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

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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.[1] 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.[2] 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.[3–5] 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.[6] 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.[7] 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.[8] On the other hand, a cross-sectional study[9] 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.[10]

Apart from those, few studies have targeted daytime napping and metabolic syndrome specifically so far. As far as we know,[11] 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". 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.

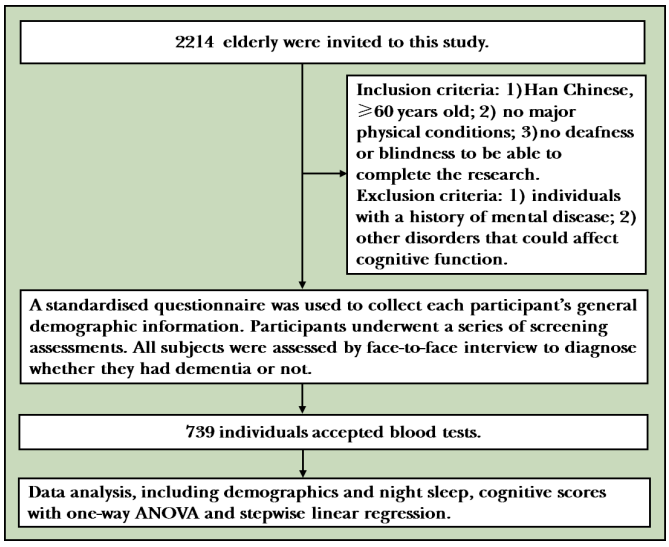

Figure 1 Research flowchart. This picture describes our research process, criteria for enrolment and the subjects eventually included in the study.

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, 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.

Table 1 Demography and cognitive scores of the subjects in the ageing Han Chinese population

	Napping (n=1534)	Non-napping (n=680)	F or χ^2	P value
Age (years)	71.09 (7.62)	70.40 (8.22)	3.63	0.057
Male/female	638/896	274/406	0.33	0.567
Education (years)	7.37 (4.72)	6.95 (4.71)	3.81	0.051
Night sleep (hours)	6.54 (1.49)	6.61 (1.51)	1.13	0.289
Smoking (Y/N)	426/1108	185/495	0.08	0.784
Drinking (Y/N)	331/1203	138/542	0.47	0.495
Hypertension (Y/N)	742/792	313/357	5.31	0.070
Diabetes (Y/N)	266/1268	106/574	1.04	0.309
Dementia (Y/N)	80/1169	47/498	2.84	0.092
MMSE				
Orientation	9.28 (1.51)	9.01 (1.83)	12.83	<0.001*
Language function	7.27 (1.92)	7.06 (2.01)	5.26	0.022*
MMSE total	25.30 (5.09)	24.56 (5.85)	8.85	0.003*
MoCA				
Orientation	5.55 (1.02)	5.41 (1.21)	7.63	0.006*
NTB				
Digit span	13.24 (6.62)	12.48 (5.62)	6.80	0.009*
Language fluency	24.35 (9.94)	23.23 (11.59)	5.40	0.020*

Data is shown as mean(SD) unless otherwise stated.
*p<0.05.
MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; NTB, Neuropsychological Test Battery.

Data analysis

Demographics and night sleep were analysed using a general linear model test (GLM) for continuous variables and a χ^2 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

Table 2 Demography and lipid metabolism in the ageing Han Chinese population

	Napping (n=428)	Non-napping (n=311)	F or χ^2	P value
Age (years)	72.79 (7.962)	71.31 (8.606)	5.777	0.016*
Male/female	180/248	131/180	0.000	0.986
Education (years)	7.44 (4.821)	7.62 (4.668)	0.259	0.611
Night sleep (hours)	6.43 (1.522)	6.56 (1.396)	1.482	0.224
Smoking (Y/N)	107/321	74/237	0.142	0.707
Drinking (Y/N)	71/357	49/262	0.092	0.762
Hypertension (Y/N)	216/212	155/156	3.766	0.152
Diabetes (Y/N)	82/346	51/260	0.930	0.335
TG (mmol/L)	1.80 (1.219)	1.75 (1.336)	7.307	0.001*
Cholesterol (mmol/L)	4.93 (1.097)	4.80 (1.120)	1.817	0.163
HDL (mmol/L)	1.25 (0.342)	1.198 (0.370)	2.983	0.051
LDL (mmol/L)	2.95 (1.154)	3.117 (2.167)	1.085	0.338

TG range (0–1.7 mmol/L), cholesterol range (0–5.18 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.

