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The association between speech impairments and depression in Chinese adults aged 45 and older: insights from the CHARLS database

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Abstract

Background Speech impairments significantly affect communication and are associated with social and psychological difficulties, particularly among adults aged 45 years and older. This study examines the relationship between speech impairments and depression using data from the China Health and Retirement Longitudinal Study (CHARLS).

Methods A total of 67,014 participants aged 45 years and older were included in the analysis. The baseline characteristics of participants with and without speech impairments were compared using chi-square tests. Multivariable logistic and linear regression models were employed to assess the association between speech impairments and depression. Sensitivity and subgroup analyses were performed to explore variations across different demographic and lifestyle characteristics.

Results Participants with speech impairments exhibited a significantly greater likelihood of depression, with adjusted odds ratios (Model II: OR = 2.16, 95% CI: 1.56–2.97, $p < 0.0001$) and higher depression scores (Model II: β = 3.03, 95% CI: 2.24–3.81, $p < 0.0001$) after controlling for confounders. Sensitivity analysis confirmed the robustness of these findings. Subgroup analysis revealed consistent associations across all the examined subgroups, with a statistically significant interaction between speech impairments and place of residence (p for interaction = 0.02), indicating a stronger association in urban residents.

Conclusion Speech impairments are strongly associated with a greater likelihood of depression in middle-aged and elderly Chinese adults. This finding underscores the importance of targeted mental health interventions and support for this population, particularly in urban settings.

Clinical trial number Not applicable.

Keywords Speech impairments, Depression, Middle-aged and elderly, CHARLS

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Introduction

Depression is one of the most prevalent mental health disorders worldwide, leading to significant personal suffering, reduced quality of life, and increased health care utilization [1–3]. It is estimated that globally approximately 10–20% of middle-aged or older individuals experience clinically significant depressive symptoms [3–5]. In China, where rapid demographic aging and shifts in social structures are underway, depression among adults aged 45 years and older is particularly concerning, with recent surveys suggesting that nearly one-third of these individuals may experience elevated depressive symptoms [6, 7]. Moreover, late-life depression is significantly correlated with functional deterioration, increased morbidity, and higher mortality risks, underscoring the urgent need to elucidate its etiological underpinnings and identify viable interventional targets to ameliorate health outcomes in the geriatric population [8].

Speech impairments may represent a potential but underexplored risk factor for depression in middle-aged and older adults. These disorders encompass a range of conditions, including muteness, dysarthria, aphasia, and severe stuttering, which disrupt fluency, articulation, or voice quality [9]. Some studies [10, 11] have shown that both the amount of speech and timing-related speech features, such as slower speech rate, longer pause time, and longer response time, are associated with depression severity and symptoms, and could serve as objective biomarkers for assessing depression. Additionally, previous research has shown that 39.4% of individuals, with a mean age of 48.9 years, experienced speech, language, or hearing disorders, with the highest prevalence among those aged 60 and older, ranging from 18–50% [12, 13]. These conditions can severely impede communication [14, 15], limiting social interaction and increasing isolation, both of which co-occur with age-related health conditions, such as key psychosocial determinants of depression [16].

Speech disorders and mental health are intricately linked, with communication impairments often acting as a catalyst for social isolation, psychological stress, and increased vulnerability to depression [16]. As the aging population increases, understanding the intersection of speech impairments with mental health, especially depression, becomes increasingly important [17–19]. Previous research has focused primarily on related conditions, such as hearing and vision impairments, which are consistently linking them to higher rates of depression and loneliness [6, 20, 21]. One study explored the relationships among stuttering, depression, and suicidal ideation in young adults, highlighting the psychological challenges associated with speech disorders [22]. Nonetheless, prior research often involved smaller samples [16, 22], and investigations specifically examining the connection between speech disorders and depression in Chinese adults aged 45 years and older remain limited.

