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Race/Ethnicity, Sleep Duration, and Diabetes Mellitus: Analysis of the National Health Interview Survey (NHIS)

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Abstract

Background—Effect of race/ethnicity on the risk of diabetes associated with sleep duration has not been systematically investigated. This study assessed whether blacks reporting short ($\leq$ 5 hours) or long ($\geq$ 9 hours) sleep durations were at greater risk for diabetes than their white counterparts. In addition, this study also examined whether the influence of race/ethnicity on associations between abnormal sleep durations and the presence of diabetes were independent of individuals' sociodemographic and medical characteristics.

Methods—A total of 29,818 Americans (age range: 18–85 years) enrolled in the 2005 National Health Interview Survey (NHIS), cross-sectional household interview survey, provided complete data for this analysis.

Results—Of the sample, 85% self-ascribed their ethnicity as white and 15% as black. The average age was 47.4; 56% were female. Results of univariate regression analysis adjusted for medical comorbidities showed that black and white participants who reported short sleep duration ($\leq$ 5 hours) were more likely to have diabetes than individuals who reported sleeping 6 to 8 hours [OR = 1.66; OR = 1.87, respectively]. Similarly, black and white participants reporting long sleep duration ($\geq$ 9 hours) had a greater likelihood to report diabetes compared with those with sleeping 6 to 8 hours [OR = 1.68; OR = 2.33, respectively]. Significant interactions of short and long sleep with black and white race were observed. Compared with white participants, greater diabetes risk was associated with being black short or long sleepers.

Conclusion—The present findings suggest that American the black short and long sleepers may be at greater risk for diabetes, independently of their sociodemographic profile or the presence of

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co-morbid medical conditions, which have previously been shown to influence habitual sleep durations. Among black individuals at risk for diabetes, healthcare providers should stress the need for adequate sleep.

Keywords

diabetes; sleep; race/ethnicity

Introduction

In the last decade, sleep duration has emerged as an important physiological factor in diabetes management. Accumulating epidemiologic evidence demonstrates a high prevalence of diabetes among individuals who report shorter or longer sleep duration than the population modal sleep duration of 7 hours.[1,2] Analysis of data from the Nurses' Health Study indicated sleep restriction could be an independent risk factor for developing symptomatic diabetes.[3] This is consistent with analyses of other data from Quebec Family Study, Sleep Heart Health[4,5] and National Health and Nutrition Examination Survey.[6]

Although ample evidence suggests that aberrant sleep durations are associated with Diabetes Mellitus[7–10] and excess total mortality risk,[11] there is little evidence of the influence of race/ethnicity on the link between sleep duration and diabetes. According to findings of a cross-sectional study, sleep duration and quality were significant predictors of glycated hemoglobin among black participants.[12] Exploring the racial/ethnic variations in the relationship between sleep duration and diabetes is especially important within the context of the higher prevalence of diabetes in blacks compared to whites.[13,14] Furthermore, blacks report a greater prevalence of both short on long sleep durations, compared with whites.[15]

The purpose of this study was two-fold. First, using data from the 2005 National Health Interview Survey (NHIS), a nationally representative and validated survey which is publicly available, we determined whether blacks reporting short or long sleep duration were at greater risk for diabetes than their white counterparts. Second, we examined whether the influence of race/ethnicity on associations between sleep duration and the presence of diabetes were independent of individuals' sociodemographic and medical characteristics.

Methods

Procedures

The NHIS is a cross-sectional household interview survey conducted annually by the National Center for Health Statistics of the Centers for Disease Control and Prevention. It utilizes a multistage area probability design that provide representative samples of U.S. households. Based on this design, probability samples of the civilian population of all 50 states and the District of Columbia were obtained. Details on sample design can be found in Design and Estimation for the National Health Interview Survey, 1995–2005.[16] The NHIS has two main components: "Basic Module," which contains basic health and demographic information, and "Supplements," which relates to specific areas of interest (e.g., adult health status, health behavior, and access to health care). In 2005, 31,428 adults from 39,284 families were surveyed. The response rate of the family sample was 86.1%. The response rate of the adult sample was 80.1%. The final response rate for the adult sample, which constitutes the basis for the present analysis, was 69.0%.

