Original Article

Napping and the risk of type 2 diabetes: a population-based prospective study

Christer Hublin [a,b,*], Mikko Lehtovirta [c], Markku Partinen [b,d], Markku Koskenvuo [b], Jaakko Kaprio [b,c,e]

[a] Finnish Institute of Occupational Health, Helsinki, Finland
[b] Department of Public Health, University of Helsinki, Helsinki, Finland
[c] Institute for Molecular Medicine Finland, University of Helsinki, Helsinki, Finland
[d] Helsinki Sleep Clinic, Vitalmed Research Centre, Helsinki, Finland
[e] National Institute for Health and Welfare, Helsinki, Finland

ARTICLE INFO

ABSTRACT

Objective: Some studies indicate an association between napping and increased risk of type 2 diabetes. We studied this prospectively in a sample representative of general population.
Methods: A questionnaire was administered to the Finnish Twin Cohort in 1990 (response rate 77%, age 33–60 years). The study population included 12,244 subjects who replied to the question "Do you sleep during the daytime (take naps)?" with five response alternatives ranging from "no need" to "every or almost every day." Information on incident cases of diabetes was obtained by linkage to nationwide registers. Logistic regression models were used to obtain odds ratios (ORs) (95% confidence intervals) for incident type 2 diabetes risk in 1991–2004 by napping category. Adjustments were made for 11 socio-demographic and lifestyle covariates. For subjects aged 33–45 years at baseline, a questionnaire in 2011 provided information on prevalent diabetes.
Results: Thirty-four per cent had no need for napping, and 15% did so on ≥3 days weekly. There were 356 incident type 2 diabetes cases during the follow-up. Using the 'no need' category as the reference, the risk of type 2 diabetes was significantly increased only among those napping most frequently [OR 1.86 (1.29–2.67), age- and sex-adjusted]. After adjusting for other covariates, the results were essentially the same, but when adjusted for body mass index, the association decreased (to about 1.3) and was statistically non-significant. Analysis of 2011 self-reported type 2 diabetes was in line with the register data.
Conclusions: Frequent napping is associated with future risk of type 2 diabetes. This association is largely explained by obesity.

© 2015 Elsevier B.V. All rights reserved.

1. Introduction

A growing number of epidemiological studies have linked sleep disturbances (insufficient sleep, fragmented sleep, circadian dysregulation, and obstructive sleep apnea) with adverse metabolic sequelae, including obesity, insulin resistance, and type 2 diabetes [1]. Also, short sleep (less than 5–6 h per night) and long sleep (8 h or more), as well as insomnia symptoms, are associated with a significantly increased risk of type 2 diabetes [2].

Napping is a common cross-cultural phenomenon occurring across the lifespan and increasing with advancing age [3]. There are, however, no widely accepted definitions or criteria of napping; it

usually refers to brief periods of daytime sleep (lasting less than several hours). Naps have also been used as a countermeasure to sleepiness during night shifts at work. In a review of earlier napping literature, Dinges [4] concluded that three-quarters of adults reported napping and the usual duration was from about 30 to 90 min. Later, Pilcher et al. [5] showed in a one-week sleep-log study in a group of young and middle-aged adults that in almost half of them, the average nap lasted less than 20 min (often called power naps).

Napping has been regarded both as a health-promoting habit [3] and as a risk factor, or a proxy, for a variety of chronic conditions [6] and mortality [7]. Among the most notable of these adversities are obesity and metabolic syndrome [8]. Obesity is both a major risk factor for type 2 diabetes [9] and also increases the risk for sleep-disordered breathing, especially obstructive sleep apnea [10]. Furthermore, while excessive daytime sleepiness and need for naps can result from poor sleep, it has also been shown that a shared

underlying factor, like chronic stress exposure, both promotes obesity and deteriorates sleep [11].

Contrary to the many studies on other aspects of sleep and metabolic changes, there are only few reports of the association between napping and diabetes [8,12–15], fasting hyperglycemia [16], glycated hemoglobin, or insulin resistance [17], respectively. These available studies suggest an association between napping and diabetes (mainly type 2 diabetes) or impaired glucose regulation. However, the direction of possible causation and the existence of known or unknown confounders have been inadequately explored.

1.1. Aims

In this study we assessed the association between napping and the risk of type 2 diabetes in a large, prospective, population-based cohort of Finnish adult twins, with 14-year follow-up data and detailed information on potential confounding or effect-modifying factors, and information on incident cases of diabetes from nationwide registers. We also examined the association among a subset of twins replying to a follow-up questionnaire. We wanted especially to address the role of obesity in this association.

