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Trabajo Original

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Adiposity-related risks among the middle-aged and elderly Chinese: the role of siesta and nocturnal sleep duration

Riesgos relacionados con la adiposidad en chinos de mediana edad y ancianos: el papel de la siesta y la duración del sueño nocturno

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Abstract

Background: increasingly, research suggests that lack of sleep is linked to adiposity worldwide, but few studies have been conducted in middle-aged and elderly Chinese subjects. The purpose of the present study was to analyze the association of siesta and nocturnal sleep duration with the prevalence of adiposity in middle-aged and elderly Chinese individuals.

Methods: a total of 7,891 community dwelling Chinese subjects who had participated in the 2015 China Health and Retirement Longitudinal Study were included. A four-stage random sampling method was used to select participants. Siesta and nocturnal sleep duration was self-reported. Adiposity, including general obesity and abdominal obesity, was assessed. Multiple logistic analyses were conducted to explore the association between siesta, nocturnal sleep duration, and adiposity.

Results: people with long siesta durations (≥ 1 hour/day) were significantly associated with an increased risk for abdominal obesity, independently and in all subgroup analyses, when compared to those without regular siesta. ORs after adjustment of confounding factors included: all subjects, OR = 1.45, 95 % CI, 1.23 to 1.70; middle-aged subjects, OR = 1.46, 95 % CI, 1.15 to 1.86; elderly, OR = 1.43, 95 % CI, 1.14 to 1.78.

Conclusions: our data show that siesta duration plays a role in the prevalence of age-specific abdominal obesity. Individuals with long siesta durations are more likely to have abdominal obesity among the middle-aged and elderly population when compared to those without regular siesta. The results of this study need to be confirmed by further studies.

Keywords:

Middle-aged. Elderly. Nocturnal sleep duration. Siesta. Obesity.

Resumen

Antecedentes: cada vez más investigaciones sugieren que la falta de sueño está relacionada con la adiposidad en todo el mundo, pero pocos estudios se han realizado en chinos de mediana edad y ancianos. El propósito del presente estudio fue analizar la asociación de la siesta y la duración del sueño nocturno con la prevalencia de la adiposidad en chinos de mediana edad y ancianos.

Métodos: se incluyeron en total 7891 chinos de la comunidad que habían participado en el "Estudio longitudinal de salud y jubilación en China" de 2015. Se utilizó el método de muestreo aleatorio de 4 etapas para seleccionar a los participantes. La duración de la siesta y del sueño nocturno fue autoinformada. Se evaluó la adiposidad, incluidas la obesidad general y la obesidad abdominal. Se realizaron múltiples análisis logísticos para explorar la asociación entre la siesta, la duración del sueño nocturno y la adiposidad.

Resultados: las personas con siestas prolongadas (≥ 1 hora al día) se asociaron significativamente a un mayor riesgo de obesidad abdominal, de forma independiente, en todos los análisis de subgrupos, en comparación con aquellos sin siesta regular. Los OR después de ajustar los factores de confusión fueron: todos los sujetos, OR = 1,45, IC del 95 %, 1,23 a 1,70; mediana edad: OR = 1,46, IC del 95 %, 1,15 a 1,86; ancianos: OR = 1,43, IC del 95 %, 1,14 a 1,78.

Conclusiones: nuestros datos muestran que la duración de la siesta juega un papel en la prevalencia de la obesidad abdominal específica de cada edad. Las personas con siestas prolongadas tienen más probabilidades de tener obesidad abdominal, entre la población de mediana edad y anciana, que las que no duermen siesta regularmente. Los resultados de este estudio deben ser confirmados por estudios adicionales.

Palabras clave:

Mediana edad. Anciano. Duración del sueño nocturno. Siesta. Obesidad.

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INTRODUCTION

Worldwide, the prevalence of obesity and overweight has doubled since 1980, and nearly one third of the world's population is classified as overweight or obese (1). Several researchers assembled data from 195 countries, which showed that obesity was intimately associated with dyslipidemia and many chronic non-communicable diseases (such as chronic kidney disease, cardiovascular disease, type-2 diabetes, etc.), reduces life expectancy (2,3), and leads to increasing medical costs (4). The prevalence of overweight, general obesity, and abdominal obesity significantly increased among Chinese adults from 1989 to 2011 (5). During the period from 1993 to 2011 the prevalence of abdominal obesity was approximately doubled (from 20.4 % to 44.0 %), and this increasing trend was also significant in both genders (6). Mild obesity was associated with the loss of one in ten, and severe obesity with the loss of one in four potential disease-free years during middle and late adulthood (7). Obesity may be far more common and requires more urgent attention. Overweight has become an important public health problem in China (8). It is urgent to develop national strategies for the prevention of obesity.

