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The relationship between childhood hunger experiences and activities of daily living disability: a mediating role of depression

Weile Zhang¹, Min Su^{1*}, Dongxu Li^{2*}, Xi Guo³, Zhengrong Li¹, Tianjiao Zhang¹ and Zheru Hu¹

Abstract

Background Hunger is an important public health issue. This study aims to explore the impact of childhood hunger experiences (CHEs) on activities of daily living (ADL) disability and to discover the mediating role of depression on this correlation.

Methods Data were derived from the China Health and Retirement Longitudinal Study 2011, 2013, 2015, 2018, and 2020. Depression was assessed using the Centre for Epidemiological Studies Depression Scale. ADL disability, basic ADL (BADL) disability and instrumental ADL (IADL) disability were assessed using the ADL scale. The relationships between CHEs, depression and ADL disability were estimated using probit methods, and the mediating effect of depression was estimated using the stepwise regression test and bootstrap methods.

Results A total of 9,905 sample were included in the study. The study found that CHEs increased ADL disability by approximately 9.1% ($\beta = 0.091$, 95% CI: 0.028, 0.154), and increased the probability of IADL disability by approximately 8.0% ($\beta = 0.080$, 95% CI: 0.016, 0.144). CHEs increased ADL disability by approximately 29.8% ($\beta = 0.298$, 95% CI: 0.202, 0.393) in samples under 60 years of age. CHEs indirectly increased ADL ($\beta = 0.062$, 95% CI: 0.000, 0.124) by increasing the probability of depression.

Conclusion CHEs predicted ADL disability, and depression mediated this correlation. There is a need to focus on the impact of CHEs on mental and physical health. In particular, focusing on mental health is necessary to prevent impairment of physical functioning.

Keywords Childhood hunger experiences, Depression, Activities of daily living disability, China

*Correspondence:

Min Su

sumin1227@126.com

Dongxu Li

lidongxu0602@126.com

¹School of Public Management, Inner Mongolia University, Zhaojun Road, Yuquan District, Hohhot, Inner Mongolia 010070, China

²School of Public Health, Jining Medical University, Hehua Road, Taibai Lake New District, Jining, Shandong 272067, China

³School of Economics and Management, Inner Mongolia University of Technology, Hohhot, Inner Mongolia, China



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Introduction

Hunger is an important public health issue [1]. The childhood hunger experiences (CHEs) refers to the situation of facing shortages of food and supplies during childhood and being exposed to malnutrition for a long time [2]. CHEs are a material deprivation of such magnitude that they can have permanent negative consequences for individual development [3], and their impacts in terms of health trajectories may be felt throughout the individual's life course [4–7]. Activities of daily living (ADL) are skills needed to meet basic and complex physical needs [8, 9]. Previous research has found that older people who experienced frequent hunger in childhood are at a significantly higher risk of frailty, and as older people become frailer, their levels of physical activity decline [10]. Individuals who suffered hunger in childhood age more rapidly, and health shocks affect health outcomes in later life [11]. It is therefore necessary to focus on the health and mobility problems caused by CHEs.

A study found depression to be associated with CHEs and ADL. Previous research has shown that hunger is strongly associated with depression [12] and may affect all stages of life. One study found that hungry children have twice as much psychological dysfunction as non-hungry children [13]. Hunger is also an independent factor in the development of depressive symptoms in adolescents [14]. Over time, young people who experience chronic hunger have relatively higher levels of depression [15]. A previous study using the China Health and Retirement Longitudinal Study (CHARLS) data found that 13.6% of depressive symptoms in the middle and older Chinese population could be attributed to hunger [16]. Previous research has also found that depression affects physical health, especially ADL [17]. Depression is negatively associated with ADL [8, 18, 19]. The negative impact of depression on ADL even persists later in life [9]. There is a reciprocal, time-varying association between ADL disability and depressive symptoms, with more severe depressive symptoms predicting a higher level of longitudinal ADL disability over time [20].

Overall, previous studies have assessed the negative health effects of CHEs and explored the relationship between depression and CHEs as well as depression and ADL disability. However, the relationship between CHEs and ADL disability in middle and older adults remain to be discovered, and whether depression mediates the relationship between the two also needs to be explored. Therefore, the present study, based on 10-year longitudinal follow-up data, identified the effects of CHEs on ADL disability and explored whether depression is a mediating mechanism for the effects of CHEs on ADL disability. These assessments are important for discovering the relationship between mental health and physical health.

