RESEARCH

Long-term effects of health during childhood on depressive symptoms in later life: evidence from a nationally representative survey in China

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Abstract

Background Childhood health significantly influences mental well-being in later life, but this relationship remains underexplored in China. This study aims to investigate the long-term associations between childhood health status and depressive symptoms in older adults, emphasizing the need for early interventions to promote lifelong mental health.

Methods We utilized data from a nationally representative survey conducted across 28 provinces of China, comprising 15,581 adults aged 45 years and older. Depressive symptoms were assessed using the Center for Epidemiological Studies Depression scale. Logistic regression and decision tree models were applied to examine the association between childhood health and depressive symptoms in later life.

Results The overall prevalence of depressive symptoms among participants was 33.75%. Those reporting excellent or very good childhood health had a lower prevalence (29.99%), while those with poor childhood health reported a markedly higher rate (47.57%). After adjusting for demographics and lifestyle factors, poor childhood health was associated with a higher likelihood of depressive symptoms (AOR 1.83, 95% CI 1.56–2.14, $P < 0.0001$). Other risk factors included aged 65–74 years (AOR 1.23, 95% CI 1.10–1.38, $P = 0.0009$), female gender (AOR 2.01, 95% CI 1.78–2.28, $P < 0.0001$), and never drinking (AOR 1.24, 95% CI 1.11–1.38, $P = 0.0012$). Protective factors included tertiary education (AOR 0.45, 95% CI 0.32–0.65, $P = 0.0030$), higher BMI (BMI 24–27.9 kg/m^2: AOR 0.72, 95% CI 0.60–0.87 kg/m^2, $P = 0.0033$; BMI ≥ 28 kg/m^2: AOR 0.69, 95% CI 0.56–0.85 kg/m^2, $P = 0.0030$), sleep duration of seven or more hours (7–10 h sleep: AOR 0.52, 95% CI 0.48–0.57, $P < 0.0001$; ≥10 h sleep: AOR 0.50, 95% CI 0.43–0.58, $P < 0.0001$), never smoked (AOR 0.77, 95% CI 0.68–0.86, $P < 0.0001$), and urban residency (AOR 0.57, 95% CI 0.50–0.64, $P < 0.0001$). The decision tree model highlighted key factors associated with depressive symptoms, including childhood health, non-communicable diseases, sleep duration, residency, alcohol consumption, and smoking status.

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Conclusions Our findings suggest that childhood health may influence mental well-being in later life. Promoting healthy behaviors from early childhood could help reduce depression risk in older age. However, the reliance on self-reported data and a cross-sectional design limit causal interpretation. Preventive care and targeted interventions for vulnerable children should be prioritized to improve long-term mental health outcomes.

Keywords Childhood health, Depressive symptoms, Healthy behaviors, China

Background

The health status of children is widely recognized as a critical determinant of lifelong physical and mental well-being. A growing body of evidence from developed countries demonstrates that adverse childhood health experiences can have lasting effects on health outcomes in adulthood, including increased risks of chronic diseases, disability, and mortality [1–4]. However, while the impact of childhood health on physical health outcomes is well-documented, the relationship between early-life health conditions and long-term mental health remains less explored, particularly in low- and middle-income countries (LMICs) such as China. Understanding this relationship is of particular importance in China, where rapid demographic transitions have led to an unprecedented increase in life expectancy and an aging population at risk for mental health disorders such as depression [5].

In China, depression among older adults is a growing public health concern, with studies reporting a high prevalence of depressive symptoms ranging from 20 to 40% in this population [6–9]. This poses a significant burden on families, communities, and healthcare systems, particularly in rural and economically disadvantaged regions. Historical events, such as the Great Chinese Famine of 1959–1961, provide a unique context for understanding the long-term effects of adverse childhood experiences on mental health in China [10, 11]. During this period, millions of children experienced severe malnutrition and other health-related adversities that may have had lasting consequences on their physical and psychological development. Studies suggest that early-life exposure to famine and deprivation is associated with a higher risk of chronic diseases in adulthood, including hypertension, diabetes, and cardiovascular diseases [11–15]. However, less attention has been paid to the potential mental health consequences of these early-life adversities, particularly in the context of depressive symptoms in older age.