During face-to-face interviews conducted by trained interviewers from the U.S. Census Bureau, participants provided sociodemographic data and information about physician-diagnosed chronic conditions. Chronic conditions documented in the interview included

hypertension, heart disease, cancer, diabetes, and arthritis. Participants estimated habitual sleep duration using full hour units, i.e., 5 hours, 6 hours, 7 hours, etc.; no information on specific sleep disorders was elicited during the interview. Respondents were asked if they ever had diabetes as diagnosed by their healthcare provider. Obesity was defined by basis of self-reported weight and height and was coded as BMI $\geq$ 30kg/m^2. Participants also reported depressed moods (i.e., feeling sadness, hopelessness, worthlessness and/or poor effort) experienced in the past 30 days. The depression severity score utilized in our analysis represents a composite score estimated through a K-6 scaling system,[17] which scores summing answers to the aforementioned four items; from 0 to 24 with scores $\geq$ 13 indicating greater depression.[18].

Surveys were conducted using computer-assisted personal interviewing (CAPI), data collection which utilizes a computer program to guide the interviewer through the questionnaire. The interviewer enters survey responses directly into the computer. The program determines if the selected response is within an allowable range, checks for consistency against other data collected during the interview and saves the responses into a survey data file.[19]

Statistical Analysis

In preliminary analyses, Pearson and Spearman correlations were used to explore relationships between variables of interest. ANOVA was used for group mean comparisons. Chi square test was employed to assess differences in categorical variables. The two primary comparison groups were whites and blacks.

Relationships between sleep duration and the presence of diabetes were examined using logistic regression analysis. The dependent variable was a binary measure, categorizing participants into two groups: those with self-reported diagnosis of diabetes versus those who were non-diagnosed. With regards to sleep duration, participants were categorized into three groups: those reporting aberrant or extreme sleep duration (i.e., short sleep [$\leq$ 5 hours] or long sleep [$\geq$ 9 hours]) vs. those reporting normal sleep duration within the range of 6 to 8 hours. Since black and white participants differed in sociodemographic (age, gender, income, body mass index), and medical factors (depression, a history of hypertension, and heart disease) (see Table 1), effects of those covariates were adjusted for in the final regression models. Prior to constructing the final model, bivariate correlations were performed to assess associations between candidate factors and the dependent variable; only factors with a p value < 0.05 were entered into the final model.[20] All analyses were performed with SPSS 18.0.

Results

Participants

A total of 29,818 Americans (age range: 18–85 years) enrolled in the 2005 NHIS provided complete data for this analysis. Of the sample, 85% self-reported their race/ethnicity as white and 15% as black (15%). Among the respondents, the average age was 47.4; 56% were female.

Sociodemographic and health characteristics of study participants are provided in Table 1. Overall, blacks were younger than their white counterparts; blacks were more likely to be female and to report a yearly income less than $35,000. Blacks had a higher prevalence of obesity, hypertension, and diabetes, whereas whites had a higher prevalence of heart disease. Of the sample, 7.8% of white participants and 11.6% of black participants reported yes to this statement [Have you EVER been told by a doctor or health professional that you have diabetes or sugar diabetes].

We observed that a greater percentage of blacks reported aberrant sleep (≤ 5.0 hrs or ≥ 9 hrs) relative to their white counterparts (see Table 2).

Within each racial/ethnic grouping short and long sleep durations were significantly associated with the presence of diabetes. (see Table 3) Results of univariate regression analysis showed that overall participants who reported short sleep duration (≤ 5 hours) were more likely to have diabetes than individuals who reported sleeping 6 to 8 hours [OR = 1.91, 95% CI = 1.91–2.25]. Similarly, participants who reported long sleep duration (≥ 9 hours) were more than twice as likely to have diabetes compared to those with the population modal sleep duration [OR = 2.25, 95% CI = 1.99–2.60] (indicated in Table 3).

We observed significant interactions of sleep duration (short and long sleep duration) with race/ethnicity such that blacks who reported short or long sleep duration had a greater risk of developing diabetes compared with white counterparts (see Table 4). After adjusting for differences in sociodemographic factors (age, sex, and income), interactions of short and long sleep with race/ethnicity for the black race and white race remained significant. Further adjustment for differences in medical factors (hypertension, heart disease, and depression) indicated that these interactions remained significant for the black race. However, interactions between short sleep and whites were no longer significant, but were marginally significant for long sleep.

