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Shiftwork, sleep habits, and metabolic disparities: results from the Survey of the Health of Wisconsin ☆,☆☆

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ABSTRACT

Background: With the expanding demand for a 24-hour society, the prevalence of sleep deprivation and other sleep-related health problems is increasing. Shiftwork is an occupational health risk of growing significance because of its high prevalence and because of its potential role as a determinant of socioeconomic-related health disparities.
Aims: The aim of this study was to examine the associations of shiftwork with overweight status and type 2 diabetes and explore whether a history of sleep problems mediates or modifies these associations.
Participants and methods: A cross-sectional study was conducted among 1593 participants in the Survey of the Health of Wisconsin (2008-2012) who were employed and reported work characteristics (traditional schedule or shiftwork), sleep habits and history of sleep problems (insomnia, insufficient sleep, and wake time sleepiness). Objective measures of body mass index and type 2 diabetes were used.
Results: Shiftworkers were more overweight than traditional schedule workers (83% vs 71% with body mass index $\geq$25) and reported more sleep problems, such as insomnia symptoms (24% vs 16%), insufficient sleep (53% vs 43%), and sleepiness (32% vs 24%). The associations between shiftwork and being overweight or diabetic were stronger among those reporting insufficient sleep, but the interaction was not statistically significant.
Conclusions: Shiftworkers face disparities in metabolic health, particularly those with insufficient sleep. Improved understanding of the relationship between sleep and metabolic states can inform health care providers' and employers' efforts to screen high-risk individuals and intervene with workplace wellness initiatives to address these disparities.

Introduction

The increasing demands of a 24-hour society have extended the traditional work day beyond the typical 9 AM to 5 PM.[1] Such job demands require an employee to depart from the normal biological rhythms of nighttime and daytime activities such as sleep/wake cycles, physical activity, or dietary intake. The resulting disturbances can have a range of tangible social and biological consequences, such as increased stress and heightened risk of injury and disease.[2,3] Animal studies support our growing understanding that disruptions in biological rhythms can shift normal molecular response mechanisms, altering homeostasis and leading to a range of adverse health effects including cancer and premature mortality.[4] Job demands at nontraditional hours may also heighten an individual's risk of diverging from the biological rhythms that optimize cardiovascular or metabolic function.[5,6]

"Alternate shift" employees are particularly vulnerable, as their jobs require them to work night, flex, extended, or rotating shifts. These types of schedules are common in emergency and hospital health care settings, production, transportation, and shipping

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occupations. Shiftworkers comprise nearly 15% of the workforce nationwide and are more commonly men, minorities, and individuals with lower educational attainment.[2]

In comparison with traditional schedule workers, shiftworkers face significant health disparities with higher morbidity and mortality. Notably, they are more prone to cancers and a range of cardiometabolic disorders, including metabolic syndrome, type 2 diabetes (T2D), obesity, and adverse cardiovascular events.[2,7-10] Recent studies have reported that shiftworkers have elevated levels of triglycerides and cholesterol and higher insulin resistance than traditional schedule workers.[11-13]

Sleep problems and insufficient sleep are common among shiftworkers. US national survey data show that the prevalence of insufficient sleep (<7 hours/day) is as high as 44% among shiftworkers compared with approximately 30% among employees who work day shifts.[14] Sleep disorders, including insufficient sleep, have also been found to adversely affect metabolic health. For example, glucose homeostasis is negatively impacted by both reduced sleep quality and moderate sleep restriction.[15] Therefore, sleep problems may explain a relationship between shiftwork and metabolic dysfunction and may play a role in shiftworker health disparities; however, few studies have examined this in employed persons selected from a general population sample.

To address this gap, we examine the relationship between shiftwork exposure and sleep problems in a population-based sample of working adults. We also examined the association of shiftwork with overweight or T2D status as markers of adverse metabolic health. We further explored the potential modifying role for insufficient sleep in these associations to see whether the putative relation between shiftwork and poor metabolic health is mitigated in workers who obtain sufficient sleep.