Many studies have shown that adiposity is related to dietary patterns, diet quality, physical activity, sedentariness, genetics, lifestyle interactions, and sleep (9,10). Increasingly, research suggests that lack of sleep is linked to adiposity worldwide. A few studies conducted in China indicated that sleep duration plays a role in adiposity (11,12). As far as we know, most of them focused on children and adolescents, or were limited to a specific population. Few studies were conducted in the middle-aged and elderly population groups, who have a greater risk of adiposity and sleep disorders.

The aim of this research was to find the relationship of siesta duration, nocturnal sleep duration, and adiposity among the middle-aged and elderly Chinese based on the data of the China Health and Retirement Longitudinal Study (CHARLS, 2015), and to provide evidence for healthy sleep interventions to help combat the epidemic of adiposity.

MATERIAL AND METHODS

STUDY DESIGN

The data for this research were taken from the China Health and Retirement Longitudinal Study (CHARLS), which had collected them in 2015. A four-stage random sampling method was used for selecting participants. In the first stage, 150 county-level units were randomly chosen with a probability proportional to size (PPS) sampling technique from a sampling frame containing all county-level units with the exception of Tibet. The sample was stratified by region, rural/urban status, and per capita statistics on gross domestic product. In the second stage, three primary sampling units (PSU) were selected in each county with the PPS sampling technique. In the third stage, all of the households in each selected PSU were mapped, and 24 households were randomly selected from among all households within each PSU. Finally, for each selected household, one resident aged ≥ 45 years was randomly selected as a participant in the survey (13). The survey started in 2011 and was conducted every 2 years—3 surveys have been carried out so far, covering 28 provinces, 150 counties, and 450 villages of mainland China. Other details were described elsewhere (14). Ethics approval was not applicable for this study as it is an analysis of secondary data. Every subject signed an informed consent form for participating in the original survey. For more information, please refer to the web page "www.g2aging.org."

PARTICIPANTS

A total of 20,284 respondents were successfully interviewed in the 2015 wave. The inclusion criteria were as follows: age ≥ 45, and age, height, weight, and waist circumference (WC) measurements available. Exclusion criteria included: missing or unbelievable outlying data (e.g., weight > 200 kg or height > 3.0 m), and failure to fully comply with measurement standards (e.g., wearing shoes when measuring height, wearing bulky clothes when measuring WC); having been previously diagnosed with a malignant tumor; receiving psychiatric or psychological treatment, taking antidepressants, or taking tranquilizers or sleeping pills; having ever undergone a major accidental injury; having received medical treatment and/or having been ill in the previous month, which could have impacted sleep duration. At last, 7,891 respondents were included in the study.

MEASURES

Sociodemographic characteristics

Gender was categorized as male or female. Age was calculated by deduction from birth date to 2015. Middle-aged was defined as 45-60 years old, and elderly was defined as 60 years and above (15). Marital status was divided into 2 groups: married (married with spouse present, married but not living with spouse temporarily for reasons such as work, cohabitation), single (separated, divorced, widowed, never married). Medical insurance was divided into 2 groups: having medical insurance (urban employee medical insurance, urban resident medical insurance, government medical insurance, urban unemployed person's health insurance, private medical insurance purchased by work unit, private medical insurance purchased by individual, rural resident medical insurance, new cooperative medical insurance, urban and rural resident medical insurance, medical aid and other medical insurance), and no medical insurance. Participant education level (including adult education) was divided into 4 groups: illiterate (never undergone formal education), primary (did not finish primary school; sishu/home school; elementary school), secondary (middle school; high school; vocational school), college or high-

er (two-/three-year college/associate degree; four-year college/bachelor's degree; master's degree; doctoral degree/Ph.D., and above). Hukou refers to a legal document produced by the Chinese administrative agency in charge of household administration. It was used to record and retain basic information on the family population. It was categorized as agricultural and non-agricultural hukou. Most of the non-agricultural household population lives in the city and works in public institutions, factories, and other workplaces. They enjoy the convenience of the city. The agricultural household population primarily lives in villages and is mostly engaged in labor-intensive industries. The income of urban residents is significantly higher than that of rural residents (16). According the last main job respondents had, their job status was divided into 4 groups: agriculture work, employee (governments, institutions, firms, non-governmental organizations), retirement, and other.

