Sleep quality and cognitive impairment in older Chinese

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Sleep quality and cognitive impairment in older Chinese: Guangzhou Biobank Cohort Study

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ABSTRACT

Background: Evidence concerning the relationship between sleep quality and cognitive impairment is limited and inconsistent.

Objective: To examine the association of sleep quality with memory impairment and poor cognitive function in a large sample of older Chinese.

Methods: 15,246 participants aged 50+ years of the Guangzhou Biobank Cohort Study who attended the second physical examination from 2008 to 2012 were included. Sleep quality was assessed using Pittsburgh Sleep Quality Index (PSQI), and cognitive performance was assessed using both Delayed Word Recall Test (DWRT) and Mini-Mental State Examination (MMSE). Memory impairment was defined by DWRT score <4 and poor cognitive function by MMSE score <25.

Results: After adjusting for potential confounders, lower habitual sleep efficiency was associated with a higher risk of memory impairment and poor cognitive function with a dose-response pattern (both P for trend <0.001). The adjusted odds ratio (OR, 95% confidence interval (CI)) for poor cognitive function in those with sleep efficiency of 75-85%, 65-75%, and <65%, versus ≥85%, was 1.31 (1.12-1.53), 1.41 (1.16-1.73) and 1.33 (1.09-1.63), respectively. No association of the global PSQI score with memory impairment or poor cognitive function was found.

Conclusions: In older Chinese people, lower habitual sleep efficiency was associated with a higher risk of memory impairment and poorer cognitive function.

Keywords

Sleep, Pittsburgh Sleep Quality Index, cognition, memory impairment, depression, older people.

Key points

- Evidence concerning the relationship between sleep quality and cognitive impairment is limited and inconsistent.
- Of 15,246 older Chinese, we found that lower habitual sleep efficiency, but not the global score of Pittsburgh Sleep Quality Index, was independently associated with poor cognitive function.
- Lower habitual sleep efficiency may be an important risk factor for poor cognitive function.

INTRODUCTION

The number of patients with dementia in China has almost doubled during the past decade and the prevalence is increasing [1]. Mild cognitive impairment is a transition phase between healthy cognitive aging and dementia [2]. One-tenth of people with mild cognitive impairment progressed to dementia or Alzheimer's disease (AD) per year, about 3 times the rate of those without the condition [3]. Identification of risk factors for mild cognitive impairment might be of etiological significance. As memory impairment is the main complaint of people with mild cognitive impairment [3, 4], we assessed memory impairment in the Guangzhou Biobank Cohort Study (GBCS), a well-designed and on-going large cohort in older Chinese.

A total of 60-70% dementia patients had sleep disturbance [5]. Some previous studies reported no association [6-9], while others reported a positive association between sleep quality and cognitive function [10-17]. Some studies did not adjust for depressive symptoms, an important confounder of the association between sleep and cognition, and might result in a bias of the association away from the null [11, 18, 19]. Moreover, sleep problems are easily recognized by oneself, and hence could be an early or concurrent indicator of cognitive impairment. Thus, we investigated the association between sleep quality and cognitive performance using data from the GBCS [20], taking into account a wide range of potential confounders including depressive symptoms.

METHODS

Participants

GBCS is a 3-way collaboration among the Guangzhou Number 12 Hospital and the Universities of Hong Kong and Birmingham. Details of the GBCS have been reported

elsewhere [20]. Briefly, all GBCS participants were Guangzhou residents and members of a community social and welfare association, which opens to older people in Guangzhou aged 50+, including about 7% of Guangzhou residents in this age group across all 10 districts of Guangzhou. The GBCS was approved by the Medical Ethics Committee of the Guangzhou Medical Association and all participants provided written, informed consent before joining in the study.

Exposure

Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI) [21]. PSQI consists of 19 individual items in seven dimensions, i.e., subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency (percentage of time in bed asleep), sleep disturbances, use of sleep medications, and daytime dysfunction (each with a score of 0-3). The sum of the scores of the seven components above was an overall score (the global PSQI score). Poor global sleep quality was defined by a global PSQI score of ≥6 [21].

