, 4894 rural participants aged 60 years and older were included in the current analysis. Figure 1 illustrates the specific process. The present study was a secondary analysis of the de-identified CHARLS public data. Ethics approval was obtained from the Biomedical Ethics Review Committee of Peking University (# IRB00001052–11015). The study adheres to institutional and national research ethics standards, including the 1964 Helsinki Declaration and its subsequent amendments or comparable ethical standards.

Depression assessment

The CHARLS used the Center for Epidemiologic Studies Depression Scale (CESD) self-rating scale with ten items

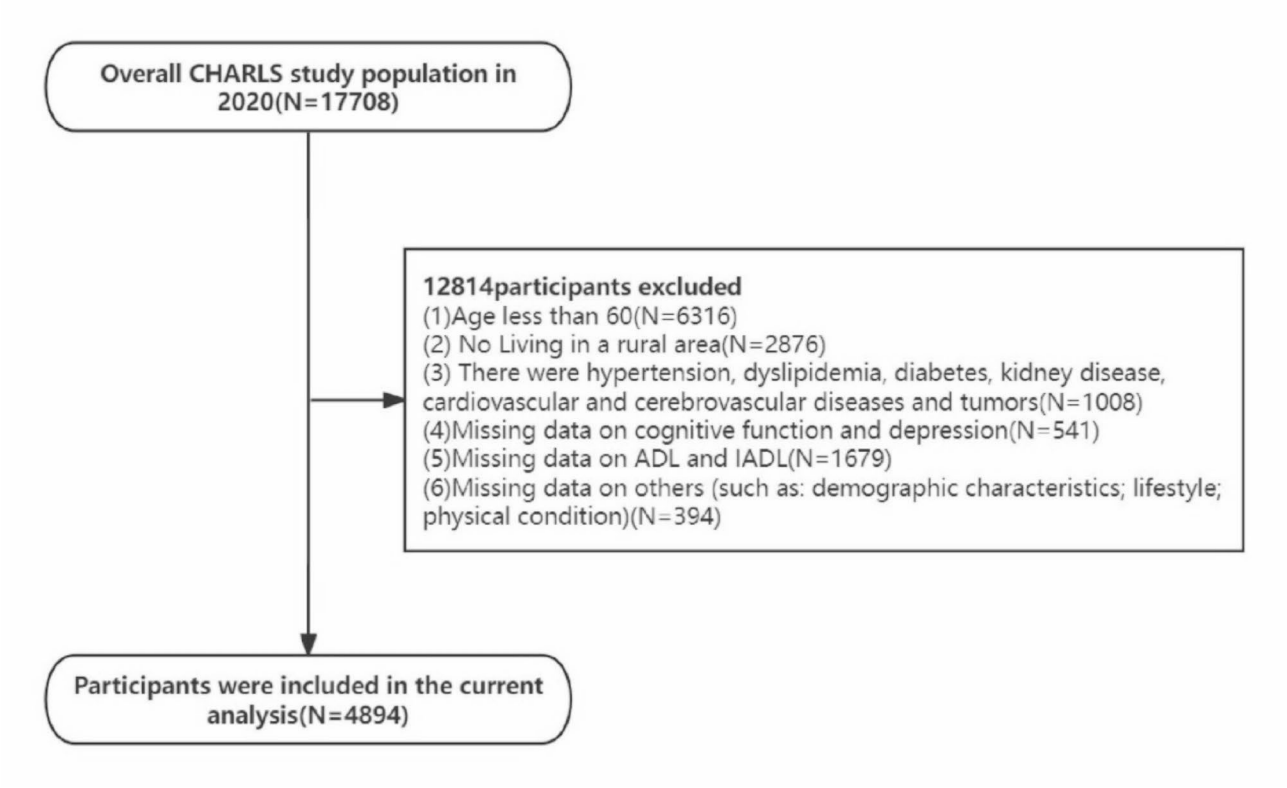

Fig. 1 Flow diagram for participants included in the study

[28]. Ten items were scored on four points Likert scale (range 1 to 4), each question was used to measure the frequency of a specific type of negative mood, where 1 indicated "rarely or none"; 2 "some days"; 3 "occasionally", and 4 "most of the times". The total score for each question was evaluated as the depressive score to assess the general depression status. The total score ranged from 10 to 40. A categorical variable for the CESD-10 score was applied to evaluate the depression status based on a cut-off of 20. Scores ≥ 20 indicate the presence of depressive symptoms.

