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# The association between sleep duration, napping, and stroke stratified by self-health status among Chinese people over 65 years old from the China health and retirement longitudinal study

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## Abstract

**Purpose** Stroke is a major cause of death in China. This study aimed to investigate the association between sleep duration (nighttime sleep and daytime napping) and stroke in elderly Chinese individuals with self-reported health status.

**Methods** A total of 4785 Chinese adults over 65 years from the 2011 China Health and Retirement Longitudinal Study (CHARLS) were included. Binary logistic regression was used to estimate odds ratios and 95% confidence intervals of the association between sleep duration and stroke stratified by self-reported health status.

**Results** A significant association between short sleep duration (< 7 h per day) and the risk of stroke (aOR = 2.05; 95% CI 1.31–3.19), after controlling for sociodemographic characteristics, lifestyle factors, health status, and comorbidities. There was no significant association between short and long sleep duration and stroke in the individuals who reported good general health status. However, in individuals who reported poor health status, short sleep duration (aOR = 2.11; 95% CI 1.30–3.44) and long sleep duration (aOR = 1.86; 95% CI 1.08–3.21) were significantly associated with increased risk of stroke, compared with normal sleep duration (7–8 h per day). Disability was significantly associated with stroke in both self-reported good and poor health groups. Rural residence was significantly associated with a lower risk of stroke among individuals who reported poor health status.

**Conclusions** Both short and long sleep duration were significantly associated with stroke among individuals who reported poor health. Stroke prevention should be focused on elderly individuals who believe that they have health problems.

**Keywords** Stroke · Sleep duration · Nap · Health status · Aging Chinese

## Introduction

Stroke accounts for a high rate of mortality around the world and is a primary cause of death in China [1]. During 2017, stroke has dominated as the leading cause of years of life lost (YLLs), notwithstanding a 33.5% decrease in age-standardized mortality since 1990 [2]. This burden is extremely remarkable among the aging Chinese population with a high prevalence of risk factors such as high blood pressure, diabetes, age, family history and genetics, overweight, and obesity [3]. Sleep duration, as well, has been documented as a potential risk factor for having a stroke [4–10].

However, there have been conflicting findings from the studies examining the relationship between sleep duration and the risk of stroke. Several studies observed a J-shaped relationship between long sleep duration and a higher risk of stroke [4–7], whereas other studies demonstrated a U-shaped relationship with both short and long sleep duration being associated with an increased risk of stroke [8–10]. In our previous work, we found a one-sided relationship between sleep duration and stroke; only short sleep duration was associated with an increased risk of stroke [11]. These conflicting results might be attributed to differences in cohort characteristics, gender, and sample size, as well as cultural region or ethnicity [12–14].

Within the Chinese culture, elderly people usually take naps after lunch to help maintain an adequate level of daytime

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functioning. A meta-analysis of prospective cohort studies shows that daytime napping and cardiovascular disease (such as stroke) might be associated via a J-shaped relation [15]. Our study found the association between stroke and sleep duration by including daytime napping in the total sleep duration [11], and more studies are needed to understand the relationship between total sleep duration (nighttime sleep and daytime napping) and stroke incidence. Self-rated health (SRH) is a simple measure recommended by the World Health Organization (WHO) [16] that allows individuals for comparison and identification of their health status [17, 18]. To date, few studies have addressed the relationship between sleep duration and stroke across different aspects of health status. In this study, we investigate the relationship between sleep duration (nighttime sleep and daytime napping) and stroke among elderly Chinese people with self-reported health status.

## Methods

### Study sample and overview

The China Health and Retirement Longitudinal Study (CHARLS) is a population-based survey of community-dwelling adults covering twenty-eight provinces in mainland China, which began in 2011 and followed up every 2 years. CHARLS gathers information at the individual, family, and community levels, reporting demographic characteristics, lifestyle habits, and general health status. All participants provided informed consent and the protocol was approved by the Institutional Review Board at Peking University. Data from the first wave, conducted in 2011, were used in this study. Further details have been described elsewhere [19]. In this study, we restricted the samples to respondents who had answered all the relevant questions in baseline 2011 wave among elderly population (over 65 years), including 4785 subjects.

### Measurements

#### Outcome

Self-reported stroke was the main outcome of interest in this study. Individuals who responded "Yes" to the question "Have you been diagnosed with stroke by a doctor?" were reported as having had a stroke.

