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Visual impairment and depression in China: a 7-year follow-up study from national longitudinal surveys

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ABSTRACT

Objectives To explore the longitudinal association between visual impairment (VI) and depression among adults 45 years and older in China based on a nationally representative follow-up dataset.

Setting Participants in China from the China Health and Retirement Longitudinal Study were included.

Participants A total of 6748 participants from two waves of the China Health and Retirement Longitudinal Study 2011–2018 were included for analysis by age group.

Primary and secondary outcome measures VI and depression were defined by self-diagnosis and the Center for Epidemiological Studies Depression Scale-10, respectively. Lagged dependent variable regression models with ordinary least squares estimation were used to evaluate the association between VI and depression. Age was divided into three groups, that is, 45–54, 55–64, and 65 years and older, to explore the relationship between VI and depression in different age groups.

Results In our study sample, VI remarkably predicted an increase in depressive scores. The magnitude of depressive scores increased among those with VI points greater than 3.517 (β=3.517; 95% CI=2.697 to 4.331) points than those without VI in the 7-year follow-up. Significant relationships were also found between VI and depression in the three age groups in the sensitivity analysis.

Conclusion VI was associated with an increase in depression scores over a 7-year period. Female respondents, low educational attainment and high alcohol intake significantly predicted an increase in depressive status.

Strengths and limitations of this study

► The first analysis of visual impairment in relation to depression in middle-aged and elderly people in China using longitudinal China Health and Retirement Longitudinal Study data.
► Large sample size and representative population.
► Lack of consideration of some unavoidable selective attrition and confounding factors.

INTRODUCTION

Visual impairment (VI) is a disabling condition that creates a large socioeconomic burden for society. The prevalence of vision loss in elderly populations is approximately 15% in people 65 years of age and older and up to 30% in people 75 years of age and older.[1] Loss of eyesight in elderly people negatively affects their daily lives, including their social activities, causes feelings of loneliness and increases their risk of depressive symptoms.[1–3]

Depression, the second leading cause of disability in China, has become an important public health problem.[4] Depressive symptoms seriously affect a person's quality of life and cause changes in feelings, thoughts, motivation, and the ability to handle daily activities and functions.[5 6] Globally, depression resulted in 43 million years of living with a disability (YLDs) in 2017[7] and accounted for 12.1% of total YLDs.[8] From 2008 to 2015, the prevalence of depressive symptoms in middle-aged and elderly people was approximately 32%–37%.[9] Depression is a very costly psychological disorder, and it is one of the largest economic burdens on society.[10] Several cross-sectional studies have investigated the association between VI and depression.[11–14] A longitudinal cohort study using the database from the Korean National Health Insurance Service (NHIS) showed that VI increases the risk of depression.[15] VI is associated with a high risk of depression in older adults.[15–17] However, this population-based study of the relationship between VI and depression lacks Chinese data.

To explore the longitudinal association between VI and depression among adults 45 years and older in China, we conducted a longitudinal cohort study by using data from the China Health and Retirement Longitudinal Study (CHARLS). Our study examined the relationship between VI and depressive symptoms for 7 years, which provides new evidence for the related risk factors of depression. In

addition, we compared the relationship between VI and depression in different age groups, which may suggest the best time for visual intervention. Our study reveals the inherent causality between VI and depression, which helps provide a basis for the formulation of public health strategies related to depression. Timely eye screening can assist in detecting VI and preventing visual loss and associated mental problems.

METHODS
Data
We used data from two waves of the CHARLS (2011 and 2018), a longitudinal survey of a nationally representative sample of Chinese adults 45 years and older. It was designed to establish a public database of the social, economic and health status of Chinese adults for scientific research by the National School of Development of Peking University. To ensure the representativeness of the sample, the CHARLS baseline survey covered 450 villages and settlements in 150 counties and districts in China. All participants were sampled in four stages: county, village, family and individual sampling. A total of 17 708 individuals from 10 257 families were interviewed, generally representing the middle-aged and elderly population in China. Trained interviewers conducted face-to-face, computer-assisted family interviews by using structured

