BMC Geriatrics

RESEARCH

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Bidirectional, longitudinal associations between depressive symptoms and IADL/ADL disability in older adults in China: a national cohort study

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Abstract

Introduction Based on the data from the China Health and Retirement longitudinal study (CHARLS), we aimed to investigate the bidirectional relationship between depressive symptoms and functional disability.

Methods Data were collected across 3 waves from 2013 to 2018. The activities of daily living (ADLs) and the instrumental activities of daily living (IADLs) scales were used to measure functional disability and the CESD-10 was used to measure depressive symptoms. Cross-lagged models were performed to examine cross effect between depressive symptoms and functional disability across three waves.

Results Data on 10,092(mean [SD] age, 61.98[8.44] years; 3764 females [37.30%]) and 10,180 participants (mean [SD] age, 62.01[8.46] years; 3788 females [37.21%]) in IADL sample and ADL sample were included in the analyses. For IADL disability, the cross-lagged model shows a bidirectional association across three waves; the multivariable GEE model revealed that changes in CESD-10 score across waves were associated with worse IADL disability (β ranges: 0.08–0.10) and vice versa, worsen of IADL disability ascending developing of CESD-10 score (β ranges: 0.09–0.10). For ADL disability, the cross-lagged model shows a bidirectional association across three waves; the multivariable GEE model revealed that changes of CESD-10 score across waves were associated with worse IADL disability (β ranges: 0.08–0.10) and vice versa, worsen of IADL disability ascending developing of CESD-10 score (β ranges: 0.09–0.10).

Discussion Study findings underscore a significant bidirectional between depressive symptoms and functional disability in older adults. Thus, simultaneous intervention should be taken to manage the mutual development of functional disability and depression.

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Introduction

The aging of the second baby boomers, as the number of dependent older persons is expected to be 14.02 million more by 2030, coupled with the increase in life expectancy, leads to a greater risk of old-age dependence in China [15]. The increase in the number of dependent older persons will generate a high social burden.

Depressive disorders are one of the common psychiatric ailments seen in the older persons population. As per the World Health Organization (WHO) prevalence of depressive disorders among the older persons is 7%,

accounting for 5.7% of the total disability-adjusted life years (DALYs) in individuals aged 60 and above [37]. In China, the lifetime prevalence of depression among individuals aged 50–64 is 7.8%, while among adults aged 65 and above, the prevalence is approximately 7.3% [23].

Depressive and functional disability, both being common among the elder populations, the relation between the two conditions has gained attention because strong correlations have been found between them in older adults [19, 27, 32, 39]. A functional disability is generally operationalized as the dependency in performing activities of daily living (ADL), such as dressing, bathing, feeding, getting into or out of bed, toileting, and contingency, or as the dependency in instrumental activities of daily living (IADL), such as cooking, doing housework, shopping, managing finances, taking medications, and making phone-call [10, 26]. According to the Disablement Process model [36], aging individuals might experience a decline in functioning due to the onset of chronic physical comorbidities, and this process is accompanied by changes in mental and psychological factors. Therefore, it can be hypothesized that there is a complex interplay between functional disabilities and depression, exhibiting reciprocal interactions over time.

Previous longitudinal studies have shown different trajectories of depressive symptoms can also have varying impacts on the risk of disabilities [1, 29, 33, 34], and vice versa, persistent high dependency participants were more likely to have depressive symptomatology [13]. Early recognition and adequate management of depression among older persons can lead to improvement in quality of life, maintaining optimal levels of function and independence, reduction in morbidity, reduction in mortality due to suicide, development of medical illnesses and treatment costs [6, 9, 12, 14, 28, 30, 31, 35]. However, their effects tend to decrease over aging [21, 22], and it is worth noting that depressive symptoms persist in more than 10% of older adults [24]. Since disability in older persons individuals may result from depression as well as from comorbidities [17, 40], disability caused by comorbidities may increase risk of depression, suggesting that further effort is needed to study the independent relationship between depression and disability in order to better guide the management of depressive symptoms among older adults.

Understanding the longitudinal, bidirectional associations and possible developmental cascades between depressive symptoms and functional disability has the potential to inform risk identification and prevention programs. Cascade processes occur when bidirectional links are carried forward across time, above and beyond within-time covariation and within-construct continuity. The fact that the worse the depressive symptoms the more serious the disability [38] and, potentially, depressive symptoms may lead to functional disability. If set in motion in aging, such a unhealthy cycle would have time to amplify, resulting in developmental cascades that consolidate the 2 problems (ie, reciprocal effects build up over time, with long-lasting cumulative consequences for functional disability).

