Postprint of a Study on the Association Between Cognitive Impairment and Sleep Duration in Community-Dwelling Older Adults

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Abstract

Objective To investigate the association between cognitive impairment and nocturnal sleep duration among community-dwelling older adults.

Methods From July to September 2018, 6000 community-dwelling older adults aged 60 years and above were randomly selected from 8 districts and counties in Fuyang City, Anhui Province, with 4837 included in the analysis. General demographic characteristics (gender, age, region, education level, etc.), lifestyle habits, chronic disease history, sleep duration, and global cognitive function were collected through questionnaires. Logistic regression was used to explore the association between nocturnal sleep duration and cognitive impairment. Restricted cubic spline models were used to plot the dose-response curve between sleep duration and cognitive impairment.

Results In unadjusted regression results, compared with the normal sleep duration (6-8h) group, the odds ratios for cognitive impairment in older adults were 1.25 (95%CI: 1.09-1.42) and 1.41 (95%CI: 1.21-1.65) for the short sleep duration ($ $6h) group and long sleep duration (>8h) group, respectively. After further adjustment for confounding factors, the results indicated that compared with the normal sleep duration group, the risk of cognitive impairment increased by 26% (OR=1.26, 95%CI: 1.09-1.46) and 22% (OR=1.22, 95%CI: 1.03-1.46) in the short sleep duration group and long sleep duration group, respectively. Based on sex-stratified analysis, the association between long sleep duration and cognitive impairment was more pronounced in male older adults, while the association between short sleep duration and cognitive impairment was more pronounced in female older adults. Restricted cubic spline curves showed an approximate U-shaped relationship between sleep duration and risk of cognitive impairment, with the nadir at approximately 7h.

Conclusion Short or long sleep duration may be an independent, dose-dependent risk factor associated with cognitive impairment. The optimal sleep duration is approximately 7h. The strength of association between long sleep duration and cognitive impairment was higher in males than in females, whereas the strength of association between short sleep duration and cognitive impairment was higher in females than in males. Therefore, sleep duration in older adults should be guided to mitigate the risk of cognitive impairment in the elderly population.

Full Text

The Association Between Cognitive Impairment and Sleep Duration Among Community-Dwelling Older Adults

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Abstract

Objective: To examine the association between cognitive impairment and nocturnal sleep duration among community-dwelling older adults.
Methods: From July to September 2018, 6,000 community-dwelling older adults aged 60 years and older were randomly selected from 8 districts and counties in Fuyang City, Anhui Province, with 4,837 participants included in the final analysis. General demographic characteristics (gender, age, region, education level, etc.), lifestyle habits, chronic disease history, sleep duration, and global cognitive function were assessed via questionnaire. Logistic regression was used to explore the association between nocturnal sleep duration and cognitive impairment, while restricted cubic spline models were employed to plot

dose-response curves.
Results: In unadjusted models, compared with the normal sleep duration group (6–8h), the odds ratios for cognitive impairment were 1.25 (95%CI: 1.09–1.42) for the short sleep duration group ($ $6h) and 1.41 (95%CI: 1.21–1.65) for the long sleep duration group (>8h). After adjusting for confounding factors, the risk of cognitive impairment increased by 26% (OR=1.26, 95%CI: 1.09–1.46) and 22% (OR=1.22, 95%CI: 1.03–1.46) for short and long sleepers, respectively. Gender-stratified analysis revealed that the association between long sleep duration and cognitive impairment was stronger in men, while the association between short sleep duration and cognitive impairment was stronger in women. Restricted cubic spline curves showed an approximately U-shaped relationship between sleep duration and cognitive impairment risk, with the nadir around 7 hours.
Conclusions: Both short and long sleep duration may be independent, dose-dependent factors associated with cognitive impairment. The optimal sleep duration is approximately 7 hours. The association between long sleep duration and cognitive impairment is stronger in men than in women, whereas the association between short sleep duration and cognitive impairment is stronger in women than in men. Therefore, sleep duration guidance for older adults should be implemented to mitigate the risk of cognitive impairment in this population.
Key Words: Cognitive impairment; Sleep duration; Older adults

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Introduction

The prevalence of mild cognitive impairment (MCI) among Chinese adults aged 60 and above is approximately 14.71%. Notably, the annual conversion rate from MCI to dementia ranges from 10% to 30%, significantly higher than that among cognitively normal older adults (1%–3%). Currently, there are no effective treatments for age-related cognitive decline or impairment, making the identification of risk factors to prevent or delay its onset a primary strategy.

