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# Relationship Between Healthy Lifestyles and Cognitive Impairment in the Elderly

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**Abstract:** *Objective*: To explore the influence of healthy lifestyles on cognitive function in the elderly population in China, and to provide a reference basis for the prevention and management of cognitive impairment. *Methods*: Based on cross-sectional data from the 2018 Chinese Longitudinal Healthy Longevity Survey (CLHLS), research subjects with samples below 60 years old and missing key variables were excluded. Ultimately, 8,687 elderly people were included. Descriptive statistics and binary logistic regression analysis were performed using SPSS 27.0 software. A restricted cubic spline model was constructed to analyze the dose-response relationship between healthy lifestyles and cognitive impairment. *Results*: Among the participants, 2072 individuals (23.85%) were identified with cognitive impairment. The results of the binary logistic regression analysis, after adjusting for covariates, lack of exercise, low social participation, abnormal sleep duration, and unhealthy diet, were all risk factors for cognitive impairment in older adults. A linear dose-response relationship was observed between the number of healthy lifestyles practiced by the elderly and cognitive impairment ($P_{overall} < 0.0001$, $P_{non\text{-}linearity} = 0.7318$). *Conclusion*: Healthy lifestyles of the elderly are closely related to their cognitive function. Encouraging the elderly to change unhealthy lifestyles and increase the number of healthy lifestyles can effectively improve their cognitive function. This finding provides an important basis for formulating targeted health intervention strategies, emphasizing that appropriate measures should be taken to carry out multidimensional education on healthy lifestyles among the elderly, so as to prevent and delay the progression of cognitive impairment.

**Keywords:** Elderly; Cognitive impairment; Healthy lifestyles

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## 1. Introduction

With the continuous advancement of population aging, the health status of the elderly has become a focus of social attention. Currently, dementia has become the fourth major disease threatening the health of the elderly, following cardiovascular diseases, cancer, and stroke [1]. A study published in The Lancet Public Health shows

that the prevalence of dementia among the elderly in China is 6.0%, and the prevalence of mild cognitive impairment is 15.5% [2]. Cognitive impairment includes Mild Cognitive Impairment and dementia. In the early stage of the disease, the main manifestation is significant memory decline, accompanied by impairment of daily living and social activity abilities. In the advanced stage, behavioral and psychological symptoms may appear, and in severe cases, the ability to live independently may be completely lost [3]. Therefore, early identification of cognitive impairment in the elderly and implementation of targeted preventive measures have important practical application value. Previous studies have shown that demographic and sociological characteristics, healthy lifestyles, psychological status, and other factors all affect the cognitive function of the elderly [4,5]. Among them, a healthy lifestyle, as a non-pharmacological intervention method, has attracted extensive attention due to its high feasibility and low cost. Healthy Lifestyles (HLs) include a reasonable diet, moderate exercise, smoking and alcohol cessation, and maintaining psychological balance [6]. Studies have shown that a healthy diet and participation in physical activities are closely related to the cognitive function of the elderly, and are modifiable factors affecting cognitive function, with gender differences. Women benefit more from a healthy diet, while men benefit more from physical activity [7–9]. However, most existing studies focus on the independent association between a single healthy lifestyle (such as a specific dietary pattern or exercise) and cognitive function, and there are few reports on how the number of healthy lifestyles adopted by the elderly affects their cognitive function. Based on the data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), this study explores the association between healthy lifestyles and cognitive impairment in the elderly, and further determines the mechanism of action of the number of healthy lifestyles on cognitive function through dose-effect analysis, aiming to provide a scientific theoretical basis for the construction of intervention strategies for cognitive impairment in the elderly.

## 2. Materials and methods

### 2.1. Data source

The data of this study were obtained from the 2018 Chinese Longitudinal Healthy Longevity Survey (CLHLS). As a national follow-up survey project on the health of the elderly covering 23 provinces, municipalities directly under the Central Government, and autonomous regions, the samples of CLHLS cover 85% of China's total population. The survey was first conducted as a baseline survey in 1998, and then followed up every 2 to 3 years, with good sample representativeness. According to the core research content of this study, samples of individuals under 60 years old and those with missing key variables, such as cognitive function and lifestyles, were excluded, and finally, 8,687 valid samples were included. In addition, the CLHLS study has been approved by the Institutional Review Board of Peking University (No. IRB00001052-13074), and all respondents participating in the survey signed a written informed consent form after fully understanding the relevant matters of the study.

