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Effects of work cessation on cognitive functioning in rural older adults in China: a cross-sectional study based on CHARLS

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ABSTRACT

Objectives This study investigated the effects of work cessation on cognitive function among older adults in rural China. Given that cognitive disorders affect 6.04% of individuals aged 60 and above—with higher prevalence in rural areas—understanding this relationship is critical.

Design A cross-sectional study was employed, using data from the 2020 wave of the China Health and Retirement Longitudinal Study (CHARLS). Regression analysis assessed the impact of work cessation on cognitive function and the moderating effects of social activities, health behaviours and internet use.

Setting Data were collected from 150 districts, 450 villages, and urban community units in China.

Participants The study included 6,318 participants, with 4,045 currently employed and 2,273 no longer working.

Main outcome measures Cognitive function was evaluated using measures of mathematical computation, temporal and image cognition, and situational memory was tested through 20 memory-related questions. Explanatory variables included work cessation status, while moderating variables encompassed social activities, health behaviours (smoking and alcohol consumption) and internet use.

Results Work cessation has a negative impact on cognitive function, particularly situational memory and overall cognitive ability. Stopping work was associated with a decrease in cognitive functioning by 0.796 SD ($p<0.01$), a reduction in situational memory capacity by 1.083 SD ($p<0.01$) and a decline in total cognitive ability by 1.879 SD ($p<0.01$). However, more social activities, better health behaviours (eg, quitting smoking) and internet use can alleviate the impact. Seniors with high social activity levels showed an increase in cognitive functioning by 0.375 SD ($p<0.01$), while those who drank less alcohol had a 0.598 SD improvement in cognitive functioning ($p<0.01$). Internet use improved cognitive function by 1.265 SD ($p<0.01$).

Conclusion Work cessation significantly reduced cognitive function in rural Chinese older adults. Leisure activities can mitigate this decline, but they often lack quality and diversity. Health behaviour improvements show heterogeneity, and internet use mitigates cognitive decline despite urban–rural digital gaps. To protect rural older adults' cognitive function, policies promoting flexible employment, enhanced recreational infrastructure, health outreach and bridging digital divides are proposed.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study leverages data from the China Health and Aged Care Tracking Survey (China Health and Retirement Longitudinal Study) 2020, a large-scale and nationally representative survey project.
⇒ The study considers multiple moderating variables, including social activities, health behaviours and internet use, to explore the mechanisms underlying the effects of work cessation on cognitive function.
⇒ The study is based on cross-sectional data, which limits the ability to establish causal relationships between work cessation and cognitive function.

INTRODUCTION

With the rapid development of society and the economy and the continuous progress of medical technology, the problem of population ageing in China is becoming increasingly serious. According to the seventh national population census, the proportion of people aged 60 and older in China reached 18.7% in 2020. By 2050, the proportion of older people is expected to reach 38.7%.[1] The ageing trend is particularly pronounced in rural areas, where the proportion was 8.3 percentage points higher by 2020 than in urban areas.[2]

As health declines with age, many rural older people face the reality of having to stop working. The retirement system in China is unit-based, which refers to a retirement framework that organises retirement benefits and policies around distinct units, such as departments or organisations, within a larger entity. Under this system, most rural older people are not entitled to retirement protection; they decide whether to stop working mainly based on their personal health and family financial situation. The income of

rural older adults comes from three main sources: the individual, the family and the government,[3] and older adults will only stop working at an age when the family income and the government's income cover a relatively high proportion of their needs. With social and economic development, the per capita disposable income in rural areas has doubled over the past decade, from 8896 yuan in 2013 to 21 691 yuan in 2023. Simultaneously, the social security system in rural areas has been progressively expanded, with benefits consistently enhanced. This has led to a gradual rise in the proportion of income derived from social security, now reaching 30%–50%.[4 5] Meanwhile, the phenomenon of 'working beyond old age' in rural areas has shown gradual alleviation.[6 7]

Older adults in rural areas experience multiple health challenges, with cognitive decline being particularly significant. As a crucial factor in preserving independent living and social engagement, cognitive impairment can substantially impact their quality of life. In China, the prevalence of cognitive disorders among people aged 60 years and above is 6.04%, and it is significantly higher in rural areas than in urban areas.[8] Cognitive dysfunction not only affects the quality of life of older adults, but also brings heavy economic, medical and care burdens to families and society. In 2015, the social and economic burden of Alzheimer's disease patients amounted to 167.74 billion U.S. dollars, accounting for approximately 1.47% of the national GDP.[9]

Prior research has focused on issues such as retirement, delayed retirement and postretirement re-employment of older adults in urban areas, and the potential impact of these phenomena on their health status has been explored in depth. In contrast, there is a lack of research on the outcomes and mechanisms of the health impacts of stopping work or 'old age without retirement' among rural older adults. Therefore, this study focuses on rural older adults and analyses the changes in cognitive functioning due to stopping work and explores the possible mechanisms of these effects. This study contributes to a deeper understanding of the patterns of change in the cognitive functions of rural older adults in the context of an ageing society and provides a scientific basis for the formulation of health promotion initiatives and social support policies for rural older adults.