Participants and methods

Study sample

We used cross-sectional data from the Survey of the Health of Wisconsin (SHOW) collected in years 2008-2012. The SHOW is a population-based health examination survey that includes home- and clinic-based interviews and physical examinations. Details on survey methods have been previously published.[16] In summary, participants were recruited using a 2-stage probability sample from the non-institutionalized 21-74-year-old adult population of Wisconsin. The SHOW data include basic clinical parameters including examination-based anthropometry (height, weight, and waist/hip ratio), blood pressure, blood chemistry, and cell count measures. In addition, SHOW data include self-reported physical health history, demographics, behavioral, and occupational health. The University of Wisconsin (UW)–Madison Health Sciences Institutional Review Board approved all SHOW protocols and informed consent documents.

Definition of outcomes

Height and weight measured at the examination were used to compute body mass index (BMI) (weight [kilogram]/height [meter]^2). Weight status was categorized using Centers for Disease Control and Prevention standard guidelines[17]: BMI <18.5 (underweight), 18.5 ≤ BMI < 25 (healthy weight), 25 ≤ BMI < 30 (overweight), and BMI ≥30 (obese). Type 2 diabetes was defined by self-report of physician-diagnosed T2D or glycated hemoglobin (HbA1c) ≥6.5%[18] as measured from a blood sample obtained at the physical examination.

Exposure assessment

Shiftwork was defined as night shift, rotating shift, or other alternate shift using self-report data on employment status and exposure to nontraditional sleep patterns via shiftwork.

Measures of sleep habits and sleep duration (eg, insufficient sleep) were captured using validated questions previously used in the National Health and Nutrition Examination Survey and the Wisconsin Sleep Cohort Study.[19] *Insomnia* was defined based on the participant reporting difficulty in falling asleep; response categories were "never" or "rarely" (once/month), "sometimes" (2-4 times/month), "often" (5-15 times/month), and "almost always" (16-30 times/month). This item was dichotomized into "often/almost always" (≥5 times/month) vs "sometimes/rarely" (<5 times/month).[20] Average daily sleep duration was estimated from the following questions: "Over the past month, how many hours and minutes do you think you actually slept? (This may be different than the time you spent in bed.) On a typical workday? On a typical nonwork day?" Average daily sleep duration was computed as ([5 × workday sleep] + [2 × weekend sleep])/7. Insufficient sleep was defined as average daily sleep duration <7 hours/day. Sleep debt was estimated in hours as the average amount of weekend sleep minus the average amount of weekday sleep.[21] The Epworth Sleepiness Scale was used to assess subjective wake time sleepiness[15]; as in previous studies,[22,23] an Epworth score >10 was used to define "excessive sleepiness."

Study participants

Participants who did not report working ≥1 day in a typical week over the past month (n = 767) were excluded from our study resulting in a potential sample size of 1808. Participants reporting diagnosis of diabetes other than type 2 were excluded from analyses (type 1, gestational; n = 33). A total of 375 participants, 20% of 1808, had missing clinical or sleep data. Therefore, 1593 participants were included in analyses pertaining to overweight/obesity and 1400 participants in analyses pertaining to T2D.

Statistical analyses

All analyses were conducted using SAS version 9.2 accounting for the complex survey design. Presence vs absence of overweight/obesity and/or T2D among participants was modeled using PROC SURVEYLOGISTIC.

Potential confounders of the relationship between metabolic outcomes (overweight/obese or HbA1c) and shiftwork exposure included age (continuous), race/ethnicity, gender, and educational attainment. Covariates were retained in the final model if associated with the outcome (p-value < .1), or if their inclusion changed the estimated main effects of interest by >10%.

To explore whether sleep explains or moderates the relationship between shiftwork and metabolic health, average daily sleep duration, insomnia, excessive wake time sleepiness, or sleep debt were included in models as continuous variables. Sleep duration was also modeled as a quadratic given the previously reported curvilinear relationship between sleep duration and cardiometabolic health[24]; however, the quadratic term was not statistically significant and was excluded from the model (results not shown). We also assessed insufficient sleep as a potential modifier of the relationship between shiftwork and indicators of metabolic health. For these analyses, associations between shiftwork and indicators of metabolic health were stratified by average daily sleep duration (<7 hours/day—insufficient sleep—vs ≥7 hours/day). Two-sided p-values were obtained using standard Wald tests with robust SEs.