Relationship between afternoon napping and cognitive function in the ageing Chinese population

Han Cai, Ning Su, Wei Li, Xia Li, Shifu Xiao, Lin Sun

ABSTRACT

Background Several studies have shown that afternoon napping promotes cognitive function in the elderly; on the other hand, some studies have shown opposite results. This current study further examined the relationship between afternoon napping and cognitive function in the ageing Chinese population.

Methods A total of 2214 elderly were included (napping group: n=1534; non-napping group: n=680). They all received cognitive evaluations by the Beijing version of the Montreal Cognitive Assessment, the Mini-Mental State Examination, and the Chinese version of the Neuropsychological Test Battery. Among all the subjects, 739 elderly volunteered to take blood lipid tests.

Results Significant differences in cognitive function and blood lipids were observed between the napping and the non-napping groups. Afternoon napping was associated with better cognitive function including orientation, language, and memory in the present study. Subjects with the habit of afternoon napping also showed a higher level of triglyceride than the non-napping subjects.

Conclusion The results demonstrated that afternoon napping was related to better cognitive function in the Chinese ageing population.

INTRODUCTION

Dementia is a disorder that interferes with occupational, domestic and social functioning because of the significant decline from one’s previous level of cognitive function. Due to longer life expectancy and the associated neurodegeneration that comes with it, approximately 5%–7% of adults aged ≥65 years have experienced dementia in most regions of the world and even higher (8%–10%) in the developed countries.

Currently, there is no effective treatment for dementia. So, it is essential to prevent and delay the occurrence of cognitive impairment by identifying and modifying the risk factors. With advancing age, there are significant changes to sleep patterns. Afternoon napping is considered a component of a healthy lifestyle from a cultural perspective. In addition, the prevalence of afternoon napping has been increasing in older adults much more than in younger individuals. Lifestyle contributes immensely to the course of cognitive function. The occurrences of dementia in the elderly can be reduced by modifying risk factors such as physical inactivity, hypertension, obesity and diabetes.

It has been confirmed that disturbed night sleep is highly associated with an increased risk of cognitive decline and dementia. While more attention has been paid to napping recently, it remains controversial whether napping could benefit cognitive function or if it might be a risk factor for cognitive impairment in the elderly. For example, a longitudinal, population-based study from 2012 including cognitively unimpaired individuals over 65 years indicated that daytime napping was associated with a lower risk of cognitive decline in 2 and 10 years. Furthermore, a comparative study between young and old adults showed that afternoon napping had benefited episodic memory retention in the former but such benefits decreased with advancing age. On the other hand, a cross-sectional study showed an increased risk of dementia or cognitive decline associated with reported excessive daytime sleepiness. Now, it has been pointed out that napping might be useful as an early marker of cognitive impairment in the elderly, and its cognitive effects may differ by nighttime sleep. Those having higher sleep efficiency and intermediate sleep duration (6–8 hours) have worse outcomes with napping, while among those with low sleep efficiency and short or long sleep duration, napping was not associated with increased risk of cognitive impairment.

Apart from these, few studies have targeted daytime napping and metabolic syndrome specifically so far. As far as we know, dementia is associated with metabolic syndrome (MS) and those who had MS showed more psychotic symptoms such as delusion, agitation, and irritability. A cross-sectional epidemiological study proposed in France examining the association between...
napping and both physical and mental chronic conditions showed that individuals who were overweight, obese, or had hypertension, diabetes, depression or anxiety disorders had an increased likelihood of napping compared with their healthy peers.12

In the current study, we explored the relationship of afternoon napping with cognitive function in a group of community elderly Chinese individuals. We hypothesised that afternoon napping was associated with higher cognitive function.

METHODS

Subjects

This study was supported by the National Pillar Program of the China Ministry of Science and Technology (CMST) (project number: 2009BAI77B03). The programme was a series of multicentric studies performed in Shanghai, Beijing, Hefei, Nanchang, Ningbo, Xi’an and Hangzhou from 2011 to 2012.13 Participants were enrolled meeting the following criteria for inclusion in the study: (1) Han Chinese, ≥60 years old; (2) no major physical conditions, including nervous system diseases or unstable, acute or life-threatening medical diseases; and (3) no deafness or blindness, to be able to complete the research. Individuals with a history of mental disease or other disorders that could affect cognitive function were excluded. Prior to the study, all subjects signed consent forms.