#### Exposure

The exposure in this study was total sleep duration and defined as nighttime sleep and daytime napping, categorized as short (< 7 h per day), normal (7–8 h per day), and long (> 8 h per day), as described in another study based on CHARLS [20]. Nighttime sleep duration was assessed by the following question: "During the past month, how many hours of actual sleep did you get every night?," and daytime napping was assessed by the question "During the past month, did you take a nap after lunch every day?" Nighttime sleep was categorized as less than 7 h, 7–8 h, or more than 8 h, and daytime napping was categorized as "Yes" or "No." The National Sleep Foundation (NSF) [21] recommends that the appropriate/normal nighttime sleep duration is 7–8 h for adults over 65.

#### Covariates

Covariates were selected based on the previous studies [6, 21]. Since this study utilizes the same dataset based on our previous work [11], we used similar variables such as sociodemographic characteristics, lifestyle variables, and comorbidity variables for assessing the relationship between sleep duration and stroke. Specifically, the sociodemographic characteristics included age, biological sex, education levels, marital status, residence, and insurance [11]. Lifestyle variables included smoking status, drinking status, and physical activity [11]. Additionally, two comorbidity variables included vision impairment and disability status. Biological sex, residence, insurance, and comorbidity variables were treated as dichotomous variables, and other variables listed above included more than two categories. Self-reported health status was coded as a dichotomous variable with good and fair/poor based on the original two similar questions "Would you say your health is excellent, very good, good, fair, or poor?" and "Would you say your health is very good, good, fair, poor or very poor?" Details regarding the variables are shown in Table 1.

### Data analysis

Characteristics of the participants and the prevalence of stroke risk factors were reported as percentages with 95% confidence intervals (95% CI) for categorical variables. Cross-tabulations and the chi-square tests were used to examine differences in proportions among demographic and other risk factors for stroke. Four models (one crude and three adjusted models) were used in the data analysis. The three adjusted models were just like the crude mode (included biological sex and age groups) except that they also included potential confounders such as sociodemographic characteristics, lifestyle, health status, and comorbidity (Table 2). Specifically, binary logistic regression was used to examine the relationship between sleep duration and stroke in the sample, adjusting for confounders (model A), and further stratified by health status to explore the relationship within each sub-group (models B and C). Adjusted odds ratios (aOR) with their corresponding 95% CI were calculated and reported. Two-tailed $P < 0.05$ was set as statistically significant and analyses were performed using PROC LOGISTIC procedures in SAS version 9.4 (SAS Institute, Cary, NC, USA), similar as our previous work [11].

## Results

Table 1 shows the descriptive statistics related to outcome stroke for the participants aged over 65 years ($n = 4785$). Overall, 44% (95% CI 42–45) reported daytime napping, 50% (95% CI 49–52) had short sleep duration (< 7 h per day), whereas 24% (95% CI 23–25) had long sleep duration (> 8 h per day) among those with total sleep duration. Additionally, a higher prevalence of stroke was observed among males (55%, 95% CI 48–62), who were older than 75 years (40%, 95% CI 33–46) and those who reported health status as fair or poor (88%, 95% CI 84–93). These descriptive findings were similar to results from our previous work [11].

Short sleep duration (< 7 h per day) was significantly associated with two times higher risk of stroke (aOR = 2.05; 95% CI 1.31–3.19) (Table 2, model A). No significant association was observed between long sleep duration and stroke (aOR = 1.56; 95% CI 0.94–2.57). After stratification by health status, there was no significant association between short or long sleep duration and stroke in those who reported good health status (model B). However, in those who reported fair or poor health status (model C), short sleep duration was over two times more likely to increase the risk of stroke (aOR = 2.11; 95% CI 1.30–3.44) and long sleep duration was around two times more likely to increase the risk of stroke (aOR = 1.86; 95% CI 1.08–3.21) compared with a normal sleep duration (7–8 h per day).