Moreover, existing studies on childhood health and depression often focus on isolated factors, such as childhood malnutrition or disease exposure, without considering the combined influence of social factors, lifestyle behaviors, and physical health conditions across the life course [11–15]. In LMICs, where access to healthcare and education is often limited, understanding how early-life health interacts with social determinants and behavioral factors to shape mental health outcomes in older adulthood is crucial. Social and lifestyle factors, such as educational attainment, smoking and drinking behaviors, sleep duration, and residential environment, are known to influence mental health in later life [16, 17]. However, few studies have explored how these factors may moderate the long-term relationship between childhood health and depression.

Addressing these gaps is critical for informing effective public health policies and interventions aimed at improving mental health outcomes among older adults in China. The current study seeks to fill this gap by investigating the association between childhood health status and depressive symptoms in older adulthood using data from a nationally representative survey conducted across 28 provinces in China. In addition, this study examines the potential moderating effects of social and lifestyle factors on this association. By identifying both risk and protective factors for depression, we aim to provide evidence to support the development of preventive and primary care strategies that target mental health disparities among older adults, particularly those with a history of poor childhood health. Our findings will be especially relevant for policymakers, healthcare providers, and public health practitioners seeking to address the growing mental health burden in China's aging population.

Methods

Study design and data collection

This study utilized data from the 2020 wave of the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative survey of Chinese adults aged 45 years or older [18, 19]. The baseline survey, conducted between June 2011 and March 2012, included 17,708 participants from 28 provinces across China [20]. CHARLS employed a four-stage, stratified, cluster sampling method to ensure national representativeness, and participants have been followed up every two years [18]. Data collection was conducted through face-to-face household interviews, capturing detailed information on demographics, socioeconomic status, biomedical measurements, and self-reported health status [19, 21].

Depressive symptoms and childhood health status

Depressive symptoms were assessed using the 10-item short form of the Center for Epidemiological Studies Depression Scale (CES-D), a widely used tool for

evaluating depressive symptoms in population-based studies [22–24]. Scores on the CES-D short form range from 0 to 30, with higher scores indicating greater depressive symptom severity. In this study, a cutoff score of 10 or higher was used to classify participants as experiencing depressive symptoms. Childhood health status was assessed through a retrospective self-report measure in which participants were asked to evaluate their health up to age 15 using a 5-point Likert scale: excellent, very good, good, fair, or poor. Previous studies have validated this retrospective measure, demonstrating its strong correlation with the historical presence of various physical and psychological conditions during childhood [25, 26].

Table 1 General characteristics of participants stratified by childhood health status (*n* = 15581)

Factor	Total %	Excellent, Very good %	Good, Fair %	Poor %	P
Depressive symptoms					< 0.0001
No	66.25	70.01	63.80	52.43	
Yes	33.75	29.99	36.20	47.57	
Age (%)					< 0.0001
45–54	32.82	35.07	31.27	25.05	
55–64	31.33	30.88	31.83	31.65	
65–74	19.80	18.21	20.66	26.77	
≥75	7.25	7.19	7.23	7.78	
Gender (%)					< 0.0001
Male	47.65	49.73	46.24	40.38	
Female	52.35	50.27	53.75	59.62	
Education					< 0.0001
Lower secondary	85.72	85.48	85.42	89.54	
Upper secondary	11.30	11.51	11.48	8.50	
Tertiary	2.91	2.96	3.00	1.97	
BMI (kg/m2)					< 0.0001
< 18.5	4.15	3.53	4.65	5.81	
18.5–23.9	37.62	36.10	38.39	44.68	
24–27.9	26.23	27.72	24.58	25.11	
≥28	10.02	10.98	9.20	7.75	
Smoking status					< 0.0001
Ever or current	39.65	42.09	37.48	34.53	
Never	60.35	57.91	62.52	65.47	
Drinking frequency					0.0450
≥1 drink/month	27.24	28.89	25.51	25.40	
<1 drink/month	9.28	8.96	9.63	9.56	
Never	63.44	62.13	64.79	65.04	
Sleep duration					< 0.0001
<7 h sleep	41.56	40.02	41.61	53.48	
7–10 h sleep	47.83	49.57	47.29	37.54	
≥10 h sleep	9.41	9.45	9.73	6.98	
Residency					< 0.0001
Main city zone	21.56	23.25	20.67	14.02	
Others	18.93	19.11	18.34	21.32	
Village	59.51	57.65	60.99	64.66	

Patient and public involvement

Patients and public were not involved in the development, design and analysis of this study.