A total of 2214 subjects were included in this study (napping: n=1534, non-napping: n=680). Participants underwent a series of screening assessments including medical history, physical and neurological examinations, and cognitive assessments. All subjects were assessed by clinical physicians to diagnose whether they had dementia or not through face-to-face interviews. All the examining physicians accepted the compulsory training about cognitive function assessments. Out of the subjects, 739 individuals accepted blood tests (napping: n=428; non-napping: n=311). The subjects were divided into two groups based on their napping history. The flowchart is shown in figure 1.

Napping characteristics

We defined afternoon napping as periods of inactivity of at least five consecutive minutes scored as sleep (inactivity) after lunch outside of the main sleep schedule.10,14 Participants responded to items concerning habitual napping. One item asked, “… did you take naps after lunch which lasted at least 5 minutes and no more than 2 hours?” (responses: “yes”, “no”). We coded participants who never napped as “non-napping” and those who napped as “napping”. Participants who reported napping were asked additional nap-related questions which was, “On average, how often did you take naps during a week”.

Figure 1 Research flowchart. This picture describes our research process, criteria for enrolment and the subjects eventually included in the study.

We then categorised the napping participants by nap frequency: once a week (rarely), 1–3 times (some days), 4 to 6 times (most days), or 7 times (every day). Individuals with uncertain napping conditions were excluded.

Cognitive assessments

The Beijing version of the Montreal Cognitive Assessment (MoCA)15 and Mini-Mental State Examination (MMSE)16 were used to measure cognitive function. These screening tests consisted of 30 items that measured multiple cognitive domains (including visual space, memory, naming, attention, calculation, abstract, orientation and language function). The MoCA test contained more attention-executive items than the MMSE. MoCA was sensitive to detect mild cognitive impairment, and MMSE was suited to distinguish dementia. The Chinese version of the Neuropsychological Test Battery (NTB) was also used in the study,17 which detected digit span, auditory verbal learning, associative learning, associative learning, visual retention, language fluency, mapping and a test with blocks.

Demographic characteristics

Demographics, lifestyle, physical illness, and nighttime sleep duration were obtained on CMST enrolment. CMST also classified the educational attainment as illiteracy, primary school, junior high school, high school, or technical secondary school, University or above. Lifestyle components which included drinking, smoking and physical diseases including hypertension and diabetes were all recorded.

Measurement of blood indexes

Following an overnight fasting period (≥12-hour fasting duration, peripheral blood samples were collected from 7:00 to 9:00. CAT Serum Sep Clot Activator tubes and anticoagulant tubes were used to assay lipid profile including cholesterol (CHOL), low-density lipoprotein (LDL), high-density lipoprotein (HDL) and triglyceride fatty acid (TG) in the Shanghai Mental Health Center.
Data analysis

Demographics and night sleep were analysed using a general linear model test (GLM) for continuous variables and a χ² test for the categorical variables between different groups. The distinguishing factors between the two groups signed with (*) in table 1 were regressed including age. Cognitive scores were analysed using one-way analysis of variance, while the blood indexes were analysed using general linear models and compared across groups after adjusting for distinguishing factors. Stepwise linear regression analysis was employed using cognitive scores as dependent variables, and sex (male/female), age (years), education (years), napping (Y=1/N=2), napping frequency (once a week=1, 1–3 times=2, 4 to 6 times=3, everyday=4), diabetes (Y/N) and hypertension (Y/N) as independent variables(Y: yes, N: no). SPSS V.17.0 software with a two-tailed p value of 0.05 was used for all of the statistical analyses.

RESULTS

Cognitive functions in the napping versus the non-napping groups

Cognitive function between the napping and non-napping groups was compared. Demographics, night sleep and cognitive scores for the napping (n=1534) and non-napping (n=680) groups are listed in table 1. The MMSE scores were statistically higher in the napping group compared with the non-napping group. Furthermore, we observed significant differences in orientation, language function in MMSE as well as orientation in MoCA (p<0.01). Besides, in NTB tests, there are significant differences in digit span (F=6.80, p=0.009) and language fluency (F=5.40, p=0.020).

Blood lipid profiles in the napping versus the non-napping groups

Blood lipid tests were obtained from a total of 739 individuals in the napping (n=428) and non-napping (n=311) groups extracted from the whole database (table 2). The effects of distinguishing factors between groups were regressed and signed by (*) in table 2. Through the regular statistical analysis, significant differences in TG were observed between the napping and the non-napping groups (F=7.307, p=0.001), while no significant differences in CHOL, HDL, and LDL levels were observed.