Cognitive impairment assessment

The CHARLS assessed the cognitive function of participants using the Chinese version of the Minimum Mental State Examination (MMSE) [29]. It consisted of 30 items. The MMSE score ranged from 0 to 30 and higher scores indicated better cognitive function. We defined cognitive impairment as an MMSE score of less than 20 in primary school students. If the score is < 20, it is MMSE, and if the score is ≥ 20, it is non-MMSE.

Definition of ADL dependency and IADL dependency

The ADL scale covered dressing, bathing, eating, getting up, using the toilet; and controlling bowel movement. The ADL scale had a 4-scale answer for each question: "no difficulty", "have difficulty but can still do it", "have difficulty and need help", and "cannot do it." The IADL scale included 6 items: doing chores, cooking, shopping, manage money, taking medications, making phone calls. The answer items of both IADL and ADL scales were the same. In subsequent analysis, dependency was defined as a dichotomous variable, with an assigned value of 0 if the respondents had no difficulty and 1 otherwise [15, 30].

Group classification by depression and cognitive impairment

We subsequently classified participants into 4 groups based on CESD-10 and MMSE scores. Group 1 consisted of participants who were not depressed and cognitively impaired, and this group was considered the reference group. Group 2 consisted of participants with cognitive impairment but without depression. Group 3 consisted of participants with depression but without cognitive impairment. Group 4 consisted of participants who had both depression and cognitive impairment. As a result, 1,307 (26.71%) participants were classified into group 1, 1395 (28.50%) participants were classified into group 2, 868 (17.74%) participants were classified into group 3, and 1,324 (27.05%) participants were classified into group 4.

Other variables

The covariates in this study were selected based on Anderson's model, which includes propensity traits (sex, age, education, smoking, drinking, sleeping, exercise, and social participation), enabling resources (income, outpatient services, and inpatient services), and demand factors (self-rated health). Age was divided into four groups: 60 to 65, 65 to 70, 70 to 75, and those above 75. Participants were categorized as literate or illiterate based on their education status. Smoking and drinking habits were evaluated based on current behaviors. The cut-off value of exercise duration in the questionnaire was 2 h. Social participation in the past month was divided into three groups: no participation, one activity, or two or more activities. Outpatient and inpatient services were categorized based on whether participants had visited a health facility in the past month and had received inpatient care in the past year. Self-rated health assessment was based on 'How do you think your health is?'.

Statistical analysis

We used Stata 17.0 software for statistical analysis and GraphPad 5.0 software for plotting graphs. Baseline characteristics were expressed as percentages (%) of categorical variables and compared using ANOVA. Logistic regression was used to calculate the odds ratio (OR) estimates with 95% confidence intervals (CI) for the association of ADL dependency and IADL dependency with depression or cognitive impairment, and we used three models separately. Model 1 was adjusted propensity traits. Model 2 was based on the adaptation of Model 1 and added enabling resources. Model 3 was based on Model 2, and demand factors were adjusted. Moreover, group 1 (not depressed and cognitively impaired) was used as the reference to compare the differences between group 2 (only cognitive impairment), group 3 (only depression), and group 4 (both depression and cognitive impairment). P value < 0.05 was considered statistically significant.

Results

General characteristics of participants

Table 1 showed information about the key demographic characteristics of the study participants. The study included 4,894 individuals, with a nearly equal male-to-female ratio. The age range of the participants was between 60 and 90 years, with more than 60% of them aged between 60 and 70. The education level of the participants varied from illiterate to primary school. Nearly half of the participants smoked and were involved in social activities. A high percentage of participants did not consume alcohol. Additionally, almost 18% and around 20% of the participants received outpatient and inpatient services.

Effects of depression and cognitive impairment on risk of dependency

Table 2 and Supplement Tables 1, 2, 3, 4, 5, 6 and 7 showed that in group 1, gender (male) (OR: 0.60, 95%CI: 0.38,0.95 for ADL, OR: 0.33, 95%CI: 0.21,0.51 for IADL), age (OR: 1.93, 95%CI: 1.29,2.88 for ADL, OR: 2.20, 95%CI: 1.45,3.34 for IADL), and inpatient services (OR: 1.93, 95%CI: 1.35,2.74 for ADL, OR: 1.50, 95%CI: 1.07,2.12 for IADL) were risk factors for the development of ADL/IADL dependence, whereas self-rated health (OR: 0.32, 95%CI: 0.20,0.52 for ADL, OR: 0.43, 95%CI: 0.28,0.64 for IADL) was a protective factor; in group 2, age (OR: 2.55, 95%CI: 1.75,3.70) and outpatient services (OR: 1.43, 95%CI: 1.02,2.00) were risk factors for the development of ADL dependence, whereas education (OR: 0.71, 95%CI: 0.55,0.91) was a protective factor for IADL dependence; and in group 4, exercise (OR: 0.65, 95%CI: 0.50,0.83) was a protective factor for IADL dependence.