To our knowledge, most of the previous studies that have attempted to unravel the longitudinal relationship between functional disability and depressive symptoms were limited to older adults (e.g., over 75 years of age) or limited sample size. Furthermore, evidence on the complex co-occurrence of disability and depressive symptoms in old age in China is lacking. In order to close the research gap, we conducted the current study to replicate and expand this previous research by testing bidirectional associations and longitudinal cascades between depressive symptoms and functional disability.

Methods

Sample

This study used data from the China Health and Longitudinal Retirement Survey (CHARLS), a nationally longitudinal survey conducted by the National School for Development (China Center for Economic Research). Further details on the study design and sampling strategies of the CHARLS have been described previously. Briefly, in the baseline survey, a multistage stratified probability-proportionate-to-size sampling was adopted, and 17,708 adults from 450 villages or urban communities in 150 counties across 28 provinces in China were recruited. The baseline survey was implemented during the 2011–2012 period (wave-1), with subsequent waves completed approximately every 2 years, and data from wave 3 were collected from 2015 to 2016.

In this study, the wave-2 (2013),wave-3 (2015) and wave-4 (2018) data were used to explore the relationship between depressive symptoms, and incidence of ADL/IADL disability because IADL data was not collected in the wave-1 survey (2011).In this study, participants with a wave 2 age older than 50 in wave 2 were included in the data analysis.

For the longitudinal analysis of depressive symptoms with IADL, the following participants were excluded step by step: (1) wave 2 participants whose ages were less than 50 ($n=3592$), or with missing age information($n=7096$); (2) participants with missing CESD-10 data($n=1582$) and IADL data ($n=108$); (3) participants who had covariates missing, including information of current smoking status or drinking status($n=2848$), and medical morbidities($n=268$).

For the longitudinal analysis of depressive symptoms with ADL, the following participants were excluded step

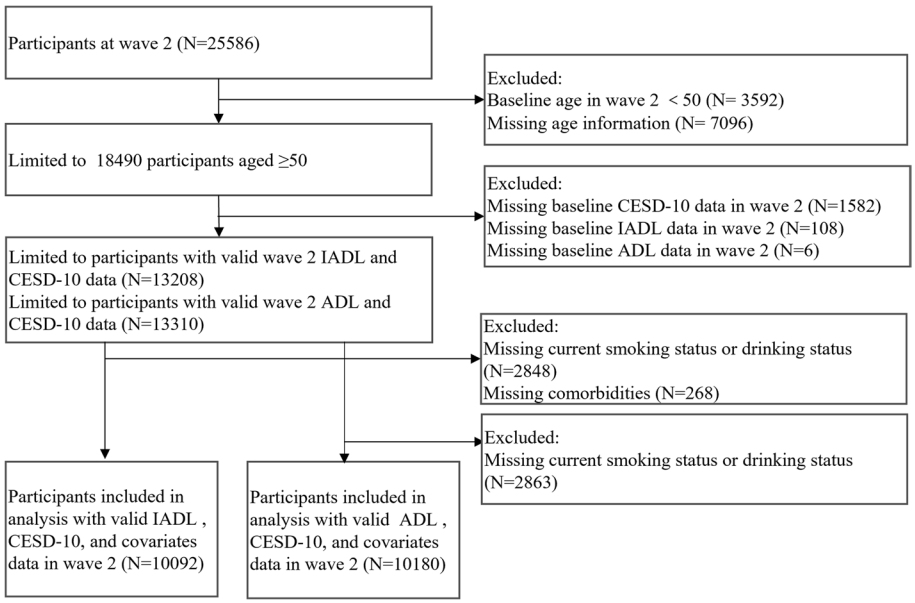

Fig. 1 Flowchart of participants in the analysis sample

by step: (1) wave 2 participants whose ages less than 50 ($n=3592$), or with missing age information($n=7096$); (2) participants with missing CESD-10 data($n=1582$) and ADL data ($n=6$); (3) participants who had wave 2 missing information of current smoking status or drinking status($n=2863$). Ultimately, this study included 10,092 and 10,180 participants in IADL sample and ADL sample respectively (Fig. 1).