Rationale and research hypotheses

Effects of work cessation on cognitive functioning

There are different theories on the effects of work cessation on cognitive functioning, such as the cognitive reserve theory, cognitive utilisation hypothesis and environmental complexity hypothesis.[10 11] However, despite a wealth of research, there is no consensus on the effects of work cessation on the health of older adults. For example, Bonsang *et al*[12] used US HRS data and the fixed-effects instrumental variable (FE-IV) method and concluded that stopping work had a negative effect on cognitive functioning. Coe *et al*[13] used European Survey of Health, Ageing, and Retirement in Europe (SHARE) data and the instrumental variable method and showed that stopping work did not have a significant effect on cognitive functioning but had a positive effect on physical health. Godard *et al* used SHARE data and the FE-IV method and concluded that work stoppages may increase the incidence of obesity.[14] Nishimura *et al*[15] replicated the study by changing the data or research methodology and ultimately attributed the discrepancy in the conclusions of the study to differences in the data and research methodology used by the researchers.

However, some consensus can be drawn from the diverse literature that the heterogeneity of the health effects of work cessation is related to the type or complexity of an individual's job. Coe *et al* found that work cessation had no effect on many cognitive indicators in white-collar workers; however, the length of time spent outside the labour force positively affected cognitive functioning in blue-collar workers.[16] Mazzonna *et al* also found that for people doing physically demanding work, stopping work improved their physical and mental health, and cognitive function.[17] This may be because heavy physical labour can cause various health problems. China's traditional agriculture uses high-intensity physical labour, but with the advances in science and technology, the level of agricultural mechanisation is increasing. The cumulative mechanisation rate of China's agriculture reached 74% in 2024 and the intensity of physical labour engaged in by most older people will be greatly reduced. We therefore posit:

Hypothesis 1: Cessation of work among rural older adults has a negative effect on cognitive function.

Mechanisms of the effects of work cessation on cognitive functioning

Leisure activities and cognitive function

According to the 'use it or lose it' hypothesis, maintaining cognitive functioning requires a certain amount of intellectual activity and mental challenge. Cognitive stimulation decreases after work stops, which has a negative impact on cognitive functioning. However, after stopping work, most people replace their time spent at work with other things, such as leisure activities. Therefore, it is important to consider a person's leisure activity levels. Leisure activities are defined as activities in which an individual engages in activities that increase enjoyment or well-being, independent of work or activities of daily living, and include mainly physical, cognitive and social activities. Many studies have shown that a variety of intellectual, physical and social activities can have cognitive enrichment effects and slow down or reduce cognitive decline in older adults. Grotz *et al* found that older adults who took on new activities after retirement, such as meeting new people, helping others and engaging in a social life, and those who adapted to their free time by feeling busy but not bored showed better cognitive performance.[18] Atalay *et al* found that the rate of cognitive decline with age was greater in men than in women after stopping work, probably because women spend more time engaging in social and family activities.[19] In recent years, scholars

have focused on exploring the effects of different leisure modes on cognition.[20] For example, Liu *et al* included five categories of leisure activities in rural China—sedentary, cognitive, physical, social contact and social activities—and found that higher physical activity was associated with better cognitive functioning.[21] Lifshitz-Vahav *et al* found that high-intensity cognitive activity and participation in physical activity had a protective effect on cognitive functioning in older men but not in older women, and leisure activities may be particularly beneficial for the cognitive functioning of older adults with low literacy.[22] Intellectual and community leisure activities were significantly associated with improved memory function, while intellectual activity was significantly associated with improved working memory, attention and processing speed.[23] The Lancet Committee on Dementia Prevention, Intervention, and Care reported that social activities may reduce cognitive decline,[24] and a study by Wang *et al* suggested that a variety of leisure activities would have a stronger preventive effect against dementia than the frequent repetition of specific leisure activities.[25] Accordingly, we formulate the second hypothesis.

Hypothesis 2: Rural older adults may enhance cognitive function through increased leisure activities.

