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Original Research

Associations between Sleep Habits and Dysglycemia in US Adults: A Cross-sectional Analysis

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ABSTRACT

Objectives: To examine the independent and joint associations between sleep duration and quality with glycated hemoglobin (A1C) levels and dysglycemia in non-institutionalized adults living in the United States.
Methods: Data from the United States National Health and Nutrition Examination Survey (2005-2008) were used (N=9478; ≥20 years). Information on sleep quantity and quality were derived from the Sleep Disorders Questionnaire and used to classify sleep quality as good, fair, poor, or very poor.
Results: Overall, sleep quantity and quality were related to A1C levels in our unadjusted models. In general, a U-shaped relationship between sleep quantity and A1C levels was observed. Compared to those who slept for 7 to 8 hours per night, sleeping for 4 hours or fewer was associated with higher A1C levels (mean, 95% CI; 5.49%, 5.45 to 5.53 vs. 5.69%, 5.60 to 5.77; p<0.05), whereas only those reporting good and very poor sleep quality had higher A1C levels than poor sleepers (mean, 95% CI: 5.63%, 5.57 to 5.69; 5.56%, 5.52 to 5.60 vs. 5.46%, 5.42 to 5.50; p<0.05). The relationships among sleep duration and quality and the joint effects of sleep quality and quantity and dysglycemia were not significant after multivariable adjustment.
Conclusions: Between 7 and 8 hours of sleep and fair/poor sleep quality were associated with optimal A1C levels, while sleeping for fewer or more hours appeared to increase dysglycemia, without adjustment for covariates. These relationships were attenuated following multivariable adjustment. Future research is necessary to refine our understanding of the sleep/glycemic-control relationship to provide a context for the clinical significance of these findings for longer-term A1C control in adults with diabetes.

Mots clés :
concentrations de l'A1c
diabète
dysglycémie
durée du sommeil
qualité du sommeil

RÉSUMÉ

Objectifs : Examiner les associations indépendantes et communes entre la durée et la qualité du sommeil et les concentrations de l'hémoglobine glyquée (A1c) et la dysglycémie chez des adultes autonomes des É.-U.
Méthodes : Nous avons utilisé les données du National Health and Nutrition Examination Survey de 2005–2008 réalisée aux É.-U. (N=9478; ≥ 20 ans). Les informations sur la quantité et la qualité du sommeil provenaient du Sleep Disorders Questionnaire et servaient à classifier la qualité du sommeil comme suit : bonne, assez bonne, mauvaise ou très mauvaise.
Résultats : Dans l'ensemble, la quantité et la qualité du sommeil étaient liées aux concentrations de l'A1c dans nos modèles non ajustés. En général, nous observions une relation en U entre la quantité de sommeil et les concentrations de l'A1c. Comparativement à ceux qui dormaient de 7 à 8 heures par nuit, ceux qui dormaient 4 heures ou moins avaient des concentrations d'A1c plus élevées (moyenne, IC à 95%; 5,49%, 5,45 à 5,53 *vs* 5,69%, 5,60 à 5,77; p<0,05), tandis que seuls ceux qui rapportaient un sommeil de bonne ou de très mauvaise qualité avaient des concentrations d'A1c plus élevées que les dormeurs qui avaient un sommeil de mauvaise qualité (moyenne, IC à 95%; 5,63%, 5,57 à 5,69; 5,56%, 5,52 à 5,60 *vs* 5,46%, 5,42 à 5,50; p<0,05). La relation entre la durée et la qualité du sommeil et les effets communs de la qualité et de la quantité de sommeil et la dysglycémie n'étaient pas significatives après l'ajustement multivarié.

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Conclusions : Le fait de dormir de 7 à 8 heures et d'avoir une qualité de sommeil assez bonne ou mauvaise était associé à des concentrations optimales de l'A1c, tandis que le fait de dormir moins ou plus d'heures semblait augmenter le risque de dysglycémie, sans ajustement sur les covariables. Ces relations étaient atténuées à la suite de l'ajustement multivarié. Des recherches subséquentes sont nécessaires pour affiner notre compréhension de la relation entre le sommeil et la régulation de la glycémie afin de situer la signification clinique de ces résultats dans le contexte de la maîtrise de l'A1c à long terme chez les adultes diabétiques.

Introduction

It is reasonably well accepted that adequate sleep is an important component of a healthy lifestyle. General guidelines suggest that 7 to 8 hours of sleep per night is sufficient and should ideally be accompanied with no insomnia, daytime sleepiness or difficulty in falling asleep (1). Unfortunately, evidence is emerging that both sleep quality and sleep duration have declined over the past few decades, at least in adults living in the United States (US) (2). Worldwide self-reported sleep duration has increased in some countries (Bulgaria, Poland, Canada, France, Britain, Korea and the Netherlands) but has decreased in others (Japan, Russia, Finland, Germany, Belgium and Austria) (3).