Discussion

Our analysis of the 2005 National Health Interview Survey data showed that participants who report short as well as long sleep duration are at increased risk for diabetes. Specifically, individuals who report short sleep duration (≤ 5 hours) were nearly twice as likely (OR = 1.91) to have diabetes compared to individuals who report normal sleep duration (6–8 hours). Likewise, long sleep duration (≥ 9 hours) was strongly associated with the presence of diabetes (OR = 2.25) compared to normal sleep duration. The relationship between sleep duration and diabetes was especially stronger in blacks compared with whites.

Our findings are consistent with previous epidemiological and clinical studies documenting diabetes risk associated with extreme sleep durations.[1,2,8,25,26] Analysis of data from the Nurses' Health Study indicated reduced sleep duration was associated with the presence of diabetes, and sleep restriction could be an independent risk factor for developing symptomatic diabetes.[3] Data from the National Health and Nutrition Examination survey have also shown that short sleep duration plays a possible etiological role in the development of diabetes in some individuals.[6]

Our study expands on these previous findings by examining the influence of race on associations between abnormal sleep duration and diabetes and is one of the seminal studies to show direct correlation between race, sleep duration, and diabetes. We observed significant interactions of short and long sleep duration with black and white race. Compared with whites, short and long sleepers of the black race had greater risk of having diabetes. Of note, these associations were independent of between-group differences in sociodemographic factors (i.e., age, sex, and income). In previous studies, these factors showed complex interactions with glucose regulation.[30] The Boston Area Community Health survey also suggested a higher prevalence of diabetes among individuals from lower socioeconomic status.[31] In that regard, it bears emphasizing the importance that income, a proxy for socioeconomic status, has had in analysis of epidemiologic sleep data. One study analysis based on questionnaire data from the Alameda County Health and Ways of Living Study suggested that individuals from lower socioeconomic status tended to report reduced sleep durations.[32]

The observation of interest is that interactions of short and long sleep with the black race in America remained significant even after further adjustment for differences in medical factors (i.e., hypertension, heart disease, and depression). However, interactions between short sleep and white race were no longer significant and interactions became only marginally significant for long sleep. Thus, the present findings suggest that blacks may be at greater risk for diabetes, independent of their sociodemographic profile or the presence of co-morbid medical conditions, which have been shown to influence habitual sleep durations.[31,32] Analysis of previous epidemiologic data suggested that these medical/psychological factors have non- negligible associations with sleep durations,[33–35], although directionality has not been unequivocally demonstrated.[2–6]

Multivariate analysis adjusting further for effects of obesity showed that interactions between race and sleep duration on predicting odds of having diabetes remained relatively elevated for blacks, but results were not statistically significant. That obesity was a strong confounder in the present analyses was not unexpected. A plethora of epidemiologic data have demonstrated that people who report short sleep duration may be at increased risk for diabetes, likely due to the presence of obesity, which is a major risk factor for insulin resistance.[5] Indeed, results of a systematic review showed that of the twenty-two studies examined, only two did not reveal a significant relationship between glucose regulation and changes in weight.[30]

Adequate management of diabetes has required the considerations of both physiological[21] and behavioral[22] factors. Several mechanisms may explain our findings. Quality of sleep has a major influence on insulin resistance and glucose intolerance.[23] Of importance is a review paper highlighting the convergence of multiple epidemiologic and laboratory data showing reduced sleep duration may place individuals at increased risk for diabetes, possibly mediated through obesity, a major risk factor for insulin resistance.[5] While the mechanisms underlying effects of short sleep have been described, with alteration in the sympathovagal balance advanced as a key factor, factors undergirding effects of long sleep have not been well defined.[24]

Previous epidemiological studies also demonstrated significant health disparities in cardiometabolic diseases, especially diabetes, among different racial/ethnic groups.[27] Sharma and colleagues have demonstrated increased cardiovascular risk factors, including diabetes, among Americans with low socio-economic status, particularly non-Hispanic blacks.[28] A meta-analysis of 13 studies exploring diabetes prevalence by race/ethnicity showed significant associations between minority status and prevalence of diabetes.[29] Our analysis is consistent with published literature and highlights the association of sleep duration with diabetes in blacks. The consistency of research findings in this research area suggests that race/ethnicity is an important factor in the understanding of associations between sleep duration and diabetes.

The observed association of sleep duration and diabetes needs to be corroborated by future studies and theories explaining the development and progression of diabetes in aberrant sleepers.