Depressive symptoms

The depressive symptoms was assessed by ten items of the Center for Epidemiologic Studies Depression (CES-D-10). Participants were administered to rate on a 4-point scale (1 = never, 2 = sometimes, 3 = often, 4 = most of the time). The CES-D-10 scale has been validated in the Chinese population and shown good reliability(Kam, Weng, Boey, Senior, & Lecturer, 1999). A total CES-D-10 score ranges from 0 to 30 (two positive worded items were reverse coded), with a higher score indicating more depressive symptoms. A score of 10 or higher is indicative of a possible depression [3].

Functional disability

Disability in activities of daily living (ADL) was defined as dependence or needing assistance in at least one of six fundamental skills typically needed to manage our basic physical needs. They include grooming and personal hygiene, dressing, toileting, transferring and ambulation, and eating. Disability in instrumental activities of daily living (IADL) on the other hand, was described as dependence or needing assistance in at least one of functions including paying bills, preparing food, communicating, house, work, and scheduling and keeping appointments. For each ADL/IADL item, participants were asked to choose one from the following four responses: (1) No, I do not have any difficulty; (2) I have difficulty, but I can still do it; (3) Yes, I have difficulty and need help; (4) I cannot do it. A score of 3 or 4 is labelled as having a disability in that ADL/IADL item. The higher the sum score of ADL/IADL items, the more severe the dependence of the ADL/IADL.

Covariates

Covariates for the present study consisted of age, gender (male/female), residence (rural/urban), educational attainment (primary school or below/junior high school or above), current smoking status, current drinking status, and medical comorbidities**.** Information on chronic diseases included hypertension, diabetes mellitus, dyslipidemia, heart disease, stroke, cancer, lung disease, arthritis, kidney disease, digestive disease, and asthma. The numbers of treated diseases at wave 2 were used as a covariate as medical comorbidities. All covariates were included and adjusted in the cross-lagged models. Current smoking status, current drinking status, and comorbidities reported at each wave were also used as time-dependent covariates in the Generalized estimating equations model for repeated measures. More detailed information on covariates is provided in the appendix Table S1.

Statistical analysis

Statistical analyses were conducted using the Statistics Analysis System (SAS 9.4; SAS Institute, Cary, NC) and Mplus version 8.5 (Muthen & Muthen). All *P* values were two-tailed with a significance level set at 0.05.

First, we performed data-driven general cross-lagged to explore the bidirectional association between depressive symptoms (total score of CES-D-10 as continuous variable) and ADL/IADL disability(composite ADL/IADL item score as continuous variable) using data in 3 waves including socioeconomic status as covariates at wave 2. Cross-lagged models allow the examination of both auto regression and reciprocal relations between two or more variables over time, controlling for auto-regression. Overall model fit was tested by considering together the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), the χ2 statistic and the ratio of χ2 to degrees of freedom. A nonsignificant χ2 value, a CFI and a TLI value of 0.90 or higher, an RMSEA value below 0.06, and a ratio of χ2 to degrees of freedom less than 3 were considered indicators of good fit.

The bidirectional associations between depressive symptoms and IADL or ADL were examined using Generalized estimating equations (GEE) for repeated measures, including time-dependent covariates at each wave. Missing data in the analysis of cross-lagged and GEE models were treated through full information maximum likelihood, which uses maximum likelihood to estimate model parameters using all available raw data.

Results

A total of 10,092 participants (Female [37.30%]) were included in IADL sample and 10,180 participants (Female [37.21%]) were included in ADL sample in this study. Characteristics at each wave of study participants are presented in Table 1.

Time-related changes

At wave 2, more than 1/3 of the participants were categorized as possible depressed(a total score of CES-D-10 greater than 10). As time progressed, this proportion gradually increased, and by wave 4, the prevalence of depression reached 40%. As time progressed, the number of comorbid physical comorbidities also increased, rising from an average of 1.65 per person in 2013 to 2.53 in 2018.IADL/ADL disability also increased with time.

