Cognitive Decline and It's Risk Factors in the Elderly in China: A Longitudinal Study

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Research Article

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Abstract

Background Cognitive decline—a prodromal symptom of Mild Cognitive Impairment (MCI) and Alzheimer’s disease (AD) with no effective treatment, often occurs in the elderly. Prevent the occurrence of diseases by controlling risk factors is the best way to reduce its harms. The aim of this study was to identify the influencing factors of the cognitive function decline.

Methods This study included analyzed 4482 participants obtained from the China Health and Retirement Longitudinal Study (CHARLS). Generalized estimating equation (GEE) model was used to analyze the factors affecting the decline of cognitive function level of the elderly.

Results According to this study, being female (OR 1.39), older (OR 1.34 to 5.73 from group 65~69 years to group age≥80 years), unmarried/divorced/widowed (OR 1.41), lower education (OR 2.37 to 45.36 from junior high school graduation to illiteracy), living in a rural area before 16 years (OR 1.87), keep smoking (OR 1.26), over napping (OR 1.28), underweight (OR 1.73), having difficulties with everyday activities (OR 1.25), and poor self-rated health (OR 1.36) were at higher risk of cognitive function decline in the elderly. While drinking once a month and above (OR 0.80), taking care of grandchildren in the last year (OR 0.71), overweight (OR 0.73), and obese (OR 0.63) were the protective factors.

Conclusion Cognitive decline in the elderly was associated with several risk factors. Thus, future research should be focused on high risk elderly with these predictive factors, both to delineate mechanisms for development of cognitive decline and to evaluate preventive interventions.

Background

Populations around the world are rapidly ageing, the ratio of elderly people over 60 was 13.2% (about 1018.18 million) in 2019 according to the United Nations, and the proportion was 17.9% in China[1]. Alzheimer’s disease, an elderly disease without effective treatment measures, is recognized by the World Health Organization as a global public health priority. The cognitive function declines easily develop into Mild Cognitive Impairment, and about 15% of MCI patients develop AD each year. Current estimates suggest that 46.8 million people live with dementia worldwide at present[2]. 20.8% of the elderly people had MCI in China[3], and 25% patients with dementia in the world were Chinese[4]. As an aging country, the number of people with cognitive dysfunction and dementia is soaring rapidly at a rate of 300,000 people per year in China[5].

As described in the previous paragraph, cognitive decline, a common and feared aspect of aging, has important implications for patients and their families[6]. But there are no drugs proven or approved to cognitive decline and treat MCI. So, further studies are needed to determine causes of MCI and risk factors of progression from cognitive decline to MCI to dementia[7]. However, no study to date has observed the development of cognitive decline in older adults, and little is known about the factors that influence cognitive function. Therefore, a comprehensive understanding of the trend of cognitive decline
in the elderly and identification of the factors influencing cognitive decline is important to advise making recommendations to improve cognitive function in the elderly.

In this study, we observed the changes in the cognitive function of the elderly over time based on data from a longitudinal population-based cohort of Chinese older adults, and we specially aimed to identify the influencing factors of the cognitive function decline using GEE Model.

Methods

Population

The data of this research comes from the CHRLS, which is a large-scale long-term follow-up survey project on the middle-aged and elderly people in China and conducted every two years. CHARLS adopted a stratified multi-stage PPS random sampling strategy to select research objects. All the interviewees are followed up for a long time to observe the changes in their physical and mental health (including cognitive function) and health-related behaviors during their lives. Designed along the lines of the United States Health and Retirement Study (HRS), CHARLS provides a unique, high-quality database to support the scientific analysis of aging issues in China. CHARLS conducted a baseline survey in 2011, and completed two waves of survey with a success rate follow-up above 87% in 2013 and 2015.

In our study, we selected 4482 elderly people aged 60 and over who completed 3 surveys from 2011 to 2015 and with comprehensive information. The survey subjects who were unable to conduct cognitive function tests due to blindness, deafness, dumbness, brain damage, or mental retardation, loss to follow-up and death during follow-up were excluded. The flowchart of participants screening and selecting was shown in Fig. 1.