Weight was measured to the nearest 0.1 kg by one of the investigators using a calibrated weight scale (Omron TMHN-286 Scale; Krill Technology (Yangzhou) Co., Ltd.), and all investigators had undergone systematic training. Height was measured to the nearest 0.1 cm using a stadiometer (Seca TM 213 Stadiometer; China Seca(Hangzhou) Co., Ltd.) without shoes (17). WC was measured using a soft measuring tape around the waist, at the level of the umbilicus, at the end of exhalation. The participants had to wear light clothes when their weight and WC were measured (1). Weight, height, and WC were measured once.

Adiposity

General obesity was defined as a body mass index (BMI) ≥ 27.5 (kg/m^2), according to WHO recommendations for Chinese individuals (18). BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

Abdominal obesity was defined as a WC ≥ 90 cm for men, and ≥ 80 cm for women, according to the International Diabetes Federation cutoffs for the Chinese (19).

Sleeping behavior

Participants were asked to recall their sleep duration and behaviors during the previous month. Nocturnal sleep duration was divided into 3 groups: < 7 hours/night, ≥ 7 hours/night and ≤ 9 hours/night, > 9 hours/night, based on the participant's response to 'During the past month, how many hours of actual sleep did you get at night (average hours for one night)?'. Participants with nocturnal sleep for < 7 hours/night were classified as with short nocturnal sleep duration. Those who slept for > 9 hours/night were classified as with long nocturnal sleep duration. Sleeping for 7-9 hours/night was considered an 'average sleep duration'. The classification of nocturnal sleep duration was based on current recommendations for adults (20,21). The duration of regular siesta was divided into 3 groups: having no regular siesta habit, short siesta duration (< 1 hour/day), long siesta duration (≥ 1 hour), based on the participant's response to 'During the past month, how long did you take a nap after lunch?'.

How often was a respondent's sleep restless during a week was asked, and answers were divided into 3 groups: rarely or never (< 1 day), sometimes or a few times (1-2 days), occasionally or a moderate number of times (3-4 days). This question partly reflects the quality of the participants' sleep.

Health behavior

Respondents were asked, 'I would like to ask whether you have or had the habit of smoking cigarettes/smoking a pipe/chewing tobacco, now or in the past. By smoking we mean smoking more than 100 cigarettes in your life'. Their smoking status was divided into 3 groups: non-smoker, ex-smoker, and active smoker. Respondents were also asked, 'Did you drink any alcoholic beverage such as beer, wine, or liquor during the past year? How often?'. Their drinking status was divided into 3 groups: non-drinker, ex-drinker, and drinker (≥ 1 drink per month).

Health status

Impaired physical function was defined as failure to finish any of the following activities independently: jogging, walking 1 km, walking 100 meters, getting up from a chair after sitting for a long period, climbing several flights of stairs without resting, stooping, kneeling or crouching, extending arms above shoulder level, lifting or carrying weights over 10 jin (5 kg), picking up a small coin from a table, dressing, bathing or showering, eating, getting into or out of bed, using the toilet, controlling urination and defecation, doing household chores, preparing hot meals, shopping for groceries, making phone calls, taking medications, managing own money.

Participants' depressive symptoms were assessed according to the Center for Epidemiological Studies Depression Scale (CES-D-10), based on participant responses to the question, 'The 10 items below refer to how you have felt and behaved during the last week. Choose the appropriate response'. The CES-D10 questionnaire contains 10 items with a 4-point scale: 0 = rarely or never (< 1 day); 1 = sometimes or a few times (1-2 days); 2 = occasionally or a moderate number of times (3-4 days); and 3 = most or all of the time (5-7 days). Each item score was summed up to generate the total CES-D10 score, which ranges from 0 to 30. A cutoff total score above 10 was defined as indicative of significant depressive symptoms (17).

Participants with a blood glucose concentration ≥ 126 mg/dL or currently taking antidiabetic drugs were defined as diabetic.

Blood pressure was measured 3 times by trained staff using calibrated automated manometers (Omron HEM-7200 Monitor), with the subjects at rest in a chair, with their arm at the same height as their heart.

An average of 3 readings of systolic (SBP) and diastolic blood pressure (DBP) was calculated to evaluate hypertension status.

Hypertension was defined as having been previously diagnosed with hypertension, being currently on treatment with antihypertensive medicines, or having a mean SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg.