Health behaviours and cognitive functioning

Individual's health behaviours contribute to cognitive functioning, and work cessation may lead to changes in certain health behaviours that may differentially affect cognitive functioning. Celidoni *et al* found systematic differences in changes in health behaviours among older adults after work cessation in European countries with different healthcare systems. Specifically, in countries with health gatekeeper systems, individuals increased their exercise and alcohol consumption after retirement.[26] In contrast, Zou[27] found that tobacco and alcohol consumption decreased significantly and health behaviours improved significantly after retirement. Eibich[28] used German socio-economic survey data and a breakpoint study method and found that stopping work significantly increased sleep time and decreased the probability of smoking and drinking among older adults, and Lang *et al*[29] and Henkens[30] also found that stopping work increased the probability of giving up smoking. The effect of retirement on alcohol consumption has been studied extensively, but the findings are not consistent. Bacharach *et al*,[31] Brennan *et al*[32] and Zou *et al*[33] found that retirement decreased the probability of alcohol consumption by weakening work-related social networks. However, Zins *et al*[34] found that older adults may increase their frequency of alcohol consumption after retirement due to work restrictions on alcohol consumption, increased leisure time, wider friendships and increased life stress.[35] Kuerbis *et al*[36] concluded that there is no significant relationship between retirement and alcohol consumption behaviour in people without a history of drinking, but retirement reduces alcohol consumption in older adults.[37] Accordingly, a third research hypothesis is proposed in this study.

Hypothesis 3: Rural older adults improve cognitive function through improved health behaviours.

Internet use and cognitive functioning

With the popularisation of mobile internet, the number of older people in rural China using the internet has become a common phenomenon. According to the 53rd Statistical Report on Internet Development in China, as of December 2023, the Internet penetration rate in rural areas is 66.5%. Mingyang *et al* found that the internet has a nonlinear effect on the health of rural older people, with normal use significantly improving their health and overuse worsening it. Green *et al*[38] found that internet use had a substantial effect on the cognitive function of older people, increasing word recall by approximately 0.759 SD. Xia *et al*[39] found that internet use can improve cognitive function in middle-aged people, and more so in middle-aged and older adults in rural areas, and that cognitive functioning improved differently depending on the frequency with which the internet was used for recreation, socialisation, study, work and business activities. Berner *et al* examined a 6-year follow-up survey of adults aged 66 years and older in Sweden and the Netherlands and found that, over time, the use of the Internet for cognitive activities was not associated with cognitive performance. The Internet was significantly associated with a reduction in cognitive decline. Internet users have half the chance of significant cognitive decline compared with non-Internet users.[40] Klimova[41] conducted a clinical study on the use of the Internet to prevent cognitive decline in healthy older adults as early as 2016, and the results suggested that using the Internet, especially an online cognitive training programme, may have a positive impact on improving cognitive function in healthy older adults. Silfvernagel *et al*[42] tailored Internet-based cognitive behavioural therapy for older adults with anxiety and depression in a randomised controlled trial. Their findings demonstrate the positive impact of Internet-based cognitive behavioural therapy on cognitive functioning and emotional well-being among older adults with anxiety and depression. Kamin and Lang[43] analysed representative data from 14 countries in the SHARE and found that Internet use had a positive impact on cognitive

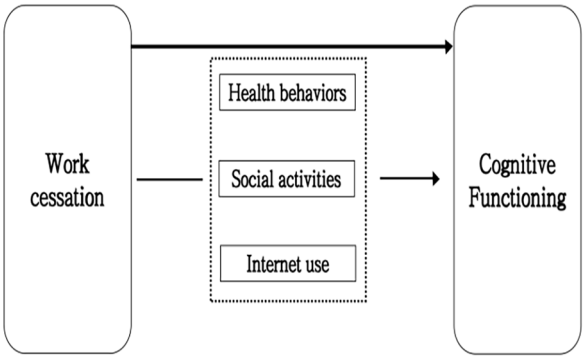

Figure 1 Logical Framework Diagram.

functioning in later life. The fourth hypothesis of the present study is based on Yu *et al*.'s[44] finding that the breadth and depth of Internet use were positively associated with cognitive functioning and that different types of Internet use had different roles in cognitive decline.

Hypothesis 4: Cognitive decline can be mitigated in rural older adults through Internet use.

Based on the literature review and the above analysis, it can be concluded that the influence mechanism of stopping work in rural older adults affects their cognitive function, as shown in figure 1.