Figure 1 Flow chart of the study sample of middle-aged and older Chinese adults: CHARLS, 2011–2018. CHARLS, China Health and Retirement Longitudinal Study.

questionnaires. The CHARLS Project conducted a national baseline survey from 2011 to 2012 and followed up every 2 years.[18]

Measurement of VI
The presence of VI was identified using a self-reported assessment of visual functions. CHARLS collected self-reported data on visual functions by asking, 'Do you have visual problems (blindness or partial blindness)?' We identified respondents as having VI if they answered 'yes'. We then categorised those responses as 'VI' or 'no VI'.

Measurement of depression
Depressive symptoms were measured using the Center for Epidemiological Studies Depression Scale-10, which was widely used in previous studies.[19 20] It contains 10 items with two parts of depressed and positively affected mood, which are answered with a 4-point scale: rarely or none of the time (<1 day), some or few times (1–2 days), occasionally or a moderate amount of the time (3–4 days), and most or all of the time (5–7 days). The total points of all items range from 0 to 30 points, and the higher the score, the higher the level of depressive symptoms.

Assessment of covariables
Considering that depression may vary across socioeconomic status, education and health, we included age (45–54, 55–64, or 65 years and above), gender, education (primary school or below, middle school, high school, or college or above), marital status (married or partnered or neither), smoking (yes or no), drinking (drink more than once a month, drink but less than once a month or none), and chronic disease (yes or no) as control variables. Chronic diseases were documented based on self-reported hypertension, dyslipidaemia and diabetes.

Statistical analysis
Differences between the three different age groups were compared using one-way analysis of variance for continuous variables and the Cochran-Mantel-Haenszel $\chi 2$ test for categorical variables. Lagged dependent variable regression models with ordinary least squares estimation were used to evaluate the relationship between VI and depression. VI was the predictor variable, and depressive status was the outcome variable, with controls for other confounding factors. The lagged dependent variable model has advantages in analysing the influence of predictor variables on an outcome with two-wave panel data while controlling for time-invariant variables.[21] Descriptive analyses were performed to assess the mean and frequency of variables. Statistical analysis was performed using the Statistical Analysis System (V.9.4, SAS Institute) for Windows. P values of <0.05 were considered statistically significant.

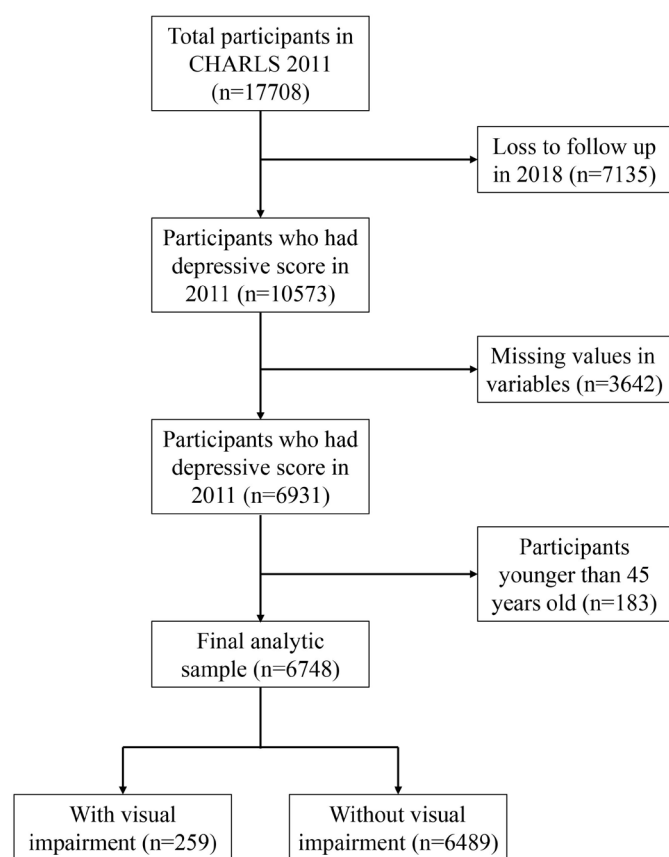### Patient and public involvement
Not applicable.