Outcomes

Cognitive function was assessed by Delayed Word Recall Test (DWRT) and Mini-Mental State Examination (MMSE). The DWRT is a test of verbal learning and recent memory requiring recall of a word list [22]. First, ten simple Chinese words (soy sauce, arm, letter, chairman, ticket, grass, corner, stone, book, and stick) were read out to the participants one by one, pausing for one second between each. The participants recalled the words they heard immediately after the last word. This procedure was repeated for three times, and a 5-minute delay was given after the third time. The DWRT score was based on the number of correct words of the 5-minutes delayed recall ranging from 0-10, with a lower score indicating worse cognitive function. Memory impairment was defined as a DWRT score <4 [22]. The MMSE

was added at the second examination to assess cognitive function. This 30-item test measures various cognitive components including orientation, memory, attention and calculation, recall, and language, with scores ranging from 0-30. Poor cognitive function was defined by an MMSE score <25 [23, 24].

Potential confounders

Potential confounders adjusted in the multivariable models were age, sex, education, occupation, body mass index (BMI), smoking and drinking status, daytime napping, snoring, self-rated health, physical activity, history of coronary heart disease (CHD) and stroke, diabetes and depressive symptoms. The short version of the Geriatric Depression Scale (GDS) was used to assess depressive symptoms. Depression was defined by a GDS score ≥8 [25].

Statistical Analysis

Pearson chi-square test and one-way analysis of variance (ANOVA) were used to compare categorical and continuous variables between groups respectively. Multivariable linear regression was used to analyze the association of sleep-related factors with cognitive function as assessed by DWRT and MMSE, giving adjusted regression coefficient (β) and 95% confidence interval (CI). Logistic regression was used to examine the association of the sleep-related factors with the presence of memory impairment and poor cognitive function. Data analysis was done using STATA/IC 14.1.

RESULTS

In GBCS, 18,129 participants returned for a second examination from 2008 to 2012. After excluding 2,883 (16%) participants with missing data of interest, 15,246 participants were included. Of them, 10,805 (71%) had good global sleep quality. Those with poor sleep quality

versus good were older and had more depressive symptoms. Poorer sleep quality was associated with a higher risk of memory impairment and poor cognitive function (please see Supplementary Table 1-3 in Supplementary Data on the journal website (www.academic.oup.com/ageing)).

Table 1 shows that in the full adjustment model (model 2), no association with DWRT scores was found for sleep quality. No association of subjective sleep quality, sleep latency, sleep disturbances, sleep medications, daytime dysfunction and global sleep quality with MMSE scores was found. Compared with sleep duration of 7-8 hours per day, duration of <5 hours or 5-6 hours showed lower (β -0.24, 95% CI -0.41 to -0.08; -0.15, -0.22 to -0.08), while >8 hours showed higher (β 0.22, 95% CI 0.04 to 0.40) MMSE scores. Compared to those who had habitual sleep efficiency of >85%, those with 75-85%, 65-75%, or <65% habitual sleep efficiency showed lower MMSE scores (β -0.25, 95% CI -0.35 to -0.16; -0.32, -0.45 to -0.20; and -0.29, -0.42 to -0.16, respectively; P for trend <0.001).

Table 2 shows that, compared with participants who had habitual sleep efficiency of >85%, those with <65% had higher risk of memory impairment (adjusted OR 1.23, 95% CI 1.00-1.50). Compared with habitual sleep efficiency of >85%, habitual sleep efficiency of 75-85% (adjusted OR 1.31, 95% CI 1.12-1.53), 65-75% (1.41, 1.16-1.73), or <65% (1.33, 1.09-1.63) was consistently associated with a higher risk of poor cognitive function defined by MMSE, with a significant dose-response pattern (P for trend <0.001). Moreover, participants with poor subjective sleep quality versus good, had a lower risk of poor cognitive function (adjusted OR 0.79, 95% CI 0.66-0.93). No significant association between other PSQI components or global sleep quality with memory impairment and poor cognitive function was found.