IADL disability

Figure 2 shows the standardized path coefficients (β) and the fit indices of the cross-lagged model between depressive symptoms and IADL disability. The stability path estimates for depressive symptoms ($\beta=0.45$ for both between waves) and IADL disability (range $\beta=0.39$ to $\beta=0.46$) were stable across follow-up. The correlation between depressive symptoms and IADL disability were significantly at each wave ($r=0.26$ in 2013, $r=0.26$ in 2015, $r=0.21$ in 2018). Cross-lagged path estimates showed that the depressive symptoms at wave 2 had significantly cross effect on IADL disability in wave 3($\beta=0.11$[95%CI, 0.09–0.12]), and the wave 3 depressive symptoms on IADL disability in wave 4($\beta=0.08$[95%CI, 0.06–0.10]). And vice versa, the IADL disability at wave 2 shows significant cross effect on depressive symptoms in wave 3($\beta=0.10$[95%CI, 0.09–0.12]), and IADL in wave 3 on depressive symptoms in wave 4($\beta=0.09$[95%CI, 0.07–0.11]).

We estimate changes of depressive symptoms and IADL disability across waves using GEE, including time-dependent covariates. For effect of depressive symptoms on IADL disability, the analysis revealed a significant impact of CESD scores on IADL disability ($\beta=0.041$, $P<0.001$), and the magnitude of this impact varies across three waves (P for interaction = 0.0089). For the effect of IADL disability on depressive symptoms, the analysis revealed a significant impact of CESD scores on IADL disability ($\beta=1.49$, $P<0.001$). Multivariable analyses show that covariates including gender, educate attainment, living areas, current smoke, current drink, and comorbidities at each wave also play important roles in the progress of depressive symptoms and IADL disability (all *P* values < 0.05) (Table 2).

ADL disability

Figure 3 shows the standardized path coefficients (β) and the fit indices of the cross-lagged model. The stability path estimates for depressive symptoms ($\beta=0.45$ for both between waves) and ADL disability (range $\beta=0.39$ to $\beta=0.46$) were stable across follow-up. The correlation between depressive symptoms and ADL disability were significantly at each wave ($r=0.26$ in 2013, $r=0.22$ in 2015, $r=0.20$ in 2018). Cross-lagged path estimates showed that the depressive symptoms at wave 2 had significant cross effect on ADL disability in wave 3($\beta=0.10$[95%CI, 0.09–0.12]), and the wave 3 depressive symptoms on ADL disability in wave 4($\beta=0.09$[95%CI, 0.07–0.10]). And vice versa, the ADL disability at wave 2 shows significant cross effect on depressive symptoms in wave 3($\beta=0.08$[95%CI, 0.07–0.10]), and IADL in wave 3 on depressive symptoms in wave 4($\beta=0.08$[95%CI, 0.06–0.10]).

Using a time-dependent multivariate GEE model, for the effect of depressive symptoms on ADL disability, the analysis revealed a significant impact of CESD scores on ADL disability ($\beta=0.034$, P < 0.001), and the magnitude of this impact varies across three waves (P

Table 1 Characteristics of study populations included in the study

Characteristics	Participants, No. (%)	
	IADL sample($n=10,092$)	ADL sample($n=10,180$)
Wave 2 (2013)		
Age, mean (SD), y	61.98(8.44)	62.01(8.46)
Sex		
Female	3764(37.30)	3788(37.21)
Male	6328(62.70)	6392(62.79)
Residence		
Rural	4041(40.04)	4069(39.97)
Urban	6051(59.96)	6111(60.03)
Education attainment		
Less than lower secondary	8966(88.84)	9056(88.96)
Upper secondary and Vocational training	970(9.61)	969(9.52)
Tertiary	156(1.55)	155(1.52)
Current smoking	1889(18.72)	8280(81.34)
Current drinking	2897(28.71)	1900(18.66)
CESD-10, mean (SD)	8.18(5.94)	8.18(5.94)
Depression, n (%)	3405(33.74)	3439(33.78)
Number of comorbidities, mean (SD)	1.65(1.51)	1.65(1.51)
Some difficult with IADL, mean (SD)	0.58(1.16)	0.58(1.16)
Some difficult with ADL, mean (SD)	0.37(0.94)	0.37(0.94)
Wave 3 (2015)		
Current smoking	1558(17.23)	7550(82.78)
Current drinking	2487(27.52)	1571(17.22)
CESD-10, mean (SD)	8.51(6.6)	8.53(6.59)
Depression, n (%)	3209(36.66)	3246(36.78)
Number of comorbidities, mean (SD)	2.17(1.72)	2.17(1.72)
Some difficult with IADL, mean (SD)	0.7(1.31)	0.71(1.32)
Some difficult with ADL, mean (SD)	0.51(1.13)	0.51(1.14)
Wave 4 (2018)		
Current smoking	1377(16.33)	1387(16.31)
Current drinking	2204(26.14)	2214(26.04)
CESD-10, mean (SD)	9(6.69)	9(6.69)
Depression, n (%)	3171(40.35)	3204(40.45)
Number of comorbidities, mean (SD)	2.53(1.97)	2.54(1.97)
Some difficult with IADL, mean (SD)	0.82(1.45)	0.82(1.45)
Some difficult with ADL, mean (SD)	0.55(1.21)	0.55(1.22)