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.[7 8 18] However, such benefits decrease with the advancement of age.[8] 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 poorer cognitive functioning, while short (<30 min), frequent (four times weekly) naps were associated with an 84% decreased risk for developing Alzheimer's disease.[19] Naps can compensate for a lack of sleep at night and reduce drowsiness and fatigue during the day. Longer daytime sleep develops the habit of sitting for a long time, reducing social activity and cognitive function.[18] It had also been found[20] that unintentional nappers had an immediate poorer performance in the word recall test than non-nappers and intentional nappers. A number of factors, such as the timing, duration, frequency, and planned or unplanned nature of naps, need to be considered when determining the benefit of daytime napping.[9] There are multiple mechanisms that may explain the associations observed between napping and cognitive function. First, an emerging hypothesis suggests that inflammation is a mediator between mid-day naps and poor health outcomes. The activity of inflammatory cytokines plays an important role in sleep disorders. In the elderly, sleep disorders or sleep deprivation at night are 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,[21] where napping, in particular, is thought to be an evolved response to inflammation.[22] Individuals with higher levels of inflammation also nap more frequently.[23] One study[24] 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 promotes immune repair. On the other hand, frequent daytime sleep is associated with the immune decline in both the young[25] and the elderly.[23] 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.[19 26]

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

Table 3 Predictors generated by linear regression with cognitive scores as dependent variables

Cognitive test	Influence factor	B	P value
MMSE total	Male/female	−1.075	<0.001*
	Age (years)	−0.175	<0.001*
	Education (years)	0.502	<0.001*
	Diabetes (Y/N)	0.563	0.037*
	Napping (Y/N)	−3.609	0.017*
MMSE Orientation	Male/female	−0.324	<0.001*
	Age (years)	−0.046	<0.001*
	Education (years)	0.100	<0.001*
	Napping (Y/N)	−1.434	0.005*
MoCA total	Male/female	−1.375	<0.001*
	Age (years)	−0.238	<0.001*
	Education (years)	0.719	<0.001*
	Diabetes (Y/N)	0.703	0.018*
	Napping (Y/N)	−5.986	<0.001*
MoCA Language function	Age (years)	−0.024	<0.001*
	Education (years)	0.087	<0.001*
	Napping (Y/N)	−0.784	0.013*
MoCA Orientation	Male/female	−0.189	<0.001*
	Age (years)	−0.029	<0.001*
	Education (years)	0.065	<0.001*
	Napping (Y/N)	−1.746	<0.001*
NTB Immediate memory	Male/female	0.433	<0.001*
	Age (years)	−0.075	<0.001*
	Education (years)	0.129	<0.001*
	Napping (Y/N)	−1.590	0.044*
NTB Delayed recall	Male/female	0.858	<0.001*
	Age (years)	−0.166	<0.001*
	Education (years)	0.297	<0.001*
	Napping (Y/N)	−3.695	0.008*
NTB Language fluency	Male/female	−0.338	<0.001*
	Age (years)	0.988	<0.001*
	Education (years)	1.319	0.013*
	Napping (Y/N)	−12.722	<0.001*

*p<0.05
MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; NTB, Neuropsychological Test Battery.

four napping groups. Stepwise linear regression analysis here suggested that better orientation, language function and memory were associated with napping frequency in the elderly. This finding is inconsistent with a previous study that linked naps to poorer cognitive performance.[20] Conflicting findings may be due to different napping styles. For instance, they bring unintentional/intentional napping into analysis while we only assessed afternoon napping (ie, post-lunch). On the other hand, most studies that reported negative effect of napping on cognitive function focused on the napping duration. Those who napped 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.[27] 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 triglyceride. 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.[28] It is known that some risk factors in metabolic syndrome are related to the occurrence of AD (Alzheimer disease). Nägga *et al*[29] 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.[30] 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.[31] 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

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.

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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.

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