Addressing these gaps is crucial to understanding how speech impairments contribute to depression risk and identifying pathways for intervention. The China Health and Retirement Longitudinal Study (CHARLS) provides a rich dataset for examining this relationship between speech impairments and depression in a nationally representative sample of Chinese adults aged 45 years and older. This study uses the CHARLS database to provide new insights into the literature, aiming to enhance our ability to address the mental health and communication needs of middle-aged and older adults. By exploring these connections, we hope to improve the quality of life of individuals with speech impairments through better, more targeted health care strategies.

Methods

Study participants

This study utilized data from the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative survey targeting individuals aged 45 years and older. The CHARLS collects extensive data on health, economic status, and social factors affecting middle-aged and older adults in China, with surveys conducted across multiple waves (2011, 2013, 2015, and 2018). Although CHARLS is a longitudinal dataset, this study employed a cross-sectional analysis due to the lack of sufficient temporal information to establish a follow-up timeline between speech impairments and depression. Participants with missing data on speech impairments or depression were excluded to ensure data completeness and reliability. After this exclusion process, the final sample included 67,014 participants. The process of participant selection is detailed in Fig. 1.

Ascertainment of speech impairments and depression

Speech impairments were identified using a standardized questionnaire administered to participants. The questionnaire included the following questions: "Do you have any of the following speech impairments: muteness or severe stuttering?" The participants were asked to respond "yes" or "no" to this question. The inclusion criteria for speech impairments were defined as follows: Muteness: Participants who reported an inability to speak. Severe stuttering: Participants who reported experiencing significant difficulty with fluency and continuity of speech, characterized by frequent repetitions or prolongations of sounds, syllables, or words.

Depressive symptoms were assessed using the 10-item Center for Epidemiological Studies Depression Scale (CES-D-10) [23, 24], a tool validated for measuring depressive symptoms among middle-aged and older adults in China [7]. The CES-D-10 consists of 10 items