Study design and data

Data sources

The data used in this study were obtained from the China Health and Aged Care Tracking Survey (China Health and Retirement Longitudinal Study, CHARLS) 2020, a large-scale interdisciplinary survey project jointly implemented by the China Social Science Research Centre at Peking University and the Peking University Youth League Committee. The CHARLS was conducted every 2 years after the national baseline survey started in 2011. This study uses the fifth (2020) national follow-up data officially released to the public on 16 November 2023, which covers 19 395 samples from 28 provinces (autonomous regions and municipalities directly under the central government), 150 districts, 450 villages, and urban community units across the country. The target population of this study was rural older adults; after screening, there were 6318 participants among rural older adults, with high-quality data and a very representative sample.

Variable setting

Outcome variables

The dependent variables in this study include cognitive integrity, episodic memory ability and overall cognitive ability. Cognitive integrity is measured from aspects such as mathematical calculation ability, temporal cognition and visual cognition, with a full score of 11 points for this section; episodic memory ability is tested through 20 questions to assess both immediate and delayed memory, with a full score of 20 points for this section. The overall cognitive ability was the sum of these two items, with a top score of 31. Higher scores on the three explanatory variables indicated better ability. In the CHARLS questionnaire, the Mini-Mental State Examination was used to measure cognitive function. Previous studies have confirmed that this scale has good reliability.[45 46] The construction of the total cognitive score (summation of subscale scores) introduces analytical dependency. Despite theoretical distinctions between subscales, the interpretative boundaries between the total score and subscales warrant careful consideration.

Explanatory variable

The explanatory variable in this study was the decision to stop work. The auxiliary variable XWorking in the questionnaire was chosen to determine whether the respondents had stopped working. In total, 4045 were employed and 2273 were not. In this paper, we study the effect of stopping work on the cognition of older adults; therefore, we assigned the value of continuing to work as 0 and stopping work as 1.

Moderating variables

Socialising

Social activities were measured by the question, "In the past month, did you engage in any of the following social activities?" In this study, participation in a particular type of social activity (Ai) was assigned a value of 1 and non-participation was assigned a value of 0. The frequency of participation in social activities was measured by "How often did you do these activities in the past month?" with an almost daily score of 2, almost weekly score of 1, and infrequently score of 0. The score of 'social activity' for older adults was calculated as follows $C = \sum_{1}^{8} A_i \times F_i$.. The theoretical value of 'social activity' of older adults can be found in the range of 0–24. From this, we can find the theoretical value of 'social activity' of older adults, the range is 0–24, and according to the research needs of this paper, it is stipulated that the value of 'social activity' of older adults ranges from 0–2 for low social activity and from 3–24 for high social activity.

Health behaviours

In this study, two indicators, smoking and alcohol consumption, were used to define the health behaviours of rural older adults. Smoking was measured using the question "Do you still smoke or have you quit?" Smoking was assigned a value of 0, and quit smoking and never smoked were assigned a value of 1. For alcohol consumption, the question "In the past year, did you drink any alcohol, including beer, rice or liquor, medicinal wine, etc.?" and "How often do you drink?" Measurements were taken, with nothing assigned a value of 0 and others assigned a value of 1.

Internet use

The following question was selected as a criterion for Internet use among older adults: "In the past month, did you go online? Including chatting, watching news, playing games, managing money, etc., on the cell phone network," assigning 0 to no internet access and 1 to others.

Control variables

Based on the related literature, the control variables in this study included sex, age, marital status, education level, pension insurance and health insurance.

RESULTS

Impact of work cessation on cognitive ability among rural older adults

Model construction

$$f(x)_n = a + bx + c_i y_i + d_j \cdot z_j + \varepsilon$$

Table 1 Results of the one-way ANOVA on the effect of stopping working on cognitive functioning, situational memory capacity, and total cognitive ability in older adults

Variable relationships	F-value	Butler's value	The chi-square value
Effect of stopping working on cognitive functioning,	348.99***	7.7401***	345.47***
Effect of stopping working on situational memory capacity	338.82***	1.3064	
Effect of stopping working on total cognitive ability	430.90***	13.7701***	403.61***

***p<0.01, **p<0.05, *p<0.1.

In this equation. $f(x)_n$ represents the first n function of the number of explanatory variables. x is the explanatory variable, 'stopping work', y_i denotes the control variable, c_i is the regression coefficient of the control variable i, z_j is the moderating variable. d_j is the regression coefficient of the moderator variable j nd ε is a randomised perturbation term.

ANOVA

First, we analysed whether the explanatory variables affected the cognitive ability of rural older people. The results are shown in table 1.