In Table 3, we adjusted for propensity traits, enabling resources, and demand factors and found that the risk of ADL dependence was highest in group 4 compared to group 1, with an OR of 2.38 and a 95%CI of 1.95–2.91 (in model 3). Regarding IADL, the study found that the risk of dependence was higher in groups 2 and 3 compared to group 1, with ORs of 2.44 (95%CI, 2.03–2.93) and 1.99 (95%CI, 1.64–2.43), respectively. However, the risk of dependence was almost 1.5 times as high in group 4, with an OR of 3.63 and a 95%CI of 3.01–4.38 (in model 3).

The goodness of fit of the constructed models showed that the explanatory power of the three models regarding risk dependency among rural older individuals gradually increased. An analysis of the Cox & Snell R^2, Nagelkerke R^2, AIC, and BIC values indicated that model 3 had the strongest explanatory power. By examining the growth in Cox & Snell R^2, we found that adding enabling resources to model 1 resulted in only a slight increase in explanatory power, whereas adding demand factors to model 2 led to a much larger increase. This suggested that propensity traits and demand factors had the greatest influence on risk dependency among rural older individuals, while enabling resources also had a certain impact. See Tables 2 and 3 and Supplement Tables 1, 2, 3, 4, 5, 6 and 7 for details.

Effects of depression and cognitive impairment on risk of dependency task

To further explore the effects of depression and cognitive impairment on the risk of dependency task. We adjusted propensity traits, enabling resources, demand factors. Figures 2 and 3 indicated that groups 2–4 were at a higher risk of dependence on activities such as dressing, bathing, getting up, using the toilet, controlling bowel movement, doing chores compared to group 1. In regards

