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Dinner fat intake and sleep duration and self-reported sleep parameters over five years: Findings from the Jiangsu Nutrition Study of Chinese adults

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ABSTRACT

Objectives: Cross-sectional studies have indicated an association between fat intake and short sleep. However, whether the association differs by meal occasions, and remains in the long term, is unknown. This study aimed to determine the association between meal specific macronutrients intake (by eating occasions) and persistent short sleep over 5 y.
Methods: Data from 1474 Chinese subjects from the Jiangsu Nutrition Study were analyzed. Two time points were examined (i.e., baseline in 2002 and follow-up in 2007). Meal specific food and macronutrients intake was assessed using three-day weighed food records. Sleep duration and sleep related symptoms (daytime sleepiness and falling asleep) were self-reported using a sleep questionnaire. Persistent short sleep was defined as <7 h/d in 2002 and ≤7 h/d in 2007.
Results: Overall, 7.4% of the participants reported persistent short sleep. Fluctuation of sleep duration over 5 y was observed with an increase in short-duration sleepers (<7 h) and a decrease in long-duration sleepers (9 h). The highest quartile of fat intake from dinner at baseline was associated with persistent short sleep over 5 y (odds ratio 3.30, 95% confidence interval 1.40–7.79, *P* for trend 0.003). The highest quartile of fat intake from breakfast at baseline was associated with less falling asleep during the day at follow up (odds ratio 0.36, 95% confidence interval 0.14–0.94, *P* for trend 0.006). Dinner fat intake at baseline was not associated with short sleep (<7 h) at follow up.
Conclusion: The association between fat intake and sleep varies according to how late or how early in the day a meal is eaten by meal occasions. While a high-fat breakfast may prevent daytime falling asleep, a high-fat dinner is—in the case of the Chinese adults of our study—associated with persistent short sleep in Chinese adults.

Introduction

The prevalence of short sleep (≤6 h/d) has been estimated at 29.9%, and an approximate increase in short sleep of 5 to 6% was observed in recent decades in the United States [1]. In China, sleep duration is relatively longer than in Western countries, with approximately 67% sleeping 7 to 8 hour/d and 11% sleeping less or equal to 6 hour/d [2]. Decreased sleep duration has been found to be associated with a range of chronic cardio-metabolic consequences [3,4].

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Diet has been shown to play a role in sleep regulation [5]. Increasing evidence has revealed an interaction between nutrition and the circadian clock [6]. In mice, the gut microbiome can be induced by high-fat feeding to modulate circadian clock gene expression [7]. Epidemiologic studies have suggested a reciprocal positive association between fat intake and short sleep in both children and adults [8,9]. Given that dietary macronutrient composition could alter the function of the central and peripheral circadian clocks in humans [10], the relationship between macronutrient composition from different meal occasions and cardio-metabolic consequences is receiving increasing attention. In mice fed with a high-fat diet, late-fed mice had a higher weight gain and blood glucose level, despite the same total fat and energy intake compared with early-fed mice [11]. In a British birth cohort study, higher energy intake at breakfast was associated with lower hypertension prevalence at baseline, and higher energy intake at late evening had higher odds of hypertension incident 10 y later [12]. Furthermore, increasing carbohydrate intake in the morning while reducing fat intake is inversely associated with the development of metabolic syndrome [13]. However, no population studies have assessed the association among the timing of macronutrients intake, sleep duration, and sleep-related symptoms.

In the Jiangsu Nutrition study, a positive cross-sectional association between fat intake and short sleep (<7 h/d) was found [9], but whether the association differs by meal occasions and persists longitudinally is unknown. Given the sparse literature on the association between macronutrients intake and sleep, particularly in the Chinese population, studying occasional macronutrients intake and sleep over a period will provide better understanding of the association and also may help further studies in different populations. We hypothesized occasional macronutrients intake, particularly fat intake, would be associated with short sleep duration over 5 y. Therefore, in the present study, we aimed to assess the following among Chinese adults: 1) the association between baseline meal specific macronutrients intake and persistent short sleep status over 5 y; 2) the association between baseline meal specific macronutrient intake and self-reported sleepiness and falling asleep at follow up using five-year longitudinal data from the Jiangsu Nutrition Study.

Materials and methods

Subjects

Data from the Jiangsu Nutrition Study cohort with subjects older than 20 y old were used in the present study. Detailed methodology has been described previously [14]. In brief, in 2002, 2849 adults at least 20 y old living in two cities and six rural areas in Jiangsu Province took part in the Chinese National Nutrition and Health Survey. In 2007, an attempt to recontact all the original participants was made. Due to the attrition, 1682 were identified for follow-up, 1492 participated in the follow-up interview. For the current analysis, we included only those subjects with sleep duration records in both 2002 and 2007 (n = 1474). The study was conducted according to the guidelines in the Declaration of Helsinki, and all procedures were approved by the Jiangsu Provincial Centre for Disease Control and Prevention. Informed consent for participation was obtained from each participant.

