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Daytime napping, sleep duration and increased 8-year risk of type 2 diabetes in a British population

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Abstract *Background and aims:* Few studies have prospectively examined the relationship between daytime napping and risk of type 2 diabetes. We aimed to study the effects of daytime napping and the joint effects of napping and sleep duration in predicting type 2 diabetes risk in a middle- to older-aged British population.

Methods and results: In 1998–2000, 13 465 individuals with no known diabetes participating in the European Prospective Investigation into Cancer-Norfolk study reported daytime napping habit and 24-h sleep duration. Incident type 2 diabetes cases were identified through multiple data sources until 31 July 2006. After adjustment for age and sex, daytime napping was associated with a 58% higher diabetes risk. Further adjustment for education, marital status, smoking, alcohol intake, physical activity, comorbidities and hypnotic drug use had little influence on the association, but additional adjustment for BMI and Waist Circumference attenuated the Odds ratio (OR) (95% CI) to 1.30 (1.01, 1.69). The adjusted ORs (95% CI) associated with short and long sleep duration were 1.46 (1.10, 1.90) and 1.64 (1.16, 2.32), respectively. When sleep duration and daytime napping were examined together, the risk of developing diabetes more than doubled for those who took day naps and had less than 6 h of sleep, compared to those who did not nap and had 6–8 h of sleep.

Conclusion: Daytime napping was associated with an increased risk of type 2 diabetes, particularly when combined with short sleep duration. Further physiological studies are needed to confirm the interaction between different domains of sleep in relation to diabetes risk.

Introduction

The association between sleep and diabetes has attracted extensive attention in the last decade [1]. Sleep duration has been the centre of the discussion, with several meta-analysis confirming a U-shaped relationship between sleep duration and risk of type 2 diabetes [2,3]. More recently, a potential link between daytime napping and type 2 diabetes has been reported. Cross-sectional studies have suggested that napping was associated with an increased prevalence of diabetes or impaired fasting plasma glucose in Chinese older adults [4,5], and in White postmenopausal women [6]. This raises questions as to whether daytime napping could simply be a consequence of diabetes. Indeed, the Health ABC study showed earlier in 235 older adults that the odds of day napping, as recorded by wrist actigraphs, was five times higher in individuals

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with diabetes compared to those without [7]. As such, prospective study designs may help determine the nature of this relationship.

To date only two published prospective studies with diabetes as the primary outcome have attempted to address this issue. One study concluded that day napping may be an independent risk factor for self-reported incident diabetes in an American population [8]. The association was modestly attenuated by adjustment for Body Mass Index (BMI), and was stronger among those with short nighttime sleep durations. A more recent study [9] found a non-significant association between frequent napping and incident type 2 diabetes in a middle-aged Finnish population, after accounting for BMI. These intriguing findings, particularly the joint effects of daytime and nighttime sleep and the influence of obesity need to be confirmed by larger prospective studies with validated ascertainment of diabetes cases, and with consideration of a wider range of anthropometric measures. Moreover, since daytime napping has a strong cultural implication, it is important to compare findings in different cultural settings.

We set out to study the prospective association between daytime napping and the risk of type 2 diabetes in a middle- to older-aged British population. Specifically this study aimed to test the role of anthropometric measures, and whether there is an interaction between daytime napping and sleep duration in relation to diabetes risk.

Methods

Study population

Participants were drawn from the European Prospective Investigation of Cancer-Norfolk (EPIC-Norfolk) cohort study, which is part of an ongoing multi-centre prospective cohort study [10]. Details of the design of the study have been described previously [11]. Briefly, a total of 25 639 men and women aged 40–74 years attended the baseline health check during 1993–1997, and were then followed up for two further health checks from 1996 to 2000 and from 2006 to 2011. In between these health examinations, participants were sent various questionnaires, which contained questions on sleep characteristics. The Norwich District Ethics Committee approved the study and all participants gave signed informed consent.

Measures

Participants were asked to report their daytime napping habit during 1998–2000. This information was collected through a yes-no question "Do you normally take a nap during the day?" In addition, participants were asked "On average, how many hours do you sleep in a 24 h period?" with six response options: "<4, 4–6, 6–8, 8–10, 10–12 and >12".

All covariates were chosen a-priori based on their relevance to sleep and diabetes [12–14]. Socio-demographic information were obtained through the baseline health questionnaire, and included age, sex, educational (highest qualification attained: no qualifications, educated to age 16 years, educated to age 18 years, or educated to degree level), and marital status (single, married, widowed, separated, or divorced). The follow up health questionnaire collected information on smoking status (current, former, or non-smokers), alcohol intake (units of alcohol drunk per week) and hypnotic drug use (yes/no). Physical activity levels was reported in four categories (inactive, moderately inactive, moderately active, or active) through a validated questionnaire [15]. Comorbidities included self-reported cardiovascular diseases (CVD), cancer, asthma and bronchitis. Anthropometric measures included objective assessed BMI (weight in kilograms divided by height in meters squared) and waist circumference (WC). WC was defined as the smallest circumference between the ribs and iliac crest, or at the level of the umbilicus if there was no natural waistline, and was measured to the nearest 0.1 cm with the volunteers standing with abdomen relaxed at the end of a normal expiration.

Participants who reported doctor-diagnosed diabetes or diabetes-specific medication use at the time of sleep measurement were excluded from the analysis (n = 629). The final study sample included 13 465 participants with complete information on daytime napping and the covariates. Incident type 2 diabetes cases were identified through multiple data sources [16] until 31 July 2006. These included self-reported doctor-diagnosed diabetes cases and diabetes-specific medication use, verified through record linkage with the general practice diabetes register, local hospital diabetes register, hospital admissions data and Office of National Statistics death certificate data with coding for diabetes. A new case was defined by a doctor's diagnosis of type 2 diabetes with no insulin prescribed within the first year following diagnosis and/or a glycated haemoglobin (HbA1c) level of greater than 7 percent at the health check. Self-reported diabetes cases that could not be verified were not included as incident cases.

Statistical analysis

Baseline characteristics of the participants were firstly compared by daytime napping (yes/no), using Pearson's χ^2 test for categorical variables and student's t-test for continuous variables. As the influence of sex on BMI and WC is potentially important, the sex-specific mean (SD) of these two measures were presented. Multivariable logistic regression was used to obtain OR (95% CI) for incident diabetes by daytime napping (with no napping being the reference group), and by sleep duration (with 6–8 h being the reference group, due to the U-shaped relationship reported previously [3]). Three models were fitted with progressive adjustment of the covariates: Model A adjusted for age and sex; model B further adjusted for education, marital status, smoking status, alcohol intake, physical activity, comorbidities and hypnotic drug use; model C additionally accounted for BMI and WC.

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