Table 1 Baseline characteristics of the participant

Variable	Total (*n* = 4894)	Group1 (*n* = 1307)	Group2 (*n* = 1395)	Group3 (*n* = 868)	Group4 (*n* = 1324)	*P* value
Sex						< 0.001
Male	2187(44.69%)	832(63.66%)	523(37.49%)	444(51.15%)	388(29.31%)	
Female	2707(55.31%)	475(36.34%)	872(62.51%)	424(48.85%)	936(70.69%)	
Age (year)						< 0.001
[60,65)	1517(31.00%)	434(33.21%)	370(26.52%)	318(36.64%)	395(29.83%)	
[65,70)	1527(31.20%)	418(31.98%)	413(29.61%)	289(33.29%)	407(30.74%)	
[70,75)	926(18.92%)	267(20.43%)	237(16.99%)	172(19.82%)	250(18.88%)	
≥ 75	924(18.88%)	188(14.38%)	375(26.88%)	89(10.25%)	272(20.54%)	
Education (literate)						< 0.001
Yes	3111(63.57%)	1161(88.83%)	607(43.51%)	741(85.37%)	602(45.47%)	
No	1783(36.43%)	146(11.17%)	788(56.49%)	127(14.63%)	722(54.53%)	
Smoking						< 0.001
Yes	2088(42.66%)	724(55.39%)	525(37.63%)	421(48.50%)	418(31.57%)	
No	2806(57.34%)	583(44.61%)	870(62.37%)	447(51.50%)	906(68.43%)	
Drinking						< 0.001
Yes	1110(22.68%)	392(29.99%)	283(20.29%)	202(23.27%)	233(17.60%)	
No	3784(77.32%)	915(70.01%)	1112(79.71%)	666(76.73%)	1091(82.40%)	
Sleeping (h)	6.00 ± 2.24	6.39 ± 1.81	6.43 ± 2.31	5.73 ± 2.05	5.36 ± 2.24	< 0.001
Exercise (h)						
< 2	1984(40.54%)	579(44.30%)	563(40.36%)	344(39.63%)	498(37.61%)	0.005
≥ 2	2910(59.46%)	728(55.70%)	832(59.64%)	524(60.37%)	826(62.39%)	
Social participation						< 0.001
No	2652(54.19%)	658(50.34%)	795(56.99%)	427(49.19%)	772(58.31%)	
1 item	1543(31.53%)	422(32.29%)	437(31.33%)	271(31.22%)	413(31.19%)	
≥ 2 items	699(14.28%)	227(17.37%)	163(11.68%)	170(19.59%)	139(10.50%)	
Income (10,000yuan)	3.65 ± 0.31	3.67 ± 0.37	3.65 ± 0.32	3.65 ± 0.22	3.64 ± 0.26	0.167
Outpatient services						< 0.001
Yes	880(17.98%)	205(15.68%)	205(14.70%)	209(24.08%)	261(19.71%)	
No	4014(82.02%)	1102(84.32%)	1190(85.30%)	659(75.92%)	1063(80.29%)	
Inpatient services						< 0.001
Yes	1017(20.78%)	220(16.83%)	243(17.42%)	208(23.96%)	346(26.13%)	
No	3877(79.22%)	1087(83.17)	1152(82.58%)	660(76.04%)	978(73.87%)	
Self-rated health						< 0.001
Good	743(15.18%)	252(19.28%)	299(21.43%)	56(6.45%)	136(10.27%)	
Average	2292(46.83%)	714(54.63%)	695(49.82%)	370(42.63%)	513(38.75%)	
Poor	1859(37.99%)	341(26.09%)	401(28.75%)	442(50.92%)	675(50.98%)	
ADL dependency						
Yes	1489(30.43%)	249(19.05%)	357(25.59%)	305(35.14%)	578(43.66%)	< 0.001
No	3405(69.57%)	1058(80.95%)	1038(74.41%)	563(64.86%)	746(56.34%)	
IADL dependency						
Yes	2237(45.71%)	313(23.95%)	703(50.39%)	377(43.43%)	844(63.75%)	< 0.001
No	2657(54.29%)	994(76.05%)	692(49.61%)	491(56.57%)	480(36.25%)	
Depression score	19.43 ± 7.22	14.53 ± 3.01	13.76 ± 4.22	25.41 ± 4.59	26.31 ± 4.77	< 0.001
MMSE score	18.15 ± 6.08	23.94 ± 2.66	13.58 ± 4.34	23.33 ± 2.50	13.86 ± 3.83	< 0.001

Note: ADL, activity of daily living; IADL, instrumental activity of daily living; MMSE, Minimum Mental State Examination

to taking medications, the risk of dependence was similar for groups 2 and 3. However, the risk of dependency on eating, cooking, shopping, managing money, making phone calls increased in groups 3, 2, and 4 when compared with group 1. Supplementary Tables 8–9 provide the OR and 95% CI for all groups.

Discussion

Our study yielded three significant findings. Firstly, we found that rural older adults who experience depression or cognitive impairment are associated with a higher risk of developing dependency, with the greatest association observed among those experiencing both depression and cognitive impairment simultaneously. Secondly, we

Table 2 Logistic regression analyses of the factors influencing the risk of ADL dependence among Chinese rural older adults in group1

Variable		Model 1	Model 2	Model 3
Propensity traits	Sex (Reference: Fmale)	0.67(0.43, 1.04)	0.60(0.38,0.93)	0.60(0.38,0.95)
	Age (years) (Reference: 60,65)			
	[65,70)	1.25(0.87,1.81)	1.22(0.84,1.78)	1.25(0.85,1.82)
	[70,75)	1.98(1.35,2.92)	1.96(1.32,2.91)	1.93(1.29,2.88)
	≥ 75	1.67(1.07,2.62)	1.44(0.91,2.28)	1.48(0.93,2.37)
	Education (literate) (Reference: No)	1.11(0.70,1.76)	1.12(0.71,1.78)	1.25(0.78,2.01)
	Smoking (Reference: No)	0.97(0.64,1.46)	1.00(0.66,1.53)	0.93(0.61,1.43)
	Drinking (Reference: No)	0.90(0.64,1.27)	0.96(0.68,1.36)	1.06(0.75,1.52)
	Sleeping (h)	0.92(0.86,1.00)	0.94(0.87,1.01)	0.95(0.87,1.02)
	Exercise (h) (Reference: <2)	0.80(0.60,1.06)	0.83(0.62,1.10)	0.86(0.64,1.15)
	Social participation (Reference: No)			
	1 item	0.95(0.69,1.31)	0.90(0.65,1.25)	0.89(0.64,1.24)
	≥ 2 items	1.12(0.76,1.64)	1.08(0.73,1.61)	1.17(0.78,1.75)
Enabling resources	Income (10,000yuan)		1.03(0.98,1.05)	1.02(0.97,1.02)
	Outpatient services (Reference: No)		1.44(1.00,2.09)	1.28(0.88,1.87)
	Inpatient services (Reference: No)		2.46(1.75,3.45)	1.93(1.35,274)
Demand factors	Self-rated health (Reference: Poor)			
	Good			0.32(0.20,0.52)
	Average			0.38(0.28,0.54)
Cox & Snell R2		0.423	0.446	0.475
Nagelkerke R2		0.438	0.474	0.521
AIC		0.982	0.965	0.939
BIC		-7985.936	-7987.710	-8006.468