In addition, respondents living in rural areas were 34% less likely to report experiencing a stroke (aOR = 0.66; 95% CI 0.45–0.97) compared with respondents living in an urban area. However, after stratification by health status, rural residence was only significantly associated with a lower risk of stroke among individuals who reported fair or poor health status compared with urban residence (aOR = 0.62; 95% CI 0.41–0.94). Vigorous physical activity (aOR = 0.31; 95% CI 0.11–0.86) was a protective factor for stroke, compared with insufficient physical activity, but this was only consistent in those who reported fair or poor health status (aOR = 0.36; 95% CI 0.13–0.99). Respondents who reported disabilities (aOR = 2.67; 95% CI 1.92–3.72) were more likely to report having a stroke compared with those without any disabilities. Similar significant results were found in both groups after stratification by health status.

## Discussion

These study results demonstrated that among elderly Chinese adults aged 65 years and older, stroke was more likely to occur among the elderly with short time sleep duration, and with self-reported fair or poor health status. Specifically, among those who reported good health status, there was no significant association between both short or long sleep duration and stroke. However, in those who reported fair or poor health status, short sleep duration was over two times likely to increase the risk of stroke (aOR = 2.11; 95% CI 1.30–3.44) compared with normal sleep duration (7–8 h per day).

Our results are consistent with previous studies where a U-shaped relationship was presented between sleep duration and cardiovascular outcomes [8–10], which means that both short and long sleep duration are associated with stroke. According to a previous study conducted among Chinese adults, an increased risk of stroke with short and long duration of sleep was particularly observed among individuals who have had hypertension [4]. Our findings observed similar results and may provide important information about how health status such as a history of hypertension may affect the relationship between sleep duration and the risk of stroke.

Previous investigations have found that increased stroke risk was associated with long sleep duration [4–7] and this might be explained by poor sleep quality or poor general health [8, 22]. This is consistent with our finding that a significant association between long sleep duration and the risk of stroke was found among individuals who self-reported poor health status. We also noticed a stronger association between short sleep time and stroke among the individuals who reported poor health status. Short sleep duration will result in exposure to elevated sympathetic nervous system activity which leads to increased hypertension and body weight [22–24]. This might contribute to the development of cardiovascular disease such as stroke. Self-rated health (SRH) is a reliable measurement of subjective general health status and has been widely used [17, 18]. Though SRH may not be as accurate as clinical assessment, it is commonly used in psychological and in public health survey research [25], and found to be at least moderately associated with clinical assessments of health [26, 27]. Our study provided noteworthy evidence that among individuals who reported poor health status, both short and long sleep duration were significantly associated with the risk of stroke.

Moreover, together with our previously published study [11], this study is novel because it adds napping to the relationship between sleep duration and the risk of stroke. A prior study suggested that only long sleep duration was significantly associated with an increased risk of stroke [28], which is different from our findings. As we discussed previously [11], the differences may be attributed to (1) the study population (participants with chronic conditions who might have different sleep behaviors compared with the general Chinese population) and (2) the failure to examine the relationship between total sleep duration (including daytime napping) and stroke. Another study showed that daytime napping and cardiovascular disease might be associated via a J-shaped relation, indicating that cardiovascular disease was associated with daytime napping for over 30 min/day [15]. Our study did not assess the relationship between stroke and daytime napping independently, but we added daytime napping to explain the relationship between the length of sleep and risk of stroke. Based on our work, the contribution of the duration of daytime napping into total sleep duration, rather than napping activity per se, may be related to a higher risk of stroke [11]. This study highlighted the importance of the measurement of the relationship between sleep duration and stroke when considering napping activity. Future prospective longitudinal studies are warranted to measure the associations among daytime napping, nighttime sleeping, and stroke.

There were limitations worth mentioning. First, the findings were based on a cross-sectional design and causal inference cannot be established from the current analysis. Specifically, since the status of sleep duration and stroke changes over time, the temporality of the association may not prove the causality and determine which factor occurred first. To better understand the association between sleep duration and stroke, a longitudinal cohort study should be conducted addressing temporality and clinical significance. In addition, CHARLS data did not provide the information on the frequency of napping (e.g., daily or weekly), which may bias our results. Further studies with the frequency of napping to accurately assess the association between sleep and stroke are needed. Nevertheless, our study is the first study stratified by health status to address the relationship between total sleep duration (including napping) and stroke using a nationally representative data of Chinese individuals over 65 years old. Such significant findings underscore the increased need for evidence-based prevention and interventions for stroke targeting sleep duration among elderly Chinese people.