for interaction = 0.0435). For the effect of ADL disability on depressive symptoms, the analysis revealed a significant impact of CESD scores on ADL disability ($\beta = 1.49$, $P < 0.001$). Multivariable analyses show that covariates including educate attainment, living areas, current smoke, and comorbidities at each wave also play important roles in the progress of depressive symptoms and ADL disability (all P values < 0.05), while in the model of depressive symptoms to ADL, no gender difference were found ($P = 0.5801$) and current drink across each wave did not show significant association ($p = 0.8282$) (Table 2).

Discussion

To our knowledge, this is the first to report developmental cascades between depressive symptoms and IADL/ADL disability in China. Our finding suggests that the symptoms of depression have contemporary and delayed effects on IADL/ADL disabilities, while IADL/ADL disabilities contribute to a continuous and stable impact on the risk of developing depressive symptoms.

Our finding of reciprocal correlations between functional disability and depressive symptoms was generally in line with the results of previous studies [4, 10, 11],

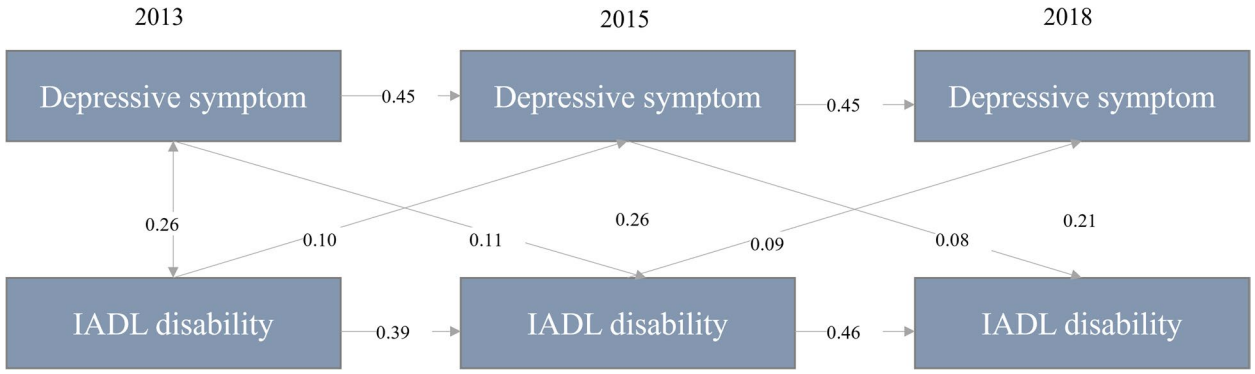

Fig. 2 Estimates from the traditional Cross-lagged model for the reciprocal associations between depressive symptoms and IADL disability. * All estimates are standardized. Fit statistics: $\chi^2_4 = 771.848$, $P < 0.001$; root mean square error of approximation = 0.137 (95% CI, 0.129–0.146); comparative fit index = 0.952; SRMR = 0.027. Covariates were socioeconomic status at wave 2. All paths are statistically significant. $P < 0.05$ was considered statistically significant