Note: Model 1 = Adjusted propensity traits (sex, age, education, smoking, drinking, sleeping, exercise, social participation)

Model 2 = Model 1 + adjusted enabling resources (income, outpatient services and inpatient services)

Model 3 = Model 2 + adjusted demand factors (self-rated health)

Table 3 OR and 95%CI of rural older adults with depression or cognitive impairment at risk of ADL /IADL dependency

Variable		Model 1	Model 2	Model 3
ADL dependency				
	Group 1	1.00	1.00	1.00
	Group 2	1.34(1.10–1.64)	1.34(1.10–1.64)	1.33(1.09–1.63)
	Group 3	2.30(1.88–2.80)	2.16(1.76–2.64)	1.76(1.43–2.17)
	Group 4	2.98(2.46–3.62)	2.83(2.34–3.44)	2.38(1.95–2.91)
Cox & Snell R2		0.465	0.477	0.511
Nagelkerke R2		0.492	0.509	0.558
AIC		1.170	1.160	1.121
BIC		-35701.215	-35719.521	-35890.484
IADL dependency				
	Group 1	1.00	1.00	1.00
	Group 2	2.41(2.01–2.88)	2.41(2.01–2.89)	2.44(2.03–2.93)
	Group 3	2.46(2.03–2.97)	2.37(1.95–2.86)	1.99(1.64–2.43)
	Group 4	4.30(3.57–5.17)	4.15(3.45–4.99)	3.63(3.01–4.38)
Cox & Snell R2		0.530	0.535	0.560
Nagelkerke R2		0.574	0.580	0.613
AIC		1.248	1.245	1.213
BIC		-35319.343	-35302.863	-35442.085

Note: Model 1 = Adjusted propensity traits (sex, age, education, smoking, drinking, sleeping, exercise, social participation)

Model 2 = Model 1 + adjusted enabling resources (income, outpatient services and inpatient services)

Model 3 = Model 2 + adjusted demand factors (self-rated health)