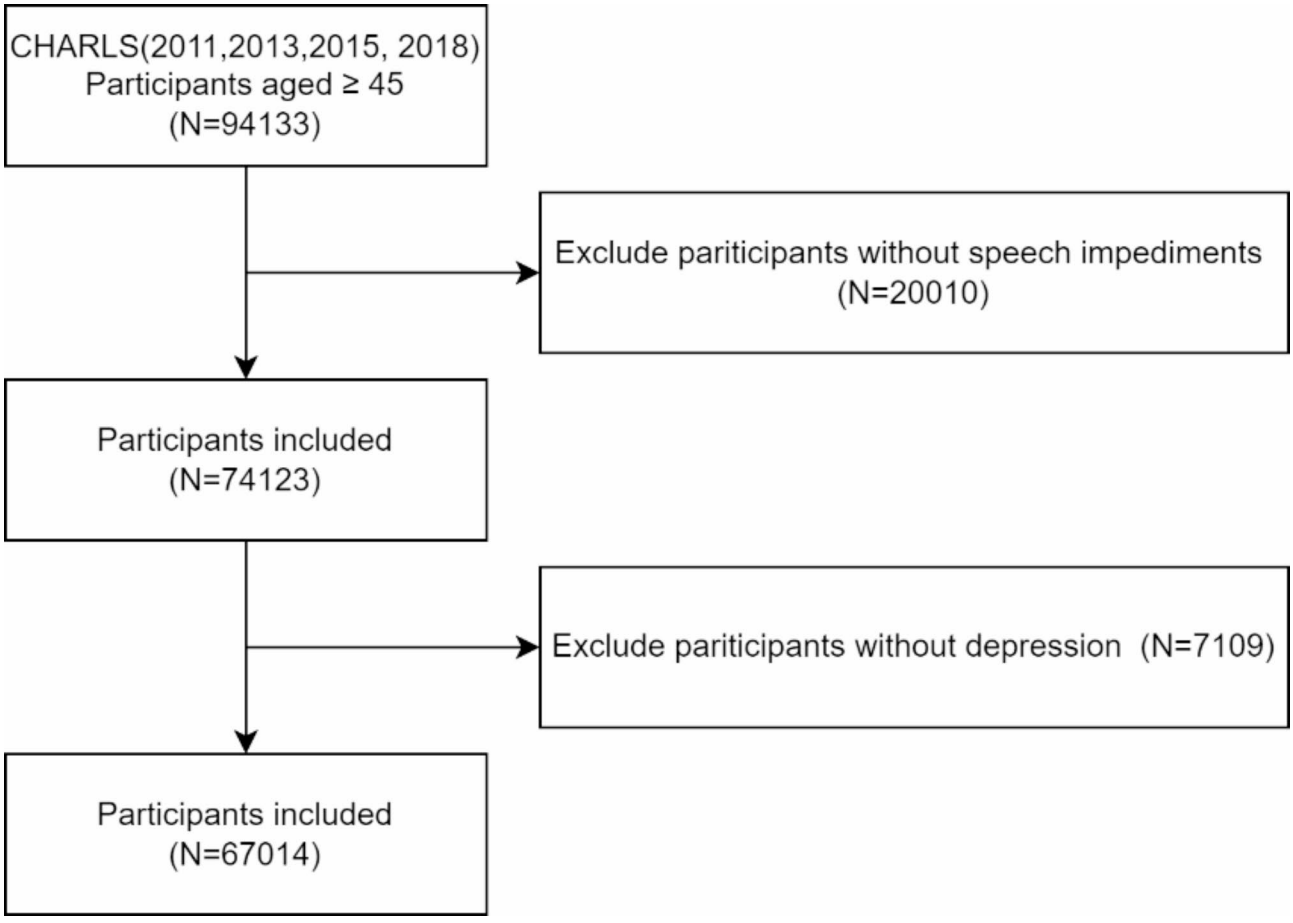

Fig. 1 Flow chart of the study participant selection process

(e.g., "In the past week I was bothered by things that usually don't bother me?"), each with 4 response options: (1) rarely or none of the time (< 1 day); (2) some or a few times (1–2 days); (3) occasionally or a moderate amount of time (3–4 days); and (4) most or all of the time (5–7 days). The response values range from 0 to 3. The total score for the assessment ranges from 0 to 30, with lower scores indicating fewer depressive symptoms. A cutoff score of ≥ 10 was used to identify respondents with significant depressive symptoms [23]. One study [25] reported that the CES-D-10 demonstrates good reliability, with a Cronbach's alpha of 0.86 and a test-retest ICC of 0.85, as well as strong validity, showing significant correlations with mental health (r = -0.71), vitality (r = -0.60), and fatigue (r = 0.57) measures. Additionally, the CES-D-10 showed strong reliability in Chinese middle-aged and older adults, with Cronbach's alpha values of 0.815 overall, 0.814 for middle-aged adults, and 0.813 for older adults, as well as robust construct validity supported by a well-fitting two-factor model (RMSEA = 0.064, CFI = 0.97, GFI = 0.97) [26].

Assessment of covariates

Sociodemographic factors were assessed through a structured questionnaire. Age was recorded in years and categorized into four groups: under 50, 50–60, 61–70, and > 70 years [27]. Sex was self-reported as male or female. Marital status was categorized into six groups: married, divorced, separated, widowed, never married, or cohabiting. Education levels were categorized into five levels: illiterate, primary school, middle school, high school, and college or above, which includes bachelor's, master's, and doctoral degrees [28, 29]. Residence was recorded as rural or urban, and geographical location was categorized into two regions, north and south, based on the participant's province of residence.

Current smoking status was defined as "no" for individuals who identified as nonsmokers and "yes" for those who reported actively smoking at the time of the survey. Drinking in the last year was categorized as "no" for nondrinkers or "yes" for those who consumed alcohol. Sleep duration was classified as optimal (7–9 hours) or nonoptimal (< 7 or > 9 hours) based on classification in the literature [30, 31]. Falls were assessed with the question: "Have you experienced a fall in the past two years?" [32].

Body pain was categorized as 'No' or 'Yes' based on participants' responses to two key questions: whether they frequently experienced body pain and the specific locations where pain was felt [33].

The World Health Organization's body mass index (BMI) classification was used to divide participants into four groups: underweight (< 18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥ 30 kg/m²) [34].