### 2.2. Variable definition

#### 2.2.1. Dependent variable

The dependent variable was defined as whether the elderly had cognitive impairment. Their cognitive function level was evaluated using the Chinese version of the Mini Mental State Examination (MMSE) adopted in CLHLS. The scale consists of 24 independent questions, mainly including five dimensions: general ability (12 points), reaction ability (3 points), attention and calculation ability (6 points), memory

ability (3 points), and language comprehension and self-coordination ability (6 points). The total score of the scale ranges from 0 to 30 points, with higher scores usually indicating better cognitive function in the elderly. Following the criteria of previous studies, this study defined MMSE score < 24 as cognitive impairment and ≥ 24 as normal cognitive function [10].

### 2.2.2. Independent variable

The independent variable were healthy lifestyles, which specifically included the assessment of smoking, drinking, exercise, social participation, sleep duration, and diet. Smoking and drinking status were investigated by two questions: "Do you smoke/drink now?" and "Have you ever smoked/drunk in the past?". Those who "have never smoked or drunk in the past and present" were classified as having a healthy lifestyle [11]. Exercise status was assessed by the question "Do you often exercise now?", with answer options of "Yes" and "No". Those who "often exercise at present" were defined as having a healthy lifestyle [12]. The assessment of social participation in CLHLS includes 8 activities, specifically housework, outdoor activities, growing flowers and raising pets, reading books and newspapers, raising livestock or poultry, playing cards or mahjong, watching TV and listening to the radio, and participating in organized social activities. Each activity has five options: 1. Almost every day; 2. Not every day, but at least once a week; 3. Not every week, but at least once a month; 4. Not every month, but sometimes; 5. Do not participate. Referring to the conclusions of previous studies, this study defined participation in any of the above activities at least once a month as having social participation, which was classified as a healthy lifestyle [13]. The National Sleep Foundation of the United States recommends that the elderly should ensure 7 to 8 hours of sleep per day to ensure adequate rest [14]. By asking the respondents "How many hours do you sleep every day?", it was judged whether they had sufficient sleep duration, and those within this range were defined as having a healthy lifestyle. Diet status was evaluated by a food frequency questionnaire. According to previous studies, questions related to 9 types of food involved in CLHLS (including fresh fruits, fresh vegetables, meat, aquatic products such as fish, eggs, soy products, dairy products, nuts, and tea) were selected for measurement [15]. The intake frequency was divided into 5 categories: "Eat almost every day", "Not every day, but at least once a week", "Not every week, but at least once a month", "Not every month, but sometimes", and "Rarely eat or never eat". When the respondent answered "Eat almost every day" or "Not every day, but at least once a week", it was regarded as intake of the food and scored 1; otherwise, 0. The degree of dietary diversity was the sum of the scores of the 9 types of food, with higher scores indicating richer food intake. A score > 3 was defined as a healthy diet, belonging to a healthy lifestyle, and a score ≤ 3 was defined as an unhealthy diet.

### 2.2.3. Covariates

The demographic and sociological characteristics included in this study were gender, age, years of education, marriage, and co-residence. Living status was specifically divided into three types: with family members, alone, and in a nursing home. Marriage was investigated by the question "What is your current marital status?", with response options including 5 categories: "Married and living with spouse", "Married but not living with spouse", "Divorced", "Widowed", and "Never married". For the convenience of subsequent statistical analysis in this study, the first category was merged into the "spouse" category, and the latter three categories were merged into the "no spouse" category.

## 2.3. Statistical methods

Excel 2013 was used to export and integrate the data of the CLHLS database, and SPSS 27.0 and R Studio were used for statistical analysis. Measurement data were described by mean ± standard deviation ($\overline{x} \pm s$), and count data were described by frequency and percentage. An independent samples t-test or chi-square test was used to analyze the distribution differences of cognitive impairment among elderly groups with different characteristics. Variables with statistically significant differences were included in a binary Logistic regression analysis, with $p < 0.05$ considered statistically significant. The restricted cubic spline (RCS) model was used to fit the dose-response relationship curve between the number of healthy lifestyles and cognitive impairment, and the RCS model with the optimal number of nodes was selected according to the Akaike Information Criterion (AIC). Two-tailed tests were used in this study, with $p < 0.05$ considered statistically significant.