Data analysis

Descriptive and inferential statistical analyses were conducted using R 3.4.1 (https://www.r-project.org/). Chi-square tests were performed to examine differences in categorical variables across childhood health groups. Logistic regression analysis was then used to assess the association between childhood health status, lifestyle behaviors, and depressive symptoms. A two-tailed p-value of less than 0.05 was considered statistically significant.

To further investigate the relationship between childhood health and depressive symptoms, a decision tree model was constructed using SPSS Statistics version 25.0. The exhaustive chi-squared automatic interaction detection method was employed to develop the tree-based classification model. The significance threshold for splitting nodes and merging categories was set at 0.05. Node splitting and category merging for ordinal dependent variables were based on chi-square tests, calculated using the likelihood-ratio method.

Results

General characteristics of study participants

Table 1 presents the general characteristics of the study participants, stratified by reported childhood health status. Among all participants, the overall prevalence of depressive symptoms was 33.75%. Participants who reported excellent or very good health during childhood had a lower prevalence of depressive symptoms (29.99%), whereas those who reported poor childhood health showed a markedly higher prevalence (47.57%). Additionally, individuals reporting poor childhood health were more likely to have lower educational attainment, lower body mass index (BMI), and shorter sleep duration in later life compared to those with better childhood health. Detailed participant characteristics are provided in Table 1.

Association between childhood health status, lifestyle behaviors, and depressive symptoms

Logistic regression analysis revealed that participants who reported poor health during childhood had significantly higher odds of experiencing depressive symptoms in later life (adjusted odds ratio [AOR] 1.83, 95% confidence interval [CI] 1.56–2.14, *P* < 0.0001) after adjusting for demographics and lifestyle behaviors. Other factors associated with an increased likelihood of depressive symptoms included age between 65 and 74 years (AOR 1.23, 95% CI 1.10–1.38, *P* = 0.0009), female gender (AOR 2.01, 95% CI 1.78–2.28, *P* < 0.0001), and never drinking alcohol (AOR 1.24, 95% CI 1.11–1.38, *P* = 0.0012).

Conversely, factors associated with a reduced likelihood of depressive symptoms included tertiary education (AOR 0.45, 95% CI 0.32–0.65, *P* = 0.0030), higher BMI (24–27.9 kg/m²: AOR 0.72, 95% CI 0.60–0.87, *P* = 0.0033; BMI ≥ 28 kg/m²: AOR 0.69, 95% CI 0.56–0.85, *P* = 0.0030), and adequate sleep duration (7–10 h: AOR 0.52, 95% CI 0.48–0.57, *P* < 0.0001; ≥10 h: AOR 0.50, 95% CI 0.43–0.58, *P* < 0.0001). Participants who had never smoked (AOR 0.77, 95% CI 0.68–0.86, *P* < 0.0001) and those living in main city zones (AOR 0.57, 95% CI 0.50–0.64, *P* < 0.0001) were also less likely to report depressive symptoms. The complete results are shown in Table 2.

Decision tree model analysis

The decision tree model analysis (Fig. 1) provided a visual representation of the factors associated with depressive symptoms among the study participants. The model incorporated variables related to general characteristics, lifestyle behaviors, and physical health status, highlighting complex patterns of associations. Key factors identified by the model included childhood health status, sleep duration, gender, place of residence, and the presence of NCDs.

The decision tree structure indicated that participants with certain characteristics were more likely to report depressive symptoms. For example, participants who were male, reported excellent or very good health during childhood, did not have arthritis or rheumatism, had

Table 2 Associations between childhood health, lifestyle behaviors, non-communicable diseases and depressive symptoms