Diabetes was defined as fasting plasma glucose ≥ 126 mg/dL, current use of antidiabetic medication, or self-reported history of diabetes. Hypertension was defined as a systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg [35], current use of antihypertensive medication, or self-reported history of hypertension.

Cardiovascular disease (CVD) [36] status was determined on the basis of two self-reported questions from the CHARLS questionnaire: one that asked whether a doctor had ever diagnosed the participant with heart disease (including conditions such as heart attack, angina, coronary artery disease, or heart failure), and the other that asked whether a doctor had diagnosed the participant with a stroke. Participants who answered "yes" to either of these questions were classified as having a CVD.

Statistical analyses

The data were recorded in Microsoft Excel and analyzed using the survey package in R version 4.4.2. Multiple imputation was performed using the mice package. Categorical variables were presented as proportions and frequencies, and analyzed with chi-square tests. To maximize statistical power and minimize bias, we employed multiple imputation with five replications to handle missing data on nationality, education level, smoking status, hypertension, diabetes, and cardiovascular disease, using a widely recognized approach for its reliability [37, 38]. The associations between speech impairments and depression were evaluated using multivariable regression, with logistic regression applied to the binary outcome of depression and linear regression to the continuous depression score. Three models were constructed: a crude model without covariate adjustments; Model One, adjusted for sociodemographic and behavioral factors (age, sex, nationality, marital status, education level, residence, geographical location, smoking, drinking, and sleep duration); and Model Two, which included all variables from Model One plus clinical factors (BMI, hypertension, diabetes, CVD, presence of chronic disease, body pain, and falls). A sensitivity analysis was conducted to asses the robustness of the findings by varying the CES-D-10 cutoff for depressive symptoms. The primary analysis used a threshold of ≥ 10, while a stricter criteria of ≥ 12 was applied in the sensitivity analysis to test whether the observed associations persisted under a more conservative definition of depression, ensuring that the results were not unduly influenced by the cutoff selection and reinforcing the robustness of conclusions. Subgroup analyses using logistic regression examined potential modifiers (age, sex, nationality, residence, geographical location, smoking, and drinking), with interaction effects assessed by including a product term for each stratifying variable and speech impairment in the regression model. Statistical significance was set at a two-sided p-value of ≤ 0.05.

Results

Characteristics of the participants

Table 1 summarizes the baseline characteristics of the participants with and without speech impairments. Chi-square tests were used to compare differences in proportions across demographic, lifestyle, and health-related variables. The participants with speech impairments were more likely to be older, with 59.69% aged > 60 years compared to 40.31% aged ≤ 60 years ($p = 0.001$). They were also predominantly male (60.73% vs. 39.27%, $p < 0.001$) and more likely to reside in rural areas (67.54% vs. 32.64%, $p = 0.04$). Educational level was notably lower in this group, with 79.05% having less than a middle school education ($p < 0.001$).

Lifestyle factors also differed significantly, with smoking rates being higher in participants with speech impairments (51.83% vs. 48.17%, $p < 0.001$). In terms of health conditions, they had a greater prevalence of hypertension (38.74% vs. 27.00%, $p < 0.001$), diabetes (21.47% vs. 11.88%, $p < 0.0001$), and cardiovascular disease (37.70% vs. 17.37%, $p < 0.0001$). Chronic disease was less common among participants with speech impairments (26.18% vs. 41.54%, $p < 0.0001$), however, body pain (63.87% vs. 39.86%, $p < 0.0001$) and falls (25.13% vs. 12.82%, $p < 0.0001$) were more common in this group. Individuals with speech impairments reported depression at a rate of 62.83%, which was significantly higher than the 34.94% reported by those without speech impairments ($p < 0.0001$). No significant differences were observed between the two groups in terms of nationality, geographical location, drinking, BMI, or sleep duration.

