

DOI: 10.21767/2572-5483.100038

## Does Sleep Duration Differ By Diabetes Status in Middle-Aged Adults?

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Received date: June 11, 2018; Accepted date: July 4, 2018; Published date: July 10, 2018

Citation: Graham EK, Alden BL, Kaur H, Wingo AR, Hartos JL (2018) Does Sleep Duration Differ By Diabetes Status in Middle-Aged Adults? J Prev Med Vol.3 No.3: 17.

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### Abstract

**Purpose:** Previous research established a relationship between sleep duration and diabetes outcomes, but there is currently insufficient research on the effect of diabetes status on sleep duration. The purpose of this study was to assess whether sleep duration differed by diabetes status in middle-aged males and females in the U.S. general population.

**Methods:** This cross-sectional analysis used 2016 data from the Behavior Risk Factor Surveillance System (BRFSS) for males and females ages 40-65 years in Georgia (N=2352), Louisiana (N=2377), New Mexico (N=2832), and Oklahoma (N=2908). Multiple logistic regression analysis by state was conducted to assess the relationship between diabetes status and sleep duration while controlling for health status, health behaviors, socioeconomic status, and demographic factors in order to determine patterns in variable relations across similar samples.

**Results:** Across states, almost one-fourth of participants reported non-moderate sleep duration (less than 6 hours or more than 8 hours, 19%-24%) and less than one-fifth reported a diagnosis of diabetes (16%-18%). The results of multiple logistic regression analysis indicated that sleep duration was not significantly related to diabetes status across states. However, sleep duration was moderately and inversely related to number of health conditions in all four states, and moderately and positively related to mental health and physical activity in at least three of four states.

**Conclusion:** Overall, the results of this study indicate that sleep duration was not related to diabetes status in middle-aged males and females in the general population. However, up to one-third of middle-aged adults reported two or more health conditions, mental health issues, and physical inactivity, and these were inversely related to moderate sleep duration. Thus, primary care providers should screen for sleep duration, health conditions, mental health, and physical activity in this target population if symptoms of any are present and educate and treat as comorbid conditions.

### Introduction

Sleep duration, whether too short or too long, can negatively impact health. This has become an issue for healthcare providers because the number of disordered sleepers has increased over the last 30 years [1]. Up to one-third of people in the U.S. report less than 6 hours of sleep per night and another third report 9 or more hours, both leading to significant loss of productivity and health [2-4]. Indeed, both short and long sleep durations are linked to chronic health conditions including hypertension, depression, cardiovascular diseases, and metabolic syndrome [1,3,4-7].

Research shows that sleep issues are related to diabetes status. Type 2 diabetes affects over 387 million people worldwide. In the U.S., it is the seventh leading cause of death and currently impacts over 30 million citizens [7-10]. Economically, diabetes costs the U.S. healthcare system \$245 billion annually, and this cost causes higher medical expenditures for diabetics than for those without the disease [7,11]. The risk of developing diabetes has been associated with both overly short and long sleep durations [1,2,5-7,10,12-14]. Several systematic review articles show evidence that men and women who slept less than five hours per night or nine or more hours had a higher risk of developing type 2 diabetes [1,2,5,6,10]. Furthermore, in men and women diagnosed with type 2 diabetes, there is a U-shaped curve between hemoglobin A1c levels and sleep duration, indicating that both short and long sleep duration may produce poor diabetic outcomes [1,5,6,14].

While ample evidence may exist for the effect of sleep on diabetes, there is currently insufficient research on the effect of diabetes on sleep issues. Whether or not diabetics tend to have abnormal sleep durations remains uncertain [5]. If abnormal sleep durations are more common in diabetics, it should be treated in addition to their diabetes to improve control of their blood glucose level [5,12,14]. Therefore, our study examines whether sleep duration differs by diabetes status in middle-aged males and females.

**Keywords:** Sleep duration; Diabetes; Middle-aged adults; General health; Mental health; Chronic conditions

## Methods

### Design

This cross-sectional analysis used 2016 data from the Behavior Risk Factor Surveillance System (BRFSS) conducted across the U.S. by the Centers for Disease Control and Prevention (CDC) [15]. Established in 1984, BRFSS is a system of health-related telephone surveys using random digit dialing techniques to collect data about U.S. residents regarding their health-related risk behaviors, chronic health conditions, and use of preventive services. BRFSS collects data in all 50 states and completes more than 400,000 adult interviews annually. The CDC compiles the data and allows researchers access to de-identified data to conduct secondary data analyses. This study was given exempt status by the Institutional Review Board of the University of North Texas Health Science Center.

