Napping Is Associated with Increased Risk of Type 2 Diabetes: The Guangzhou Biobank Cohort Study

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Study Objective: Intentional napping is very common, particularly in China. However, there are limited data regarding its potential health effects. We therefore examined the possible relationship between napping and type 2 diabetes.

Design: Cross-sectional analysis of baseline data from the Guangzhou Biobank Cohort Study.

Setting: Community-based elderly association in Guangzhou, China.

Participants: 19,567 Chinese men and women aged 50 years or older.

Measurements and Results: Self-reported frequency of napping was obtained by questionnaire and type 2 diabetes was assessed by fasting blood glucose and/or self-reports of physician diagnosis or treatment. Participants reporting frequent naps (4-6 days/week and daily) were 42% to 52% more likely to have diabetes. The relationships remained essentially unchanged after adjustments were made for demographics, lifestyle and sleep habits, health status, adiposity, and metabolic markers (odds ratio for diabetes 1.36 [95% CI 1.17–1.57] in 4-6 days/week, 1.28 [1.15–1.44] in daily nappers). Similar associations were found between napping and impaired fasting glucose. Removal of those with potential ill health and daytime sleepiness did not alter the observed associations.

Conclusions: Napping is associated with elevated prevalence of diabetes and impaired fasting glucose in this older Chinese sample. Our finding suggests that it is less likely that diabetes leads to daytime sleepiness. This raises the possibility that napping may increase the risk of diabetes. Confirmation by longitudinal studies is needed.

Keywords: Napping, type 2 diabetes, impaired fasting glucose, Chinese

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INTENTIONAL DAYTIME NAPPING OR SIESTA IS COMMON PRACTICE IN MANY PARTS OF THE WORLD, BUT DATA ON THE IMPACT OF NAPPING ON HEALTH are surprisingly limited.[1] Previous studies primarily focused on cardiovascular consequences and have generated conflicting results.[2-5] Relationships between napping and other health outcomes, such as diabetes, have been even less well characterized. Two recent studies from Germany and the United States suggested a higher prevalence of diabetes in those who reported napping.[5,6] In these populations napping is not the norm and could be the result of underlying health problems. For example, diabetes itself has been suggested to induce tiredness and hence may encourage napping.[7] In China, however, napping is a well-accepted practice in all age groups and is practiced by many as a planned, regular routine.[8,9] A clearer picture of the health impact of napping might thus be seen in such a setting compared with those in Western populations, where napping is more likely to be unplanned and initiated by sleepiness. Given the rapidly increasing incidence of type 2 diabetes in China,[10] we sought to examine the possible association of habitual napping with diabetes in a large sample of older residents of Guangzhou in southern China.

A commentary on this paper appears in this issue on page 285.

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METHODS

The Guangzhou Biobank Cohort Study, a collaboration between the Guangzhou Number 12 People's Hospital and the Universities of Birmingham and Hong Kong, has been described previously.[11] Participants were selected from the Guangzhou Health and Happiness Association for the Respectable Elders (GHHARE), a community social and welfare association whose membership is open to older persons for a monthly fee of 4 Yuan (US $0.5) and comprises about 7% of permanent Guangzhou residents aged 50 years and over. Recruitment was conducted in phases (2003-2004 and 2005-2006), each drawn from 11% (about 10,000) of the membership population. Only those who were capable of consenting, ambulatory, and not receiving treatment modalities for any immediate life-threatening conditions were included. Of those eligible, 90% of the men and 99% of the women participated (n = 20,431) and underwent a half-day detailed assessment, which included a structured interview on lifestyle and medical history and a physical examination. The study received approval from the Medical Ethics Committee of the Guangzhou Medical Association, and all participants gave written informed consent.