The association between speech impairments and depression

Table 2 shows the multivariable analysis of the association between speech impairments and depression. The odds of depression were significantly greater among individuals with speech impairments, as estimated using logistic regression. According to the crude model, individuals with speech impairments had higher odds of depression (OR = 3.15, 95% CI: 2.35–4.22, $p < 0.0001$). This association remained robust in Model I, which

Table 1 Baseline characteristics of the participants by speech impairments

Variable	Total ($n=67014$)	Speech impairments		*P*-value
		No ($n=66823$)	Yes ($n=191$)	
Age(years)				0.001
< 50	10,406(15.53)	10,386(15.54)	20(10.47)	
50–60	25,945(38.72)	25,888(38.74)	57(29.84)	
61–70	20,154(30.07)	20,082(30.05)	72(37.70)	
> 70	10,509(15.68)	10,467(15.66)	42(21.99)	
Sex				< 0.001
Male	32,157(47.99)	32,041(47.95)	116(60.73)	
Female	34,857(52.01)	34,782(52.05)	75(39.27)	
Nationality				1.00
Han	61,857(92.30)	61,681(92.31)	176(92.15)	
Minority	5157(7.70)	5142(7.69)	15(7.85)	
Marital status				< 0.0001
Married	58,390(87.13)	58,238(87.15)	152(79.58)	
Divorced	658(0.98)	652(0.98)	6(3.14)	
Separated	235(0.35)	234(0.35)	1(0.52)	
Widowed	7247(10.81)	7223(10.81)	24(12.57)	
Never married	454(0.68)	446(0.67)	8(4.19)	
Cohabitation	30(0.04)	30(0.04)	0(0.00)	
Education level				< 0.001
Illiterate	28,617(42.70)	28,512(42.67)	105(54.97)	
Primary school	15,152(22.61)	15,106(22.61)	46(24.08)	
Middle school	14,702(21.94)	14,673(21.96)	29(15.18)	
High school	6986(10.42)	6975(10.44)	11(5.76)	
College or above	1557(2.32)	1557(2.33)	0(0.00)	
Place of residence				0.04
Rural	40,291(60.12)	40,162(60.10)	129(67.54)	
Urban	26,723(39.88)	26,661(39.90)	62(32.46)	
Geographical location				0.24
North	37,052(55.29)	36,955(55.30)	97(50.79)	
South	29,962(44.71)	29,868(44.70)	94(49.21)	
Current smoking				< 0.001
No	40,282(60.11)	40,190(60.14)	92(48.17)	
Yes	26,732(39.89)	26,633(39.86)	99(51.83)	
Drinking last year				0.61
No	43,792(65.35)	43,671(65.35)	121(63.35)	
Yes	23,222(34.65)	23,152(34.65)	70(36.65)	
Body mass index (BMI)				0.25
Normal weight	40,229(60.03)	40,102(60.01)	127(66.49)	
Underweight	3885(5.80)	3876(5.80)	9(4.71)	
Overweight	19,355(28.88)	19,306(28.89)	49(25.65)	
Obesity	3545(5.29)	3539(5.30)	6(3.14)	
Hypertension				< 0.001
No	48,920(73.00)	48,803(73.03)	117(61.26)	
Yes	18,094(27.00)	18,020(26.97)	74(38.74)	
Diabetes				< 0.0001
No	59,050(88.12)	58,900(88.14)	150(78.53)	
Yes	7964(11.88)	7923(11.86)	41(21.47)	
Cardiovascular disease (CVD)				< 0.0001
No	55,374(82.63)	55,255(82.69)	119(62.30)	
Yes	11,640(17.37)	11,568(17.31)	72(37.70)	
Presence of chronic disease				< 0.0001

Table 1 (continued)