Household information

A sedentary lifestyle directly affects calorie metabolism, and car owners may prefer to drive instead of walk, which means that they may burn fewer calories in their commute. Therefore, we categorized travelling mode based on whether the respondent had a car, and whether the building they were currently living in had an elevator, all of which was self-reported.

STATISTICAL ANALYSIS

All analyses were done using the statistical software IBM SPSS22 (SPSS, version 22.0, IBM Corporation, New York, NY, USA). P-values below 5 % were considered statistically significant. Data are presented as median and quartile for non-normally distributed continuous variables, and as numbers (percentage) for categorical variables. Differences in baseline characteristics between subgroups were examined using the Mann-Whitney U-test and the chi-squared test according to data distribution. Age was used as a continuous variable when analyzing the data. Multiple logistic regression analyses were carried out to detect association between variables and the primary outcome variable. Three logistic models, adjusted for different factors, were used to detect association between sleep duration and adiposity. Odds ratios (OR) and 95 % confidence intervals (CI) were calculated. ORs in model 1 were adjusted for sociodemographics (age, gender, marital status, level of education, job status, insurance, and hukou status). Model 2 included the adjusted factors in model 1 plus health status (functional limitation, depression, hypertension, diabetes, frequency of restless sleeping). Model 3, in turn, included the adjusted factors in model 2 plus health behaviors (smoking status, drinking habit, house has elevator, automobile traveler). Subjects with 5-9 hours of nocturnal sleep duration, without siesta habits, were considered as references during logistic analyses. Adjustments for the complex survey design and survey non-responses, post-stratification adjustment to match the total population, individual response adjustments, and blood samples were used in the weighted analysis.

RESULTS

DEMOGRAPHIC CHARACTERISTICS

Demographic and lifestyle characteristics, health status, sleep duration, and the prevalence of adiposity in study participants (middle-aged and elderly) are provided in table I.

Of the 7,891 respondents, 49.69 % were middle-aged and 50.31 % were elderly individuals. Middle-aged subjects tended to have a higher BMI (24.34 *versus* 23.34) and WC (87.00 *versus* 86.50), to be more educated (college and above account for 1.81 % *versus* 1.06 %), and to be more commonly married (95.70 % *versus* 81.78 %), current smokers (30.28 % *versus* 29.50 %) and drinkers (29.40 % *versus* 26.19 %) when compared to elderly individuals. The elderly were more likely to have hypertension (35.99 % *versus* 21.62 %), diabetes (11.65 % *versus* 7.32 %), functional limitations (9.61 % *versus* 2.72 %), and either longer (5.93 % *versus* 4.66 %) or shorter (44.07 % *versus* 41.34 %) nocturnal sleep durations when compared to the middle-aged group.

PREVALENCE OF GENERAL OBESITY AND ABDOMINAL OBESITY

We calculated the prevalence of general obesity and abdominal obesity by age group within each category of sleep duration (Table II). The prevalence of general obesity and abdominal obesity was significantly different across siesta duration groups in all subjects and the middle-aged group ($p < 0.05$). No statistical significance was found for differences in any other subgroup analysis.

ASSOCIATIONS BETWEEN NOCTURNAL SLEEP DURATION AND RISK OF ADIPOSITY BY AGE

The multivariable-adjusted odds ratios and 95 % CIs for adiposity across categories of nocturnal sleep duration are provided in table III.

We found no significant association between nocturnal sleep duration and general obesity or abdominal obesity in any of the subgroup analyses.

ASSOCIATIONS BETWEEN SIESTA DURATION AND RISK OF ADIPOSITY BY AGE

When compared to respondents without siesta habits, subjects with long siesta durations (≥ 1 hour) were significantly associated with increased risk of abdominal obesity, independently, in all subgroup analyses. ORs after adjusting for confounding factors were: all subjects, OR = 1.45, 95 % CI, 1.23 to 1.70; middle-aged, OR = 1.46, 95 % CI, 1.15 to 1.86; elderly, OR = 1.43, 95 % CI, 1.14 to 1.78).

For all subjects, when compared to respondents without siesta habits, short siesta duration (< 1 hour) was significantly associated with increased risk of abdominal obesity after adjusting for health status factors (OR = 1.28, 95 % CI, 1.04 to 1.58), but this association disappeared after adjusting for health behaviors (OR = 1.23, 95 % CI, 0.99 to 1.53). While long siesta duration was significantly associated with increased risk of general obesity in all subjects (OR = 1.29, 95 % CI, 1.06 to 1.58), no such association was observed in the middle-aged or the elderly groups (Table IV).