First, we conducted a normality test and homogeneity of variance test on the data. The first three columns of table 1 present the ANOVA results for the impact of work cessation on cognitive functioning, situational memory capacity and total cognitive ability of the participants. The results show that the F-values of all three groups are significant, except for Butler's test on the variable 'stopping work' and situational memory capacity, which is not significant. This indicates that there is a significant difference in the impact of stopping work on the situational memory capacity of older adults. Additionally, the p-values of Butler's test for the variable 'stopping work' in relation to cognitive functioning and total cognitive ability are highly significant, indicating that the variances in these two groups are not uniform. Therefore, it is necessary to use the Kruskal–Wallis H-test. The results are shown in the fourth column of table 1.

Table 1 shows that the p-values of the χ^2 tests for the two groups are highly significant, indicating that the effects of stopping work on the cognitive functioning and total cognitive ability of the participants were not identical. The effects of stopping work on the cognitive functioning, situational memory capacity and total cognitive ability of older adults were all significantly different and can be analysed using regression analysis.

Regression analysis

Stepwise Ordinary Least Squares (OLS) regression analysis of work cessation on cognitive functioning in older adults

This study uses OLS regression analysis. Although OLS regression typically assumes that the error term follows a normal distribution, according to the central limit theorem, the estimated regression coefficients still have asymptotic normality in large samples.[47] Furthermore, this study primarily focuses on the significance of relationships between variables rather than the precise distribution of parameter estimates, so the results from OLS remain highly valuable. A stepwise OLS regression was conducted to analyse the effects of six control variables on the cognitive functioning of the older adults, excluding the explanatory variable of 'stopping work', in Model 1. Then, 'social activeness' was added as a moderator variable in Model 2; 'health behaviour' was added in Model 3, and 'Internet use' was added in Model 4. The results of this analysis are presented in table 2.

In the four models shown in table 2, the effects of stopping work on the cognitive functioning of the older adults were all highly significant and negative. This indicates that the cognitive functioning of older adults who stopped working is significantly lower than that of those who continued to work, which confirms hypothesis 1 in terms of cognitive functioning; that is, stopping working had a negative impact on the cognitive functioning of the participants.

Model 1 shows that all control variables had a significant effect on the cognitive functioning of the older adults, and the cognitive functioning of males was higher than that of females. In the column on age, from the impact coefficient (−0.274>−1.680), the older the age, the lower the cognitive functioning. In terms of marriage, married older people had higher cognitive functioning than unmarried older adults; in the column on education, it can be seen from the impact coefficient (2.517<3.697) that the higher the educational status, the higher the cognitive functioning; under social security, the cognitive functioning of older adults who were able to access pension/medical insurance was higher than that of older adults who did not participate in the pension/medical insurance schemes.

Model 2 shows that the older adults with high social activity levels have higher cognitive functioning compared with those with low social activity levels. In Model 3, after adding health behaviours, the effect of smoking on the cognitive functioning of older adults was not significant, but the coefficient was negative, indicating that the cognitive functioning of older adults who smoked was slightly lower than that of older adults who did not smoke. The effect of drinking more on the cognitive functioning of older adults was not significant, whereas the effect of drinking less was significant, indicating that the cognitive functioning of the older adults who drank less was higher. Among the control variables, the influence of

Table 2 Stepwise OLS regression analysis of the effect of work cessation on cognitive functioning in older adults

Variables	Model 1	Model 2	Model 3	Model 4
Control variables				
Male	0.661***	0.677***	0.671***	0.694***
70–80 years	−0.274***	−0.276***	−0.126	0.0291
80 and over	−1.680***	−1.683***	−1.724***	−1.530***
Married	0.391***	0.413***	0.401***	0.399***
Junior high school and below	2.517***	2.499***	2.481***	2.374***
High school and above	3.697***	3.647***	3.692***	3.351***
Participation in pension insurance	0.363***	0.357***	0.232	0.220
Participation in health insurance	0.541***	0.527***	0.831***	0.754***
Moderating variables				
Highly socially active		0.375***	0.356**	0.253*
Smoking			−0.0725	−0.0455
Drinking a lot			0.0540	0.0606
Drinking less			0.598***	0.555***
Internet access				1.265***
Stopping work	−0.796***	−0.796***	−0.885***	−0.868***
Constant	2.188***	2.122***	1.946***	1.851***
Sample size	6311	6311	2811	2811
R^2	0.293	0.295	0.242	0.259

***p<0.01, **p<0.05, *p<0.1.

sex, education and medical insurance on the cognitive functioning of the older adults did not change significantly. However, in terms of age, in the age group 70–80 the effect on cognitive functioning became insignificant, while the cognitive functioning of those over 80 years decreased significantly. Under the influence of health behaviours, there was no significant difference in the effect of pension insurance participation on the cognitive functioning of older adults. In Model 4, after adding internet use, it can be seen that the cognitive functioning of older adults who were frequently online was significantly higher than those who were online less. The effects of the control variables and other moderating variables on the cognitive functioning of older adults after the addition of internet use were not significantly different from those in Model 3.