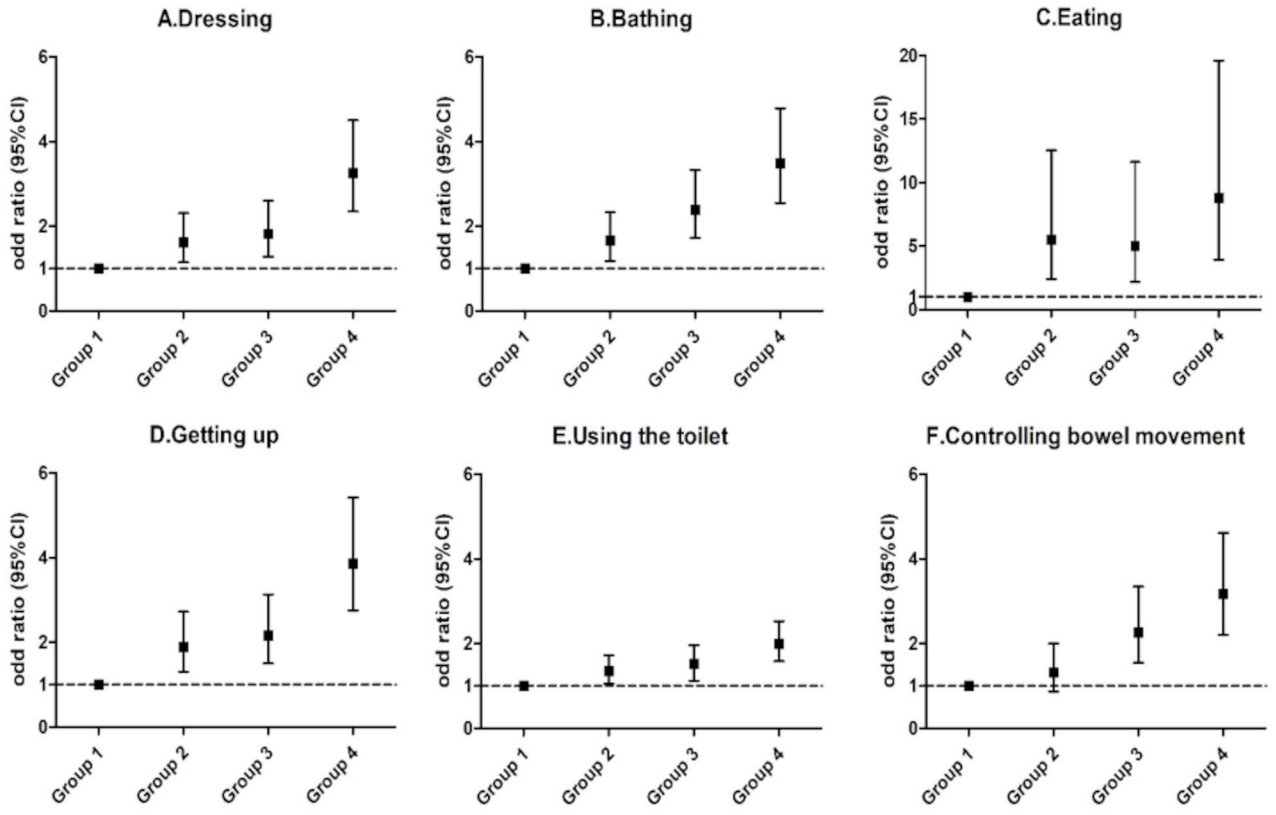

Fig. 2 Depression or cognitive impairment associated with ADL dependency task. Dependency with activities of daily living includes (A) dressing; (B) bathing; (C) eating; (D) getting up; (E) using the toilet; and (F) controlling bowel movement. Models derived from logistic regression and adjusted for the factors included propensity traits (sex, age, education, smoking, drinking, sleeping, exercise, social participation), enabling resources (income, outpatient services and inpatient services), demand factors (self-rated health). Group 1 was defined as a reference. OR: Odds ratios, represented by black squares; 95%CI: 95% confidence interval, represented by black vertical lines

observed that depression was more strongly associated with ADL dependence compared to cognitive impairment, while an equal or inverse relationship existed for IADL dependence. Thirdly, we identified variations in the risk factors and their relative strengths in association with ADL and IADL dependence.

We found that only depression or cognitive impairment was associated with an increased risk of dependence. This was consistent with previous studies, which showed a positive correlation between depression or cognitive impairment and the risk of ADL [31]. The connection between depression, cognitive impairment, and dependency risk was complex. Research showed that individuals with depression often experience difficulties with multiple cognitive functions [3]. Depressive symptoms had been identified as both a precursor to cognitive decline and a risk factor for cognitive impairment, leading to a greater risk of dependence when compared to cognitive impairment alone [4, 5]. Additionally, depression frequently coexists or complicates mild cognitive impairment or dementia [2]. However, the impact of the relationship between depression and cognitive impairment on the risk of dependency requires further investigation. Our research indicated that several factors may contribute to a higher risk of Group 4 dependence. Firstly, individuals in Group 4 exhibited more severe symptoms of depression or cognitive impairment in comparison to other groups, which could have influenced their risk of dependence. Secondly, models 1 and 3 demonstrated that propensity traits, enabling resources, and demand factors play a role. In our study, we factored in the influence of these variables as confounding factors. Lastly, our findings suggest that depressive symptoms and cognitive impairment may have a synergistic effect on the risk of dependence, with the risk of dependence being nearly 1.5 times as high for those with both disorders as opposed to just one. For instance, the combination of psychomotor agitation caused by depression and wandering behavior caused by visuospatial dysfunction could be more hazardous [16, 17].