| Variables	Depressive symptoms %	OR (95% CI)	P	AOR (95% CI)	P
Health during childhood					
Excellent, very good	29.99	1.0		1.0	
Good, Fair	36.20	1.33(1.24,1.42)	0.0265	1.34(1.23,1.45)	0.7978
Poor	47.57	2.12(1.86,2.42)	< 0.0001	1.83(1.56,2.14)	< 0.0001
Age					
45–54	30.76	1.00		1.00	
55–64	33.23	1.12(1.03,1.22)	0.1172	1.03(0.93,1.13)	0.1315
65–74	37.79	1.37(1.25,1.50)	< 0.0001	1.23(1.10,1.38)	0.0009
≥75	35.55	1.24(1.08,1.42)	0.2531	1.09(0.93,1.28)	0.9519
Gender					
Male	26.49	1.00		1.00	
Female	40.36	1.88(1.75,2.01)	< 0.0001	2.01(1.78,2.28)	< 0.0001
Education					
Lower secondary	36.21	1.00		1.00	
Upper secondary	19.29	0.42(0.37,0.48)	< 0.0001	0.61(0.53,0.72)	0.4197
Tertiary	17.45	0.37(0.29,0.48)	< 0.0001	0.45(0.32,0.65)	0.0030
BMI (kg/m²)					
18.5–23.9	42.85	1.00		1.00	
<18.5	36.80	0.78(0.66,0.91)	0.2364	0.85(0.71,1.01)	0.1599
24–27.9	31.87	0.62(0.53,0.74)	< 0.0001	0.72(0.60,0.87)	0.0033
≥28	32.60	0.65(0.54,0.78)	0.0012	0.69(0.56,0.85)	0.0030
Sleep duration					
<7 h sleep	42.80	1.00		1.00	
7–10 h sleep	26.70	0.49(0.45,0.52)	< 0.0001	0.52(0.48,0.57)	< 0.0001
≥10 h sleep	27.99	0.52(0.46,0.59)	< 0.0001	0.50(0.43,0.58)	< 0.0001
Smoking status					
Ever or current	29.31	1.00		1.00	
Never	36.67	1.40(1.30,1.50)	< 0.0001	0.77(0.68,0.86)	< 0.0001
Drinking frequency					
≥1 drink/month	26.57	1.00		1.00	
<1 drink/month	30.34	1.20(1.06,1.37)	0.2900	1.09(0.93,1.28)	0.7918
Never	37.34	1.65(1.52,1.78)	< 0.0001	1.24(1.11,1.38)	0.0012
Residence					
Village	23.79	1.00		1.00	
Main city zone	28.53	0.49(0.45,0.53)	< 0.0001	0.57(0.50,0.64)	< 0.0001
Other	39.02	0.62(0.57,0.68)	0.0158	0.75(0.67,0.84)	0.9999
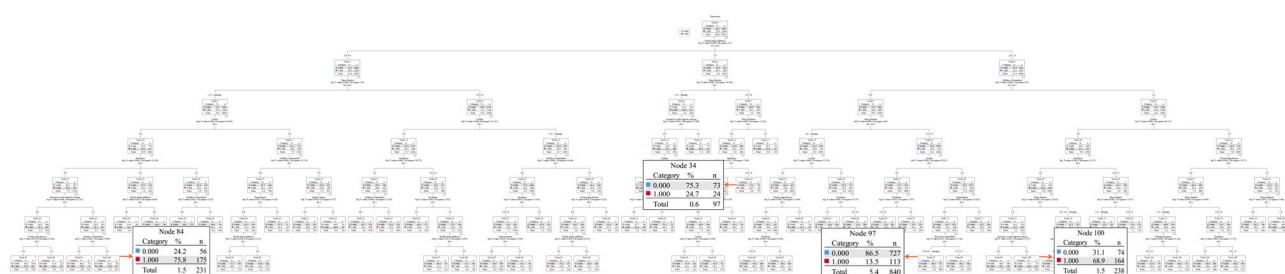
Fig. 1 The structure of the decision tree model

adequate sleep, maintained normal blood pressure, and were overweight had the lowest prevalence of depressive symptoms (13.5%, Node 97). Conversely, participants who reported poor or fair childhood health, slept less than 7 h, were female, lived in villages, and had conditions such as digestive diseases or arthritis showed the highest prevalence of depressive symptoms (75.8%, Node 84) (Fig. 1, Table S1).

The red boxes indicate the prevalence of depressive symptoms, while the blue boxes indicate the prevalence of no depressive symptoms. The factors included in the model are gender (1: Male, 2: Female), health during childhood (1: Excellent, 2: Very good, 3: Good, 4: Fair, 5: Poor), residence (1: Main city zone, 2: Other, 3: Village), sleep duration (1: <7 h, 2: 7–10 h, 3: ≥10 h), BMI (1: 18.5–23.9, 2: <18.5, 3: 24–27.9, 4: ≥28), hypertension (1: Yes, 2: No), arthritis or rheumatism (1: Yes, 2: No), stomach or other digestive diseases (1: Yes, 2: No), dyslipidemia (1: Yes, 2: No), chronic lung diseases (1: Yes, 2: No), heart problem (1: Yes, 2: No), and kidney disease (1: Yes, 2: No).