RESULTS

A total of 6748 participants were included for analysis by age group after filtering (figure 1). The participants with VI were older, female, less educated and smokers (table 1). Notably, the depression scores of participants with VI were significantly higher than those without VI, regardless of whether the data were pulled from 2011 or 2018. Moreover, the depression scores of participants with VI exceeded 10.

Table 2 presents the findings regarding the relationship of VI and the change in depressive scores from 2011 to 2018. A strong positive association was found between the depressive scores in 2011 and the corresponding 7-year change in the depressive scores (β=0.023; 95% CI=0.003 to 0.043). Higher baseline scores predicted more severe depression in 2018. After adjusting for other sociodemographic data (age, sex), lifestyle factors (marital status, smoking status and drinking status) and health conditions, VI was found to be a strong predictor of increasing depressive score after 7 years. The magnitude of depressive score increase among those with VI was 3.517 (β=3.517; 95% CI=2.697 to 4.331) points greater than those without VI in the 7-year follow-up. Therefore, VI was associated with an increase in depression scores

Table 1	Characteristics of respondents with visual impairment or not		
	Visual impairment		
Variables	**Yes**	**No**	**P value**
Age, years	58.89±8.1	56.23±7.8	**<0.001***
Depressive score 2011	10.19±6.52	7.42±5.91	**<0.001***
Depressive score 2018	11.17±6.85	7.44±6.04	**<0.001***
Gender			**0.020†**
Male	112 (43.2%)	3286 (50.6%)	
Female	147 (56.8%)	3203 (49.4%)	
Education			**<0.001†**
Primary or below	182 (70.3%)	3560 (54.9%)	
Middle school	50 (19.3%)	1837 (28.3%)	
High school	16 (6.2%)	720 (16%)	
College or above	11 (4.2%)	372 (11%)	
Marriage			0.208†
Married or partnered	234 (90.3%)	6000 (92.5%)	
Otherwise	25 (9.7%)	489 (7.5%)	
Smoking			**0.003†**
Yes	81 (31.3%)	2634 (40.6%)	
No	178 (68.7%)	3855 (59.4%)	
Drinking			0.106†
Drink more than once a month	180 (69.5%)	4183 (64.5%)	
Drink but less than once a month	19 (7.3%)	544 (8.4%)	
None	60 (23.2%)	1762 (60%)	
Hypertension			0.330†
Yes	64 (24.7%)	1437 (22.1%)	
No	195 (75.3%)	5052 (77.9%)	
Hyperlipidaemia			0.358†
Yes	31 (12%)	662 (10.2%)	
No	228 (88%)	5827 (89.8%)	
Diabetes			0.871†
Yes	14 (5.4%)	336 (5.2%)	
No	245 (94.6%)	6153 (94.8%)	

Bold values represent statistically significant differences.
*One-way analysis of variance.
†Cochran-Mantel-Haenszel χ^2 test.

Table 2 Ordinary least squares regression of depressive score change over time on visual impairment, cognitive function in 2011 and control variables of all ages

Independent variables	Depressive score (2018–2011)			
	β	95% CI	t	P value
Visual impairment	3.517	2.697 to 4.331	0.456	**0.049**
Depressive score 2011	0.023	0.003 to 0.043	1.720	**0.036**
Age	0.021	0.001 to 0.042	2.001	**0.045**
Male	−0.191	−0.642 to 0.260	−0.831	0.406
Education	0.067	−0.117 to 0.251	0.718	0.473
Married or partnered	0.179	−0.419 to 0.776	0.586	0.558
Smoking	0.072	−0.358 to 0.503	0.329	0.742
Drinking	−0.036	−0.240 to 0.167	−0.352	0.725
Hypertension	−0.083	−0.473 to 0.308	−0.414	0.679
Hyperlipidaemia	−0.291	−0.828 to 0.246	−1.063	0.288
Diabetes	−0.278	−0.997 to 0.440	−0.759	0.448

Bold values represent statistically significant differences.

over a 7-year period. Moreover, the depression score was found to increase by 0.021 points for every 1 year increase in age (β=0.021; 95% CI=0.001 to 0.042). Therefore, age is also a risk factor for depression.