# 3. Results

## 3.1. Cognitive function of the elderly with different characteristics

A total of 8,687 elderly people were included in this study, among whom 3,934 were male (45.29%); the age distribution was 1,192 cases (13.72%) aged 60–69 years, 2,413 cases (27.78%) aged 70–79 years, and 5,082 cases (58.50%) aged 80 years and above; 3,944 cases (45.40%) had no education, 2,950 cases (33.96%) had 1–6 years of education, and 1,793 cases (20.64%) had more than 6 years of education; 4,092 cases (47.10%) had a spouse, and 4,595 cases (52.90%) had no spouse; 2,102 cases (24.20%) lived with their families, 2,900 cases (33.38%) lived alone, and 3,685 cases (42.42%) lived in a nursing home.

The results showed that a total of 2,072 (23.85%) elderly people had cognitive impairment. The detection rate of cognitive impairment was higher in elderly people who were female, aged ≥ 80 years, had no education, no spouse, lived alone, did not smoke, did not drink alcohol, did not exercise, had no social participation, had abnormal sleep duration and had an unhealthy diet, with statistically significant differences (all $p < 0.05$). **Table 1**.

**Table 1.** Comparison of cognitive impairment among older adults with different characteristics (n = 8687)

| Item | Category | Number of respondents (n/%) | Number of cognitive impairment cases(n/%) | Number of non-cognitive impairment cases(n/%) | $\chi^2$ | *p* |
|---|---|---|---|---|---|---|
| Gender | Male | 3934(45.29) | 588(14.95) | 3346(85.05) | 313.932 | < 0.001 |
| | Female | 4753(54.71) | 1484(31.22) | 3269(68.78) | | |
| Age(years) | 60–69 | 1192(13.72) | 42(3.52) | 1150(96.48) | 1177.815 | < 0.001 |
| | 70–79 | 2413(27.78) | 147(6.09) | 2266(93.91) | | |
| | ≥ 80 | 5082(58.50) | 1883(37.05) | 3199(62.95) | | |
| Years of education | 0 | 3944(45.40) | 1613(40.90) | 2331(59.10) | 1175.525 | < 0.001 |
| | 1-6 | 2950(33.96) | 349(11.83) | 2601(88.17) | | |
| | > 6 | 1793(20.64) | 110(6.13) | 1683(93.87) | | |
| Marriage | Spouse | 4092(47.10) | 414(10.12) | 3678(89.88) | 803.454 | < 0.001 |
| | No spouse | 4595(52.90) | 1658(36.08) | 2937(63.92) | | |
| Co-residence | With family members | 2102(24.20) | 326(15.51) | 1776(84.49) | 106.678 | < 0.001 |

| Item | Category | Number of respondents (n/%) | Number of cognitive impairment cases(n/%) | Number of non-cognitive impairment cases(n/%) | $\chi^2$ | *p* |
|---|---|---|---|---|---|---|
| | Alone | 2900(33.38) | 780(26.90) | 2120(73.10) | | |
| | In a nursing home | 3685(42.42) | 966(26.21) | 2719(73.79) | | |
| Non-smoking | Yes | 5994(69.00) | 1593(26.58) | 4401(73.42) | 79.041 | < 0.001 |
| | No | 2693(31.00) | 479(17.79) | 2214(82.21) | | |
| Non-drinking | Yes | 6331(72.88) | 1644(25.97) | 4687(74.03) | 57.532 | < 0.001 |
| | No | 2356(27.12) | 428(18.17) | 1928(81.83) | | |
| Exercise | Yes | 3053(35.14) | 387(12.68) | 2666(87.32) | 323.704 | < 0.001 |
| | No | 5634(64.86) | 1685(29.91) | 3949(70.09) | | |
| Social participation | Yes | 7791(89.69) | 1461(18.75) | 6330(81.25) | 1081.435 | < 0.001 |
| | No | 896(10.31) | 611(68.19) | 285(31.81) | | |
| Normal sleep duration | Yes | 3219(37.06) | 563(17.49) | 2656(82.51) | 113.958 | < 0.001 |
| | No | 5468(62.94) | 1509(27.60) | 3959(72.40) | | |
| Healthy diet | Yes | 6162(70.93) | 1266(20.55) | 4896(79.45) | 127.607 | < 0.001 |
| | No | 2525(29.07) | 806(31.92) | 1719(68.08) | | |