Methods

Data sources

CHARLS includes data on the health and related issues of middle and older adults (aged 45 years and above). The CHARLS data are representative in measuring ADL disability and depression [21]. The CHARLS national baseline survey was conducted in 2011, covering 150 district units and 450 village units. It was followed by 5 subsequent surveys in 2011, 2013, 2015, 2018, and 2020, and the Life Course Survey of Chinese Residents in 2014. After data cleansing, a total of 9,905 individuals participated in six surveys.

Variable selection and assignment

Independent variables

The independent variable in this study was CHEs, and the research question was derived from the responses to the question, “When you were a child before age 17 was there ever a time when your family did not have enough food to eat?” (NO=0, YES=1).

Dependent variable

The dependent variable in this study was ADL disability. The most widely used measure of disability is the ADL scale [17]. ADL are usually categorised as “basic activities of daily living” (BADL), which involve dressing, bathing or showering, eating, getting into or out of bed, using the toilet, and controlling urination and defecation, and “instrumental activities of daily living” (IADL), which include doing household chores, preparing hot meals, shopping, taking medications and managing money [22]. Dependence or the need for assistance with respect to at least one of these was defined as disability in daily activities [21]. Having an ADL disability was defined as 1 (0 otherwise). Similarly, having a BADL disability was defined as 1 (0 otherwise), and having a IADL disability was defined as 1 (0 otherwise).

Mediating variables

The mediating variable for this study was depression. The CHARLS data assessed depression using the Centre for Epidemiological Studies Depression Scale (CES-D-10), which involves 10 questions about the respondent's feelings of annoyance and difficulty in concentrating in the past week. The CES-D-10 scores ranged from 0 to 30, with a higher score indicating more severe depression. According to previous studies [23, 24], a CES-D-10 score of less than 10 is considered to indicate no depression and given a value of 0, and a score greater than or equal to 10 indicates depression and is given a value of 1.

Based on prior research [25, 26], this study included gender (Female=0, Male=1), age (<60=0, ≥60=1), income (Lower=0, Higher=1), residence (Rural=0, Urban=1), marital status (Unmarried=0, Married=1),

educational level (Primary school or below =0, Middle school or above =1), health insurance (NO=0, YES=1), pension insurance (NO=0, YES=1), and chronic disease (NO=0, YES=1) as control variables. Previous studies have found that financial support for older adults is inversely associated with depressive symptoms [27], and we took this factor into account to minimize confounding and used child financial support (Lower=0, Higher=1) as the control variable. In addition, this study controlled for fixed effects of time and region (Eastern region=0, Central region=1, and Western region=2).

Statistical methods

In this study, probit models were used to test the relationship between CHEs, depression and ADL disability. Based on previous studies, the stepwise regression test (BK) method was used for mediated effects analysis [28]. Moreover, the bootstrap method was used to assess the robustness of the results. Regarding descriptive statistics,

categorical variables were expressed as frequencies and percentages. All operations were performed using STATA 15.1. The significance level for all hypothesis tests was set at 0.05.

Results

Descriptive statistics

Table 1 shows the descriptive statistical analysis. A total of 9,905 respondents were included in this study, 7,117 (71.853%) individuals experienced childhood hunger, and 2,788 (28.147%) did not. 5,873 (59.293%) respondents were younger than 60 years old, 4,209 (42.494%) respondents with lower incomes, and 7,782 samples had lower child financial support. A total of 6,622 (66.855%) individuals lived in rural areas and 3,283 (33.145%) in urban areas; 8,915 were married (90.005%), 6,771 (68.359%) had primary education or below, and 9,412 (95.023%) were covered by health insurance. 1,024 (10.338%) samples

Table 1 Descriptive statistical analysis (2011, $N=9,905$)