Variable	Total (*n* = 67014)	Speech impairments		*P*-value
		No (*n* = 66823)	Yes (*n* = 191)	
No	39,179(58.46)	39,038(58.42)	141(73.82)	
Yes	27,835(41.54)	27,785(41.58)	50(26.18)	
Body pain				< 0.0001
No	40,305(60.14)	40,236(60.21)	69(36.13)	
Yes	26,709(39.86)	26,587(39.79)	122(63.87)	
Falls				< 0.0001
No	58,425(87.18)	58,282(87.22)	143(74.87)	
Yes	8589(12.82)	8541(12.78)	48(25.13)	
Sleep duration				0.07
Nonoptimal sleep (< 7 or > 9 h/d)	53,049(79.16)	52,887(79.14)	162(84.82)	
Optimal sleep (7 to 9 h/d)	13,965(20.84)	13,936(20.86)	29(15.18)	
Depression				< 0.0001
No	43,547(64.98)	43,476(65.06)	71(37.17)	
Yes	23,467(35.02)	23,347(34.94)	120(62.83)	

Table 2 Multivariable analysis of the association between speech impairments and depression

	Crude model	Model I	Model II
Speech impairments	**Depression**		
	OR (95% CI) *P*-value	**OR (95% CI)*P*-value**	**OR (95% CI)*P*-value**
No	ref	ref	ref
Yes	3.15(2.35, 4.22) < 0.0001	2.99(2.21, 4.04) < 0.0001	2.16(1.56, 2.97) < 0.0001
Speech impairments	**Depression score**		
	β (95% CI)*P*-value	**β (95% CI)*P*-value**	**β (95% CI)*P*-value**
No	ref	ref	ref
Yes	4.89(4.00, 5.78) < 0.0001	4.43(3.58, 5.28) < 0.0001	3.03(2.24, 3.81) < 0.0001

OR: odds ratio, β: regression coefficient, CI: confidence interval, Ref: reference category

Crude model: adjusted for no variables

Model I adjusted for: age, sex, nationality, marital status, education level, place of residence, geographical location, current smoking, drinking last year, sleep duration

Model II adjusted for: age, sex, nationality, marital status, education level, place of residence, geographical location, current smoking, drinking last year, sleep duration, body mass index (BMI), hypertension, diabetes, cardiovascular disease (CVD), presence of chronic disease, body pain, and falls

adjusted for age, sex, nationality, marital status, education level, place of residence, geographical location, current smoking, drinking in the last year and sleep duration (OR = 2.99, 95% CI: 2.21–4.04, $p < 0.0001$). In Model II, which additionally adjusted for BMI, hypertension, diabetes, CVD, the presence of chronic disease, body pain, and falls, the association remained statistically significant (OR = 2.16, 95% CI: 1.56–2.97, $p < 0.0001$).

Similarly, individuals with speech impairments had significantly higher depression scores, as estimated using linear regression. The crude model revealed a significant positive association between speech impairments and depression scores (β = 4.89, 95% CI: 4.00–5.78, $p < 0.0001$). This association persisted in Model I (β = 4.43, 95% CI: 3.58–5.28, $p < 0.0001$) and Model II (β = 3.03, 95% CI: 2.24–3.81, $p < 0.0001$), indicating that speech impairments are consistently associated with higher depression scores even after adjusting for multiple confounders.

Sensitivity analysis of speech impairments and depression

Table 3 displays the sensitivity analysis conducted using logistic regression to assess the association between speech impairments and depression, categorized as "No" for scores < 12 and "Yes" for scores ≥ 12. In the crude model, speech impairment was significantly associated with depression (OR = 2.95, 95% CI: 2.22–3.93, $p < 0.001$). After adjusting for age, sex, nationality, marital status, education level, place of residence, geographical location, current smoking, drinking, and sleep duration in Model I, the association remained significant (OR = 2.79, 95% CI: 2.08–3.74, $p < 0.001$). After further adjustments for BMI, chronic diseases, and other factors in Model II, which remained evident (OR = 1.97, 95% CI: 1.44–2.70, $p < 0.001$).