Table 2 GEE for repeated measures of bidirectional association

	IADL sample			ADL sample		
Outcome	**β**	**SE**	***P* value**	**β**	**SE**	***P* value**
Depressive symptoms to IADL/ADL						
Waves	0.006	0.008	0.4644	-0.000	0.064	0.9553
CESD10	0.041	0.002	< 0.001	0.034	0.007	< 0.001
CESD10 × wave	0.002	0.001	0.0089	0.001	0.002	0.0435
Age in wave 2	0.032	0.001	< 0.001	0.019	0.001	< 0.001
Gender	0.122	0.021	< 0.001	0.010	0.018	0.5801
Educate						
Upper secondary and Vocational training	-0.126	0.031	< 0.001	-0.071	0.027	0.0076
Tertiary	-0.268	0.074	0.0003	-0.158	0.063	0.0124
Rural	0.184	0.018	< 0.001	0.104	0.016	< 0.001
Current smoke at each wave	-0.055	0.018	0.0018	-0.059	0.020	0.0039
Current drink at each wave	-0.020	0.024	0.4092	0.003	0.150	0.8282
Comorbidities at each wave	0.097	0.005	< 0.001	0.094	0.004	< 0.001
Outcome						
IADL/ADL to depressive symptoms						
Wave	0.023	0.028	0.4099	0.048	0.266	0.0729
Disability (IADL or ADL)	1.49	0.054	< 0.0001	1.483	0.648	< 0.001
Disability (IADL or ADL) × wave	-0.034	0.020	0.0918	-0.077	0.024	0.001
Age in wave 2	-0.047	0.006	< 0.001	-0.034	0.006	< 0.001
Gender	1.557	0.111	< 0.001	1.684	0.111	< 0.001
Educate						
Upper secondary and Vocational training	-1.367	0.163	< 0.001	-1.435	0.163	< 0.001
Tertiary	-1.851	0.388	< 0.001	1.959	0.390	< 0.001
Rural	1.452	0.096	< 0.001	1.545	0.096	< 0.001
Current smoke at each wave	-0.178	0.091	< 0.001	0.550	0.124	< 0.001
Current drink at each wave	0.519	0.124	0.0494	-0.237	0.090	0.0086
Comorbidities at each wave	0.632	0.025	< 0.001	0.626	0.025	< 0.001

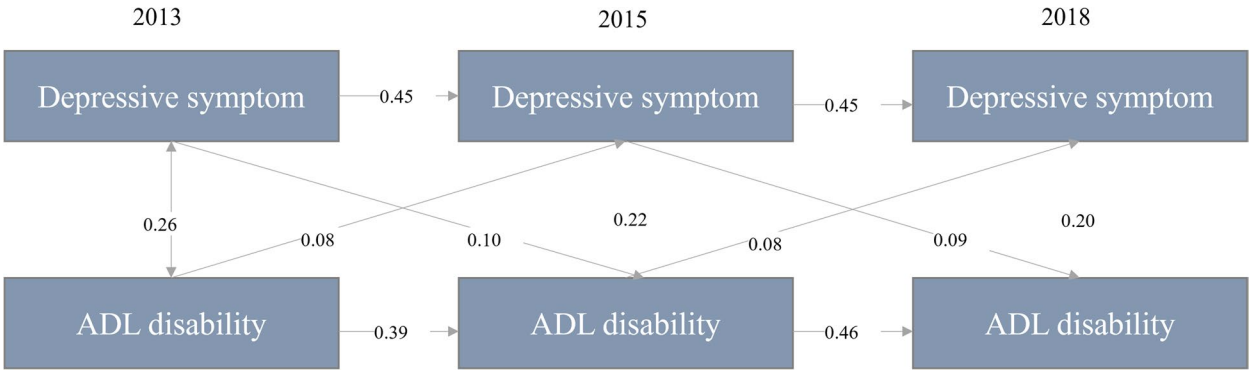

Fig. 3 Estimates from the traditional Cross-lagged model for the reciprocal associations between depressive symptoms and ADL disability. * All estimates are standardized. Fit statistics: $\chi^2_4 = 771.848$, $P < 0.001$; root mean square error of approximation = 0.137 (95% CI, 0.129–0.146); comparative fit index = 0.952; SRMR = 0.028. Covariates were socioeconomic status at wave 2. All paths are statistically significant. $P < 0.05$ was considered statistically significant