Sleep Habits

Participants were asked to describe their napping habits, which was categorized into never (including < 1 time per week),

1-3 times per week, 4-6 times per week, and daily. The total duration of daytime and nocturnal sleep per day, and the presence of insomnia (taking > 30 min to initiate sleep or any use of hypnotic drugs), daytime sleepiness (having difficulty staying alert during daytime), and snoring (yes, no, don't know) were also acquired during the interview. After the baseline assessment, a sample of participants (n = 3,822) were re-contacted for further information on the period of the day they usually napped (morning [before lunch], within 1 h after lunch, afternoon), and the duration of nap and nighttime sleep, respectively.

Type 2 Diabetes and Impaired Fasting Glucose

Blood samples were taken from all participants, who fasted overnight before coming to the examination center early in the morning. Individuals were classified as having a normal glycemic profile if their fasting plasma glucose was < 5.6 mmol/L. Type 2 diabetes was defined as fasting glucose ≥ 7.0 mmol/L and/or having a previous physician diagnosis, including receiving treatment with insulin or an oral hypoglycemic medication. In order to investigate the effect of the knowledge of diabetic status, we separated the diabetic participants into the "diagnosed" (those with self-reported diabetes and/or treatment) and the "previously diagnosed" (those who had fasting glucose ≥ 7.0 mmol/L and were not previously diagnosed). Impaired fasting glucose in nondiabetic participants was classified as fasting glucose ≥ 5.6 mmol/L and < 7.0 mmol/L.[12]

Other Measures

Highest education level (primary or below, secondary, tertiary) and longest held occupation (manual, non-manual office setting, non-manual other setting, other) were used as proxies for socioeconomic status. Levels of physical activity were categorized into inactive, minimally active, and active, based on the short version of the International Physical Activity Questionnaire (IPAQ), which has been validated in the Chinese population.[13] Health status was assessed by an objective measure (hospital admission in the previous 6 months) and a subjective 4-point rating scale (very good, good, poor or very poor), which was dichotomized into good or poor. In addition, the participants were asked to report if they were diagnosed of hypertension (or blood pressure ≥ 140/90 mm Hg at the time of interview or receiving antihypertensive medication) and other cardiovascular comorbidities (coronary heart disease, stroke, myocardial infarction, angina, or peripheral heart disease). Any diagnosis of diabetes in the next-of-kin of the participants (parents, siblings, and offspring) was recorded. Waist circumference was used as an indicator of adiposity.

Statistical Analysis

All data analyses were performed in Stata (version 10.1). Potential confounders were selected a priori according to available scientific evidence (Table 1). Trends of these confounders across different napping frequency groups, adjusted for age (50-59, 60-69, ≥ 70 years) were evaluated using a nonparametric test for trend for categorical variables, and linear regression for continuous variables. Logistic regression models were constructed to assess the relationship between napping and diabetes and impaired fasting glucose, relative to normal glycemic profile. The odds ratios (ORs) together with their 95% confidence intervals (CIs) of 2 models are presented. In Model 1, we adjusted for sex, age, education level, occupation, smoking (never, ever), alcohol use (never, ever), physical activity level, self-rated health status, hospital admission, the presence of hypertension and cardiovascular conditions, family history of diabetes, waist circumference, triglycerides, and total cholesterol. Model 2 was the fully adjusted model, including sleep variables (total sleep duration, insomnia, daytime sleepiness, and snoring) in addition to the aforementioned factors. We specifically examined whether the associations between the outcomes and napping were consistent across sex and age group (above or below the median age of 62 years) by assessing the statistical significance of an interaction term obtained by running models with and without the interaction term and the value of the likelihood ratio test of the difference between the 2 models. In an attempt to clarify the issue of reverse causality, we repeated the analysis by excluding a subset of participants who perceived themselves as having poor health, were physically inactive, had daytime sleepiness, were admitted to a hospital in the previous 6 months, had hypertension or a history of cardiovascular condition, as well as those who had a family history of diabetes.

RESULTS

Of the 20,431 participants recruited, 19,567 (96%) had complete information on all variables of interest and were included for subsequent analyses. There were more women (n = 13,972) than men (n = 5,595) because of the predominance of women in the GHHARE membership, and a combination of job engagements and a cultural reluctance to give blood among men. Age ranged from 50 to 93 years, and the men were older (mean ± SD: 64.2 ± 6.3 years) than the women (61.4 ± 6.7 years).