The findings of this study challenged earlier research by highlighting a strong link between cognitive impairment and reliance on assistance for daily and instrumental tasks. Of note was the significant impact on

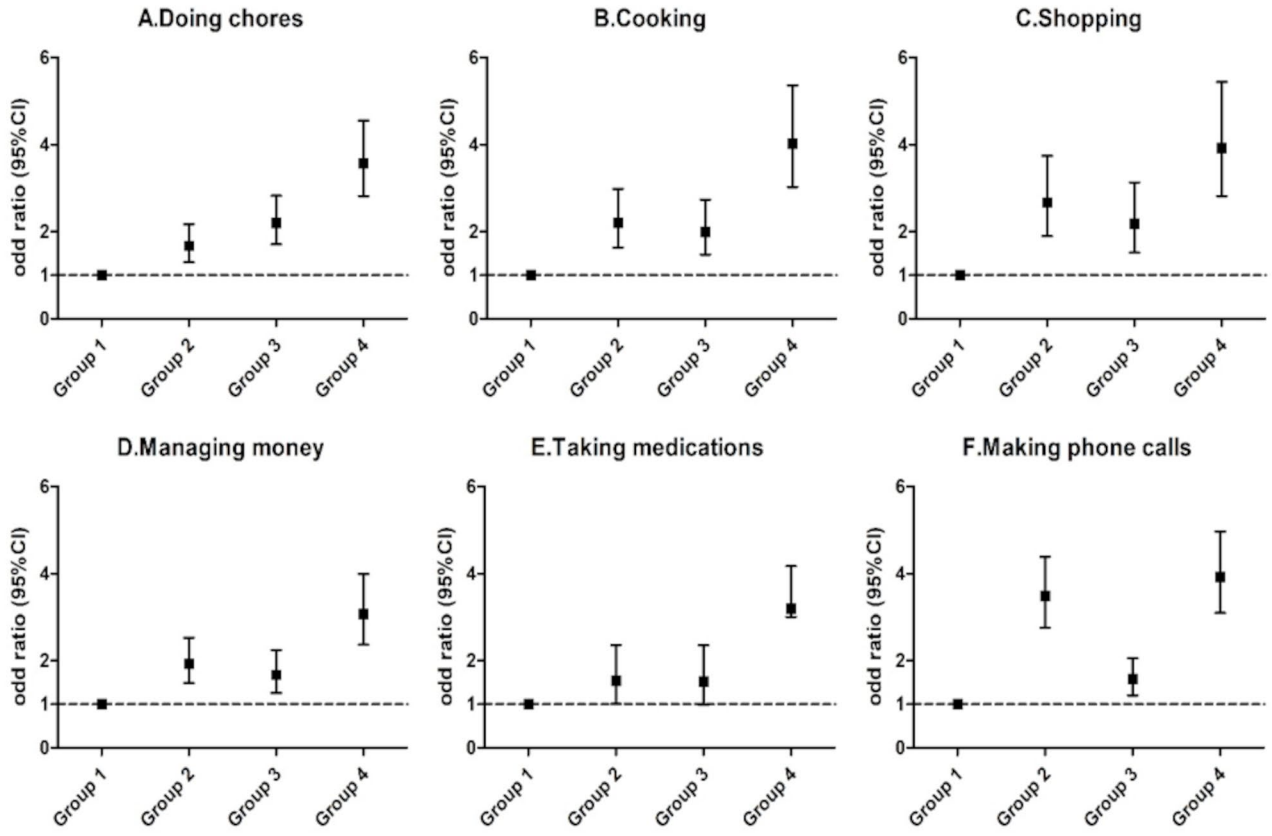

Fig. 3 Depression or cognitive impairment associated with IADL dependency task. Dependency with instrument activities of daily living includes **A**. doing chores; **B**. cooking; **C**. shopping; **D**. managing money; **E**. taking medications; and **F**. making phone calls. Models derived from logistic regression and adjusted for the factors included propensity traits (sex, age, education, smoking, drinking, sleeping, exercise, social participation), enabling resources (income, outpatient services and inpatient services), demand factors (self-rated health). Group 1 was defined as a reference. OR: Odds ratios, represented by black squares; 95%CI: 95% confidence interval, represented by black vertical lines

instrumental activities, such as cooking, shopping, managing money, and making phone calls. Prior studies that did not exclude individuals with depression nor account for depression as a covariate failed to assess the impact of cognitive impairment on dependency risk fully [32, 33]. This approach inadequately considered the potential interaction and overlap between cognitive impairment and depression. Additionally, it is worth considering that rural seniors may need to fully recognize the extent of their cognitive impairment when reflecting on how it may affect their daily activities for our reliance on self-reported data [34, 35]. It is important to note that executive dysfunction resulting from cognitive impairment can make it challenging to maintain purposeful activities, leading to distractions and difficulty completing tasks. cooking, shopping, managing money, and making phone calls. can be particularly challenging as they require selecting products and performing specific functions in a distracting environment.