despite the contemporary and delayed effect of depressive symptoms on functional disability [18], Ormel, Rijsdijk, Sullivan, van Sonderen, & Kempen, 2002). Specifically, research conducted by the United States and Germany did not show a relationship of early-stage depression on the occurrence of functional disabilities, whereas significant cascade relationship was identified in this study using CHARLS data. Such difference might be attributed to several factors. Firstly, the study included younger older participants, specifically those aged 60 and above. This design allowed for the observation of the interplay between depressive symptoms and functional disabilities in younger older individuals, providing evidence for interventions targeted at this aging population. Secondly, unlike previous studies conducted in the United States, our research did not limit itself to participants with ongoing exposure to chronic stress or initial physical limitations, allowing us to observe changes in the more physically healthy group, ensuring that the results can be applied to a broader group of older adults, and additionally contributing to the likelihood that our path coefficients between depressive symptoms and functional disability were smaller than previous studies. The third point is that this study had a long follow-up period, and previous research has shown that a follow-up of over 3 years is needed to observe the mutual relationship between the two factors [4]. As a result, the description of the trajectory of the co-occurrence of depression and disabilities is clearer. These factors contribute to the differences observed compared to other studies.

Our study extends previous findings by revealing dynamic and reciprocal effects build up over time, with long-lasting cumulative consequences between depressive symptoms and functional disability. Indeed, multiple risk factors, each with a small effect, underlie the occurrences of both depressive symptoms and functional disability. Thus, the magnitude of cross-lagged models and GEE models in relation to depressive symptoms and disabilities estimates that we found were overall small. This may also be due to the fact that in elder populations, functional disability may result from depression as well as from physical comorbidities [7] and older populations often underreport their depressive symptoms [5]. Even so, our findings suggest that interventions targeting depressive symptoms remain critical to preventing disability.

The potential mechanisms for the mutual influence between disability and multimorbidity may be multiple and intricate. Functional disability, which is the loss of independence, is itself a challenging source of stressor that can be particularly difficult for older people to cope with. It may be one of the key reasons for experiencing depressive emotions(Aldwin, Sutton, Chiara, & Spiro, 1996; [8]). Moreover, due to limitations in daily activities, individuals with functional impairment may not be able to participate in their usual social activities, which can lead to feelings of loneliness, social isolation, and a lack of support systems, further increasing the risk of depression. The presence of synergistic effects of physical and mental chronic conditions on functional disability suggests that their simultaneous management is crucial in delaying or preventing disability [16].

Limitations

The limitations of the present study should be mentioned. First, other possible influences including e.g. social-environment, individual psychological and somatic factors are all in the developmental pathway of depressive symptoms and functional disability, and future research could explore these possible moderate effects to provide a more fine-grained basis for the provision of management and

intervention. Second, similar to limitations reported in other similar studies, the use of self-report methods to obtain functional disability, especially when the measurement tool has low sensitivity to minor changes in functional abilities, which may also contribute to the stability of the associations. Third, a large portion of the participants was excluded because missing data, excluded and included respondents in the analyses may differ both demographically and functionally, introducing selective bias into the study.

Conclusion

The findings from CHARLS provided evidence of a bidirectional, longitudinal association between depressive symptoms and functional disability among older adults in China. Giving this finding, primary carers and medical practitioners should take intensive monitoring and interventions on both mental health and functional ability to prevent individuals from disability.

Abbreviations

ADLs	Activities of daily living
IADLs	Instrumental activities of daily living
DALYs	Disability-Adjusted Life Years
GEE	Generalized estimating equations

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-024-05248-y.

Additional file 1: Table S1. Covariates included in analysis.

Acknowledgements

The authors thank the China Health and Retirement Longitudinal Study (CHARLS) team for providing data.

Authors' contributions

Study concept and design:PH and ZS.Acquisition of data: PH. Analysis and interpretation of data: XZ,YW,YL,RD,ZS,HP. Drafting of the manuscript: XZ.Critical revision of the manuscript for important intellectual content: YW,YL,RD,ZS,HP. The author(s) read and approved the final manuscript.

Funding

This work was supported by the following funders: The Major Project of the National Social Science Fund of China (21&ZD187), Beijing Municipal Natural Science Foundation (9212009), and Capital's Funds for Health Improvement and Research Program (2022–4-2125). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Availability of data and materials

The datasets used and analyzed in the current study are available upon reasonable request from the official CHARLS application (https://charls.pku.edu.cn/en/). If someone want to request data from this study, please contact professor PH, corresponding author of this paper.

Declarations

Ethics approval and consent to participate

The protocol of the CHARLS was approved by the Ethical Review Committee at Peking University. The ethical approval number was IRB00001052–11015. Written informed consent was obtained from all participants.

Competing interests

The authors declare no competing interests.

Received: 8 April 2024 Accepted: 25 July 2024
Published online: 06 August 2024

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