Stepwise OLS regression analysis of the effect of work cessation on situational memory capacity in older adults

Stepwise OLS regression was conducted to analyse the effects of the six control variables on the situational memory ability of the older adults, except for the explanatory variable 'stopping work' that is, Model 5. 'Social activeness' was added as a moderator in Model 6; 'health behaviour' was added in Model 7, and 'Internet use' was added in Model 8. The results of this analysis are presented in table 3.

In the four models in table 3, the effects of stopping work on the situational memory ability of older adults are all significant and negative. This means that the situational memory ability of older adults who stopped working is significantly reduced, which confirms Hypothesis one that stopping working has a negative effect on the cognitive function of rural older adults from the aspect of situational memory ability.

Model five shows that all control variables had a significant effect on the situational memory capacity of older adults. The results of the analysis show that males have lower situational memory capacity than females; in the column of age, from the influence coefficient (−0.970>−2.875), the older the age, the lower the situational memory capacity; in marriage, the married have higher situational memory capacity than the unmarried older adults; in the column of education, from the influence coefficient (2.408<4.252), the higher the education, the higher the situational memory capacity; in social security, those who participate in pension/medical insurance have higher situational memory capacity than those who do not participate in pension/medical insurance.

Model 6 shows that the participants with high social activity levels exhibited higher episodic memory abilities compared with those with low social activity levels. The effect of incorporating social activity level into the model made the impact of sex on episodic memory abilities insignificant, suggesting that social activity level weakens the influence of sex on the episodic memory abilities of older adults. After adding health behaviours to Model

Table 3 Stepwise OLS regression analysis of the effect of work cessation on situational memory capacity in older adults

Variables	Models 5	Models 6	Models 7	Models 8
Control variables				
Male	−0.195*	−0.163	−0.493**	−0.463*
70–80 years	−0.970***	−0.974***	−1.061***	−0.861***
80 and over	−2.875***	−2.880***	−2.797***	−2.546***
Married	0.328***	0.372***	0.0995	0.0966
Junior high school and below	2.408***	2.373***	2.549***	2.410***
High school and above	4.252***	4.154***	4.195***	3.752***
Participation in pension insurance	0.571***	0.560***	0.612***	0.597***
Participation in health insurance	0.687***	0.659***	0.692**	0.593*
Moderating variables				
Highly socially active		0.732***	0.613***	0.480**
Smoking			0.0158	0.0508
Drinking a lot			0.206	0.215
Drinking less			0.891***	0.835***
Internet access				1.642***
Stopping work	−1.083***	−1.083***	−1.214***	−1.191***
Constant	3.640***	3.511***	3.743***	3.619***
Sample size	6311	6311	2811	2811
R^2	0.193	0.197	0.185	0.201

***p<0.01, **p<0.05, *p<0.1.

7, the effect of smoking on situational memory was not significant. In the case of alcohol consumption, the effect of less alcohol consumption on the situational memory of older adults was very significant. Among the control variables, after adding health behaviours, the significance of the effects of age, education and social security on the situational memory of older adults did not change significantly; however, the effect of sex on situational memory was significant. There was no significant difference in the effect of being married on the situational memory capacity of older adults under the influence of health behaviours. The significance of health insurance participation decreases slightly. In Model 8, after adding internet use, it can be seen that the older adults who are online have a higher situational memory capacity than those who are not online. After adding internet use, the effects of the control variables and other moderating variables on the situational memory ability of older adults are not much different from those in Model 7, but participation in health insurance under the influence of health behaviours and internet behaviours is still significant, but its significance decreased. The significance of social activity also decreased from highly significant to relatively significant.

Stepwise OLS regression analysis of work cessation on total cognitive ability in older adults

Stepwise OLS regression was conducted to analyse the effects of six control variables on the total cognitive ability of older adults, except for the explanatory variable 'stopping work', that is, Model 9; then 'social activeness' was added as a moderator in Model 10; 'health behaviour' was added in Model 11, and 'internet use' was added in Model 12. In Model 10, 'social activity' was added as a moderator variable; in Model 11, 'health behaviour' was added as a moderator variable, and in Model 12, 'internet use' was added as a moderator variable. The results of this analysis are presented in table 4.

In the four models in table 4, the effect of stopping work on the total cognitive ability of older adults is very significant and all of them are negative; the coefficient of the effect of stopping work on the total cognitive ability of older adults increases after adding the moderating variables. Compared with those who continue to work, those who stop working have significantly lower total cognitive ability, which supports Hypothesis 1; that is, stopping working has a negative effect on cognitive function in rural older adults.