Discussion

Our study reveals a significant association between childhood health status and depressive symptoms in later life, emphasizing the potential long-term impact of early-life health on adult mental health outcomes. These findings highlight the importance of addressing childhood health issues as part of a preventive approach to reduce the risk of depression in adulthood. Public health campaigns that promote healthy lifestyle behaviors from an early age may be instrumental in mitigating mental health risks later in life. This study underscores the need for policymakers and health professionals to recognize the enduring influence of childhood health on mental well-being and to prioritize preventive and primary care services for children, particularly in vulnerable populations.

This investigation primarily explored the relationship between childhood health and depressive symptoms in middle-aged and older Chinese adults. The prevalence of depressive symptoms was significantly lower among individuals who reported excellent or very good childhood health (29.99%) compared to those who reported poor childhood health (47.57%). Even after adjusting

for demographic factors and lifestyle behaviors, poor childhood health remained strongly associated with an elevated risk of depressive symptoms in adulthood. The decision tree model provided additional insights, suggesting that childhood health status influences adult mental health through complex pathways involving lifestyle factors, physical health conditions, and socio-demographic characteristics. Notable factors associated with depressive symptoms included NCDs, sleep duration, place of residence, and health behaviors such as smoking and drinking (Fig. 1, Table S1).

Our findings illustrate that while poor childhood health is associated with a higher prevalence of depressive symptoms in later life, this relationship is not uniform across all individuals. The decision tree analysis showed that certain lifestyle behaviors and physical health conditions modify the relationship between childhood health and adult depressive symptoms. For example, participants with poor childhood health but healthy lifestyle behaviors and adequate sleep in adulthood exhibited a relatively lower prevalence of depressive symptoms (Node 34, 24.7%). In contrast, participants with excellent or very good childhood health but unhealthy behaviors and physical ailments in later life had a notably high prevalence of depressive symptoms (Node 100, 68.9%). These observations suggest that adult mental health outcomes are shaped by both early-life health status and later-life experiences. Previous studies have similarly demonstrated that mental health trajectories are dynamic, evolving across different life stages, social roles, and experiences [27, 28].

The decision tree model highlighted arthritis/rheumatism and digestive diseases as the most significant NCDs associated with depressive symptoms (Fig. 1, Table S1). These conditions are prevalent among middle-aged and older adults in China, with more than 40% of affected individuals experiencing depressive symptoms. This aligns with existing research showing a bidirectional relationship between physical and mental health, where chronic conditions can exacerbate psychological distress and depression may, in turn, worsen physical health outcomes [29]. Depression has been identified as both a consequence and a risk factor for NCDs, with

untreated depression linked to poorer health outcomes and increased mortality in individuals with chronic diseases [30–32]. Additionally, research has indicated that untreated depression in older adults with NCDs is linked to worse health outcomes [33]. Understanding the interplay between arthritis/rheumatism, digestive diseases, and mental health could inform targeted interventions aimed at improving both physical and psychological well-being in aging populations.

Our study also identified protective factors that may reduce the risk of depressive symptoms in later life. Consistent with prior research, healthy lifestyle behaviors, higher education levels, urban residency, and adequate sleep were associated with better mental health outcomes [6, 7, 22]. Individuals living in main city zones reported lower rates of depressive symptoms, possibly due to better access to healthcare, social services, and community resources [34, 35]. Such results would promote more effective depression prevention programs addressing healthy lifestyle behaviors and good social status for Chinese over the entire life cycle, especially those who reported poor health during childhood.

However, some findings regarding lifestyle behaviors, such as alcohol consumption and BMI, were counterintuitive compared to existing literature [36]. Participants who never consumed alcohol were more likely to report depressive symptoms, which contradicts studies suggesting that moderate alcohol consumption may have a protective effect on mental health [36, 37]. This discrepancy may be explained by the cultural context of our study in China, where moderate alcohol consumption is often associated with positive social interactions. Conversely, abstaining from alcohol could signal social isolation or underlying health concerns, both of which are linked to depression [6, 34]. The association between higher BMI and a lower prevalence of depressive symptoms may reflect the "obesity paradox", where individuals with higher BMI may benefit from better social support or healthcare access, or it could be influenced by self-reporting biases and measurement errors [38, 39]. Future studies should explore these associations further, taking into account cultural factors, reverse causality, and the heterogeneity of obesity phenotypes.