Study strength and limitations

The following limitations of our findings should be noted. Our analysis relied on subjective estimation of sleep duration, which does not always correspond well to objective sleep measurements.[36] Likewise, the NHIS data solicits subjective response to questions regarding physician-diagnosed medical conditions, with no verification of such diagnoses. Notwithstanding these limitations, our analysis supports an independent link between sleep duration and diabetes using national data derived from a well-established population-based

Centers for Disease Control protocol. Given the high prevalence of diabetes[14,37] and sleep apnea[38–41] in blacks, future studies should explore possible lifestyle and therapeutic interventions to reduce associated risk in this population.

Conclusion

Our analysis suggests that sleep should be targeted in the management of diabetes. In particular, a sleep component should be incorporated into treatment management programs, highlighting the need for adequate sleep in reducing risk of diabetes. Our study shows diabetes risk is higher in Black American short and long sleepers than in their white counterparts, efforts to increase awareness of the link between aberrant sleep and diabetes will be beneficial for blacks, with the most benefit resulting from culturally relevant awareness campaign. The results of our study indicate that optimal management of Diabetes Mellitus seems to necessitate knowledge of patient's sleep need as well as their race/ethnic background.

Acknowledgments

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Table 1

Comparison of sociodemographic and health characteristics of black and white Americans participating in the 2005 National Health Interview Survey.

Sociodemographic and Health Characteristics of NHIS Participants Based on Race/Ethnicity			
Variable	**Black (15%) (n=4418)**	**White (85%) (n=23,873)**	**P**
Age (± SD)	45.5 ±16.9	48.0 ± 18.0	<.001
Female sex (%)	61.3	55.5	<.001
Income, >$35,000 (%)	16.4	24.3	<.001
BMI (Mean ± SD)	27 ± 5.7	28 ± 6.5	<.001
(% Normal)	28.9	37.1	<.001
(% Overweight)	35.0	35.7	<.001
(% Obese)	34.1	24.4	<.001
Hypertension (%)	35.7	27.1	<.001
Diabetes (%)	11.6	7.8	<.001
Heart Disease (%)	6.3	8.6	<.001

Table 2

Self-reported sleep duration (SD) from black and white participants in the 2005 National Health Interview Survey

Classification of Self-Reported Sleep Durations (SD) Based on Ethnicity		
Variable	**Black (15%)**	**White (85%)**
SD ≤ 5.0 hours (%)	11.0	7.8
SD = 5 – 6 hours (%)	23.9	20.2
SD = 6 – 7 hours (%)	24.1	31.0
SD = 7 – 8 hours (%)	30.0	32.5
SD ≥ 9 hours (%)	11.0	8.5

Table 3

Crude associations between race/ethnicity and the presence of diabetes.

Crude Associations Between Race and Diabetes		
Variable	**OR**	**95% C.I.**
Black Short Sleepers	1.66	1.19–2.30
White Short Sleepers	1.87	1.57–2.24
Black Long Sleepers	1.68	1.21–2.33
White Long Sleepers	2.33	1.98–2.73

Table 4

Multivariate-adjusted logistic regression analysis indicating odds ratios (OR) associated with the presence of diabetes based on interactions between short/long sleep duration and race/ethnicity. In the first pane, effects of sociodemographic (age, sex, and income), factors were adjusted; in the second pane, effects of medical factors (hypertension, heart disease, and depression) were also adjusted, and in the third pane effects of obesity was also adjusted but was statistically insignificant. In Model A, short sleep was defined as sleep durations ≤ 5hoursand in Model B, long sleep was defined as sleep durations ≥9 hours.

Associations of Short/Long Sleep Duration, Sociodemographic, and Medical Factors with Diabetes				
	Model A: Short Sleep		Model B: Long Sleep	
Variables	OR	95% C.I.	OR	95% C.I.
Sleep Duration X Black	2.56	1.94–3.37	2.15	1.62–2.83
Sleep Duration X White	1.41	1.18–1.68	1.28	1.08–1.51
Sleep Duration X Black	1.74	1.30–2.34	1.68	1.26–2.24
Sleep Duration X White	1.07	0.89–1.29	1.19	1.01–1.42
Sleep Duration X Black	1.25	0.86–1.80	1.45	1.00–2.12
Sleep Duration X White	1.01	0.80–1.28	1.23	0.98–1.53