Model 9 shows that all control variables have a significant effect on the total cognitive ability of older adults (table 2). The analysis results (table 3) indicated that males had higher total cognitive ability than females (impact coefficient of 0.661), and males had lower situational memory capacity than females (impact coefficient of −0.195). Males have a higher total cognitive ability than females (with an impact coefficient of 0.466, which is the sum of 0.661 and −0.195). In the column of age,

Table 4 Stepwise OLS regression analysis of the effect of work cessation on total cognitive ability in older adults

Variables	Models 9	Models 10	Models 11	Models 12
Control variables				
Male	0.466***	0.515***	0.178	0.231
70–80 years	−1.244***	−1.251***	−1.187***	−0.831***
80 and over	−4.555***	−4.563***	−4.521***	−4.075***
Married	0.718***	0.785***	0.501	0.496
Junior high school and below	4.924***	4.872***	5.029***	4.783***
High school and above	7.949***	7.801***	7.887***	7.103***
Participation in pension insurance	0.935***	0.917***	0.844**	0.816**
Participation in health insurance	1.228***	1.186***	1.523***	1.347***
Moderating variables				
Highly socially active		1.106***	0.969***	0.733**
Smoking			−0.0567	0.00530
Drinking a lot			0.260	0.275
Drinking less			1.488***	1.390***
Internet access				2.907***
Stopping work	−1.879***	−1.879***	−2.098***	−2.059***
Constant	5.829***	5.633***	5.689***	5.469***
Sample size	6311	6311	2811	2811
R^2	0.280	0.284	0.250	0.270

***p<0.01, **p<0.05, *p<0.1.

the impact coefficient shows that (−1.244>−4.555) the older the age, the lower the total cognitive ability. In the column of marriage, the total cognitive ability is higher in married than unmarried older people; in the column of education, the impact coefficient (4.924<7.949) shows that the higher the educational level, the higher the total cognitive ability. In terms of social security, the total cognitive ability of older adults who participated in pension/medical insurance was higher than that of those who did not participate.

Model 10 shows that, compared with older adults with low social activity levels, those with high social activity levels exhibited significantly better overall cognitive abilities. In Model 11, after adding health behaviours, the effect of smoking on the total cognitive ability of older adults was not significant, and the effect of drinking more on the total cognitive ability of older adults was not significant, whereas the effect of drinking less was very significant. Among the control variables, the significance of the effects of age, education and social security on the total cognitive ability of older adults did not change much after adding health behaviours but the effects of gender and marriage on the total cognitive ability of older adults became non-significant, indicating that there is no significant difference between the effects of gender and marital status on the total cognitive ability of older adults under the influence of health behaviours. After adding internet use to Model 12, it can be seen that the total cognitive ability of older adults who are online is significantly higher than that of those who are not online. After adding Internet use, the effects of control variables and other moderating variables on the total cognitive ability of older adults are not much different from those in Model 11, but the significance of participation in pension insurance and high social activity reduced from very significant in Model 11 to less significant, indicating that the effects of participation in pension insurance and high social activity on the total cognitive ability of older adults are still significant, but the degree of significance has been reduced under the influence of internet behaviour. This shows that under the influence of online behaviour, the effects of pension insurance participation and high social activity on the total cognitive ability of older adults are still significant, but the degree of significance has decreased.

The effects of each variable on the total cognitive ability of older adults are cumulative. Across multiple models, the effects of stopping work on cognitive functioning, situational memory capacity and total cognitive ability of older adults were all highly significant and negative, indicating that stopping work had a negative effect on the cognitive functioning, situational memory ability and total cognitive ability of older adults. Hypothesis 1 is therefore confirmed, and under the influence of moderating variables, the impact of the explanatory variable, whether an older adult has stopped working, on their cognitive ability remained significant, indicating that the setting of moderating variables in this study was reasonable and effective. Among the moderating variables, the higher

the social activity, the higher the cognitive functioning, situational memory ability and total cognitive ability of older adults, which supports Hypothesis 2. Among the healthy behaviours, smoking did not have a great impact; drinking had a greater impact on the three cognitive abilities of older adults, especially those who drank less alcohol, whose cognitive functioning, situational memory ability, and total cognitive ability were higher; thus, the healthier the behaviours, the higher the cognitive functioning, situational memory ability and total cognitive ability of the older adults. The healthier the behaviour, the higher was the cognitive functioning, the situational memory ability and the total cognitive ability of the older adults, which confirms the hypothesis of Proposition 3: in Internet use, older adults who used the internet had higher cognitive functioning, situational memory ability and total cognitive ability than those who did not use the internet, which confirms Hypothesis 4.