Measures

Assessments of Cognitive function

Cognitive function items included in CHARLS are components of the Telephone Interview of Cognitive Status (TICS), which is similar to the HRS. In this study, the cognitive function of the elderly is evaluated by combining mental status and episode memory ability. The mental status evaluated by time orientation, computing power, and visual space ability. Time orientation includes recognition of date: year, month, day, season, and week of the day of the interview. A correct answer counts 1 point. For computing power, the respondent needs to perform 5 calculations (serial subtraction of 7 s from 100, up to five times). One correct answer counts 1 point. Regarding visual space ability, the respondent needs to redraw a picture of overlapping pentagons, the one who draws the image will be awarded 1 point. The mental status score is the sum of the scores of the above tests, with a full score of 11 points. The episode memory ability evaluation includes 10 words immediate and delayed memory recall tests both ranging from 0 to 10 points. The immediate memory ability test requires the interviewee to recall 10 words the
interviewer has just read, while the delayed memory ability test requires the interviewee to recall the previous interviewer’s reading after about 5 minutes. The average score of the immediate memory score and the delayed memory score is used to assess the respondents’ episodic memory ability[11], the total score is still 0–10 points. Composite scores using all the items create a measure of cognitive functioning, which can range from 0 to 21.

**Dependent variable**

Short-term cognitive function change as the dependent variable was mainly measured by the decline in cognitive function scores. The baseline cognitive scores in 2011 were subtracted from the cognitive scores of the first follow-up survey in 2013 and the second follow-up survey in 2015 to obtain the cognitive decline value after 2 years of follow-up and the cognition after 4 years of follow-up.

**Independent variables**

The independent variables of this study included some questionnaire items and physical examination results in the first wave of survey in 2011. Independent variables including sociodemographic characteristics such as gender, age, and marital status and so on; health-related behaviors such as smoking, drinking, and sleeping and the like; health status such as hypertension, diabetes, self-care ability, etc. The measurement process has been described specifically in detail in the previous literature[12, 13].

**Covariate**

Considering that cognitive function changes may vary across different baseline cognitive function, we set cognitive score of participants in 2011 as control variables.

**Statistical analysis**

In this study, continuous variables were summarized using the mean and standard deviation (SD) and the majority of categorical data were presented as the number (n) and percentage (%). Generalized estimating equation model was used to analyze the factors affecting the decline of cognitive function level of the elderly. In univariate analysis, we set a certain characteristic of the survey object as independent variable, the baseline cognitive function score (2011) as a covariate, and the decline value as dependent variable ran the GEE model. In multivariate analysis, all independent variables with statistical significance in univariate analysis were used as independent variables in the GEE model. The analysis results of risk factors were presented in the form of odds ratio (OR). The level of statistical significance was set at α = 0.05 with 95% confidence intervals (CI). Statistical analysis mentioned above was completed with SPSS21.0 (IBM Corp., Armonk, NY, USA).

**Results**

**Baseline Characteristics**
A total of 4482 elderly people who completed all 3 waves of survey from 2011 to 2015 with comprehensive information were included in this study. The mean age of participants was 66.89 ± 5.85 years, and 2317 of 4482 participants (51.70%) were male. 3683 participants (82.17%) were in married. The education level of most participants (80.04%) is elementary school and below. 4097 participants (91.43%) lived in rural area before 16 years old. Other baseline characteristics of participants are presented in Appendix STable1.

**Cognitive Function Changes**

The median cognitive function score was 10.56 ± 4.07 points in 2011, 9.66 ± 4.79 points in 2013, and 9.50 ± 4.53 points in 2015. Cognitive function decline value after 2 years of follow-up was 0.90 ± 3.73 points, while after 4 years of follow-up was 1.06 ± 3.37 points. The details of the cognitive function changes of the survey subjects with different characteristics were shown in Appendix STable1.