At least one nap per week was reported by 67.2% (n = 13,152; 95% CI 66.6%–67.9%), more commonly in the males (76.4%) than the females (63.6%). Among these, 59.4% (n = 7,807) practiced daily. Table 1 gives descriptive data in relation to frequency of napping. Those who napped more frequently were more likely to be men, older and had higher educational attainment. Positive dose-response relationships between frequency of napping and systolic blood pressure and fasting glucose levels were observed. Total sleep duration was longer and less daytime sleepiness was reported in more frequent nappers than in never nappers.

As baseline assessment did not include questions on period and duration of nap, a sample of participants (n = 3,822) were re-contacted for further information. Of those who napped at least once per week (n = 2,510), 83.3% napped within 1 h after lunch and 16.3% in the afternoon. The mean nap duration was 60 ± 31 min (range 10-240 min), with 78% napping ≤ 60 min. Daily nappers had slightly longer nighttime sleep duration (6.4 ± 1.1 h) than those who did not nap (6.2 ± 1.2 h, P = 0.004). Nonetheless, across different nocturnal sleep duration (< 5, 5-5.9, 6-6.9, ≥ 7 h) the length of nap was unchanged (mean: 59.4-66.6 min; P = 0.091).

Overall, type 2 diabetes was identified in 13.5% (95% CI 13.0%–14.0%) of this sample, and was more prevalent in participants who reported napping (Table 2). The increase generally followed a dose-dependent manner, those who napped 4-6 days/week (14.7%) and daily (15.1%) had higher prevalence of diabetes than the never nappers (11.7%). Univariate analy-

Table 1—Characteristics of 19,567 Chinese adults according to frequency of napping, the Guangzhou Biobank Cohort Study, 2003-2006

	Frequency of napping				
	Never	1-3 days/ week	4-6 days/ week	Daily	P value*
n	6,415	2,833	2,512	7,807	
Sex					
Men	20.6	23.7	29.5	36.6	
Women	79.4	76.3	70.5	63.4	< 0.001
Age (year)	61.4 ± 6.8	61.2 ± 6.6	62.8 ± 6.4	63.0 ± 6.6	< 0.001
Education					< 0.001
Primary or below	49.8	43.4	43.8	42.9	
Secondary	43.7	47.6	45.7	45.8	
Tertiary	6.5	9.1	10.5	11.3	
Occupation					0.67
Manual	70.9	68.9	69.6	68.1	
Non-manual (office setting)	12.4	14.9	16.7	17.2	
Non-manual (other setting)	9.5	8.9	9.2	8.9	
Other	7.3	7.2	4.5	5.8	
Ever smoked	20.4	21.9	24.1	28.8	0.009
Ever consumed alcohol	15.5	18.1	17.8	20.9	0.20
Physical activity level†					0.013
Inactive	10.3	9.5	5.3	7.3	
Minimally active	48.8	48.3	41.7	48.9	
Active	41.0	42.2	53.0	43.9	
Health status					
Poor self-rated health status	15.0	16.8	14.2	17.0	0.014
Hospital admission in last 6 months	3.0	3.2	2.9	4.5	0.12
Hypertension	41.9	42.7	47.5	48.4	< 0.001
Cardiovascular conditions	4.6	4.3	5.7	6.4	0.17
Familial history of diabetes	9.1	10.4	9.3	8.9	0.26
Adiposity and metabolic markers					
Waist circumference (cm)	78.7 ± 8.8	78.7 ± 8.9	79.9 ± 8.9	79.6 ± 8.9	0.10
Systolic blood pressure (mm Hg)	130 ± 22	130 ± 22	133 ± 22	132 ± 22	0.001
Fasting glucose (mmol/L)	5.7 ± 1.6	5.7 ± 1.7	5.9 ± 1.7	5.9 ± 1.8	< 0.001
Triglycerides (mmol/L)	1.6 ± 1.2	1.6 ± 1.3	1.61 ± 1.1	1.7 ± 1.3	< 0.001
Total cholesterol (mmol/L)	6.0 ± 1.2	6.0 ± 1.2	5.8 ± 1.1	5.9 ± 1.2	0.44
Sleep variables					
Total sleep duration (hour)	6.6 ± 1.2	6.9 ± 1.3	6.9 ± 1.2	7.2 ± 1.4	< 0.001
Insomnia	15.8	14.7	13.4	14.1	0.46
Daytime sleepiness	5.5	5.1	2.8	2.5	< 0.001
Snoring	38.7	42.9	50.4	43.6	0.63