Approximately 50% of older adults experience various forms of sleep disorders, including difficulty falling asleep, sleep maintenance problems, excessive daytime sleepiness, sleep-disordered breathing, and abnormal sleep behaviors. Research indicates that sleep duration may influence cognitive function in older adults. A systematic review demonstrated that both short and long sleep duration increase the risk of cognitive impairment among older adults. However, findings remain inconsistent across studies. For instance, some research found that only short sleep duration was associated with decreased cognitive function scores, while other studies identified associations only for long sleep duration, and some found no relationship at all. These discrepancies may stem from inconsistent cut-off values for defining short and long sleep duration across studies, potentially obscuring the true association.

To address this, our study first categorized sleep duration based on previous literature to explore the association between short/long sleep duration and cog-

nitive impairment. We then employed restricted cubic spline (RCS) models to examine the dose-response relationship between sleep duration and cognitive impairment risk, aiming to identify optimal sleep duration for both male and female older adults.

Methods

1.1 Study Population Data were derived from the baseline survey of the Fuyang Older Adults Health and Environmental Controllability Cohort. From July to September 2018, this cohort was established jointly by the School of Public Health at Anhui Medical University and the Fuyang Center for Disease Control and Prevention. Using probability proportionate sampling based on population distribution across Fuyang' s 8 districts and counties, 6,000 older adults aged 60 and above were selected for investigation. A total of 5,186 individuals (86.43%) agreed to participate. The spatial distribution of participants' residential addresses is shown in [Figure 1: see original paper].

Inclusion criteria: (1) Age $ $60 years; (2) Clear consciousness and ability to communicate normally with investigators.
Exclusion criteria: (1) Previously diagnosed with dementia or psychiatric disorders; (2) Visual or hearing impairments that could not be corrected to normal function even with assistive devices. After applying these criteria and excluding missing data, 4,837 older adults were included in the final analysis. The study was approved by the Ethics Committee of Anhui Medical University (Approval No.: 20190288), and all eligible participants provided written informed consent after receiving a detailed description of the study.

1.2.1 Cognitive Function Assessment Cognitive function was assessed using the Chinese version of the Mini-Mental State Examination (MMSE), originally designed by Folstein et al. The scale covers seven domains: time orientation, place orientation, immediate memory, attention and calculation, delayed memory, language, and visuospatial ability. Scores range from 0 to 30, with higher scores indicating better cognitive function. Cognitive impairment was defined as: (1) Illiterate with MMSE score $ $17; (2) 1–6 years of education (primary school) with MMSE score $ $20; or (3) More than 6 years of education (middle school or higher) with MMSE score $ $24.

1.2.2 Sleep Duration Assessment Participants were asked about their average nocturnal sleep duration (in hours) over the past month. Based on classification criteria from relevant literature, older adults were categorized into three groups: short sleep duration ($ $6h), normal sleep duration (6–8h), and long sleep duration (>8h).

1.2.3 Covariates Covariates included general demographics (gender, age, region, education level, occupation, marital status, living alone, and economic

status), lifestyle factors (smoking, alcohol consumption, and physical exercise), and chronic disease history (hypertension, diabetes, depression, and body mass index [BMI]).

Economic status was self-reported as poor, average, or wealthy. **BMI** categories were: <18.5 kg/m^2 (underweight), 18.5–23.9 kg/m^2 (normal), 24–27.9 kg/m^2 (overweight), and $ 28kg/m^{2}$ (obese). **Smoking** was defined as cumulative or continuous smoking for $ $6 months. **Alcohol consumption** was defined as drinking at least one alcoholic beverage in the past 30 days. **Physical exercise** referred to intentional activities for health improvement, excluding mandatory activities such as work. **Hypertension** was defined as systolic blood pressure $ $140 mmHg and/or diastolic blood pressure $ $90 mmHg, or a history of hypertension or use of antihypertensive medication. **Diabetes** was defined as fasting blood glucose $ $7.0 mmol/L or HbA1c $ $6.5%, or previous diagnosis. **Depression** was assessed using the 15-item Geriatric Depression Scale (GDS-15), with scores $ $5 indicating depression.