Table I. Sociodemographic characteristics of the study stratified by age group

Characteristics		Age groups				p
		Middle-aged		Elderly		
Total		3,903	49.69 %	3,988	50.31 %	
Abdominal obesity						
No		1,567	40.43 %	1,817	44.55 %	< 0.001
Yes		2,336	59.57 %	2,171	55.45 %	
General obesity						
No		3,270	84.53 %	3,561	88.84 %	< 0.001
Yes		633	15.47 %	427	15.16 %	
Age (years)*	(median and quartile)	52.00	49.00-56.00	66.00	63.00-72.00	< 0.001
WC (cm)*	(median and quartile)	87.00	80.00-94.00	86.50	79.40-93.60	0.006
BMI (kg/m^2)*	(median and quartile)	24.34	21.98-26.70	23.34	20.91-25.75	< 0.001
Gender						
Male		1,903	49.06 %	2,129	52.87 %	< 0.001
Female		2,000	50.94 %	1,859	47.13 %	
Marital status						
Married		3,737	95.70 %	3,298	81.78 %	< 0.001
Single		166	4.30 %	690	18.22 %	
Education groups						
Illiterate		433	11.11 %	1,135	28.43 %	
Primary		1,007	26.00 %	1,700	42.16 %	< 0.001
Secondary		1,342	33.94 %	726	18.09 %	
College or higher		54	1.81 %	48	1.06 %	
Insurance						
No		293	7.26 %	341	9.15 %	0.113
Yes		3,530	89.86 %	3,602	89.82 %	
Smoking						
Smoker		1,195	30.28 %	1,210	29.50 %	< 0.001
Ex-smoker		367	9.15 %	626	16.13 %	
Non-smoker		2,341	60.57 %	2,150	54.32 %	
Drinking						
Drinker		1,158	29.40 %	1,057	26.19 %	< 0.001
Non-drinker		2,191	56.24 %	2,181	55.14 %	
Ex-drinker		550	14.26 %	748	18.62 %	
Depression						
No		3,052	78.28 %	2,833	71.29 %	< 0.001
Yes		689	17.56 %	858	21.07 %	
Hukou status						
Agriculture hukou		2,544	64.06 %	2,903	77.89 %	< 0.001
Non-agricultural hukou		538	15.26 %	822	22.18 %	
Functional limitation						
No		3,790	97.28 %	3,609	90.39 %	< 0.001
Yes		113	2.72 %	379	9.61 %	

(Continuation in the next page)

Table I (Cont.). Sociodemographic characteristics of the study stratified by age group

Characteristics	Age groups				p
	Middle-aged		Elderly		
Hypertension					
No	3,033	77.48 %	2,511	63.12 %	< 0.001
Yes	841	21.62 %	1,441	35.99 %	
Diabetes					
No	2,898	74.24 %	2,893	72.22 %	< 0.001
Yes	280	7.32 %	475	11.65 %	
Job status					
Agriculture work	1,660	40.10 %	1,847	44.06 %	
Employee	522	14.31 %	172	4.49 %	< 0.001
Other	1,207	32.58 %	488	12.61 %	
Retirement	156	4.31 %	662	17.90 %	
House has elevator					
No	3,230	81.64 %	3,275	80.74 %	0.460
Yes	673	18.36 %	711	19.19 %	
Automobile traveler					
No	3,313	84.31 %	3,789	93.85 %	< 0.001
Yes	590	15.69 %	199	6.15 %	
Nocturnal sleep duration(hours/night)					
< 7	1,607	41.34 %	1,767	44.07 %	< 0.001
7-9	2,089	54.00 %	1,974	50.00 %	
> 9	207	4.66 %	247	5.93 %	
Frequency of restless sleeping					
< 1 day	588	14.42 %	602	14.47 %	0.908
1-2 days	637	15.97 %	637	16.54 %	
3-4 days	2,678	69.61 %	2,749	68.99 %	
Siesta duration (hours/day)					
No siesta	1,573	40.03 %	1,551	40.09 %	0.092
< 1	651	17.22 %	629	15.26 %	
≥ 1	1,664	42.15 %	1,793	44.29 %	

*WC: waist circumference; BMI: body mass index. *This variable was analyzed using the Mann-Whitney U-test.*

DISCUSSION

The results of previous studies regarding the relationship between sleep duration and adiposity differ. Discrepancies are partially explained by differences in the definitions of sleep duration categories and of adiposity, partially resulting from different research methods and populations. Controlling variables also varied from study to study (22,23). Most of them explained the relationship between nocturnal or total sleep duration on one day and the prevalence of adiposity. Data were limited for siesta duration or sleep pattern as related to adiposity. Our study explored the association between nocturnal sleep duration, siesta duration, and adiposity among middle-aged and elderly subjects. We found that, among the middle-aged and elderly populations, individuals with long siesta duration have more odds of having abdominal obesity when compared to those without regular siesta. To the best of our knowledge, this is the first study to explore the relationship between siesta duration and adiposity in Chinese middle-aged and elderly subjects.