## 3.2. Logistic regression analysis of lifestyle and cognitive function in the elderly

Taking cognitive function (normal cognition = 0, cognitive impairment = 1) as the dependent variable, and demographic and sociological characteristics and lifestyle as independent variables, binary Logistic regression analysis was used to analyze the influencing factors of cognitive function in the elderly. The results showed that female gender (*OR* = 1.396), advanced age (70–79 years old: *OR* = 1.491; ≥ 80 years old: *OR* = 6.586), no spouse (*OR* = 1.666), living alone (*OR* = 1.252), smoking (*OR* = 1.193), lack of exercise (*OR* = 1.464), absence of social participation (*OR* = 3.787), abnormal sleep duration (*OR* = 1.359) and unhealthy diet (*OR* = 1.326) were all risk factors for cognitive impairment in the elderly. Longer years of education (1–6 years: *OR* = 0.375; > 6 years: *OR* = 0.303) was a protective factor for cognitive function in the elderly. Living in a nursing home and drinking alcohol had no significant effect on the cognitive function of the elderly ($p > 0.05$). See **Table 2** for details.

**Table 2.** Logistic regression analysis of the impact of lifestyle on cognitive impairment in older adults

| Item | Category$\beta$ | | Reference group | | |
|---|---|---|---|---|---|
| | | | *OR*(95%*CI*) | *p* | |
| Gender | Female | Male | 0.333 | 1.396(1.195–1.631) | < 0.001 |
| Age(years) | 70–79 | 60–69 | 0.400 | 1.491(1.042–2.134) | 0.029 |
| | ≥ 80 | | 1.885 | 6.586(4.730–9.170) | < 0.001 |
| Years of education | 1–6 | 0 | -0.981 | 0.375(0.323–0.435) | < 0.001 |
| | > 6 | | -1.192 | 0.303(0.239–0.386) | < 0.001 |
| Marriage | No spouse | Spouse | 0.510 | 1.666(1.442–1.924) | < 0.001 |
| Co-residence | Alone | With family members | 0.225 | 1.252(1.047–1.497) | 0.014 |
| | In a nursing home | | 0.117 | 1.125(0.943–1.341) | 0.190 |
| Non-smoking | No | Yes | 0.176 | 1.193(1.015–1.401) | 0.032 |

| Item | Category$\beta$ | | Reference group | | |
|---|---|---|---|---|---|
| | | | *OR(95%CI)* | *p* | |
| Non-drinking | No | Yes | -0.039 | 0.962(0.823–1.124) | 0.623 |
| Exercise | No | Yes | 0.381 | 1.464(1.272–1.685) | < 0.001 |
| Social participation | No | Yes | 1.332 | 3.787(3.200–4.480) | < 0.001 |
| Normal sleep duration | No | Yes | 0.307 | 1.359(1.197–1.543) | < 0.001 |
| Healthy diet | No | Yes | 0.282 | 1.326(1.168–1.504) | < 0.001 |

## 3.3. Dose-response relationship between the number of healthy lifestyles and cognitive impairment in the elderly

To further explore the relationship between the number of healthy lifestyles and cognitive impairment in the elderly, the number of healthy lifestyles was included as a continuous variable in the RCS model to draw the dose-response curve. The number of nodes in the RCS model generally ranges from 3 to 7 [16]. According to the spline regression coefficient and AIC criterion, this study found that the AIC value of the number of healthy lifestyles was 6881.875, which was the smallest, with 3 nodes at this time. The model results showed that there was a linear dose-response relationship between the number of healthy lifestyles and the risk of cognitive impairment in the elderly ($p$ for overall trend < 0.0001, $p$ for non-linearity = 0.7318), that is, for each increase in one healthy lifestyle, the risk of cognitive impairment decreased linearly. Among them, the number of healthy lifestyles at the intersection of the dashed line of confidence interval = 1 was 4, suggesting that when the number of healthy lifestyles reaches 4 or more, it can play a significant protective role in the cognitive function of the elderly. **Figure 1**.