We further analysed whether the association between VI and depression varied with age in the three age groups, that is, 45–54, 55–64, and 65 years and above, as shown in table 3. Significant relationships were found between VI and depression in the 45–54 age group. When compared with individuals without VI, the depression scores of people aged 45–54 years were found to increase by 2.833 points in individuals with VI (β=2.833; 95% CI=1.307 to 4.359). Similarly, the 2011 baseline depression score also contributed 0.040 points to the increase in depression scores in the 45–54 age group (β=0.040; 95% CI=0.001 to 0.080). Compared with subjects who completed primary school, subjects who finished college or above education showed an insignificant decrease in change of depressive scores in the 45–54 age group (β=−1.061; 95% CI=−1.966 to −0.156). Compared with women, Chinese men showed milder depressive symptoms in 55–64 age group.

DISCUSSION
Our study is the first analysis of VI in relation to depression for middle-aged and older people in China with longitudinal CHARLS data. The lagged dependent variable regression was used as follow-up data from 2011 to 2018 were time series and the degree of depression was time lagging. We found that VI was associated with a huge raise in depression over a 7-year period. Significant relationships were found between VI and depression in 45–54 age group. Therefore, eye screening should be carried out as soon as possible, especially before the age of 45 years. Female respondents, low educational attainment and high baseline depressive score significantly predicted an increase in depressive status in different age groups.

For subjects with VI in 2011, the change of depressive score from 2011 to 2018 increased by 3.517 points. This result suggests that VI may account for a large part of the increase in depression, which is consistent with several cross-sectional studies.[22–24] VI is associated with an increased risk of depression among socially vulnerable adults aged 50 years and above in Armenia (OR=2.75; 95% CI=1.29 to 5.87).[22] A Chinese cross-sectional study showed that older Chinese adults with VI had 43% higher odds of depression than those with normal vision, based on the WHO Study on Global Ageing and Adult Health.[23] A cross-sectional study using the same database as our study shows that respondents with VI had a greater risk of depression (OR=1.78; 95% CI=1.59 to 1.99) than those without VI.[24] However, a causal or temporal relationship between VI and depression could not be obtained based on a cross-sectional design. Therefore, this longitudinal study was designed to clarify the causal or temporal relationship between the two.

A recent cohort study from the Korean NHIS has also revealed a causal relationship between VI and depression.[15] After adjusting for confounding factors, the adjusted HR for the development of depression in participants with a VI was 1.19.[15] In our study, we found that VI was associated with a raise in depression over a 7-year period (β=3.517). We included Chinese adults aged 45 years and above, and NHIS included Koreans of all age groups. Moreover, the NHIS study showed that the effect of VI on middle-aged people (30–59 years old) was stronger than that on the elderly (60+ years old).[15] Consistently, the β for depressive score on VI was higher in the 45–54 age group than in the 55–64 age group in our study.

VI causes depression due to several factors. First, VI may cause dramatic changes in people's lives and affect daily life, especially social activities.[25 26] Depression can

Table 3 Ordinary least squares regression of memory change over time on visual impairment, depressive score in 2011 and control variables by age