**Univariate analysis**

Among sociodemographic characteristics, being female, older, poor marital status, lower education, and residence in rural area before 16 years had significantly increased cognitive function decline probability in the elderly according to univariate analysis. While being at work was protective factor. Among the health-related behavior characteristics, keep smoking, drinking more than once a month in the last year, sleep less than 6 hours or more than 8 hours at night, no nap, taking care of grandchildren in the past year were the significant related factors associated with cognitive function decline. In additional, hypertension, dyslipidemia, abnormal BMI value, poor current self-rated health status, and having difficulties with everyday activities, among health status characteristics were also the significant risk factors associated with cognitive function decline (Appendix STable2).

**Multivariate analysis**

The multivariate analysis of GEE model indicated that being female (OR 1.39, 95%CI 1.09–1.787, older (OR 1.34 to 5.73 from group 65 ~ 69 years to group age ≥ 80 years), unmarried/divorced/widowed (OR 1.41, 95%CI 1.12–1.77), with lower education (OR 2.37 to 45.36 from Junior high school graduation to Illiteracy), and living in a rural area before 16 years (OR 1.87, 95%CI 1.39–2.53) were the significant risk factors in sociodemographic characteristics associated with cognitive function decline among the elderly (Fig. 2).

Among health-related behavior characteristics, keep smoking (OR 1.26, 95%CI 1.10–1.57) and over 90 minutes of nap in the past month (OR 1.28, 95%CI 1.00-1.64) were the main risk factors for cognitive function decline (Fig. 2). While drinking once a month and above in the past year (OR 0.80, 95%CI 0.65–0.98), taking care of grandchildren in the past year (OR 0.71, 95%CI 0.58–0.87) were the two significant protective factors (Fig. 2).

The model also indicate that underweight (OR 1.73, 95%CI 1.28–2.35), having difficulties with everyday activities (OR 1.25, 95%CI 1.04–1.50), and poor current self-rated health (OR 1.36, 95%CI 1.12–1.66) were the significant risk factors in health status associated with cognitive function decline. While overweight
(OR 0.73, 95%CI 0.60–0.89) and obese (OR 0.63, 95%CI 0.47–0.85) were the two protective factors (Fig. 2).

**Discussions**

It was previously reported that old age was an important independent predictor of cognitive decline[14], and the present study also confirmed that increasing age was associated with cognitive decline. The possible reason is the gradual decline in cognitive function due to physical deterioration with age[15]. Females exhibit a higher risk of cognitive decline, which was consistent with the findings of previous studies[16]. There are possible reasons: first, the elderly people in this study were born before the 1950s. The traditional family patriarchal concept of patriarchal family resulted in women's social status, education level, and nutritional supply being inferior to men, adversely affected women's cognitive function[17, 18]; second, the decreased secretion of estrogen in elderly women performed less protective effect on cholinergic nerve fibers, which damaged their cognitive function[19]. Lower level of education is a risk factor for cognitive decline according to this study. Previous researches indicated that the incidence of MCI decreases significantly with the increase of education level[20], as a possible result of their high ability to accept and learn new things. And the brain was constantly stimulated to increase its cognitive reserve and synaptic connections through learning[21]. The elderly in married took a lower risk of cognitive decline, which may be related to their positive and optimistic attitudes. It's consistent with a previous study which found being married was associated with better cognitive function[22]. The elderly lived in rural areas before the age of 16 was at greater risk of cognitive decline. This may be due to the poor education and nutritional status of older people living in rural areas during their early years, which affected the cognitive function of the elderly.

Some health behaviors associated with cognitive decline were found by the present study, for example, current smokers were more likely to experience cognitive decline than former smokers or non-smokers, consistent with previous studies[23, 24]. As the world's largest producer and consumer of tobacco, China should viable strategies such as stronger control regulations of tobacco and education about the dangers of exposure to secondhand smoke to reduce the cognitive decline and MCI epidemic in the elderly[25]. Several previous studies have shown that limited alcohol intake in early adulthood and small to moderate alcohol intake in old age may decrease the risk of cognitive decline and dementia [26, 27]. And in consistent with previous studies, the current study found that drinking once a month and above in the past year was associated with reduced risk of cognitive decline[28]. However, contrary findings have also been reported. So the researches on mechanisms based on the observed association between alcohol and brain function are required in the future[23]. A previous study showed healthy seniors took a 90-minute nap every day as a napping regimen, so we selected 90 minutes as the critical point for judging excessive nap time[29]. The results of the present study showed findings that long naps increase the risk of cognitive decline in older adults. However, the relationship between napping and cognitive function deserves further study[29, 30]. Additionally, although we found that taking care of grandchildren was protectively against the progression of cognitive decline, as compared to not taking care of juniors, the impact of caring for grandchildren on the physical and mental health of older adults is controversial now.
Some scholars have found that caring for grandchildren increased the risk of cognitive decline by increasing the mental burden and physical exertion of older adults[31]. While other scholars believed that caring for the younger generation was beneficial to the cognitive function of the elderly, because it not only increased the frequency of activities, but also promoted their physical and mental health[32].