Correlation between napping frequency and cognitive function

The association between demography, napping, napping frequency, physical diseases, and cognition were explored through statistical analysis. The significant association between sex, age, education, diabetes, napping, and cognition indexes were found through linear regression. The coefficients of these variables as shown in table 3 showed that napping was associated with better cognitive function including orientation, language, and memory.

DISCUSSION

Main findings

To our knowledge, this is the first study to explore the relationship of napping with cognitive function and biochemical indexes in the elderly community in the
Han Chinese population. In this study, three major findings were presented. First, the elderly individuals who took afternoon naps showed significantly higher cognitive performance compared with those who did not nap. Second, higher levels of TG were found in napping elderly individuals. Finally, afternoon napping was strongly associated with orientation, language function and memory.

This study highlighted higher cognitive performance in nappers in the elderly, supporting previous observational studies. However, such benefits decrease with the advancement of age. In addition to reducing sleepiness, mid-day naps offer a variety of benefits such as memory consolidation, preparation for subsequent learning, executive functioning enhancement and a boost to emotional stability, but these effects were not observed in all cases. Longer and more frequent naps were associated with orientation, language function and memory.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Demography and lipid metabolism in the ageing Han Chinese population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Napping (n=428)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>72.79 (7.962)</td>
</tr>
<tr>
<td>Male/female</td>
<td>180/248</td>
</tr>
<tr>
<td>Education (years)</td>
<td>7.44 (4.821)</td>
</tr>
<tr>
<td>Night sleep (hours)</td>
<td>6.43 (1.522)</td>
</tr>
<tr>
<td>Smoking (Y/N)</td>
<td>107/321</td>
</tr>
<tr>
<td>Drinking (Y/N)</td>
<td>71/357</td>
</tr>
<tr>
<td>Hypertension (Y/N)</td>
<td>216/212</td>
</tr>
<tr>
<td>Diabetes (Y/N)</td>
<td>82/346</td>
</tr>
<tr>
<td>TG (mmol/L)</td>
<td>1.80 (1.219)</td>
</tr>
<tr>
<td>Cholesterol (mmol/L)</td>
<td>4.93 (1.097)</td>
</tr>
<tr>
<td>HDL (mmol/L)</td>
<td>1.25 (0.342)</td>
</tr>
<tr>
<td>LDL (mmol/L)</td>
<td>2.95 (1.154)</td>
</tr>
</tbody>
</table>

TG range (0–1.7 mmol/L), cholesterol range (0–4.18 mmol/L), HDL range (male: 1.04–1.66 mmol/L, female: 1.1–1.74 mmol/L), LDL range (0–3.12 mmol/L). Data are shown as mean (SD) unless otherwise stated.

*p<0.05.

HDL, high-density lipoprotein; LDL, low-density lipoprotein; TG, triglyceride fatty acid.

caused by increased levels of IL-6 and C reactive protein, the release of inflammatory transmitters, promotion of oxidative stress and accumulation of reactive oxygen species. At the same time, high levels of inflammatory responses lead to adverse events, such as cognitive impairment and increased mortality. Sleep is known to be a regulator of the immune response that counters these inflammatory mediators, where napping, in particular, is thought to be an evolved response to inflammation. Individuals with higher levels of inflammation also nap more frequently. One study found that during 6 years of follow-up, patients with high levels of inflammatory mediators had significantly decreased cognitive function. So, when a disease or cell damage occurs, napping may help regulate the inflammatory response. The relationship between napping and immunity is also contradictory. On the one hand, daytime sleep is beneficial to the recovery of the immune system, while naps and night sleep promote immune repair. On the other hand, frequent daytime sleep is associated with the immune decline in both the young and the elderly. Second, the production and accumulation of beta-amyloid (Aβ) lead to toxic damage to nerve cells. One PET scan study found that the elders aged 60 and above on average who slept excessively during the day had 2.75 times higher odds of Aβ deposition than those who slept normally after an average of 15.7 years later. The study also found that napping was associated with the subsequent trend level of the Aβ state. Therefore, for normal elderly people, excessive sleep is also a risk marker for Aβ deposition.