Many studies show that short sleep duration is related to an increased risk of general obesity/abdominal obesity; most were conducted in adolescents, children, and/or young adults (24,25). Such results were not observed in our study. The National Sleep Foundation currently recommends sleeping seven to seventeen hours per 24-hour period, with age-specific recommendations decreasing as age increases (26).

Table II. Prevalence of adiposity in middle-aged and elderly Chinese subjects by habitual sleep duration

Subgroups	Nocturnal sleep duration category (hours/night)				Siesta duration category (hours/day)			
	< 7	7-9	> 9	p	No	< 1	≥ 1	p
All subjects	3,374	4,063	454		3,124	1,280	3,457	
General obesity	440 (12.51 %)	551 (13.78 %)	69 (14.97 %)	0.423	374 (11.40 %)	175 (13.83 %)	505 (14.81 %)	0.007
Abdominal obesity	1919 (56.35 %)	2,346 (58.89 %)	242 (53.09 %)	0.181	1,712 (54.59 %)	776 (60.31 %)	2,002 (59.33 %)	0.001
Middle-aged	1,607	2089	207		1,573	651	1,664	
General obesity	251 (12.51 %)	343 (13.78 %)	39 (14.97 %)	0.464	223 (11.40 %)	112 (13.83 %)	294 (14.81 %)	0.019
Abdominal obesity	940 (56.35 %)	1,275 (58.89 %)	121 (53.09 %)	0.270	897 (54.59 %)	412 (60.31 %)	1,018 (59.33 %)	0.008
Elderly	1,767	1,974	247		1,551	629	1,793	
General obesity	189 (10.16 %)	208 (12.02 %)	30 (11.31 %)	0.743	151 (9.85 %)	63 (10.16 %)	211 (12.60 %)	0.138
Abdominal obesity	979 (55.88 %)	1,071 (55.84 %)	121 (48.91 %)	0.161	815 (53.07 %)	364 (59.04 %)	984 (56.35 %)	0.068

Table III. Associations between nocturnal sleep duration and risk of adiposity in middle-aged and elderly Chinese subjects

Subgroups	Nocturnal sleep duration category (hours/night)		
	< 7	7-9	> 9
General obesity			
All subjects	3,374	4,063	454
Model 1[a]	0.91 (0.76, 1.08)	1	1.20 (0.83, 1.73)
Model 2[b]	0.85 (0.69, 1.04)	1	1.13 (0.76, 1.69)
Model 3[c]	0.85 (0.69, 1.05)	1	1.11 (0.74, 1.67)
Middle-aged	1,607	2,089	207
Model 1[a]	0.86 (0.68, 1.10)	1	1.12 (0.68, 1.85)
Model 2[b]	0.87 (0.66, 1.15)	1	0.97 (0.56, 1.70)
Model 3[c]	1.02 (0.65, 1.57)	1	0.96 (0.54, 1.70)
Elderly	1,767	1,974	247
Model 1[a]	0.96 (0.73, 1.25)	1	1.31 (0.77, 2.24)
Model 2[b]	0.83 (0.60, 1.13)	1	1.24 (0.68, 2.26)
Model 3[c]	0.82 (0.60, 1.23)	1	1.21 (0.66, 2.23)
Abdominal obesity			
All subjects	3,374	4,063	454
Model 1[a]	0.88 (0.77, 1.00)	1.00	0.91 (0.69, 1.20)
Model 2[b]	0.87 (0.75, 1.01)	1.00	0.86 (0.63, 1.17)
Model 3[c]	0.87 (0.75, 1.01)	1.00	0.86 (0.62, 1.18)
Middle-aged	1,607	2,089	207
Model 1[a]	0.83 (0.69, 1.01)	1.00	0.78 (0.52, 1.18)
Model 2[b]	0.84 (0.67, 1.05)	1.00	0.65 (0.41, 1.04)
Model 3[c]	0.84 (0.67, 1.06)	1.00	0.63 (0.39, 1.02)
Elderly	1,767	1,974	247
Model 1[a]	0.91 (0.76, 1.09)	1.00	1.04 (0.72, 1.50)
Model 2[b]	0.89 (0.72, 1.09)	1.00	1.08 (0.71, 1.65)
Model 3[c]	0.89 (0.72, 1.10)	1.00	1.07 (0.70, 1.65)