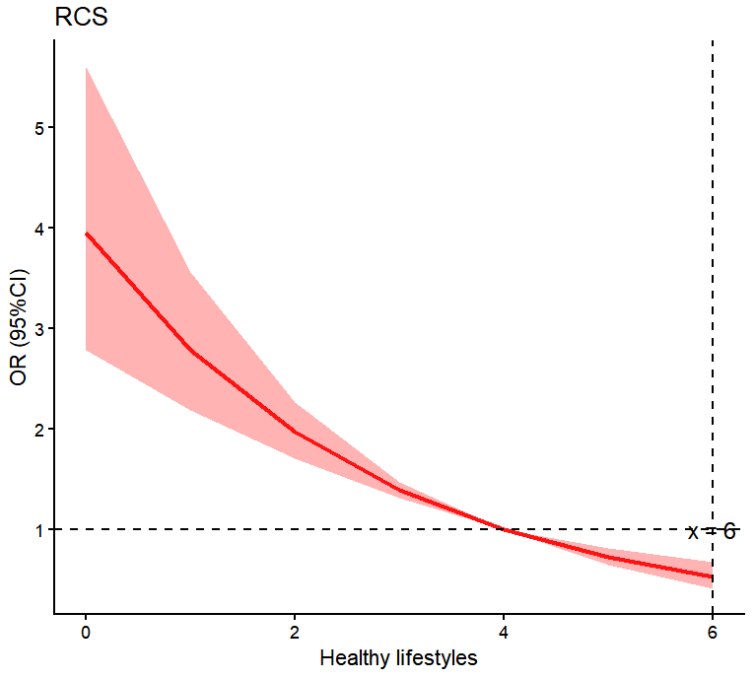


**Figure 1.** Dose-response relationship between the number of healthy lifestyles and the risk of cognitive impairment in older adults

# 4. Discussion

## 4.1. Differences in the incidence of cognitive impairment in the elderly

Based on the data from the 2018 Chinese Longitudinal Healthy Longevity Survey, this study systematically explored the association between healthy lifestyles and cognitive impairment among the elderly aged 60 and above in China. The results showed that the prevalence of cognitive impairment in this age group was 23.85%, which was higher than the research result of Zhang et al (10.59%), but lower than the survey result of Zheng et al on the elderly in nursing institutions (41.28%) [17,18]. This difference may be related to the characteristics of the research objects, the cognitive function assessment tools used, and the differences in diagnostic criteria. The research objects of the latter were all elderly people over 80 years old, and the detection rate of cognitive impairment in the elderly increased significantly with age; the results of this study also confirmed that compared with the 60–69 age group, the risk of cognitive impairment in the ≥ 80 age group was significantly increased ($OR = 7.313$, $p < 0.001$). Both Zhang et al and this study used the MMSE scale to assess cognitive function, while Zheng et al used the Montreal Cognitive Assessment (MoCA) scale. Compared with MMSE, MoCA has a higher detection rate and stronger sensitivity for cognitive impairment [19]. Zhang et al defined MMSE score ≥ 18 as normal cognitive function, while this study adopted a stricter scoring standard of MMSE score ≥ 24, so the detection rate of normal cognitive function was lower than that of Zhang et al's study.

## 4.2. The impact of healthy lifestyles on the risk of cognitive impairment in the elderly

The results of this study showed that smoking increased the risk of cognitive impairment ($OR = 1.193$), which was consistent with the conclusions of previous studies [20]. The potential mechanism may be that harmful components such as nicotine in cigarettes can damage the capillary endothelium of the human body, leading to vascular stenosis and platelet aggregation, increasing the probability of vascular occlusion, and ultimately inducing stroke or vascular dementia, indirectly impairing cognitive function. However, a few studies have suggested that short-term and low-dose smoking can have a protective effect on cognitive function through the dual effects of nicotine on nerve cells [21]. This difference needs to be further verified by increasing the follow-up duration, controlling the smoking dose, and targeting population characteristics. In existing studies, the harmful effects of smoking on cognitive function have been confirmed by most studies, and it is recommended to include smoking cessation intervention in the measures for the management of cognitive function in the elderly. Lack of physical exercise ($OR = 1.464$) was a risk factor for cognitive impairment in the elderly, which was consistent with the conclusions of previous studies [4]. Physical exercise can protect the cognitive function of the elderly by reducing the inflammatory response in the body and promoting the release of important neurotrophic factors such as insulin-like growth factor-1 (IGF-1) [22]. This provides an important theoretical basis for exercise intervention to prevent cognitive decline in the elderly, and it is necessary to encourage the elderly to engage in moderate physical exercise and reduce bad behaviors, such as a sedentary lifestyle. Low level of social participation ($OR = 3.787$) was the most significant risk factor for cognitive impairment in the elderly in this study. Social participation includes housework, social, and intellectual activities. According to the "cognitive reserve" theory, these activities help optimize brain regions or brain networks related to memory, reduce the impact on memory function, and thus prevent the occurrence of cognitive impairment [23]. Based on this, promoting social participation can be included in the intervention strategies for protecting the cognitive function of the elderly, by reducing their social isolation and potential loneliness to protect cognitive function [24]. Abnormal sleep duration (< 7