### Sample

The samples included males and females ages 40-65 years old in Georgia (N=2352), Louisiana (N=2377), New Mexico (N=2832), and Oklahoma (N=2908). These states were chosen because they had larger proportions of diabetic residents in the target age range compared to the other states based on BRFSS prevalence data [16].

### Data

The outcome, sleep duration, was originally measured in BRFSS as the average number of hours of sleep per night. We dichotomized this number to reflect two categories of sleep duration: "moderate" (averaging 6 to 8 hours of sleep per night) vs "non-moderate" (averaging more than or less than 6 to 8 hours per night). The factor of interest, diabetes status, was measured as "yes" or "no" to having a diagnosis of diabetes.

Control variables included number of health conditions, general health status, mental health status, tobacco use, physical activity, income level, education level, employment status, gender, ethnicity/race, and age category. The number of health conditions was determined as the number of "yes" responses to diagnoses for the following: heart attack, CHD, stroke, skin cancer, other cancer, COPD, arthritis, depression, kidney disease, and asthma. This number was then categorized as "0 health conditions", "1 health condition" or "2 or more health conditions" other than diabetes.

Participant's general health status was categorized as "good or better" or "poor or fair". Mental health was dichotomized as "yes" or "no" to 30 days of good mental health in the past 30 days. Tobacco use was measured as "current smoker" or "non-smoker". Physical activity was dichotomized as "yes" or "no" to "are having performed physical activity or exercise in the past 30 days". Income level was measured as "\$50,000 or more" and "less than \$50,000". Education level was dichotomized as "yes" or "no" to "having graduated college/technical school".

Employment was categorized as "yes" or "no" to being "employed". Because the majority of participants reported white race, ethnicity/race was dichotomized as "white, non-Hispanic" or "other". Age was categorized as "40-49", "50-59" and "60-65." Descriptive statistics and categories for all variables across the four states are shown in **Table 1**.

### Analysis

Frequency distributions by state were used to describe the sample and to identify any problems with variable distributions. Multiple logistic regression analysis by state was used to assess the relationship between diabetes status and sleep duration while controlling for factors related to health status, health behaviors, socioeconomic status, and demographic factors. Models were originally run by gender but because the results were very similar, in the spirit of parsimony, we decided to run one model for both genders. We chose to analyze data separately by state to assess patterns in relations between variables across similar samples. As such, a similar result in three or four out of four states was considered reliable evidence for a relationship. Observations with missing data for any of the variables were excluded from the multivariable analysis. All analyses were conducted in STATA 15 (Copyright 1985-2017 StataCorp LLC).

## Results

### Descriptive statistics

**Table 1** lists participant characteristics for middle-aged males and females in Georgia, Louisiana, New Mexico and Oklahoma. Across states, the majority of participants reported a moderate amount of sleep each night (6-8 hours, 76%-81%) and less than one-fifth reported a diagnosis of diabetes (16%-18%). For other health indicators, most reported good or better general health (76%-78%); the majority had one or more health conditions other than diabetes (55%-60%); and the majority reported good mental health in past 30 days (62%-69%). For health behaviors, most did not smoke tobacco (79%-84%) and the majority performed physical activity in the past 30 days (68%-79%).

For socioeconomic status, almost half reported earning \$50,000 or more (43%-51%); the majority reported not graduating college or technical school (62%-69%); and the majority reported being employed (57%-61%). For demographic factors, the majority of participants were female (57%-62%) and white, non-Hispanic (51%-78%) with roughly one-third in each category (ages 40-49: 25%-25%; ages 50-59: 41%-43%; ages 60-65: 29%-36%).