DISCUSSION

Our study found low habitual sleep efficiency was associated with memory impairment or poor cognitive function, even after adjustment for depressive symptoms and other confounding factors. However, no association between the global PSQI score and cognitive function was found, indicating that low habitual sleep efficiency, instead of the general assessment of sleep quality, may be an important risk factor for mild cognitive impairment in older people.

A positive association of sleep efficiency and cognitive function was reported previously focusing mostly on patients or sex-specific samples [11, 14, 16]. A case-control study in South Korea found that poor sleep efficiency was associated with cognitive dysfunction in patients with Alzheimer's Disease [11]. A survey in Canada showed that habitual sleep efficiency was associated with amnestic and general incident cognitive impairment in men after 1-year follow-up [16]. Similarly, a study in USA found that lower objective sleep efficiency as assessed by an Actigraph was associated with subsequent cognitive decline followed over 3.4 ±0.5 years [14]. Thus, our study is in agreement with previous studies supporting that poor sleep efficiency is an easily recognized and more reported risk factor for cognitive impairment in relatively healthy older people.

We found no association between PSQI global score or other components with cognitive function, consistent with several cross-sectional studies [6, 9]. However, some other case-control and cross-sectional studies reported that poor sleep quality assessed by global score was associated with poor cognitive performance [10, 18, 26]. Moreover, two prospective studies, one in Germany and the other in Korea, found that longer sleep duration

and latency were associated with greater cognitive decline in community-dwelling and cognitively impaired older people [15, 17]. The discrepancies of the results might be explained in part by whether the model was adjusted for important confounders such as education, napping and depressive symptoms [13, 19, 27, 28]. An overview suggested that depression might be linked to poor sleep quality in a bidirectional manner, i.e., poor sleep quality could be a symptom as well as a risk factor for depression [29]. Besides, a case-control study showed that disturbed sleep in older patients with depression was associated with poor cognitive function [30]. Our results showed that the differences of memory impairment (no or yes) in 'daytime dysfunction' could be partly accounted for by depressive symptoms, and low habitual sleep efficiency was associated with cognitive impairment largely independent from depression.

In conclusion, our results showed that in older Chinese, lower habitual sleep efficiency was associated with a higher risk of memory impairment and poorer cognitive function. (1,494 words)

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CONFLICT OF INTERESTS

The authors have no conflict of interest to report.

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Table 1. Mean differences in the Delayed Word Recall Test (DWRT) score (95% confidence interval) and Mini-Mental State Examination (MMSE) score (95% confidence interval) by Pittsburgh Sleep Quality Index (PSQI) components and global sleep quality