Most prior studies on napping and cognitive function in older adults focused on the time or the duration rather than frequencies. There was thus a need for studies to further examine the association between cognitive function and naps of different frequency. Therefore, the frequencies of napping in the present study were categorised into...
The napping duration of the elderly in our research did not exceed 2 hours, which could also be a reason why we came to different conclusions. The mechanisms of sleep-related memory consolidation have been intensely investigated. REM (rapid eye movement) sleep seems particularly important for emotional and procedural memory, whereas NREM (non-rapid eye movement) sleep (that is predominant in naps) is particularly important for the declarative hippocampus-dependent memories. It could be the reason why there was a relationship between napping frequency, and only orientation, language function and memory but not with other cognitive aspects.

Afternoon nappers had been shown to have a higher level of triglycerides. Several studies had reported that napping was positively associated with cardiovascular disease risk factors such as age, waist circumference, systolic blood pressure, triglycerides, fasting glucose, postload glucose and HbA1c. It is known that some risk factors in metabolic syndrome are related to the occurrence of AD (Alzheimer disease). Näggl et al showed that increased levels of triglycerides at midlife predict brain Aβ and tau pathology 20 years later in cognitively healthy individuals. Triglycerides cross the blood–brain barrier rapidly, and induce both central leptin resistance and insulin receptor resistance, decreasing satiety and cognition. While a study only found a higher serum level of total cholesterol was significantly correlated with APOE e4 status in a cognitively normal, non-diabetic ageing population, no correlation between APOE genotypes and serum levels of glucose or total triglyceride was found. Napping may be partly due to sedentary lifestyle which results in reciprocal changes in the circulating levels of leptin and ghrelin, which in turn might increase appetite and caloric intake, reduce energy expenditure and facilitate obesity development. However, the napping group showed a higher level of triglyceride but was still within normal range, which is perhaps the reason it did not cause a worse effect on cognitive function. The relevant mechanism needs to be further studied.

**Limitations**

This study had some limitations. First of all, as a nature of cross-sectional study design, it could not show direct causality of napping, whether beneficial or harmful. A lack of detailed information regarding napping duration and time also limited the description of napping status. Self-selected napping based on self-reported by subjects, and several factors including education, lifestyle and comorbidity, might be associated with self-selected napping, which is a possible bias. The sample size of blood indexes was significantly smaller than the overall database since only elderly subjects in Shanghai were able to take blood tests. The present study is inadequate to reflect dementia occurrence with napping, and we will perform further research on this cohort in the future.

**Implications**

The study’s results demonstrate that afternoon napping was associated with better cognitive function including orientation, language and memory. Subjects with afternoon nap more than 2 hours are more likely to show worse cognitive functions. The napping duration of the elderly in our research did not exceed 2 hours, which could also be a reason why we came to different conclusions. The mechanisms of sleep-related memory consolidation have been intensely investigated. REM (rapid eye movement) sleep seems particularly important for emotional and procedural memory, whereas NREM (non-rapid eye movement) sleep (that is predominant in naps) is particularly important for the declarative hippocampus-dependent memories. It could be the reason why there was a relationship between napping frequency, and only orientation, language function and memory but not with other cognitive aspects.
napping habit showed a higher level of triglyceride than non-napping.

Contributors HC finished the writing of the manuscript. SN and WL took part in the data collection. XL and SX devised the study. LS provided critical revision for the manuscript. All the authors contributed to and approved the final manuscript.

Funding This study was funded by grants from the clinical research center project of Shanghai Mental Health Center (CRC2017ZD02), Western medical guidance project of Shanghai Science and Technology Commission (17411970100). National Natural Science Foundation of China (81301139) and Precision medical research project of Shanghai Jiao Tong University School of Medicine (15ZH4010).

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval This study was carried out in accordance with the recommendations of the ‘Shanghai Mental Health Center Ethical Standards Committee on human experimentation’ with written informed consents from all subjects. All subjects gave written informed consents in accordance with the Declaration of Helsinki. The protocol was approved by the ‘Shanghai Mental Health Center Ethical Standards Committee’. Research Ethics Approval Number/ID is 2012-19.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID ID
Han Cai http://orcid.org/0000-0002-5418-1201

REFERENCES
5 Pace-Schott EF, Spencer RMC. Age-related changes in the cognitive function of sleep. Prog Brain Res 2011;191:75–89.
18 de Rezende LF, Rey-López JP. Environmental interventions are needed to provide sustained physical activity changes. Exerc Sport Sci Rev 2015;43:238.
21 Mantua J, Spencer RMC. Exploring the nap paradox: are mid-day sleep bouts a friend or foe? Sleep Med 2017;37:88–97.