Data are means ± SD or percentages.
*P value for linear trend was adjusted for age
†Physical activity was quantified using the short version of the International Physical Activity Questionnaire (IPAQ)

sis suggested significant association between diabetes and napping 4-6 days/week (OR = 1.52 [95% CI 1.32–1.75]) and napping daily (1.45 [1.31–1.60]). These associations remained significant despite some attenuation of the ORs (1.36 [95% CI 1.17–1.57] and 1.28 [1.15–1.44], respectively) after adjustments for a panel of potential confounders including sex, age, education level, occupation, smoking, alcohol use, level of physical activity, health status, adiposity and metabolic markers, and sleep variables (Model 2). There was no evidence from the assessment of heterogeneity of effect across strata that the relationship between napping and diabetes varied with sex or age (data not shown). In the subsample in which further information on sleep habits was obtained, we investigated the relationship between nap duration and diabetes. There was a statistically significant trend of increasing risk of diabetes with longer nap duration (P = 0.006), with the ORs being 1.35 (95% CI 1.00–1.82) and 1.41 (1.11–1.81) for naps of ≤ 30 min and > 30 min, respectively, compared to never nappers.

To reduce potential contamination by the participants' knowledge on their own glycemic status on voluntary napping, we separated the diabetic participants into those who had been diagnosed and/or were receiving treatment and those who had no previous diagnosis but had a fasting glucose ≥ 7.0 mmol/L at the time of assessment. Logistic regression modeling showed both subgroups had similar elevated odds associated with increasing frequency of napping (Table 2). We also studied the relationship between napping and impaired fasting glucose. Similar to diabetes, napping was associated with higher risk of impaired fasting glucose, although the OR was slightly lower in daily nappers.

In order to address the potential issue of poor health-induced sleepiness, we repeated the analyses restricting to individuals who felt "healthy" and thus were less likely to nap because of underlying chronic conditions (Table 3). This was defined as individuals who perceived themselves as having very good or good health, were at least minimally active, did not have daytime sleepiness, were not admitted to a hospital in the previous 6 months, and did not have hypertension or any cardiovascular condition. In this group, the adjusted OR for diabetes in daily nappers was 1.38 (95% CI 1.12–1.71), compared to those who never napped. Further exclusion of those who had familial history of diabetes did not alter the relationship (adjusted OR = 1.42 [1.13–1.79]).

DISCUSSION

In a large group of older Chinese, we observed a modest but significant dose-dependent relationship between habitual napping frequency and

prevalence of type 2 diabetes and impaired fasting glucose. This association remained after adjustment for potential confounders including demographics, lifestyle and sleep habits, health status, and adiposity and metabolic markers. Strengths of the current study include the large sample size, with over 19,000 participants, and the wide range of data collected, which allowed us to adjust and stratify for a much wider set of potential confounders than previous studies examining the health effects of napping.