Variable	TOTAL	CHEs	NOT CHEs	P
Gender				<0.001
Female	5,312 (53.629%)	3,667 (51.525%)	1,645 (59.003%)	
Male	4,593(46.371%)	3,450 (48.475%)	1,143 (40.997%)	
Age				<0.001
<60	5,873(59.293%)	4,050(56.906%)	1,823(65.387%)	
≥60	4,032(40.707%)	3,067(43.094%)	965(34.613%)	
Income				<0.001
Lower	4,209(42.494%)	3,149(44.246%)	1,060(38.020%)	
Higher	5,696(57.506%)	3,968(55.754%)	1,728(61.980%)	
Child financial support				<0.001
Lower	7,782(78.566%)	5,516(77.505%)	2,266(81.277%)	
Higher	2,123(21.434%)	1,601(22.495%)	522(18.723%)	
Residence				<0.001
Rural	6,622(66.855%)	4,868(68.400%)	1,754(62.912%)	
Urban	3,283(33.145%)	2,249(31.600%)	1,034(37.088%)	
Marital status				0.024
Married	8,915(90.005%)	6,436(90.431%)	2,479(88.917%)	
Unmarried	990(9.995%)	681(9.569%)	309(11.083%)	
Educational level completed				<0.001
Primary school or below	6,771(68.359%)	5,086(71.463%)	1,685(60.438%)	
Middle school or above	3,134(31.641%)	2,031(28.537%)	1,103(39.562%)	
Health insurance				0.248
YES	9,412 (95.023%)	6,774(95.181%)	2,638(94.620%)	
NO	493 (4.977%)	343(4.819%)	150(5.380%)	
Pension insurance				<0.001
YES	1,024(10.338%)	652(9.161%)	372(13.343%)	
NO	8,881(89.662%)	6,465(90.839%)	2,416(86.657%)	
Chronic disease				<0.001
YES	6,629(66.926%)	1,772(68.245%)	4,857(63.558%)	
NO	3,276(33.074%)	1,016(31.755%)	2,260(36.442%)	
N	9,905(100%)	7,117 (71.853%)	2,788(28.147%)	

NOTE: Table 1 based on cross-tabulation, and showing the distribution of CHEs in different feature samples. All variables were expressed as N (%), and chi-squared tests were used

were covered by pension insurance, and 6,629 (66.926%) samples had chronic disease.

Benchmark regression: an analysis of the impact of CHEs on ADL disability

Table 2 shows that, CHEs increased ADL disability by approximately 9.1% ($\beta=0.091$, 95% CI: 0.028, 0.154), and increased the probability of IADL disability by approximately 8.0% ($\beta=0.080$, 95% CI: 0.016, 0.144), and were not significantly associated with BADL disability ($\beta=0.034$, 95% CI: -0.053, 0.120). CHEs increased ADL disability by approximately 29.8% ($\beta=0.298$, 95% CI: 0.202, 0.393) in samples under 60 years of age, and were not significantly associated with ADL disability in samples aged 60 years and older ($\beta=-0.062$, 95% CI: -0.140, 0.017).

Analysis of the mediating effect of depression on the relationship between CHEs and ADL disability

Table 3 analyses the mediating effect of depression. Based on the analysis results, CHEs significantly increased the probability of depression by 29.7% ($\beta=0.297$, 95% CI: 0.247, 0.346), and thus, depression could serve as a mediating variable. Further placing both depression and CHEs in a regression model revealed that CHEs remained significantly related to ADL disability ($\beta=0.062$, 95% CI: 0.000, 0.124) but were not significantly related to BADL disability ($\beta=0.012$, 95% CI: -0.074, 0.097) and IADL disability ($\beta=0.051$, 95% CI: -0.012, 0.114), whereas depression was significantly related to ADL disability ($\beta=0.325$, 95% CI: 0.285, 0.364), BADL disability ($\beta=0.244$, 95% CI: 0.188, 0.301) and IADL disability ($\beta=0.320$, 95% CI: 0.279, 0.361). Thus, depression has a partial mediating effect regarding the effect of CHEs on ADL disability.

Mediation effect test

Table 4 shows the mediation effect test. Based on the analysis results, the mediating effect of depression was robustly tested using the bootstrap method and found to be significant in the CHEs-ADL relationship ($\beta=0.007$, $P<0.001$), the CHEs-BADL relationship ($\beta=0.002$, $P<0.001$), and the CHEs-IADL relationship ($\beta=0.006$, $P<0.001$).

Discussion

Using CHARLS data from 2011, 2013, 2015, 2018, and 2020, and the Life Course Survey of Chinese Residents in 2014, we found that CHEs increased ADL disability in middle and older adults and that depression was a mediating variable between CHEs and ADL disability. We tested this result using bootstrap methods.