1.3 Statistical Analysis Data were analyzed using SPSS 23.0 and R 3.6.1, with a two-sided significance level of α=0.05. Chi-square tests were used to compare the distribution of cognitive impairment and sleep duration across different demographic characteristics, lifestyle factors, and disease conditions. Logistic regression was employed to examine the association between sleep duration and cognitive impairment, with normal sleep duration as the reference group. Interaction terms between gender and sleep duration were constructed to explore whether gender modified this association. RCS models were used to fit dose-response curves between sleep duration (as a continuous variable) and cognitive impairment.

Results

Among the 4,837 older adults, 2,366 (48.9%) were male and 2,471 (51.1%) were female. The mean age was 71.13 ± 5.50 years. A total of 4,028 (83.3%) resided in rural areas and 809 (16.7%) in urban areas.

Cognitive impairment was detected in 1,811 older adults (37.4%). The prevalence was significantly higher among women, those aged 80 and above, rural residents, individuals with primary school education or less, the unemployed, those without spouses, those in poverty, never smokers, non-drinkers, those who did not exercise, those with hypertension, underweight individuals, and those with depression (all P<0.05). No significant differences were observed in cognitive impairment prevalence between those living alone and those not living alone, or between those with and without diabetes (P>0.05) (Table 1).

The average sleep duration was 6.95 ± 1.75 hours. Specifically, 36.7% of participants slept $ $6 hours (n=1,773), 43.2% slept 7–8 hours (n=2,088), and 20.1%

slept >8 hours (n=976). The proportion of individuals with normal nocturnal sleep duration was significantly lower among women, those aged 80 and above, rural residents, illiterate individuals, those engaged in physical labor, those with spouses, those in poverty, non-drinkers, those who exercised, those with diabetes, those with normal BMI, and those with depression (all $P<0.05$).

Frequency distribution histograms of average sleep duration by gender are shown in [Figure 2: see original paper]. Both male and female sleep durations exhibited approximately normal distributions, with most individuals sleeping 5-9 hours. The mean sleep duration was 7.09 $\pm$ 1.71 hours for men and 6.82 $\pm$ 1.78 hours for women.

2.3 Association Between Sleep Duration and Cognitive Impairment Table 2 presents the association between cognitive impairment and sleep duration for the total sample and by gender. Univariate analysis showed that older adults with short and long sleep duration had 1.25 times (95%CI: 1.09-1.42) and 1.41 times (95%CI: 1.21-1.65) higher odds of cognitive impairment, respectively, compared with those with normal sleep duration. After adjusting for gender, age, and region, the odds ratios were 1.24 (95%CI: 1.09-1.42) for short sleep and 1.33 (95%CI: 1.13-1.56) for long sleep. Following full adjustment for all covariates including education, occupation, marital status, living alone, economic status, smoking, alcohol consumption, exercise, hypertension, diabetes, BMI, and depression, the odds ratios were 1.26 (95%CI: 1.09-1.46) for short sleep and 1.22 (95%CI: 1.03-1.46) for long sleep.

Subgroup analyses by gender revealed that the association between long sleep duration and cognitive impairment was stronger in men (OR_3=1.35, 95%CI: 1.06-1.72) than in women (OR_3=1.08, 95%CI: 0.84-1.40). Conversely, the association between short sleep duration and cognitive impairment was stronger in women (OR_3=1.29, 95%CI: 1.06-1.58) than in men (OR_3=1.22, 95%CI: 0.98-1.51).

2.4 Dose-Response Relationship Between Cognitive Impairment and Sleep Duration To further explore the association, sleep duration was modeled as a continuous variable in RCS models to generate dose-response curves ([Figure 3: see original paper]). After adjusting for confounders, results showed an approximately U-shaped relationship between sleep duration and cognitive impairment risk within the most common range (4-10 hours), with the lowest risk around 7 hours. When sleep duration was <7 hours, the risk of cognitive impairment increased as sleep duration decreased. When sleep duration was >7 hours, the risk increased as sleep duration increased.