In previous studies concerning the health impact of napping, few had examined the relationship with diabetes. In those that did, small increases in the prevalence of diabetes were found among those who napped frequently.[3-5] Nevertheless, diabetes was not the primary outcome and the finding was not commented on or discussed. Our findings are also consistent with the results reported in a recent study by Picarsic et al.,[6] in which the napping habits in 414 community-dwelling elderly people (aged 70 to 89 years) were studied. These authors found that diabetes was more prevalent in those who reported napping (OR = 1.87 [95% CI 1.17–3.01]), and that diabetes was associated with longer nap duration (12.3 min longer). They then hypothesized that napping is likely to be a consequence of sleep apnea and fragmented nighttime sleep resulting from diabetes or other chronic comorbidities. While we were not able to compare the nocturnal sleep quality between nappers and non-nappers, reported insomnia and snoring, characteristics of sleep apnea, were the same in the 2 groups. Moreover, we repeated the analysis by excluding a subset of participants who were less healthy than the others as assessed by a range of subjective and objective parameters, and the association between napping and diabetes remained essentially unaltered.

Table 2—Prevalence and odds* of type 2 diabetes and impaired fasting glucose according to frequency of napping

		Type 2 diabetes		
Frequency of napping	**n (%)**	**Univariate**	**Model 1†**	**Model 2**
Never	751 (11.7)	1.00	1.00	1.00
1-3 days/week	339 (12.0)	1.05 (0.92–1.21)	1.02 (0.88–1.18)	1.00 (0.86–1.16)
4-6 days/week	368 (14.7)	1.52 (1.32–1.75)	1.37 (1.18–1.59)	1.36 (1.17–1.57)
Daily	1,181 (15.1)	1.45 (1.31–1.60)	1.31 (1.17–1.46)	1.28 (1.15–1.44)
P for linear trend		< 0.001	< 0.001	< 0.001
		Diagnosed diabetes		
Frequency of napping	**n (%)**	**Univariate**	**Model 1**	**Model 2**
Never	461 (7.2)	1.00	1.00	1.00
1-3 days/week	208 (7.3)	1.05 (0.89–1.25)	1.00 (0.84–1.20)	0.99 (0.92–1.19)
4-6 days/week	211 (8.4)	1.42 (1.19–1.69)	1.25 (1.04–1.51)	1.24 (1.03–1.50)
Daily	742 (9.5)	1.48 (1.31–1.68)	1.31 (1.15–1.50)	1.29 (1.13–1.48)
P for linear trend		< 0.001	< 0.001	< 0.001
		Previously undiagnosed diabetes		
Frequency of napping	**n (%)**	**Univariate**	**Model 1**	**Model 2**
Never	290 (4.5)	1.00	1.00	1.00
1-3 days/week	131 (4.6)	1.06 (0.85–1.31)	1.05 (0.84–1.31)	1.02 (0.82–1.27)
4-6 days/week	157 (6.3)	1.68 (1.37–2.06)	1.54 (1.25–1.91)	1.52 (1.23–1.88)
Daily	439 (5.6)	1.40 (1.20–1.63)	1.30 (1.11–1.52)	1.26 (1.07–1.49)
P for linear trend		< 0.001	< 0.001	0.001
		Impaired fasting glucose		
Frequency of napping	**n (%)**	**Univariate**	**Model 1**	**Model 2**
Never	1,734 (27.0)	1.00	1.00	1.00
1-3 days/week	812 (28.7)	1.09 (0.99–1.21)	1.10 (0.99–1.22)	1.09 (0.98–1.21)
4-6 days/week	878 (35.0)	1.57 (1.42–1.74)	1.37 (1.23–1.53)	1.37 (1.23–1.53)
Daily	2,365 (30.3)	1.26 (1.17–1.36)	1.15 (1.06–1.25)	1.15 (1.06–1.25)
P for linear trend		< 0.001	< 0.001	< 0.001

Data are odds ratio (95% confidence interval) unless otherwise stated.
*Relative to normal glycemic profile, with never nappers as the referent group
†Model 1 adjusted for sex, age, education level, occupation, smoking, alcohol use, level of physical activity, health status (self-rated health status, hospitalization, presence of hypertension and cardiovascular conditions, family history of diabetes), and adiposity and metabolic markers (waist circumference, triglycerides, and total cholesterol). Model 2 additionally adjusted for sleep variables (total sleep duration, insomnia, daytime sleepiness, and snoring).