The study found that CHEs significantly increased ADL disability in middle and older adults, which is consistent with the results of previous studies [29]. Malnutrition early in life is detrimental to health in later life

[11]. Hunger increases the odds of worsening health by 16% [30]. This may be because hunger leads to reduced health in childhood, increasing the risk of frailty in later life [31]. Hunger-induced ageing triggers biological waste throughout the body, which affects ADL [32]. Previous research has found that the high risk of hunger may persist into adolescence [33], and the experience of hunger in youth was significantly associated with an elevated risk of depression in 3 study cycles spanning 6 years [15]. Our study extended this finding using data conducted over a 10-year period, revealing that the negative impact of CHEs persists into middle and older age adulthood in China. The negative health effects of CHEs persist throughout the life course, with persistent negative cumulative effects on the quality of life [34]. As the standard of living in China rises, there is more security for the nutritional levels and ADL of those who experience hunger; however, more food only allows for catch-up growth [35]. Complete nutritional recovery and catch-up growth in adulthood are not sufficient to compensate for the health effects of early malnutrition [36]. This may be because childhood nutrient deficiencies can lead to long-term neurodevelopmental and health problems [37, 38]. Thus, CHEs increased ADL disability even into middle and older age. Our study also found that IADL were more affected, which may be due to the fact that IADL includes more complex activities that are more susceptible to external influences [9]. Thus, intervention strategies that reduce stress or improve nutritional availability may help reduce the risk of depressive symptoms [1, 16]. Further exploration of age groups may reduce confounders [39], our study found that CHEs in the under-60 years group had a greater impact on the ADL. This reflects the difference in the ADL of the under-60 years group, and there is a need to pay more attention to the group that is about to enter old age. We also found a positive correlation between chronic disease and ADL, which is consistent with previous studies, which may be due to the inability of older adults with chronic disease to perform ADL independently [40], and it is likely that older adults with chronic disease have lower levels of ADL, making them feel stressed and ultimately leading to depression [41].

Our findings identified depression as a mediating variable in the effect of CHEs on ADL disability. Hunger was significantly associated with depression [1, 16, 42, 43]. On the one hand, experiencing hunger during childhood coincides with a period of brain development [16], and coping with stress during a period of declining health may increase the risk of depressive symptoms, which has a negative impact on mental health. On the other hand, hunger may constitute one of the burdens associated with poverty that has a unique impact on the mental health of children living in poverty [13]. Poverty in childhood increases the likelihood of negative events later in