Table 3 Sensitivity analysis of the association between speech impairments and depression

	Crude model	Model I	Model II
	OR (95% CI) *P*-value	OR (95% CI) *P*-value	OR (95% CI) *P*-value
Speech impairments			
No	ref	ref	ref
Yes	2.95(2.22,3.93)	2.79(2.08,3.74)	1.97(1.44,2.70)

OR: odds ratio, CI: confidence interval, Ref: reference category

Crude model: adjusted for no variables

Model I adjusted for: age, sex, nationality, marital status, education level, place of residence, geographical location, current smoking, drinking last year, sleep duration

Model II adjusted for: age, sex, nationality, marital status, education level, place of residence, geographical location, current smoking, drinking last year, sleep duration, body mass index (BMI), hypertension, diabetes, cardiovascular disease (CVD), presence of chronic disease, body pain, and falls

Table 4 Subgroup analysis of the association between speech impairments and depression

Character	OR (95% CI)	*p*	*p* for interaction
Age(years)			0.49
< 50	5.52(2.21,15.61)	< 0.001	
50–60	3.34(1.97,5.83)	< 0.0001	
61–70	2.80(1.75,4.57)	< 0.0001	
> 70	2.38(1.29,4.49)	0.01	
Sex			0.45
Male	3.23(2.24,4.67)	< 0.0001	
Female	4.12(2.50,7.12)	< 0.0001	
Nationality			0.52
Han	3.06(2.27,4.17)	< 0.0001	
Minority	4.48(1.53,16.19)	0.01	
Place of residence			0.02
Rural	2.43(1.71,3.48)	< 0.0001	
Urban	4.98(2.98,8.59)	< 0.0001	
Geographical Location			0.61
North	2.94(1.96,4.49)	< 0.0001	
South	3.43(2.27,5.26)	< 0.0001	
Current smoking			0.87
No	3.39(2.21,5.31)	< 0.0001	
Yes	3.22(2.17,4.84)	< 0.0001	
Drinking last year			0.73
No	3.36(2.31,4.97)	< 0.0001	
Yes	3.02(1.89,4.87)	< 0.0001	

Subgroup analysis of the association between speech impairments and depression

Table 4 presents a logistic regression-based subgroup analysis of the associations between speech impairments and depression across several demographic and lifestyle characteristics. The association was significant across all subgroups. For age, the odds ratios were 5.52 for those under 50 years of age, 3.34 for those aged 50–60 years, 2.80 for those aged 61–70 years, and 2.38 for those older than 70 years (interaction $p = 0.49$). Both males (OR = 3.23) and females (OR = 4.12) showed significant associations (interaction $p = 0.45$). Han (OR = 3.06) and minority (OR = 4.48) nationalities also showed significant associations (interaction $p = 0.52$). Compared to rural residents (OR = 2.43), urban residents had a stronger association (OR = 4.98) (interaction $p = 0.02$). Northern (OR = 2.94) and southern (OR = 3.43) residents had similar associations (interaction $p = 0.61$). Both nonsmokers (OR = 3.39) and smokers (OR = 3.22) showed significant associations (interaction $p = 0.87$). Those who did not drink (OR = 3.36) and those who did (OR = 3.02) also had significant associations (interaction $p = 0.73$). Overall, the association between speech impairments and increased odds of depression was consistent across all subgroups, with a significant interaction effect observed for place of residence.

Discussion

This study, which utilized a comprehensive dataset from CHARLS, is the first to reveal a significant association between speech impairments and depression among middle-aged and elderly Chinese adults. The sensitivity

and subgroup analyses yielded consistent results. These findings align with those of prior studies highlighting the substantial impact of speech disorders on mental health [16, 22, 39]. Speech impairments, such as muteness and severe stuttering, can hinder communication and reduce engagement in daily activities, which are key risk factors for depression [40, 41]. Notably, the association between speech impairment and depression remained significant even after adjusting for demographic and clinical variables, suggesting that communication disorders may contribute to negative psychological outcomes.

Our findings are consistent with those of prior studies highlighting the significant association between speech impairments and depression across different populations. Eric [42] reported that speech pauses, both in number and duration, were significantly linked to depressive symptoms in adults with schizophrenia spectrum disorders, suggesting that speech analysis could be a valuable tool for depression assessment in psychiatry. Lee [43] revealed that speech and language impairments were positively associated with depressive disorders in children. König [10] observed that speech changes were linked to depression in healthy young adults, potentially serving as an early marker. Palmer [16, 40] emphasized that communication impairments, such as stuttering, significantly impact the social relationships and psychological well-being of older adults, contributing to social isolation and depression.