## Conclusions

Both short and long sleep duration were significantly associated with stroke among Chinese individuals aged 65 years and older who reported poor general health. Our research not only provides the guidance and direction for appropriate sleep duration and stroke prevention but also suggests that prevention of stroke should focus on elderly individuals who believe that they have health problems. Future public health policies should include this vulnerable population to reduce morbidity and mortality. We speculate that adequate sleep duration and appropriate sleep aid programs (e.g., yoga, meditation), especially among elderly Chinese people who believe that they have health problems, need to be considered in primary stroke prevention interventions.

### Compliance with ethical standards

Ethical approval for collecting data on human subjects was received at Peking University by their institutional review board (IRB). All participants gave their explicit written informed consent before recruitment into the study.

**Conflict of interest** The authors declare that they have no competing interests.

## Appendix

**Table 1** Basic characteristics related to outcome stroke for the overall sample ($n = 4785$)

| Variables | Total/overall % (95% CI) | Stroke (yes) % (95% CI) | Stroke (no) % (95% CI) | *P* value |
|---|---|---|---|---|
| *Total sleep duration (hour per day) | | | | 0.0007 |
| < 7 | 50.1 (48.7–51.5) | 60.4 (53.6–67.2) | 49.2 (47.8–50.7) | |
| 7–8 | 26.1 (24.9–27.4) | 15.2 (10.2–20.2) | 26.9 (25.6–28.2) | |
| > 8 | 23.8 (22.6–25.0) | 24.4 (18.4–30.4) | 23.9 (22.7–25.2) | |
| Nighttime sleep (hour per day) | | | | 0.0559 |
| < 7 | 59.8 (58.4–61.1) | 67.0 (60.4–73.6) | 59.1 (57.7–60.6) | |
| 7–8 | 31.3 (29.9–32.6) | 23.9 (17.9–29.8) | 31.8 (30.5–33.2) | |
| > 8 | 9.0 (8.2–9.8) | 9.1 (5.1–13.2) | 9.1 (8.2–9.9) | |
| Daytime napping | | | | 0.0844 |
| Yes | 43.5 (42.0–44.9) | 63.0 (55.7–70.4) | 56.2 (54.7–57.7) | |
| No | 56.5 (55.1–58.0) | 37.0 (29.6–44.3) | 43.8 (42.3–45.3) | |
| Age (year) | | | | 0.0392 |
| 65–70 | 38.7 (37.3–40.1) | 31.0 (24.5–37.4) | 39.1 (37.7–40.5) | |
| 70–75 | 28.7 (27.5–30.0) | 29.4 (23.1–35.8) | 28.8 (27.5–30.1) | |