Independent variables	45–54 (N=3000)				55–64 (N=2703)				65 and above (N=1045)			
	β	95% CI	t	P value	β	95% CI	t	P value	β	95% CI	t	P value
Visual impairment	2.833	1.307 to 4.359	0.778	**0.037**	0.283	−4.015 to 4.582	0.129	0.897	1.051	−14.209 to 12.107	0.157	0.875
Depressive score 2011	0.040	0.001 to 0.080	1.943	**0.042**	−0.002	−0.045 to 0.040	−0.111	0.911	0.049	−0.020 to 0.118	1.397	0.063
Male	0.491	−0.216 to 1.198	1.361	0.174	−0.757	−1.472 to −0.042	−2.075	**0.038**	−0.317	−1.378 to 0.744	−0.586	0.558
Education												
Middle school	0.405	−0.118 to 0.927	1.519	0.129	−0.153	−0.772 to 0.465	−0.486	0.627	0.001	−1.074 to 1.074	0.001	0.997
High school	0.361	−0.303 to 1.025	1.066	0.287	−0.470	−1.467 to 0.528	−0.923	0.356	0.922	−1.432 to 3.276	0.769	0.442
College or above	−1.061	−1.966 to −0.156	−1.672	**0.045**	−0.875	−2.148 to 0.398	−1.348	0.178	−0.208	−1.604 to 1.188	−0.292	0.770
Married or partnered	0.139	−1.026 to 1.305	0.234	0.815	0.277	−0.654 to 1.208	0.583	0.560	−0.116	−1.214 to 0.983	−0.207	0.836
Smoking	−0.279	−0.962 to 0.404	−0.801	0.423	0.232	−0.448 to 0.913	0.670	0.503	0.464	−0.536 to 1.464	0.910	0.363
Drinking	0.109	−0.196 to 0.415	0.702	0.483	−0.110	−0.434 to 0.214	−0.664	0.506	0.519	0.265 to 0.772	0.960	**0.037**
Hypertension	−0.217	−0.854 to 0.420	−0.668	0.504	0.025	−0.567 to 0.617	0.083	0.934	0.025	−0.891 to 0.941	0.054	0.957
Hyperlipidaemia	−0.057	−0.923 to 0.809	−0.129	0.897	−0.447	−1.258 to 0.363	−1.082	0.279	−0.273	−1.602 to 1.056	−0.404	0.687
Diabetes	−0.506	−1.680 to 0.667	−0.846	0.398	0.129	−0.960 to 1.218	0.232	0.817	−0.491	−2.191 to 1.208	−0.568	0.570

Bold values represent statistically significant differences.

occur when people are struggling with vision loss and its effect on daily life.[17 27] Second, people with VI are more likely to be discriminated against than those with normal vision.[28] Continuous exposure to negative social events causes continuous negative thoughts and emotions and loss of self-confidence, which eventually leads to loneliness and depression.[29] Third, treatments for VI, such as vascular endothelial growth factor inhibitor (anti-VEGF) therapy for neovascular age-related macular degeneration (nAMD), may also cause patients to experience distress and anxiety. Approximately 56% of patients with nAMD feel anxious about anti-VEGF treatment, mostly due to potential complications and treatment effects.[30]

Moreover, our study revealed that education is one of the protective factors against depression among the 45–54 years old, which is similar to some previous studies.[31–33] Higher educational achievement lowers the level of later depression using structural equation modelling from three datasets: the China Family Panel Studies, the China Education Panel Survey, and the Gansu Survey of Children and Families.[34] One possible reason is that the education received can help people correctly recognise and deal with some negative events and emotions in life. In addition, we found that female respondents significantly predicted an increase in depression. Women are more likely to suffer from depression than men, possibly due to the effects of oestrogen.[35 36] The prevalence of depression during childbirth and menopause is particularly high.[37 38] For each year increase in age, the change of depressive score from 2011 to 2018 increased by 0.023 points, which is consistent with previous studies.[39 40]

The limitations of our study should also be mentioned. First, self-reported VI may have been overidentified or underidentified. Further work could include some objectives and measurable visual indicators to improve the precision of analysis. Second, as a longitudinal study, selective attrition could influence the findings, which is unavoidable. Third, based on the existing database, some confounding factors related to the development of depression may not be included, leading to some bias in the final conclusion.

Despite all these limitations, our study reliably demonstrated the casual relationship between VI and depression. Therefore, early prevention and treatment of VI is highly important for subsequent depression. Intervention to VI should be made as soon as possible, especially before the age of 45 years. Cataracts are the main cause of VI in developing countries.[41] Other important causes include glaucoma, AMD, diabetic retinopathy and trachoma.[41] The treatment for VI, including surgical intervention, and the prevention of depression must be improved.

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