	N	Mean differences in the DWRT score		Mean differences in the MMSE score	
		Model 1	Model 2	Model 1	Model 2
Subjective sleep quality					
Good	12,959	Ref. (0)	Ref. (0)	Ref. (0)	Ref. (0)
Poor	2,287	-0.02 (-0.11 to 0.06)	-0.002 (-0.09 to 0.08)	-0.04 (-0.14 to 0.07)	0.10 (-0.003 to 0.20)
Sleep latency					
≤30 min	11,527	Ref. (0)	Ref. (0)	Ref. (0)	Ref. (0)
31-60 min	2,536	0.03 (-0.04 to 0.11)	0.05 (-0.03 to 0.13)	-0.12 (-0.21 to -0.02)*	-0.03 (-0.12 to 0.07)
>60 min	1,183	-0.04 (-0.15 to 0.07)	-0.01 (-0.12 to 0.10)	-0.25 (-0.39 to -0.12)***	-0.09 (-0.23 to 0.04)
P for trend	-	0.90	0.68	<0.001	0.17
Sleep duration					
<5 hours	759	0.02 (-0.11 to 0.16)	0.03 (-0.11 to 0.17)	-0.29 (-0.46 to -0.12)**	-0.24 (-0.41 to -0.08)**
5-6 hours	6,607	0.01 (-0.05 to 0.07)	0.01 (-0.06 to 0.07)	-0.15 (-0.22 to -0.07)***	-0.15 (-0.22 to -0.08)***
7-8 hours	7,276	Ref. (0)	Ref. (0)	Ref. (0)	Ref. (0)
>8 hours	604	-0.08 (-0.23 to 0.07)	-0.10 (-0.25 to 0.05)	0.24 (0.05 to 0.43)*	0.22 (0.04 to 0.40)*
P for trend	-	0.82	0.69	0.03	0.02
Habitual sleep efficiency†					
≥85%	10,256	Ref. (0)	Ref. (0)	Ref. (0)	Ref. (0)
75-85%	2,522	-0.07 (-0.15 to 0.01)	-0.08 (-0.16 to 0.001)	-0.23 (-0.33 to -0.13)***	-0.25 (-0.35 to -0.16)***
65-75%	1,273	0.02 (-0.08 to 0.13)	0.03 (-0.08 to 0.13)	-0.34 (-0.47 to -0.21)***	-0.32 (-0.45 to -0.20)***
<65%	1,195	-0.08 (-0.19 to 0.03)	-0.07 (-0.18 to 0.04)	-0.31 (-0.44 to -0.17)***	-0.29 (-0.42 to -0.16)***
P for trend	-	0.23	0.26	<0.001	<0.001
Sleep disturbances					
Not at all or <once per week	14,921	Ref. (0)	Ref. (0)	Ref. (0)	Ref. (0)
At least once per week	325	0.03 (-0.18 to 0.23)	0.09 (-0.12 to 0.29)	-0.20 (-0.45 to 0.05)	0.26 (0.01 to 0.50)
Sleep medications					
Not at all	14,584	Ref. (0)	Ref. (0)	Ref. (0)	Ref. (0)
Used	662	-0.01 (-0.15 to 0.14)	0.01 (-0.14 to 0.15)	0.03 (-0.15 to 0.20)	0.11 (-0.07 to 0.28)
Daytime dysfunction					
Not at all or <once per week	14,174	Ref. (0)	Ref. (0)	Ref. (0)	Ref. (0)
At least once per week	1,072	-0.18 (-0.29 to -0.06)**	-0.12 (-0.24 to 0.002)	-0.42 (-0.57 to -0.28)***	-0.05 (-0.19 to 0.10)
PSQI global sleep quality					

Good (PSQI <6)	10,805	Ref. (0)	Ref. (0)	Ref. (0)	Ref. (0)
Poor (PSQI ≥6)	4,441	0.005 (-0.06 to 0.07)	0.03 (-0.04 to 0.09)	-0.19 (-0.27 to -0.11)***	-0.06 (-0.14 to 0.02)

Ref: reference

†: Percentage of time in bed asleep

Model 1: Adjusting for age, sex, education, occupation, body mass index, smoking, drinking, daytime napping, snoring, self-rated health, physical activity, coronary heart disease history, stroke history, and diabetes.

Model 2: Additionally adjusting for depressive symptoms

*: P <0.05; **: P <0.01; ***: P <0.001

Table 2. Adjusted odds ratio (OR, 95% confidence interval (CI)) of memory impairment (DWRT score <4) and poor cognitive function (MMSE score <25) by Pittsburgh Sleep Quality Index (PSQI) components and global sleep quality