Obtaining adequate sleep on a regular basis is, however, essential for health because it reduces the risk for daytime dysglycemia (4,5) and coronary heart disease (6) as well as cardiovascular-related mortality (7). Short sleep duration and poor sleep quality are independently linked with poor glycemic control in prediabetes and diabetes (4,8). Studies of the relationship between glycated hemoglobin (A1C) and sleep duration or quality also support an inverted U-shaped relationship (5,8–12). For sleep duration, only the most extreme (i.e. <5 h or >8 h per night) categories of sleep duration are associated with diabetes risk (13,14). Nonetheless, analyses from the Whitehall II study suggest that as little as a 2-hour increase in self-reported sleep duration increases the 5-year risk for development of type 2 diabetes by approximately 50% (15). Difficulty in falling asleep and difficulty in maintaining sleep are also associated with a 57% and 84% greater risk for diabetes, respectively (14). Therefore, both sleep duration and quality are important for glycemic control. However, the interconnected relationship between sleep duration and quality is rarely considered in studies because the latter is often poorly defined (16), even though this relationship may, in part, explain the association between increased sleep duration and higher diabetes risk (15). Moreover, the mere presence of diabetes and the various diabetes-related comorbidities may result in decreased sleep quality, and to compensate, people may report spending more time in bed, which may or may not be reflective of sleep duration (15,17,18).

Therefore, given the pervasiveness of sleep deprivation and the higher prevalence of chronic diseases, such as diabetes, in modern societies, it is important to determine the independent relationship between sleep duration and quality and glycemic control, as well as to quantify the joint relationship between sleep duration and quality and dysglycemia at the population level. The majority of sleep research to date has focused on the relationship between sleep duration and glycemic control in clinical or experimental settings. Therefore, the current study examined the independent and joint effects of sleep duration and sleep quality on dysglycemia in non-institutionalized adults in a representative sample of the US adult population.

Methods

Participants

Data for this analysis came from the 2005–2008 cycles of the National Health and Nutrition Examination Survey (NHANES), a nationally representative, noncivilian and noninstitutionalized sample of the US population (19). Approximately 10,000 participants are sampled biannually by using a stratified sampling design. The National Center for Health Studies Ethics Review Board approved the protocol, and informed consent was obtained from all participants prior to data collection. Data collection involves at-home interviews as well as standardized physical examinations and biosample collections at the mobile examination center. During the interview component, participants' demographic, socioeconomic, dietary, behavioural and health-related information were also obtained (19). During a subsequent physical examination, participants' medical, dental and physiologic details were collected by trained medical personnel. The current study is a pooled analysis of the 2005–2006 and 2007–2008 examination cycles that had an original sample size of 20,497 participants (2005–2006: N=10,348; 2007–2008: N=10,149). Our exclusion criteria included pregnancy (n=439), age <20 years (n=9537), missing sleep variables (n=88) and missing A1C values (n=1004), yielding a final analytic sample of 9429 adults age 20 years or older (2005–2006: n=4157; 2007–2008: n=5272).

Glycated hemoglobin levels

Blood specimens were processed, stored and shipped to the analyzing sites for high-performance liquid chromatography analysis. For 2005–2006, A1C concentrations were measured by the Tosoh A1C 2.2 Plus Glycohemoglobin Analyzer (Tosoh Medics, San Francisco, California, US); for the 2005–2006 cycle, at the Diabetes Laboratory, University of Minnesota (Minneapolis, Minneapolis, US) (20). In 2007–2008, measurements were performed by the A1C G7 HPLC Glycohemoglobin Analyzer (Tosoh Medics) at the Fairview Medical Center Laboratory, University of Minnesota) (21). Data for 2005–2006 and 2007–2008 were standardized according to the National Glycohemoglobin Standardization Program (20,21).

Sleep variables

The Sleep Disorders Questionnaire was used to obtain sleep duration and quality variables (19). Sleep duration was obtained from a single question: "How much sleep do you usually get at night on weekdays or workdays?" Responses were recorded as whole numbers, from 1 to 11 hours per night, and truncated at 12 hours or more; responses were categorized as sleep duration of 4 hours or fewer (very short), 5 to 6 hours (short), 7 to 8 hours (adequate) and 9 hours or longer (long) (22).

Sleep quality was determined on the basis of 6 sleep-quality questions from the same questionnaire:

- In the past month, how often did you have trouble falling asleep?
- In the past month, how often did you wake up during the night and have trouble getting back to sleep?
- In the past month, how often did you wake up too early in the morning and were unable to get back to sleep?
- In the past month, how often did you feel unrested during the day, no matter how many hours of sleep you had had?