*[a]OR was adjusted for age, gender, marital status, level of education, job status, insurance, hukou status. [b]OR was adjusted for factors in model 1 plus health status (functional limitation, depression, hypertension, diabetes, frequency of restless sleeping). [c]OR was adjusted for factors in model 2 plus health behaviors (smoking status, drinking status, house with elevator, automobile traveler). *p < 0.05. Data are presented as odd ratio (95 % confidence interval).*

Table IV. Associations between siesta duration and risk of adiposity in middle-aged and elderly Chinese subjects

Subgroups	Siesta duration category (hours/day)		
	No	< 1	≥ 1
General obesity			
All subjects	3,124	1,280	3,457
Model 1[a]	1.00	1.15 (0.92, 1.45)	1.27 (1.07, 1.52)*
Model 2[b]	1.00	1.11 (0.85, 1.44)	1.27 (1.04, 1.54)*
Model 3[c]	1.00	1.08 (0.83, 1.41)	1.29 (1.06, 1.58)*
Middle-aged	1,573	651	1,664
Model 1[a]	1.00	1.34 (0.99, 1.83)	1.36 (1.07, 1.74)*
Model 2[b]	1.00	1.26 (0.89, 1.79)	1.28 (0.97, 1.68)
Model 3[c]	1.00	1.20 (0.84, 1.71)	1.29 (0.97, 1.70)
Elderly	1,551	629	1,793
Model 1[a]	1.00	0.93 (0.65, 1.33)	1.19 (0.92, 1.53)
Model 2[b]	1.00	0.91 (0.60, 1.36)	1.31 (0.98, 1.75)
Model 3[c]	1.00	0.88 (0.59, 1.33)	1.31 (0.98, 1.76)
Abdominal obesity			
All subjects	3,124	1,280	3,457
Model 1[a]	1.00	1.23 (1.02, 1.47)*	1.42 (1.23, 1.63)*
Model 2[b]	1.00	1.28 (1.04, 1.58)*	1.46 (1.24, 1.72)*
Model 3[c]	1.00	1.23 (0.99, 1.53)	1.45 (1.23, 1.70)*
Middle-aged	1,573	651	1,664
Model 1[a]	1.00	1.28 (0.98, 1.68)	1.41 (1.15, 1.73)*
Model 2[b]	1.00	1.40 (1.02, 1.92)*	1.46 (1.15, 1.85)*
Model 3[c]	1.00	1.32 (0.95, 1.81)	1.46 (1.15, 1.86)*
Elderly	1,551	629	1,793
Model 1[a]	1.00	1.14 (0.88, 1.47)	1.42 (1.17, 1.72)*
Model 2[b]	1.00	1.14 (0.85, 1.53)	1.45 (1.17, 1.82)*
Model 3[c]	1.00	1.12 (0.83, 1.50)	1.43 (1.14, 1.78)*

*[a]OR was adjusted for age, gender, marital status, level of education, job status, insurance, hukou status. [b]OR was adjusted for factors in model 1 plus health status (functional limitation, depression, hypertension, diabetes, frequency of restless sleeping). [c]OR was adjusted for factors in model 2 plus health behaviors (smoking status, drinking status, house with elevator, automobile traveler). *p < 0.05. Data are presented as odd ratio (95 % confidence interval).*

That is primarily due to the use of different study methods and different populations, and also increased adiposity is linked to multiple causes of death -obese individuals are more likely to not survive to old age (27). In the present study we found no significant associations between long nocturnal sleep duration and adiposity. Another study conducted in China also did not find a significant association between long nocturnal sleep duration with abdominal obesity among adults (30-79 years old) (11), which is in line with our study. Furthermore, previous studies conducted in Korea and China found that people with long nocturnal sleep durations have a reduced risk of adiposity (28,29). It is worth noting that only 207 middle-aged and 247 elderly subjects had long nocturnal sleep durations in our study- due to this limited sample size, the relationship between long nocturnal sleep duration and adiposity needs to be further explored.