	Adjusted OR (95% CI) of memory impairment (DWRT score <4)			Adjusted OR (95% CI) of poor cognitive function (MMSE score <25)		
	N (% cases)	**Model 1**	**Model 2**	**N (% cases)**	**Model 1**	**Model 2**
Subjective sleep quality						
Good	12,959 (7.76)	Ref. (1)	Ref. (1)	12,959 (8.38)	Ref. (1)	Ref. (1)
Poor	2,287 (9.18)	1.09 (0.93-1.29)	1.01 (0.85-1.19)	2,287 (9.31)	0.95 (0.80-1.11)	0.79 (0.66-0.93)**
Sleep latency						
≤30 min	11,527 (7.43)	Ref. (1)	Ref. (1)	11,527 (7.96)	Ref. (1)	Ref. (1)
31-60 min	2,536 (9.19)	1.09 (0.93-1.28)	1.04 (0.89-1.22)	2,536 (9.50)	0.97 (0.83-1.13)	0.89 (0.76-1.05)
>60 min	1,183 (10.65)	1.23 (1.00-1.51)*	1.13 (0.92-1.40)	1,183 (11.92)	1.18 (0.96-1.44)	0.99 (0.80-1.22)
P for trend	-	0.04	0.24	-	0.27	0.48
Sleep duration						
<5 hours	759 (11.73)	1.16 (0.90-1.48)	1.12 (0.87-1.44)	759 (12.78)	1.15 (0.90-1.46)	1.05 (0.82-1.35)
5-6 hours	6,607 (8.11)	0.99 (0.87-1.13)	0.99 (0.87-1.13)	6,607 (9.29)	1.11 (0.98-1.26)	1.10 (0.96-1.25)
7-8 hours	7,276 (7.49)	Ref. (1)	Ref. (1)	7,276 (7.56)	Ref. (1)	Ref. (1)
>8 hours	604 (7.45)	0.88 (0.63-1.22)	0.90 (0.65-1.26)	604 (6.29)	0.73 (0.51-1.05)	0.76 (0.53-1.09)
P for trend	-	0.65	0.70	-	0.48	0.52
Habitual sleep efficiency†						
≥85%	10,256 (7.24)	Ref. (1)	Ref. (1)	10,256 (7.10)	Ref. (1)	Ref. (1)
75-85%	2,522 (8.72)	1.08 (0.92-1.27)	1.09 (0.93-1.28)	2,522 (10.35)	1.29 (1.10-1.51)**	1.31 (1.12-1.53)**
65-75%	1,273 (8.88)	1.04 (0.84-1.29)	1.02 (0.82-1.26)	1,273 (11.94)	1.46 (1.20-1.78)***	1.41 (1.16-1.73)**
<65%	1,195 (11.63)	1.26 (1.03-1.54)*	1.23 (1.00-1.50)*	1,195 (13.22)	1.40 (1.15-1.70)***	1.33 (1.09-1.63)**
P for trend	-	0.04	0.08	-	<0.001	<0.001
Sleep disturbances						
Not at all or <once per week	14,921 (7.89)	Ref. (1)	Ref. (1)	14,921 (8.39)	Ref. (1)	Ref. (1)
At least once per week	325 (11.69)	1.11 (0.77-1.59)	0.89 (0.61-1.29)	325 (14.46)	1.26 (0.90-1.76)	0.83 (0.59-1.18)
Sleep medications						
Not at all	14,584 (7.95)	Ref. (1)	Ref. (1)	14,584 (8.52)	Ref. (1)	Ref. (1)
Used	662 (8.31)	1.02 (0.76-1.37)	0.99 (0.73-1.33)	662 (8.61)	0.99 (0.74-1.32)	0.90 (0.67-1.22)
Daytime dysfunction						
Not at all or <once per week	14,174 (7.73)	Ref. (1)	Ref. (1)	14,174 (8.12)	Ref. (1)	Ref. (1)
At least once per week	1,072 (11.10)	1.26 (1.02-1.56)*	1.05 (0.85-1.31)	1,072 (13.81)	1.47 (1.21-1.80)***	1.04 (0.85-1.29)

PSQI global sleep quality						
Good	10,805 (7.32)	Ref. (1)	Ref. (1)	10,805 (7.57)	Ref. (1)	Ref. (1)
Poor	4,441 (9.55)	1.10 (0.97-1.26)	1.03 (0.90-1.18)	4,441 (10.83)	1.13 (0.99-1.28)	0.97 (0.85-1.11)

DWRT: Delayed Word Recall Test; MMSE: Mini-Mental State Examination; Ref: reference

N (% cases): Total number of subjects in each group (% with memory impairment or % with MMSE score <25)

†: Percentage of time in bed asleep

Model 1: Adjusting for age, sex, education, occupation, body mass index, smoking, drinking, daytime napping, snoring, self-rated health, physical activity, coronary heart disease history, stroke history, and diabetes.

Model 2: Additionally adjusting for depressive symptoms

*: P <0.05; **: P <0.01; ***: P <0.001