Table 2 Analysis of the impact of CHEs and control variables on ADL disability

Variables	ADL disability			BADL disability			IADL disability		
	ALL	< 60	≥ 60	ALL	< 60	≥ 60	ALL	< 60	≥ 60
	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)
CHEs (Reference group: No)	0.091 (0.028, 0.154)	0.298 (0.202, 0.393)	< 0.001	0.124	0.034 (-0.053, 0.120)	0.444	0.080 (0.016, 0.144)	0.014	
Gender (Reference group: Female)	-0.281 (-0.339, -0.224)	-0.210 (-0.301, -0.118)	< 0.001	< 0.001	-0.191 (-0.271, -0.112)	< 0.001	-0.251 (-0.309, -0.192)	< 0.001	
Age (Reference group: < 60)	0.269 (0.217, 0.321)	—	—	—	0.393 (0.316, 0.470)	< 0.001	0.245 (0.192, 0.298)	< 0.001	
Income (Reference group: Lower)	-0.280 (-0.332, -0.228)	-0.235 (-0.316, -0.154)	< 0.001	< 0.001	-0.243 (-0.321, -0.165)	< 0.001	-0.310 (-0.365, -0.256)	< 0.001	
Child financial support (Reference group: Lower)	-0.080 (-0.123, -0.038)	-0.033 (-0.108, 0.043)	< 0.001	< 0.001	-0.122 (-0.174, -0.069)	0.110	-0.084 (-0.128, -0.041)	< 0.001	
Area of residence (Reference group: Rural)	-0.209 (-0.270, -0.149)	-0.111 (-0.205, -0.016)	0.021	< 0.001	-0.138 (-0.221, -0.055)	0.001	-0.198 (-0.259, -0.136)	< 0.001	
Marital status (Reference group: Unmarried)	-0.251 (-0.316, -0.187)	-0.327 (-0.477, -0.177)	< 0.001	< 0.001	-0.213 (-0.284, -0.141)	< 0.001	-0.220 (-0.286, -0.154)	< 0.001	
Educational level completed (Reference group: Primary school or below)	-0.518 (-0.587, -0.450)	-0.545 (-0.643, -0.448)	< 0.001	< 0.001	-0.435 (-0.524, -0.346)	< 0.001	-0.560 (-0.631, -0.489)	< 0.001	
Health insurance (Reference group: NO)	-0.079 (-0.161, 0.002)	0.059 (-0.101, 0.220)	0.469	0.004	-0.143 (-0.240, -0.045)	0.015	-0.084 (-0.168, -0.001)	0.049	
Pension insurance (Reference group: NO)	-0.084 (-0.135, -0.033)	-0.129 (-0.216, -0.041)	0.004	0.276	-0.036 (-0.101, 0.029)	0.006	-0.053 (-0.106, 0.000)	0.049	
Chronic disease (Reference group: NO)	0.469 (0.407, 0.530)	0.461 (0.367, 0.555)	< 0.001	< 0.001	0.468 (0.393, 0.544)	< 0.001	0.424 (0.361, 0.486)	< 0.001	
Time Effect	YES	YES	YES	YES	YES	YES	YES	YES	
Regional Effect	YES	YES	YES	YES	YES	YES	YES	YES	
Wald chi2	1691.13	466.06	921.33	837.22	1598.18	< 0.001	< 0.001	< 0.001	
P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	
N	49,545	20,037	29,488	49,525	49,525	49,525	49,525	49,525	

Note: β denotes regression coefficient

Table 3 Analysis of the mediating effect of depression on the relationship between CHEs and ADL disability

Variables	Depression	ADL disability	BADL disability	IADL disability
	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)
CHEs (Reference group: NO)	0.297 (0.247, 0.346)	0.062 (0.000, 0.124)	0.012 (-0.074, 0.097)	0.051 (-0.012, 0.114)
Depression (Reference group: NO)		0.325 (0.285, 0.364)	0.244 (0.188, 0.301)	0.320 (0.279, 0.361)
Gender (Reference group: Female)	-0.406 (-0.451, -0.361)	-0.243 (-0.300, -0.186)	-0.162 (-0.241, -0.084)	-0.213 (-0.272, -0.155)
Age (Reference group: <60)	-0.045 (-0.085, -0.005)	0.278 (0.226, 0.330)	0.396 (0.319, 0.472)	0.255 (0.201, 0.308)
Income (Reference group: Lower)	-0.127 (-0.166, -0.089)	-0.275 (-0.328, -0.223)	-0.240 (-0.318, -0.162)	-0.305 (-0.359, -0.251)
Child financial support (Reference group: Lower)	-0.039 (-0.074, -0.005)	-0.076 (-0.119, -0.034)	-0.047 (-0.107, 0.014)	-0.080 (-0.124, -0.037)
Residence (Reference group: Rural)	-0.282 (-0.329, -0.235)	-0.183 (-0.243, -0.123)	-0.118 (-0.200, -0.035)	-0.172 (-0.233, -0.111)
Marital status (Reference group: Unmarried)	-0.136 (-0.190, -0.082)	-0.245 (-0.309, -0.181)	-0.301 (-0.386, -0.216)	-0.215 (-0.280, -0.149)
Educational level completed (Reference group: Primary school or below)	-0.159 (-0.210, -0.108)	-0.504 (-0.572, -0.436)	-0.250 (-0.343, -0.156)	-0.547 (-0.617, -0.476)
Health insurance (Reference group: NO)	-0.042 (-0.111, 0.026)	-0.079 (-0.160, 0.003)	-0.136 (-0.248, -0.024)	-0.084 (-0.168, 0.000)
Pension insurance (Reference group: NO)	-0.030 (-0.071, 0.011)	-0.084 (-0.136, -0.033)	-0.100 (-0.173, -0.028)	-0.053 (-0.106, -0.001)
Chronic disease (Reference group: NO)	0.379 (0.333, 0.426)	0.434 (0.373, 0.494)	0.586 (0.496, 0.676)	0.389 (0.328, 0.451)
Time Effect	YES	YES	YES	YES
Regional Effect	YES	YES	YES	YES
Wald chi2	1594.96	1941.09	903.67	1820.20
P	<0.001	<0.001	<0.001	<0.001
N	49,525	49,525	49,525	49,525