**Table 1:** Participant characteristics by state.

Variable	Georgia (N=2352)		Louisiana (N=2377)		New Mexico (N=2832)		Oklahoma (N=2908)	
	n	%	n	%	n	%	N	%
Sleep Duration	2352	100	2377	100	2832	100	2908	100
Moderate	1806	77	1813	76	2293	81	2344	81
Non-moderate	546	23	564	24	539	19	564	19
Diabetes	2345	100	2370	100	2829	100	2894	100
Yes	416	18	420	18	473	17	464	16
No	1929	82	1950	82	2356	83	2430	84
General Health Status	2344	100	2367	100	2828	100	2896	100
Poor or fair	524	22	577	24	654	23	642	22
Good, very good, or excellent	1820	78	1790	76	2174	77	2254	78
Health Conditions	2289	97	2367	100	2762	98	2760	95
0 conditions	1017	44	923	40	1249	45	1145	41
1 or more conditions	626	27	642	28	811	29	761	28
2 or more conditions	646	28	741	32	702	25	854	31
Mental Health Status	2352	100	2377	100	2832	100	2908	100
30 days of good health	1634	69	1484	62	1886	67	1895	65
Less than 30 days of good health	718	31	893	38	946	33	1013	35
Tobacco Use	2256	96	2276	96	2742	97	2803	96
Current smoker	420	19	487	21	446	16	497	18
Non-smoker	1836	81	1789	79	2296	84	2306	82
Physical Activity	2348	100	2377	100	2830	100	2905	100
Yes in past 30 days	1633	70	1627	68	2225	79	2034	70
No in past 30 days	715	30	750	32	605	21	871	30
Income Level	1989	85	2080	88	2510	89	2442	84
Less than \$50,000	1025	52	1060	51	1442	57	1196	49
\$50,000 or more	964	48	1020	49	1068	43	1246	51
Education Level	2342	100	2368	100	2826	100	2899	100
Graduated college or technical school	887	38	742	31	962	34	982	34
Did not	1455	62	1626	69	1864	66	1917	66
Employment status	2336	100	2361	99	2821	100	2885	99
Employed	1352	58	1339	57	1659	59	1766	61
Not employed	984	42	1022	43	1162	41	1119	39
Sex	2351	100	2375	100	3832	100	2906	100
Male	1002	43	906	38	1241	44	1201	41
Female	1349	57	1469	62	1591	56	1705	59
Race	2295	98	2335	98	2747	97	2876	99
White, non-Hispanic	1351	59	1560	67	1413	51	2229	78
Non-white	944	41	775	33	1334	49	647	22

Age	2345	100	2370	100	2829	100	2894	100
40-49	669	29	591	25	760	27	737	25
50-59	987	42	980	41	1204	43	1187	41
60-65	689	29	799	34	865	31	970	36

### Adjusted Statistics

As shown in **Table 2**, the results of multiple logistic regression analysis for middle-aged males and females in Georgia, Louisiana, New Mexico and Oklahoma indicated that after controlling for all other variables in the model, sleep duration was not significantly related to diabetes status across states. However, compared to those who reported no health conditions, participants in all four states who reported 2 or more health conditions (not including diabetes) were about 1.5 to 2

times less likely to report moderate sleep duration. In contrast, those who reported 30 days of good mental health in all four states were about 1.5 times more likely to report moderate sleep duration compared to those who reported less than 30 days of good mental health, and those who performed physical activity in the past 30 days in three of four states were about 1.5 times more likely to report moderate sleep compared to those who did not perform physical activity in the past 30 days.

**Table 2:** Adjusted results by state.

Predicting Sleep Duration (non-moderate vs. moderate)	Georgia			Louisiana			New Mexico			Oklahoma		
	AOR	95% CI		AOR	95% CI		AOR	95% CI		AOR	95% CI	
		Low	High		Low	High		Low	High		Low	High
Diabetes												
Yes	0.92	0.68	1.23	0.93	0.7	1.25	0.99	0.74	1.31	1.14	0.85	1.54
General Health Status												
Good, very good, excellent	1.74	1.3	2.34	1.3	0.98	1.72	1.32	0.99	1.74	1.99	1.49	2.67
Health Conditions												
0 conditions	ref	-	-	ref	-	-	ref	-	-	ref	-	-
1 condition	0.87	0.64	1.18	0.86	0.64	1.16	0.87	0.66	1.15	0.45	0.33	0.62
2 or more conditions	0.63	0.46	0.87	0.58	0.43	0.78	0.62	0.46	0.83	0.5	0.36	0.7
Mental Health Status												
Good in past 30 days	1.65	1.28	2.12	1.38	1.09	1.75	1.62	1.28	2.05	1.3	1.01	1.68
Tobacco Use												
Current Smoker	0.83	0.62	1.11	0.93	0.71	1.21	1.08	0.81	1.45	0.77	0.58	1.02
Physical activity												
Yes in past 30 days	1.4	1.09	1.8	1.2	0.94	1.54	1.38	1.07	1.78	1.41	1.1	1.81
Income Level												
\$50,000 or more	1.52	1.14	2.02	1.48	1.13	1.94	1.2	0.92	1.55	1.3	0.99	1.71
Education Level												
Graduated college or technical school	0.95	0.72	1.25	0.98	0.75	1.29	1.42	1.08	1.86	1.05	0.8	1.37
Employment Status												
Employed	1.19	0.9	1.56	1.68	1.3	2.16	1.44	1.13	1.83	2.02	1.54	2.65
Sex												
Male	1.07	0.85	1.37	0.79	0.63	1	0.79	0.63	0.99	0.86	0.68	1.09
Race												