**Table 1** (continued)

| Variables | Total/overall % (95% CI) | Stroke (yes) % (95% CI) | Stroke (no) % (95% CI) | *P* value |
|---|---|---|---|---|
| 75+ | 32.5 (31.2–33.9) | 39.6 (32.8–46.4) | 32.1 (30.8–33.5) | |
| Biological sex | | | | 0.1414 |
| Male | 50.2 (48.8–51.2) | 55.3 (48.4–62.3) | 50.0 (48.5–51.4) | |
| Female | 49.8 (48.8–51.2) | 44.7 (37.7–51.6) | 50.0 (48.6–51.5) | |
| Education | | | | 0.5712 |
| Less elementary | 60.9 (59.5–62.2) | 59.4 (52.5–66.3) | 61.0 (59.6–62.4) | |
| Elementary | 21.3 (20.2–22.5) | 19.8 (14.2–25.4) | 21.4 (20.2–22.6) | |
| Middle school | 10.1 (9.3–11.0) | 10.7 (6.4–15.0) | 10.1 (9.2–11.0) | |
| Over high school | 7.7 (6.9–8.5) | 10.2 (5.9–14.4) | 7.6 (6.8–8.3) | |
| Marital status | | | | 0.2551 |
| Married with spouse present | 68.7 (67.4–70.1) | 70.6 (64.2–76.9) | 68.9 (67.5–70.2) | |
| Married not living with spouse | 2.7 (2.2–3.1) | 1.0 (0.0–0.2) | 2.8 (2.3–3.2) | |
| Separated/divorced/widowed | 27.7 (26.5–29.0) | 28.4 (22.1–34.7) | 27.5 (26.2–28.8) | |
| Never | 0.9 (0.6–1.1) | 0.00 (0.00–0.00) | 0.9 (0.6–1.2) | |
| Smoking status | | | | 0.0012 |
| Current | 28.0 (26.6–29.2) | 21.3 (15.4–27.1) | 28.2 (26.9–29.6) | |
| Quit | 12.6 (11.7–13.6) | 20.7 (15.0–26.5) | 12.3 (11.3–13.3) | |
| Never | 59.5 (58.1–60.9) | 58.0 (50.9–65.0) | 59.5 (58.0–60.9) | |
| Drinking status | | | | 0.0631 |
| Current high frequency | 11.2 (10.2–12.1) | 9.7 (5.3–14.1) | 11.2 (10.3–12.2) | |
| Current low frequency | 12.4 (11.4–13.4) | 11.4 (6.7–16.1) | 12.5 (11.5–13.5) | |
| Quit | 9.1 (8.3–10.0) | 14.9 (9.6–20.1) | 8.9 (8.0–9.8) | |
| Never | 67.4 (66.0–68.8) | 64.0 (56.9–71.1) | 67.4 (66.0–68.9) | |
| Residence | | | | 0.0092 |
| Rural | 76.1 (74.8–77.3) | 68.5 (62.0–75.1) | 76.6 (75.4–77.8) | |
| Urban | 23.9 (22.7–25.2) | 31.5 (24.9–38.0) | 23.4 (22.2–24.6) | |
| Insurance | | | | 0.7363 |
| Yes | 92.9 (92.1–93.6) | 92.3 (88.5–96.0) | 92.9 (92.1–93.6) | |
| No | 7.1 (6.4–7.9) | 7.7 (4.0–11.5) | 7.1 (6.4–7.9) | |
| Vision impairment | | | | 0.0082 |
| Yes | 37.6 (36.2–38.9) | 46.7 (39.7–53.7) | 37.4 (36.0–38.8) | |
| No | 62.4 (61.1–63.8) | 53.3 (46.3–60.3) | 62.6 (61.2–64.0) | |
| Physical activity | | | | 0.0006 |
| Light | 13.2 (12.2–14.1) | 17.8 (12.4–23.1) | 13.1 (12.1–14.1) | |
| Moderate | 10.6 (9.7–11.5) | 6.6 (3.1–10.1) | 10.9 (10.0–11.8) | |
| Vigorous | 8.3 (7.5–9.1) | 2.0 (0.6–4.0) | 8.7 (7.9–9.5) | |
| Insufficient | 67.9 (66.6–69.3) | 73.6 (67.5–79.8) | 67.4 (66.0–68.7) | |
| Disability status | | | | < 0.0001 |
| Yes | 28.9 (27.6–30.2) | 49.8 (42.8–56.7) | 27.9 (26.6–29.2) | |
| No | 71.1 (69.8–72.4) | 50.2 (43.3–57.2) | 72.1 (70.8–73.4) | |
| Health status | | | | 0.0027 |
| Good | 20.4 (19.2–21.5) | 11.9 (7.3–16.4) | 20.7 (19.5–21.9) | |
| Fair or poor | 79.6 (78.5–80.8) | 88.1 (83.6–92.7) | 79.3 (78.1–80.5) | |