Similar to some Mediterranean populations,[2,4] napping in China is a social norm, which is practiced by all ages primarily as a habit started in childhood.[8] In the current sample as well as the study population in Israel,[2] napping was more common in men, and was associated with longer nocturnal sleep duration (or better quality). In Western countries where other napping studies have been conducted, napping is less common and is often unplanned and prompted by sleepiness likely caused by aging, deteriorating health status, or nighttime complaints.[14,15] Compared to other samples, our Chinese participants are relatively physically active (high levels of walking),[13] and those who napped were more physically active than those who did not, which lends further support against that napping is associated with frailty. In contrast, while regular physical activity has been consistently shown to reduce the risk of diabetes,[16] an association between napping and diabetes was observed despite higher levels of physical activity in nappers, suggesting the relationship might have been stronger had it not been offset by the protective effects of physical activity.

While there was some evidence suggesting an association between the presence of symptoms of insomnia (difficulty initiating or maintaining sleep or early awakening) and napping,[9] the authors reported a much lower prevalence of insomnia when daytime consequences (including daytime sleepiness) was taken into consideration (8.9% vs. 32.9% for any insomnia symptoms). In this sample there was no evidence of an association between daytime sleepiness and napping, which corroborated our finding as well as those from others[6,17] that napping did not reduce nighttime sleep duration.

Emerging evidence suggests that apart from sleep deprivation, long sleep duration is also a risk factor for incident diabetes.[18-20]

Table 3—Prevalence and odds* of type 2 diabetes according to frequency of napping in healthy participants

		Type 2 diabetes		
Frequency of napping	**n**	**n (%)**	**Univariate**	**Adjusted†**
Excluding participants with ill health‡				
Never	2,603	187 (7.2)	1.00	1.00
1-3 days/week	1,139	72 (6.3)	0.90 (0.68–1.19)	0.90 (0.67–1.21)
4-6 days/week	986	83 (8.4)	1.37 (1.04–1.80)	1.25 (0.94–1.67)
Daily	2,921	280 (9.6)	1.46 (1.20–1.78)	1.38 (1.12–1.71)
P for linear trend			< 0.001	0.001
Excluding participants with ill health or with family history of diabetes				
Never	2,375	151 (6.4)	1.00	1.00
1-3 days/week	1,035	59 (5.7)	0.91 (0.67–1.25)	0.94 (0.68–1.30)
4-6 days/week	909	65 (7.2)	1.31 (0.96–1.78)	1.21 (0.88–1.66)
Daily	2,682	228 (8.5)	1.45 (1.17–1.81)	1.42 (1.13–1.79)
P for linear trend			< 0.001	< 0.001

Data are odds ratio (95% confidence interval) unless otherwise stated.
*Relative to normal glycemic profile, with never nappers as the referent group
†Adjusted for sex, age, education level, occupation, smoking, alcohol use, waist circumference, triglycerides, total cholesterol, total sleep duration, insomnia, and snoring. History of diabetes was also included where appropriate.
‡Ill health was defined as poor self-rated health status, physically inactive, presence of daytime sleepiness, admitted to a hospital in the previous 6 months, and the presence of hypertension or any cardiovascular condition.

In these studies, only nighttime sleep duration was investigated. Nevertheless, both sleep homeostatic and circadian processes have profound influences on multiple physiological functions including the release of and sensitivity to metabolic hormones (e.g., insulin), and sympathetic-parasympathetic balance.[21,22] Thus, napping could affect the risk for diabetes through several potential inter-related sleep and circadian mechanisms.[23,24] For example, increasing sympathetic activity on awakening from naps results in activation of the renin-angiotensin system, which can modulate insulin resistance and associated hyperglycemia.[23,25] Results from the current study showed that there was a linear relationship between risk of diabetes and duration of nap, in keeping with reports from other groups that suggested excess mortality[2] and myocardial infarction[3] in individuals who took long naps compared to the short or never nappers. It is possible that waking from deeper sleep could cause greater metabolic perturbation. On the other hand, sleep disordered breathing has been hypothesized to be responsible for the association of long sleep duration and incident diabetes.[20] In the current analyses, although snoring, a symptom of sleep apnea, was independently associated with diabetes, the inclusion of snoring in the regression model did not change the OR estimate for napping. Similarly, the adjustment of adiposity (proxied by waist circumference) did not alter the magnitude of OR.