In the present study people with long siesta durations had more odds of having general obesity when all subjects were considered, but this relation was not found in any of the subgroup analyses. This is partially due to the varying sample size of the subgroups of interest, and partially due to the interaction effect between age and siesta duration on the prevalence of general obesity. The present study only explored the relationship between sleep duration and general obesity: the relationship between sleep duration and overweight, obesity, and overweight plus obesity needs to be further explored.

Researchers suggested that long and late nappers may have a higher risk of poor nocturnal sleep quality (30). Compared with younger adults, older adults are often retired, and may have more opportunities to take naps during daytime. Excessive day-

time sleepiness was inversely associated with abdominal obesity, health status, and increased all-cause mortality risk in various populations (31,32). In our study, we found that individuals with long siesta durations had more odds of having abdominal obesity when compared to those without regular siesta habits within both the middle-aged and elderly groups, even when confounding factors were adjusted for. A study conducted in Spanish elderly subjects suggested that longer daytime napping (objectively measured) is associated with a higher prevalence of type-2 diabetes (T2D) (≥ 90 min/day), and greater adiposity measures (≥ 30 min/day) (32). Long daytime napping (≥ 1.5 h) was associated with an increased risk of renal hyperfiltration in the general Chinese population (1). The cut-off point for long daytime napping remained unclear, and different cut-off points were associated with different health outcomes across different populations. Napping ≥ 30 min per day may have induced elevations in post-nap cortisol levels which, in turn, may increase fat deposition among people 54-87 years old (34). We speculate that this mechanism may cause fat mainly to accumulate in the abdomen. The causes of the increased chronic cortisol levels seen in the majority of people with obesity have not been fully elucidated. The mechanisms underlying increased cortisol exposure in obesity may lead to a more effective implementation of cortisol-lowering therapies and potential new treatment targets (35). The present study may provide clues for decreasing the prevalence of abdominal obesity by changing sleep behaviors and duration.

A study suggested nappers with poor night-time sleep are associated with adverse health outcomes, rather than those with good night-time sleep (36). And the timing of siesta matters with respect to same-day nocturnal sleep duration (37). A cohort study observed that people who took a siesta for 30 min/day had a lower risk of becoming obese (38). However, our study did not find any significant associations between short siesta duration and adiposity among the middle-aged and the elderly. The results of the above studies suggested that both siesta timing and duration have health implications. A review study suggested that napping is a particularly effective countermeasure in younger adults and the professional population (night and shift work schedules) (39). As far as the body composition of middle-aged and elderly individuals is concerned, is siesta good, bad, or neither? It is not yet possible to come to conclusions on the deleterious effect of siesta on abdominal obesity considering that sleep was a complex behavior consisting of interdependent siesta and nocturnal sleep occurrences of varying timing, lengths, and quality (36). Sleep patterns integrating siesta and nocturnal sleep and their relationship to abdominal obesity among the middle-aged and elderly population should be further assessed in a real-life environment.

LIMITATIONS

Several limitations should be addressed in our study. First, this is a cross-sectional survey research. There may be no causal relationship between variables and the primary outcome variable. For example, it may be that sleep duration influences the occurrence of adiposity. In contrast, it is also likely that adiposity may affect sleep duration and quality. Secondly, no well-defined sleep quality questionnaire was available, although elderly respondents always reported poor sleep quality. Information on sleep habits was also unavailable—for example, frequency of daytime naps, and the timing of siesta and nocturnal sleep. Therefore, this study did not analyze the relationship between sleep quality or sleep pattern and adiposity. In the third place, sleep duration was self-reported by respondents in our study. Self-reported total sleep duration was overestimated by 60 minutes when compared to wrist actigraphy recordings in Chinese adults (40). Recall bias is unavoidable in this study. Lastly, most of the respondents' physical activities remained unknown and were not taken into account for the analysis. Since the intensity of physical activity required for work is variable, the adjustment for job status during the analysis to some extent reflects the physical activities performed by the respondents. Given the above limitations, additional prospective studies are warranted to examine the effects of sleep patterns on adiposity, and to establish critical windows of vulnerability for potential effects.

CONCLUSIONS

In conclusion, our data show that sleep duration does play an important role in the prevalence of abdominal obesity. Our findings demonstrate that both middle-aged and elderly subjects with long siesta durations are more likely to exhibit abdominal obesity. No association between siesta duration, nocturnal sleep duration, and general obesity was observed in the middle-aged and elderly groups. Our findings need to be confirmed by prospective studies.

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