* Sleep duration is recoded with nighttime sleep and daytime nap

**Table 2** Binary logistic regression assessing the association between sleep duration with nap and stroke ($n = 4785$)

| Variables | [a]Model A adjusted odds ratio (95% CI) | [b]Model B adjusted odds ratio (95% CI) | [c]Model C adjusted odds ratio (95% CI) |
|---|---|---|---|
| Sleep duration (hour per day) | | | |
| < 7 | *2.05 (1.31–3.19)** | 1.70 (0.52–5.57) | *2.11 (1.30–3.44)** |
| 7–8 | Ref. | Ref. | Ref. |
| > 8 | 1.56 (0.94–2.57) | 0.47 (0.10, 2.08) | *1.86 (1.08–3.21)** |
| Biological sex | | | |
| Male | 1.28 (0.83–1.97) | 2.52 (0.64–9.95) | 1.20 (0.75–1.91) |
| Female | Ref. | Ref. | Ref. |
| Age | | | |
| 65–70 | Ref. | Ref. | Ref. |
| 70–75 | 1.04 (0.69–1.57) | 1.87 (0.48–7.32) | 0.95 (0.62–1.48) |
| 75+ | 1.10 (0.73–1.66) | 1.53 (0.41–5.76) | 1.06 (0.68–1.65) |
| Marital status | | | |
| Married with spouse present | Ref. | Ref. | Ref. |
| Married not living with spouse | 0.61 (0.15–2.56) | < 0.001 (0, ∞)[#] | 0.69 (0.16–2.92) |
| Separated/divorced/widowed | 0.99 (0.68–1.45) | 3.16 (1.06–9.42) | 0.86 (0.56–1.30) |
| Never | < 0.001 (0, ∞)[#] | < 0.001 (0, ∞)[#] | < 0.001 (0, ∞)[#] |
| Education | | | |
| < Elementary | 0.81 (0.46–1.45) | 2.63 (0.30–23.48) | 0.72 (0.39–1.32) |
| Elementary | 0.80 (0.43–1.48) | 2.36 (0.24–23.45) | 0.70 (0.36–1.34) |
| Middle school | Ref. | Ref. | Ref. |
| ≥ High school | 1.24 (0.62–2.50) | 1.27 (0.07–23.14) | 1.26 (0.61–2.63) |
| Physical activity | | | |
| Light | 1.28 (0.85–1.92) | 1.35 (0.41–4.50) | 1.28 (0.82–1.99) |
| Moderate | 0.63 (0.33–1.19) | 0.79 (0.16–3.81) | 0.61 (0.30–1.23) |
| Vigorous | *0.31 (0.11–0.86)** | < 0.001 (0, ∞)[#] | *0.36 (0.13–0.99)** |
| Insufficient | Ref. | Ref. | Ref. |
| Drinking status | | | |
| Current high frequency | 1.07 (0.60–1.91) | 2.07 (0.52–8.21) | 0.91 (0.47–1.79) |
| Current low frequency | 1.05 (0.62–1.76) | 0.63 (0.72–9.67) | 0.93 (0.52–1.65) |
| Quit | 1.61 (0.98–2.66) | < 0.001 (0, ∞)[#] | 1.76 (1.05–2.95) |
| Never | Ref. | Ref. | Ref. |
| Smoking status | | | |
| Current | 0.75 (0.47–1.20) | 0.88 (0.26–2.94) | 0.69 (0.41–1.16) |
| Quit | 1.26 (0.78–2.04) | 0.38 (0.04–3.59) | 1.38 (0.83–2.28) |
| Never | Ref. | Ref. | Ref. |
| Residence | | | |
| Rural | *0.66 (0.45–0.97)** | 0.98 (0.27–3.63) | *0.62 (0.41–0.94)** |
| Urban | Ref. | Ref. | Ref. |
| Insurance | | | |
| Yes | 0.90 (0.50–1.60) | 1.17 (0.14–10.02) | 0.86 (0.47–1.58) |
| No | Ref. | Ref. | Ref. |
| Disability status | | | |
| Yes | *2.67 (1.92–3.72)*** | *2.89 (1.04–8.07)** | *2.62 (1.84–3.73)*** |
| No | Ref. | Ref. | Ref. |
| Vision impairment | | | |
| Yes | 1.34 (0.97–1.86) | 1.30 (0.46–3.72) | 1.35 (0.96–1.91) |
| No | Ref. | Ref. | Ref. |

**Table 2** (continued)

| Variables | [a]Model A adjusted odds ratio (95% CI) | [b]Model B adjusted odds ratio (95% CI) | [c]Model C adjusted odds ratio (95% CI) |
|---|---|---|---|
| Health status | | | |
| Good | 0.61 (0.37–1.00) | - | - |
| Fair or poor | Ref. | - | - |

(0, ∞)[#] represents any value in the interval (0, ∞) due to the small sample size; Italicized point estimates indicate statistical significance at $P<0.05$; *$P<0.05$, **$P<0.01$

[a] Model A: Adjusted for age, gender, education, marital status, smoking status, drinking status, residence, insurance, vision impairment, physical activity, disability, vision impairment, and health status

[b] Model B: Adjusted for age, gender, education, marital status, smoking status, drinking status, residence, insurance, vision impairment, physical activity, disability, and vision impairment among self-reported health as good

[c] Model C: adjusted for age, gender, education, marital status, smoking status, drinking status, residence, insurance, vision impairment, physical activity, disability, and vision impairment among self-reported health as fair or poor

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