hours or > 8 hours, *OR* = 1.359) was a risk factor for cognitive impairment in the elderly, possibly because too long sleep duration can lead to prolonged reaction time and increased error rate of visual memory; while insufficient sleep duration can cause the deposition of β-amyloid protein, leading to cognitive decline and a vicious circle [25–27]. Therefore, it is recommended that 7 to 8 hours be taken as the optimal sleep duration for the elderly, and personalized intervention measures should be taken for those with abnormal sleep, such as cognitive behavioral therapy to improve insomnia and moderate exercise to regulate excessive sleep [28,29]. In addition, the degree of healthy diet intake was negatively correlated with the risk of cognitive impairment, and an unhealthy diet (*OR* = 1.326) increased the risk of the disease. A healthy diet includes fresh fruits, fresh vegetables, meat, aquatic products such as fish, eggs, soy products, dairy products, nuts, and tea. This finding is consistent with the conclusions of previous studies. A diversified dietary structure can provide sufficient nutrients, especially foods rich in antioxidants and Omega-3 fatty acids, which can protect the brain from oxidative stress and inflammatory damage, thereby protecting cognitive function [30–32]. It can be seen that promoting a balanced and diversified healthy diet pattern among the elderly should become an important intervention strategy for preventing cognitive impairment. Although the results of this study did not find a significant association between drinking alcohol and cognitive impairment ($p > 0.05$), it does not mean that the importance of drinking alcohol can be ignored. Studies have shown that there is a non-linear relationship between alcohol consumption and cognitive impairment; moderate drinking can reduce the risk of cognitive impairment, while excessive drinking increases the risk [33].

### 4.3. The relationship between the number of healthy lifestyles and the risk of cognitive impairment

This study confirmed that adhering to a healthy lifestyle has a positive effect on reducing the risk of cognitive impairment in the elderly, which is consistent with the conclusions of previous studies [34]. The results of the RCS model analysis showed that there was a dose-effect relationship between the number of healthy lifestyles and cognitive function. The cumulative effect of healthy lifestyles showed a significant positive trend in preventing cognitive decline; that is, the healthier lifestyles, the lower the probability of cognitive impairment in the elderly. This may be related to the fact that a combination of multiple healthy lifestyles can protect cognitive function by improving cardiovascular health, regulating metabolic function, and optimizing the balance of the neuroendocrine system [32,35]. This finding emphasizes the importance of a multidimensional healthy lifestyle, transcending the limited contribution of a single healthy lifestyle to cognitive function. The “threshold effect” observed in the study indicates that when the number of healthy lifestyles is more than 4, its protective effect on the cognitive function of the elderly is significant. This finding provides an important basis for formulating health promotion strategies for the elderly, emphasizing the necessity of comprehensively promoting the adoption of multiple healthy lifestyles among the elderly, rather than just focusing on the improvement of a certain aspect.

## 5. Limitations and future directions of the study

In conclusion, healthy lifestyles are significantly associated with cognitive impairment. This finding not only deepens the understanding of the complex mechanism of cognitive impairment in the elderly, but also emphasizes the importance of changing unhealthy lifestyles for protecting cognitive function. Cognitive impairment will seriously reduce the quality of life of the elderly, and at the same time, bring a heavy

burden to family care and social medical resources. Therefore, early cognitive function screening for the elderly, targeted strengthening of health education for the elderly, guiding the elderly to reduce unhealthy lifestyles, and adhering to a comprehensive model of multiple healthy lifestyles, such as a healthy diet, social participation, and adequate sleep, are of great significance for preventing cognitive decline. This study also has certain limitations. First, the research data were derived from the cross-sectional data of the 2018 CLHLS database. Due to the limitations of the research design, it is impossible to directly infer the causal relationship between various healthy lifestyles and the cognitive function of the elderly. Second, this study analyzed healthy lifestyle as a comprehensive variable, and failed to explore the specific impact of a single healthy lifestyle and its degree on cognitive function in detail. Finally, the assessment of some variables relied on the self-report of the elderly, which may introduce the risk of reporting bias.

## 6. Data availability

The data used in this study were drawn from the Chinese Longitudinal Healthy Longevity Survey (https://opendata.pku.edu.cn/dataverse/CHADS). This study submitted the application to the website and received the data package.

## Disclosure statement

The authors declare no conflict of interest.

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