Furthermore, after analyzing multiple dependent variables, such as propensity traits, enabling resources, and demand factors, the findings indicated the demand factor has the greatest impact on the risk of dependence among rural older adults, which aligns with the findings of Malhotra et al. [36]. This suggests that self-rated health status is more closely related to the risk of ADL/IADL dependence. Individuals who self-rated health poor health may limit their daily activities due to physical pain or discomfort, or reduce physical activity out of fear of safety risks, such as falls, which can ultimately lead to ADL/IADL dependence [37]. Among the predisposition traits, the findings indicated a positive correlation between being female, older age, and the risk of dependence [38, 39]. In contrast, education level and exercise are inversely associated with ADL/IADL dependence [40, 41]. In addition, enabling resources also play an important role in the risk of ADL/IADL dependence. Although their impact is less significant than that of the demand factor, it should not be overlooked when considering ways to improve the independence of older adults. Studies have shown that inpatient and outpatient services can reflect the severity of health conditions in older adults, particularly the

frequency of chronic diseases or acute health problems [42]. Moreover, the availability of these services may be linked to older adults' ability to manage their health within their region. In under-resourced settings, older adults often lack timely access to high-quality healthcare, and over-reliance on these services can lead to unnecessary hospitalizations and even increased dependence on ADL/IADL [43].

This study focused on the rural older adult population primarily due to the unique challenges they face in terms of healthcare access and social support [44]. Compared to urban areas, older adults in rural regions often encounter significant barriers to accessing medical services, such as limited healthcare facilities, inconvenient transportation, and inadequate social support networks [45]. These factors make it more difficult for rural seniors to manage their health and prevent diseases. Furthermore, due to the relatively scarce healthcare resources in rural areas, older adults may struggle to receive timely, high-quality medical care, which can lead to insufficient management of chronic conditions and, in turn, exacerbate their functional dependence [46]. Therefore, when developing health management and dependence prevention strategies for older adults, it is essential to pay attention to the specific needs of rural seniors, and to design targeted health interventions that effectively reduce the risk of functional dependence.

Limitations

Our study had certain limitations that were worth noting. Firstly, while we used screening tools like CESD-10 and MMSE to assess independent variables such as depression and cognitive impairment, we did not rely on diagnostic interviews with mental health professionals. Secondly, as our study had an observational design, there was a possibility of unmeasured confounding factors that could skew the results. For instance, we needed more information on psychotropic drug use, which was a crucial limitation given the challenges of obtaining reliable data on drug classes and their purposes in large-scale community surveys of older adults. Thirdly, the rural older population tended to have a lower level of education, which could lead to information bias in their understanding of survey questions, and recall bias could affect self-reporting. Finally, the absence of information on specific comorbidities like Parkinson's syndrome or stroke, which were associated with dependence and risk of cognitive impairment or depression, could have impacted our findings.

Conclusion

This study reveals the significant impact of depression and cognitive impairment on daily functional dependence among rural older adults, with an especially pronounced increase in dependence risk when the two disorders coexist. Additionally, gender, age, inpatient services, outpatient services, and self-assessed health status are strongly associated with functional dependence among older adults. These findings suggest that targeted policy measures should be developed to promote mental health interventions and improve cognitive function, aiming to reduce the burden of functional dependence.

Abbreviations

CHARLS	The China Health and Retirement Longitudinal Study
ADL	Activities of Daily Living
IADL	Instrumental Activities of Daily Living
CEDS	The Center for Epidemiologic Studies Depression Scale
MMSE	The Minimum Mental State Examination
OR	Odds ratio
CI	Confidence intervals

Supplementary Information

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Supplementary Material 1

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Author contributions

The author declares that this work is completed by them and will bear the claims and responsibilities related to this article. Mingfei Jiang, and Baozhen Dai: study design, analyses, interpretation, and writing of the final manuscript. The authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

All participants provided informed consent, and the protocol was approved by the Ethical Review Board of Peking University (approval number: IRB00001052-11,015).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Data sharing

The data that support the findings of this study are available from the Institute of Social Science Survey, Peking University, Beijing, China (http://charls.pku.edu.cn). Data for 2020 will be available upon request to the corresponding author.

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