There are several potential limitations that deserve mention. Because of the cross-sectional design, we were not able to establish the temporal sequence in the association between napping and diabetes. However, as napping is a long-term habit[8,9] and diabetes essentially was not found (< 1%) in the Chinese general population until the introduction of economic reform by Deng Xiaoping in 1978,[26] it is likely that napping would have preceded the development of the diabetes. Prospective studies are needed to examine the association further. Although recruited from an association whose membership is open to anyone, our sample is unlikely to be totally representative of the older population in China. Nevertheless, bias would only be introduced if we had systematically missed those who had a specific relation between napping and diabetes. Furthermore, the prevalence rates of napping and diabetes were similar to those in recent surveys using national samples of Chinese.[8,10] The lack of objective measure in napping and other sleep variables might also limit the interpretation of the finding, but actigraphy and polysomnography are not practical in a large scale study like ours. We believe misclassification or underreporting of habitual napping was unlikely, as napping is a well-accepted practice in China, and the aim of this study was concealed from the participants and the interviewers. While we have attempted to control for a wide range of potential confounders, we acknowledge that the observed association could have been confounded by factors that were not measured because of the financial constraints and logistical issues. For example, diet was not adjusted for because of the difficulty of obtaining reliable and accurate dietary data in large scale community-based surveys,[27] particularly in our Chinese participants who share several dishes during a meal. Our study was conducted in a setting with unique social and cultural characteristics. This enables the investigation of issues such as this that might not be possible in many Western populations.

In summary, our data suggest that there is an association between frequent napping and higher prevalence of type 2 diabetes in the older Chinese. Our finding might help explain a previous observation that napping is a surrogate for subclinical atherosclerosis,[5] which is widely accepted as one of the vascular complications of diabetes.[28] While we cannot confirm causality or the direction of association due to the cross-sectional nature of the study, these analyses suggest this is less likely to be the result of confounding or reverse causality. The present finding highlights the need for further studies on the nature of this association. If napping is shown to increase the risk of diabetes, this would have profound public health implications in China, where the habit is very common and where there is an emerging diabetes epidemic in the face of rapid socioeconomic transition.

ABBREVIATIONS

GHHARE, Guangzhou Health and Happiness Association for the Respectable Elders
IPAQ, International Physical Activity Questionnaire
OR, Odds ratio
CI, Confidence interval