Note: β denotes regression coefficient

Table 4 Mediation effect test

	β	P	Percentile CI	Bias-Corrected CI
CHEs-depression-ADL disability	0.007	<0.001	(0.006,0.008)	(0.006, 0.008)
CHEs-depression-BADL disability	0.002	<0.001	(0.002, 0.003)	(0.002, 0.003)
CHEs-depression-IADL disability	0.006	<0.001	(0.005, 0.007)	(0.005, 0.007)

Note: β denotes regression coefficient

life [44]. Overall, hunger is a physical experience that develops into a psychological experience as the individual grows, evolving into fear of hunger and insecurity [45]. The greater the stress, the greater the likelihood of developing mental illnesses, such as depression and anxiety [41].

Depression in middle and older adults also raises the probability of ADL disability. Depressive symptoms are negatively associated with quality of life and ADL disability [31, 46, 47]. Our study found that depression increased ADL disability among middle and older adults.

On the one hand, this may be because functional disability, including activity limitations and participation limitations, is a major symptom of depression [48]. Depression tends to lead to a lack of energy and decreased motivation, which can lead to decreased physical functioning [49]. Older adults with depression show a stronger link between pain and functional limitations [50]. On the other hand, depressive symptoms can act as a stressor, causing and exacerbating inflammatory processes and thereby increasing the risk of subsequent ADL disability [20]. Depression may exacerbate medical disorders that

can lead to ADL disability. Depression is considered to be a reversible disease [51]; therefore, mental health is necessary to prevent the impairment of physical functioning [52]. We also found that depressive states are particularly intervening between CHEs and IADL. Compared to BADL, IADL includes more complex mobility [22], which means that people with IADL disability are more in need of emotional support. Therefore, it is necessary to improve community health services, pay attention to the mental health of those with CHEs, carry out early intervention, and improve health awareness and health level.

However, our findings have some shortcomings. On the one hand, respondents recalled CHEs, and depression and ADL disability were scale-generated and not medical diagnoses, which may have influenced the results. In the future, it is necessary to use medical diagnosis to determine whether depression is present. On the other hand, we used longitudinal survey data over a 10-year period, which has limitations in observing the long-term relationship between CHEs, depression and ADL disability. People with CHEs have a faster decline in health as they age [11], the level of ADL disability is also declining [53], so it is necessary to pay attention to the mediating role of depression in this long-term relationship. In addition, this study is a correlation rather than a causal relationship, and causal analysis is necessary for future research.

Conclusion

Using data from 6 surveys over a 10-year period of CHARLS, this study found that CHEs increased ADL disability in middle and older adults and that depression mediated this relationship. There is a need to focus on the mental health of people who experience childhood hunger, while preventing mental illness is necessary to protect physical functioning.

Abbreviations

ADL	Activities of daily living
BADL	Basic activities of daily living
CES-D	The Centre for Epidemiological Studies Depression Scale
CHARLS	The China Health and Retirement Longitudinal Study
CHEs	Childhood hunger experiences
IADL	Instrumental activities of daily living

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Author contributions

Weile Zhang, Min Su, and Dongxu Li had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Weile Zhang, Min Su, Dongxu Li, Xi Guo, Zhengrong Li, and Tianjiao Zhang participated in concept and design. Weile Zhang, Zhengrong Li, Tianjiao Zhang, and Zheru Hu participated in acquisition, analysis, or interpretation of data. Weile Zhang, Min Su, Dongxu Li, Xi Guo, and Zhengrong Li contributed to drafting of the manuscript. Weile Zhang, Dongxu Li, Tianjiao Zhang, and Zheru Hu participated in statistical analysis. Min Su, and Dongxu Li contributed to supervision.

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Data availability

Data is provided within the manuscript files.

Declarations

Ethical approval and consent to participate

The ethics review board of Peking University approved the CHARLS study (approval number IRB00001052–11015). Informed consent was obtained, and the data were anonymized for analysis. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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