This study showed significant associations between cognitive decline and health status, including difficulties with everyday activities, current self-rated health status and BMI. Studies previously have shown physical activity was associated with a decreased risk of cognitive impairment and provided a modest improvement in the cognition function[23, 33]. The elderly who had difficulties in everyday activities were more likely to lack physical activity due to inconvenience. So, it’s easy to understand that the cognitive function of them declines faster. The current study also found that the elderly having difficulties in everyday activities were at high risk of cognitive decline. In this study, we found that poor self-rated health was associated with cognitive decline. But self-rated health is so comprehensive and non-specific that it is difficult to interpret[34]. A previous study found that self-rated health strongly affecting instrumental abilities of daily living decline, and it may be related to cognitive decline[35]. However, it is clear that there are still many unanswered questions and significant uncertainty with respect to the relationship between self-rated health and cognitive decline, and need for more research it.

The majority of participants underweight were more susceptible to cognitive decline, while overweight and obese were vital protective factors for them. The relationship between obesity and cognitive function or AD in the elderly is controversial at present[36, 37], and further prospective researches are needed to provide relevant evidence.

This study covered 150 county-level units and 450 village-level units in China, and the sample is highly representative. The results from this analysis may suggest important policy implications for the cognitive function of Chinese elderly people. However, the follow-up period since the baseline survey in this study was only 4 years, and cognitive function change is a chronic process that requires longer follow-up observation. In addition, all participants in this study were from China, and heterogeneity of samples also affects cognitive decline studies due to their differences in origins, locations and cultures. Researches which contain a wide range of populations with different cultures will be needed in the future.

Conclusions

In summary, this study demonstrated several risk factors for cognitive function decline of the elderly in China rely on the important data source – CHARLS 2011-15 data. Being female, older, unmarried/divorced/widowed, lower education, living in a rural area before 16 years, smoking, over napping, underweight, poor self-rated health and difficulty in everyday activities were the significant risk factors associated with cognitive function decline. While being overweight or obese, taking care of grandchildren and drinking once a month and above were the important protective factors for cognitive function decline. Future researches should focus on the high-risk elderly with these predictive factors, not only to delineate mechanisms for development of cognitive decline, but also to evaluate preventive
interventions. Such research is vital if we want to prevent and control the cognitive decline of the elderly and reduce the occurrence of Alzheimer's.

**Abbreviations**

MCI
Mild Cognitive Impairment
AD
Alzheimer's disease
OR
Odds Ratio
CI
Confidence Intervals
GEE
Generalized Estimating Equation
HRS
Health and Retirement Study
TICS
Telephone Interview of Cognitive Status

**Declarations**

**Statement**

All methods were carried out in accordance with relevant guidelines and regulations.

**Ethical approval and consent to participate**

This study analyzed secondary data from CHARLS, and therefore ethical approval is not a requirement. The original study received approval from the Ethical Review Committee (IRB) at Peking University in June 2008 (IRB00001052–11015). All consenting participants signed a written consent form.

**Consent for publication**

Not applicable.

**Availability of data and materials**

All data generated or analyzed during this study are included in this published article.

**Competing interests**

The authors declare that they have no competing interests.
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Authors’ contributions

YP and WJ contributed to the conception and design of the research. DXX and HFR completed the acquisition, analysis, or interpretation of data for the work. DXX drafted this manuscript. YP, WJ, HFR and DXX provided critical revisions of the manuscript and approved submission of the final manuscript.

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