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DISCLOSURE STATEMENT

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REFERENCES

1. Dhand R, Sohal H. Good sleep, bad sleep! The role of daytime naps in healthy adults. Curr Opin Pulm Med 2006;12:379-82.
2. Bursztyn M, Ginsberg G, Stessman J. The siesta and mortality in the elderly: Effect of rest without sleep and daytime sleep duration. Sleep 2002;25:187-91.
3. Campos H, Siles X. Siesta and the risk of coronary heart disease: results from a population-based, case-control study in Costa Rica. Int J Epidemiol 2000;29:429-37.
4. Naska A, Oikonomou E, Trichopoulou A, Psaltopoulou T, Trichopoulos D. Siesta in healthy adults and coronary mortality in the general population. Arch Intern Med 2007;167:296-301.
5. Stang A, Dragano N, Poole C, et al. Daily siesta, cardiovascular risk factors, and measures of subclinical atherosclerosis: results of the Heinz Nixdorf Recall Study. Sleep 2007;30:1111-9.
6. Picarsic JL, Glynn NW, Taylor CA, et al. Self-reported napping and duration and quality of sleep in the lifestyle interventions and independence for elders pilot study. J Am Geriatr Soc 2008;56:1674-80.
7. Grootenhuis PA, Snoek FJ, Heine RJ, Bouter LM. Development of a type 2 diabetes symptom checklist: a measure of symptom severity. Diabet Med 1994;11:253-61.
8. Liao JQ, Xu QZ, Yuan ZY, Wu T, Li TH. A study on the popularity and reasons of napping in China. Renlei Gongxiao Xue 2000;6:16-9.
9. Liu X, Liu L. Sleep habits and insomnia in a sample of elderly persons in China. Sleep 2005;28:1579-87.
10. Gu D, Reynolds K, Duan X, et al. Prevalence of diabetes and impaired fasting glucose in the Chinese adult population: International Collaborative Study of Cardiovascular Disease in Asia (InterASIA). Diabetologia 2003;46:1190-8.
11. Jiang C, Thomas GN, Lam TH, et al. Cohort profile: The Guangzhou Biobank Cohort Study, a Guangzhou-Hong Kong-Birmingham collaboration. Int J Epidemiol 2006;35:844-52.
12. Genuth S, Alberti KG, Bennett P, et al. Expert Committee on the Diagnosis and Classification of Diabetes Mellitus: Follow-up report on the diagnosis of diabetes mellitus. Diabetes Care 2003;26:3160-7.
13. Deng HB, Macfarlane DJ, Thomas GN, et al. Reliability and validity of the IPAQ-Chinese: the Guangzhou Biobank Cohort study. Med Sci Sports Exerc 2008;40:303-7.
14. Hays JC, Blazer DG, Foley DJ. Risk of napping: excessive daytime sleepiness and mortality in an older community population. J Am Geriatr Soc 1996;44:693-8.
15. Asplund R. Daytime sleepiness and napping amongst the elderly in relation to somatic health and medical treatment. J Intern Med 1996;239:261-7.
16. Gill JM, Cooper AR. Physical activity and prevention of type 2 diabetes mellitus. Sports Med 2008;38:807-24.
17. Goldman SE, Hall M, Boudreau R, et al. Association between nighttime sleep and napping in older adults. Sleep 2008;31:733-40.
18. Gottlieb DJ, Punjabi NM, Newman AB, et al. Association of sleep time with diabetes mellitus and impaired glucose tolerance. Arch Intern Med 2005;165:863-7.
19. Mallon L, Broman JE, Hetta J. High incidence of diabetes in men with sleep complaints or short sleep duration: a 12 year follow-up of a middle-aged population. Diabetes Care 2005;28:2762-7.
20. Yaggi HK, Araujo AB, McKinlay JB. Sleep duration as a risk factor for the development of type 2 diabetes. Diabetes Care 2006;29:657-61.
21. Spiegel K, Leproult R, Van Cauter E. Impact of sleep debt on metabolic and endocrine function. Lancet 1999;354:1435-39.
22. Spiegel K, Knutson K, Leproult R, Tasali E, Van Cauter E. Sleep loss: a novel risk factor for insulin resistance and Type 2 diabetes. J Appl Physiol 2005;99:2008-19.
23. Smolensky MH, Hermida RC, Castriotta RJ, Portaluppi F. Role of sleep-wake cycle on blood pressure circadian rhythms and hypertension. Sleep Med 2007;8:668-80.
24. Laposky AD, Bass J, Kohsaka A, Turek FW. Sleep and circadian rhythms: key components in the regulation of energy metabolism. FEBS Lett 2008;582:142-51.
25. Rasch B, Dodt C, Mölle M, Born J. Sleep-stage-specific regulation of plasma catecholamine concentration. Psychoneuroendocrinology 2007;32:884-91.
26. Pan XR, Yang WY, Li GW, Liu J. Prevalence of diabetes and its risk factors in China, 1994. National Diabetes Prevention and Control Cooperative Group. Diabetes Care 1997;20:1664-69.
27. Hebert JR, Clemow L, Pbert L, Ockene IS, Ockene JK. Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. Int J Epidemiol 1995;24:389-98.
28. Beckman JA, Creager MA, Libby P. Diabetes and atherosclerosis: epidemiology, pathophysiology, and management. JAMA 2002;287:2570-81.