Speech impairments often disrupt communication, leading to social isolation, reduced social participation, and stigmatization, which collectively increase the risk of depression [16]. The higher prevalence of depression, exceeding 60%, observed in individuals with speech impairments in our study likely reflects the complex interconnection of these factors. These challenges not only limit social connections but also heighten psychological distress, including frustration, anxiety, and low self-esteem [22, 44, 45]. Over time, the anticipation of communication difficulties may result in avoidance behaviors, further reinforcing social withdrawal and negative emotional states. This interplay of social and emotional stressors creates a pathway through which speech impairments contribute to the development of depression.

Our analysis revealed a significant interaction effect between place of residence and the impact of speech impairments on depression, with a stronger effect observed in urban residents. This disparity may stem from the heightened social and professional demands in urban environments, where effective communication is often crucial for maintaining personal and professional relationships [46]. Urban residents experiencing speech impairments might face greater social and occupational challenges, increasing their vulnerability to depression. The significant interaction effect highlights the importance of considering contextual factors, such as place of residence, when assessing mental health outcomes among individuals with speech impairments. This underscores the need for tailored interventions that account for both individual characteristics and environmental influences.

These findings emphasize the critical need for to integrate mental health services into the care of individuals with speech impairments, particularly those at high risk of depression. Early targeted interventions addressing both communication and psychological challenges are essential to alleviate the mental health burden and improve overall outcomes.

At the public policy level, creating accessible and inclusive environments is imperative to ensure equitable social participation for individuals with speech impairments. Policies should prioritize reducing communication barriers, combating stigma, and fostering social inclusion. The promotion of models such as the clubhouse [47], which provides structured peer support and opportunities for meaningful engagement, has shown potential in reducing depressive symptoms, restoring social functioning, and improving quality of life.

Community-based initiatives remain crucial for addressing stigma and enhance public understanding of speech impairments. Such efforts should aim to create environments that support open communication and accessibility, facilitating greater social integration for this vulnerable population [48].

Further investigations are necessary to elucidate the underlying mechanisms linking speech impairments to depression and to assess the effectiveness of specific interventions designed for this population. Such research will deepen our understanding and guide the development of more effective strategies to manage both speech disorders and associated mental health issues [49].

This study has several limitations. First, the cross-sectional analysis limits the ability to infer causality between speech impairments and depression due to the lack of temporal information. Second, reliance on self-reported data may introduce bias, as participants could underreport or overreport symptoms due to stigma or misunderstanding. Third, some variables (e.g., indoor air pollution, internet use), were not included in the analysis because of the relatively limited sample size. Fourth, generalizability is limited as the CHARLS sample may not represent other populations or age groups. Fifth, the binary assessment of "speech impediment" overlooks symptom duration, limiting alignment with DSM-5 criteria and comparability with depression measures.

Conclusions

This study reveals a robust and consistent association between speech impairments and depression among middle-aged and elderly Chinese adults, with individuals having speech impairments showing significantly higher odds of depression and depression scores in individuals. Sensitivity analyses further confirmed the robustness of these findings. Subgroup analyses identified the universality of this relationship across diverse demographic and lifestyle groups, with urban residents experiencing greater psychological impacts. These findings highlight the need for targeted mental health support and interventions specifically designed for individuals with communication disorders, aiming to improve their well-being and societal integration.

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Author contributions
JM conceived and designed the study. HZ and ZF implemented the study and analyzed the data. SH assisted in the manuscript preparation. JF contributed to manuscript revisions. JM had primary responsibility for the final content, and all the authors have read and approved the final manuscript.

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Data availability
All CHARLS data and information are publicly available at http://charls.pku.edu.cn/en.

Declarations

Ethics approval and consent to participate
The Biomedical Ethics Review Board of Peking University provided ethical approval for the collection of CHARLS data (IRB00001052-11015), and all participants signed an informed consent form.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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