2. Methods

2.1. Population sample

The Older Finnish Twin Cohort is a longitudinal study of Finnish twin pairs of the same gender born before 1958 with both co-twins alive in 1975. These pairs were selected from the Central Population Registry of Finland in 1974 [18]. Zygosity was determined using an accurate and validated questionnaire method [19]. The third questionnaire survey in 1990 was mailed to pairs born in 1930–1957 with both co-twins resident in Finland in 1987, and 16,179 twin individuals could be contacted (response rate 77.3%; *N* = 12,502; 54.4% women; mean age in 1990 43.9 years). The questionnaire included 103 multiple-choice questions, of which 22 were sleep- and vigilance-related. A fourth questionnaire survey was conducted in 2011–2012 among twins born in 1945–1957 [20]. This subpopulation included 5419 subjects (450 type 2 diabetes cases) who replied in both 1990 and 2011.

The ethical committee of the Department of Public Health, University of Helsinki has approved the study. Informed consent was obtained from all respondents.

2.2. Questionnaire and register data

The study population included 12,244 subjects who replied to the question "Do you sleep during the daytime (take naps)?" with response alternatives: (1) no need; (2) I would like to but I cannot sleep during the daytime; (3) on two days weekly or more seldom; (4) on three to five days weekly; or (5) every or almost every day. Additionally there were questions on working (working outside home / housekeeper, working at home / retired / studying / unemployed); working time (regular daytime work / regular nighttime work / shiftwork without nightshift / shiftwork with nightshift / not working) [21]; height in cm and weight in kg to calculate BMI as (weight in kg)/(height in meters)^2; use of alcohol (more than five bottles of beer or comparable amount at least once monthly yes/ no, number of pass outs during the last year) [22,23]; smoking (never / occasional / former / current); sleep length (6 h or less / 6.5 / 7 / 7.5 / 8 / 8.5 / 9 / 9.5 / 10 h or more) [24]; and excessive sleepiness in the morning or during the day [25]; snoring; and insomnia (all asked using the following alternatives: every or almost every day / three to five days weekly / one to two days weekly / less than weekly / less than monthly or never) [21]. Information on diurnal type was from the 1981 questionnaire, using the question, "Will you try to estimate to what extent you are a morning or an evening person" with reply alternatives, "I am clearly a morning person", "I am to some extent a morning person", "I am to some extent an evening person", and "I am clearly an evening person" [26]. The 2011 questionnaire included a self-report of type 2 diabetes.

Information on incident cases of diabetes in 1991–2004 was obtained by linkage of nationwide registers, using the unique personal ID assigned to all Finns, from death certificates, the National Hospital Discharge Register and the Medication Register of the Social Insurance Institution, and classified as type 1 diabetes, type 2 diabetes, and other as described in detail elsewhere [9,27]. Those having diabetes onset prior to 1991 were excluded based on 1975 and 1981 questionnaire data and on follow-up from nationwide registers during 1975–1991. Data on vital status during follow-up were obtained from the Population Register Centre of Finland, which holds information on deaths, migration, or current address in Finland. In the fourth questionnaire survey in 2011, subjects were asked if they had ever been diagnosed with diabetes by a physician. Response alternatives were: never; no but elevated blood sugar; gestational diabetes; type 1 diabetes; type 2 diabetes; could not say which type of diabetes. We examined risk of type 2 diabetes vs never in relation to napping.

2.3. Data analysis and statistical methods

Standard statistical methods were used in data analysis and implemented in the Stata package (version 13.1, Stata Corp, College Station, TX, USA, www.stata.com). Logistic regression models were used to obtain odds ratios (ORs) and their 95% confidence intervals (CI) for risk of incident type 2 diabetes by napping class (no need; I would like to but I cannot sleep during the daytime; on two days weekly or more seldom; on three to five days weekly; or every or almost every day). Those having diabetes onset prior to 1991 were excluded. Logistic regression was used instead of survival models as type 2 diabetes typically has an insidious onset and thus a firm date of diagnosis cannot be defined unambiguously.

We selected potential covariates that are known or suspected risk factors for type 2 diabetes and have been associated with sleep behaviors, including napping. In addition they had to be available in the data. We tested for the equality of means of continuous variables by napping categories using a one-way analysis of variance approach, while associations of napping categories with categorical variables was done using chi-squared tests. Logistic regression models were used for estimating the odds ratios of type 2 diabetes by napping categories. Covariates were added in a stepwise procedure to illustrate their effect, resulting in four models.

Means and frequency distributions of the variables did not differ by zygosity, indicating that the twin individuals come from the same base population. This was an analysis of twins as individuals; as they had been sampled as twin pairs, the statistical lack of independence of two observations in a pair was taken into account by using complex survey methods with twin pair membership as the primary sampling unit in analyses (Stata svy procedures) or using a robust estimator of variance to derive proper standard errors and hence *p*-values (cluster option in Stata). Effectively the modest correlations of twins within pairs for napping reduce the effective sample size and thus *p*-values are consequently larger than if the statistical non-independence is (incorrectly) ignored. However, point estimates (such as odds ratios) are unaffected by these procedures.

3. Results

The distribution of answers to the question on napping was as follows: no need, 34.3%; I would like to but I cannot sleep during the daytime, 15.7%; on two days weekly or more seldom, 35.2%; on three to five days weekly, 7.7%; and every or almost every day, 7.1%.