White, non-Hispanic	1.25	0.98	1.69	1.35	1.06	1.71	1.04	0.82	1.31	1.49	1.15	1.94
Age												
40-49	ref	-	-	ref	-	-	ref	-	-	ref	-	-
50-59	1.16	0.87	1.55	1.04	0.78	1.37	0.98	0.75	1.28	1.03	0.77	1.37
60-65	1.12	0.81	1.55	1.35	0.99	1.85	1.19	0.88	1.62	1.44	1.04	1.98
<b>Note:</b> AOR=adjusted odds ratio; 95% CI=95% confidence intervals; ref=referent group; boldface indicates significance (AORs with 95% CI that do not include 1.00 are significant).												

## Discussion

The purpose of this study was to assess whether sleep duration differed by diabetes status in middle-aged males and females in the U.S. general population. The results of adjusted analyses indicated that sleep duration was not significantly related to diabetes status across states, which differs from previous studies that found a significant relationship between sleep duration and diabetes status [1,3-7,10,12-14]. This discrepancy could be due to measurement differences, as we measured moderate sleep duration as 6 to 8 hours whereas other studies measured it from as low as 5 hours to as high as 10 hours [1]. Discrepancies could also be attributed to differences between the target populations. In a review of 40 prospective cohort studies [3], only six of those studies examined males and females in America. Additionally, the majority of prior research examined the effects of sleep duration on diabetes risk [1,3,6,7,13], whereas this study assessed whether sleep duration differed by diabetes status.

However, the results of this study did indicate that sleep duration is related to number of health conditions. Males and females 40-65 years old with two or more health conditions were about 2 times less likely to report moderate sleep duration. This is consistent with prior research that found abnormal sleep duration to be significantly related to chronic health conditions including cardiovascular disease, coronary heart disease, dyslipidemia, depression, hypertension, and obesity [2,3,7,12,13]. However, this study extends findings by showing that the number of chronic health conditions is also related to sleep duration and not just to each condition.

The results of this study also indicate that moderate sleep duration was consistently and moderately related to mental health and physical activity in males and females ages 40-65. Across all four states, participants who reported good mental health were about 1.5 times more likely to report moderate sleep, a moderate relationship also established in prior studies [17-19]. In addition, results in three of four states indicated that those who reported performing physical activity were about 1.5 times more likely to report moderate sleep, also shown in previous research [17,20] thus, sleep duration may be related more to the severity and management of multiple health issues, including diabetes.

## Limitations

BRFSS provides large general population samples to assess variable relations across states; however, the data does not

detail the severity or management of diabetes or other health conditions, including information on medications, many of which could induce somnolence or insomnia and affect sleep duration. Also, sleep duration in our study was measured subjectively. Because self-reported sleep duration has been shown previously to be higher than measured sleep duration, some participants may have qualified themselves under moderate sleep duration while actually having short sleep duration [21].

## Conclusion

The results of this population-based study may generalize to middle-aged males and females in a primary care setting. Primary care providers may expect up to one-fourth of their middle-aged male and female patients to report non-moderate sleep duration or to have a diabetes diagnosis. However, the results of this study indicated that diabetes status and sleep duration were not related. Thus, primary care providers should screen for diabetes and sleep issues when symptoms present, but treat them separately and refer to specialists as needed. In addition, primary care providers may expect up to one-third of their middle-aged patients to report two or more health conditions, mental health issues, or lack of physical activity. Because the results of this study indicate that sleep duration is moderately related to these, providers should screen for sleep duration, health conditions, mental health, and physical activity if symptoms of any are present. Providers should educate patients about managing their symptoms and chronic conditions, coordinate treatment plans for comorbid conditions, and make referrals to appropriate specialties as needed.

## Disclaimers

No author has any conflict of interest.

## Source of support

There was no financial support for the conduct or findings of this study.

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