CONCLUSIONS

This study systematically analysed the direct effects and mechanisms of work cessation on cognitive function among rural Chinese older adults based on CHARLS 2020 survey data. Key findings are as follows:

Work cessation significantly reduced cognitive function among rural older people

The findings indicate that older people who stop working experience marked declines in cognitive integrity (short-term cognition scores), episodic memory and overall cognition compared with those who continued to work. These results are consistent with studies from the U.S.,[10] Europe,[48] Australia[19] and South Korea.[49] This phenomenon may relate to reduced physical and cognitive stimulation post-cessation, which is particularly pronounced in older adults aged ≥80 and those with low educational attainment.

Leisure activities demonstrated buffering effects but require quality and variety in the activities

Rural older adults with higher social engagement exhibited significantly mitigated cognitive decline after work cessation, with physical activities showing the strongest protective effects. While consistent with findings by Ihle[50] and Lee,[51] most rural leisure activities remained individual-based with low complexity (80.6% with low activity participation rates). Current leisure patterns inadequately substituted the dynamic stimulation function of labour.

Health behaviour improvements showed heterogeneity

Quitting smoking or drinking postwork cessation yielded limited cognitive benefits, with only moderate drinkers (vs heavy drinkers) showing significant cognitive enhancement (scoring coefficients: 0.555–1.390, $p<0.01$)—similar to observations by Ayyagari[52] and Ge.[53] These findings highlight the need for nuanced health interventions tailored to diverse populations.

Internet use mitigated cognitive decline, yet urban–rural digital gaps persist

While internet adoption (eg, digital training programmes for older adults, adopted by 12.05% in the sample) significantly improves cognitive integrity ($\sigma=1.265$, $p<0.01$), only few used it compared with urban older adults. Moreover, applications centre on *basic communication* (eg, social messaging) rather than *cognitive training tools*—consistent with Green[38] and Jeon.[54]

Based on the findings and rural realities, the following actionable strategies for cognitive protection among older rural-dwelling adults are proposed:

First, it is important to develop flexible, diverse and age-friendly employment opportunities. Participation in socio-economic activities should be encouraged through supported labour mechanisms (eg, training in light physical skills, assistance for low-literacy groups) to create a low-intensity–continued engagement transition, avoiding abrupt cognitive decline after labour withdrawal. Second, the accessible cultural and recreational infrastructure must be strengthened. Age-friendly activity centres in the community with essential equipment must be established, and local volunteer teams to provide monthly cognitive-boosting interventions (companionship reading, storytelling) for high-risk peers must be deployed. Third, it is important to conduct community-wide health outreach programmes using culturally appropriate approaches. Memory-enhancement information via village clinics (dialect-guided health boards and oral campaigns linking balanced diets/exercises to cognition) must be disseminated. Health fairs must be organised during festivals, offering free screenings and distributing low-salt/low-alcohol recipe guides. Finally, digital divides using pragmatic technology adoption must be bridged. Rural authorities should promote tailored digital literacy training focused on practical skills (video calls, news apps); develop low complexity agricultural management tools (weather forecast apps, family photo-sharing platforms) and leverage university student village workers to teach essential e-commerce and daily-use functions.

This study has some limitations. First, the cross-sectional design restricts causal inference, as unobserved confounders may bias the observed associations, despite statistical controls. Second, self-reported measures for variables such as social activity frequency and alcohol consumption may introduce recall or social desirability bias, potentially affecting data accuracy. Third, operationalising ‘work cessation’ as a binary variable overlooks nuances like part-time or informal work common in rural settings, which could moderate cognitive outcomes. Finally, the total cognitive ability score was derived by summing the

two subscale scores (situational memory and cognitive functioning). While the subscales were designed to measure distinct cognitive domains, the observed significant effects for the total score may essentially reflect combined contributions from its constituent subscales (situational memory and cognitive functioning), rather than representing an independent cognitive dimension. Future studies should consider non-additive integrative frameworks (eg, latent variable models) to better disentangle multidimensional cognitive constructs. Nonetheless, the findings offer practical insights for promoting healthy ageing in rural China and contribute empirical data to global ageing research.

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Ethics approval Each round of the CHARLS (China Health and Retirement Longitudinal Study) survey has been approved by the Biomedical Ethics Committee of Peking University. The fieldwork plan for this round of household questionnaire surveys has been approved, and the approval number is: IRB00001052 - 11015.

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