[Figure 4: see original paper] illustrates the non-linear dose-response relationship between sleep duration and cognitive impairment by gender. The association between sleep duration and cognitive impairment was more pronounced in men than in women.

Discussion

This study found a cognitive impairment detection rate of 37.4% among older adults, similar to the findings of Ren et al. (43.15%) but higher than the national MCI prevalence of 14.71% reported in 2016. Consistent with previous research, cognitive impairment prevalence was significantly higher among women, those aged 80 and above, rural residents, individuals with primary school education or less, the unemployed, those without spouses, those in poverty, never smokers, non-drinkers, those who did not exercise, those with hypertension, underweight individuals, and those with depression. The mean sleep duration was 6.95 hours, higher than the 6.44 hours reported by Chen et al. but lower than the 7.66 hours reported by Zhang et al. As in prior studies, the proportion of individuals with normal nocturnal sleep duration was significantly lower among women, those aged 80 and above, rural residents, illiterate individuals, those engaged in physical labor, those with spouses, those in poverty, non-drinkers, those who exercised, those with diabetes, those with normal BMI, and those with depression.

Our study examined the relationship between sleep duration and cognitive impairment in older adults. In unadjusted models, short and long sleep duration increased the odds of cognitive impairment by 25% and 41%, respectively. After adjusting for relevant factors, short and long sleep duration increased the odds by 26% and 22%, respectively, compared with normal sleep duration. RCS models revealed an approximately U-shaped relationship between sleep duration and cognitive impairment risk within the 4–10 hour range. These findings align with Lo et al.' s meta-analysis involving 19 Western countries, Singapore, and 3 Chinese cohorts, which found that both short and long sleep duration increased cognitive dysfunction risk. Wu et al. also identified a U-shaped dose-response relationship between sleep duration and cognitive impairment across 9 cohort studies. However, some studies have reported inconsistent results, possibly due to differences in race, cognitive assessment tools, and sleep measurement methods (self-reported vs. objective). Our study extends previous research by focusing on a low- to middle-income Chinese population using a representative sample of community-dwelling older adults from Fuyang, allowing for generalization to other Chinese older adults, particularly rural residents. Additionally, while previous studies often categorized sleep duration, our use of RCS models better illustrates the potential dose-response trend.

The mechanisms underlying the relationship between sleep duration and cognitive impairment remain unclear. Some research suggests that β-amyloid protein deposition is a key factor in Alzheimer' s disease pathogenesis, and insufficient sleep may increase amyloid deposition in the brain. Sleep deprivation also increases inflammatory markers and alters HPA axis activity, potentially leading to cognitive impairment. Conversely, long sleep duration may accelerate frontotemporal gray matter atrophy, potentially impairing memory and causing

cognitive decline.

Gender-stratified analyses showed that in men, short and long sleep duration increased the odds of cognitive impairment by 22% and 35%, respectively, while in women, the corresponding increases were 29% and 8%. Long sleep duration was associated with cognitive impairment in men but not significantly in women, whereas short sleep duration showed stronger associations in women. Similar patterns have been observed in other Chinese studies. Although it is premature to draw definitive conclusions about gender-specific associations, the apparent sex differences in Chinese older adults warrant attention. Socioeconomic factors cannot fully explain these differences, as adjustment for age, education, residence, occupation, and other factors did not eliminate them. Some researchers suggest that different sleep patterns between genders and hormonal differences may contribute to these specific associations. Given these differences, gender-specific sleep education and interventions are needed to optimize sleep duration and quality. More research is required to elucidate the role of gender in the relationship between sleep behavior and cognitive function.

This study has several limitations. First, sleep duration was self-reported, lacking objectivity. Second, sleep duration was assessed based on recall over the past month, which may introduce recall bias. Third, daytime napping was not assessed, which would affect total daily sleep duration. Fourth, this cross-sectional study cannot establish causality between sleep duration and cognitive impairment.

Despite these limitations, our study demonstrates a U-shaped association between sleep duration and cognitive impairment, with optimal sleep duration around 7 hours. The association appears stronger in men than in women. As the country with the largest aging population, China faces significant challenges in dementia prevention, diagnosis, and treatment. These findings provide valuable evidence for preventing cognitive impairment and intervening in dementia among older adults.

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