Data collection and measurements

Participants were interviewed at their homes by trained health workers using a precoded questionnaire. Interviews took about 2 h to complete and included questions on diet, sociodemographic information, medical history, cigarette smoking, physical activity, and other lifestyle factors.

Dietary intake

Dietary data were obtained by food weighing plus consecutive individual 3-d food records [9]. Predefined meal occasions were provided, including "breakfast", "lunch", "dinner", "snacks between breakfast and lunch", "snacks between lunch and dinner", and "snacks after dinner". Mean intake of carbohydrate, protein, and fat (in g) from each meal was calculated according to the Chinese food composition table [15]. As food intake was measured by weighted food records, we did not consider under- or overreporting for energy intake as a problem. Health workers reviewed the food diaries during their daily household visit and would clarify any values for particular foods that fell below or above the usual value in the study area. Total energy intake was estimated from the three-day weighed food records.

Sleep measurement

At baseline in 2002, only sleep duration was collected but additional sleep related symptoms were collected at follow up in 2007. The sleep questionnaire was adapted from a validated Finnish questionnaire to screen for sleep disturbances and sleep apnea [16]. Sleep duration was determined by the question "How many hours do you usually sleep each day?" Sleep duration was categorized into three categories: <7 h/d, 7 to 8 h/d, and ≥9 h/d. Extended periods of sleep duration (≥14 h/d) was excluded. Sleep symptoms such as daytime sleepiness and falling asleep were assessed in 2007. Daytime sleepiness was determined by the question "Do you feel sleepy during the day?"Falling asleep during the day was determined by the question "Do you fall asleep involuntarily during the day?"

Anthropometric measurement and other variables

In 2002 and 2007, anthropometry was conducted using standard protocols and techniques. Body weight was measured in light indoor clothing without shoes to the nearest 0.1 kg. Height was measured without shoes to the nearest mm using a stadiometer. Body mass index (BMI, kg/m^2) was categorized into four groups, which included underweight (<18.5), normal weight (18.5–23.9), overweight (24–27.9), and obese (≥28), according to the guideline for Chinese adults [17]. Waist circumference was measured to the nearest mm midway between the inferior margin of the last rib and the crest of the ilium, in the midauxillary line in a horizontal plane. Blood pressure was measured twice with a mercury sphygmomanometer on the right upper arm of the subject, who was seated for 5 min before the measurement. The mean of these two measurements was used in the analyses. Hypertension was defined as a systolic blood pressure above 140 mmHg and/or a diastolic blood pressure above 90 mmHg or the use of antihypertensive drugs.

Cigarette smoking was assessed by asking the frequency of daily cigarette smoking in the past 30 d. Alcohol consumption was estimated based on the three-day weighed food records. Education was recoded into either "Low" (illiteracy, primary school); "Medium" (junior middle school); or, "High" (high middle school or higher), based on six categories of education levels in the questionnaire. Occupation was recoded into "Manual" or "Non-manual" based on a question with 12 occupational categories. Sedentary activity was recoded into four categories: <1 h/d, 1–2 hs/d, 2–3 hs/d, and ≥3 hs/d based on the questions asked on the hours spent per day on sedentary activities including watching TV, reading, computer using and video games. Family history of hypertension (yes/no) was asked at baseline and follow-up.

Statistics analysis

Meal specific (breakfast, lunch, and dinner) macronutrients intakes (g) were recoded into quartiles. Chi-square tests were used to compare the differences between categorical variables, and analysis of variance was performed to compare differences in continuous variables between groups. The lowest quartile of meal specific macronutrients intake was used as the reference group in different models. The association between meal specific macronutrients intake and sleep measures were determined by logistic or Poisson (for prevalence >10%) regression adjusting for age, sex, energy intake, BMI, smoking, alcohol consumption, education, occupation, sedentary activity, and family history of hypertension. We identified persistent short sleep as "<7 h/d at baseline" and "≤7 h/d at follow up."

Currently there is no consensus on the definition of short sleep. While the Western population has a prevalence of ≤6 h/d at 30% [1], it was only about 11% in Chinese population (age range 18–90 in both genders) [2]. This may indicate that average sleep duration in Chinese population is relatively longer than western populations. We tested for a liner trend across quartiles of macronutrient intakes by assigning each participant the median value of each macronutrients intake from certain meals at each quartile and modelling this value as a continuous variable. Interactions between macronutrients intake and sex, being overweight, job, and region were conducted by adding a multiplicative term with sex, being overweight, job, and region as a binary variable and the quartiles of macronutrients intake as category variable in fully adjusted models. Sensitivity analysis was performed to assess the association between meal specific macronutrients intake (standardized value treated as continuous variable) and persistent short sleep (<7 h/d at both baseline and follow up). All