Several potential mechanisms could explain the observed relationship between childhood health and adult depressive symptoms. Chronic inflammation, often resulting from early-life health challenges such as recurrent infections or malnutrition, has been implicated in the development of depressive symptoms in adulthood [40, 41]. Inflammation can disrupt neurotransmitter systems, impair neuroplasticity, and alter hypothalamic-pituitary-adrenal (HPA) axis function, all of which are linked to depression [42, 43]. Additionally, childhood health issues may lead to long-term social disadvantages, such as reduced educational attainment, limited employment opportunities, and lower socioeconomic status, which are well-established risk factors for depression [43]. Poor childhood health may also impact self-esteem, resilience, and coping mechanisms, further influencing mental health outcomes later in life.

The role of early-life socioeconomic status (SES) and adverse childhood experiences (ACEs) should not be overlooked. Children from lower SES backgrounds often face limited access to healthcare, nutritious food, and safe environments, which can contribute to both physical and mental health challenges in adulthood [43, 44]. Furthermore, ACEs such as abuse, neglect, or household dysfunction can have long-lasting effects on mental health by impairing emotional regulation, disrupting brain development, and increasing susceptibility to depression [45–48]. Our study did not explicitly measure SES or ACEs, which are potential confounders that may have influenced the observed associations. Future research should incorporate these factors to better understand the multifaceted pathways linking childhood health to adult mental health.

Our study has several limitations that should be considered when interpreting the results. First, the cross-sectional nature of our study does not allow us to establish causality or determine the temporal sequence of events. While we identified associations between childhood health, lifestyle factors, and depressive symptoms in later life, it is possible that reverse causality may be at play. For example, depressive symptoms could lead to changes in sleep patterns, influence an individual's ability or willingness to move from a village to a city, and even affect their perception of experiencing arthritis/rheumatism and digestive diseases. Therefore, our results should be viewed as highlighting potential pathways and associations rather than definitive causal relationships. Second, the health status during childhood and other variables such as arthritis and rheumatism were self-reported by the participants. This reliance on self-reported data could introduce bias, as individuals with depression may perceive and recall their health differently. Additionally, we did not account for changes in living situations over the life course, which could have significant impacts on both physical and mental health. Lastly, the use of a single time points for measuring adult outcomes limits our ability to observe changes over time and establish temporal precedence. Future longitudinal studies with multiple time points would be better equipped to address these limitations and provide a more comprehensive understanding of the relationships between childhood health, lifestyle factors, and mental health outcomes.

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Conclusions

In conclusion, this study highlights significant associations between childhood health and depressive symptoms in later life among middle-aged and older Chinese adults. The findings underscore the importance of early-life health as a determinant of mental well-being in later life, suggesting that public health policies should prioritize early interventions to promote healthy development. Addressing modifiable risk factors, including lifestyle behaviors and NCD management, could help reduce the burden of depression in aging populations. Further longitudinal research is needed to clarify the complex pathways linking childhood health to adult mental health outcomes and to develop effective strategies for improving mental health across the lifespan.

Abbreviations

CES-D	Center for Epidemiological Studies Depression
LMICs	Low- and middle-income countries
CHARLS	China Health and Retirement Longitudinal Study
NCD	Non-communicable disease
BMI	Body mass index
OR	Odds ratio
SES	Socioeconomic status
ACEs	Adverse childhood experiences

Supplementary Information

The online version contains supplementary material available at https://doi.or g/10.1186/s12889-025-21862-w.

Supplementary Material 1

Data availability

The datasets generated and/or analyzed during the current study are available in the CHARLS repository. All data in CHARLS are maintained at the National School of Development of Peking University and will be accessible to researchers around the world at the study website (https://charls.charlsdata.co m/pages/data/111/zh-cn.html).

Declarations

Ethics approval and consent to participate

Ethical approval for the study was granted by the Ethical Review Committee of Peking University (approval No. IRB00001052-11015). The study was conducted in accordance with the principles outlined in the Declaration of Helsinki. All individuals in this study provided written consent at the time of participation, and written informed consent was obtained from all study participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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