

Sleep Duration and Reported Functional Capacity among Black and White US Adults

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Objective: Evidence suggests that individuals reporting sleeping below or above the population's modal sleep duration are at risk for diabetes, hypertension, and other cardiovascular diseases. Evidence also indicates that individuals with these conditions have reduced functional capacity. We assessed whether reported sleep duration and functional capacity are independently associated and whether individuals' race/ethnicity has an effect on this association.

Method: Data were obtained from 29,818 black and white Americans (age range: 18-85 years) who participated in the 2005 National Health Interview Survey (NHIS). The NHIS uses a multistage area probability design sampling of non-institutionalized representatives of the US civilian population. Of the sample, 85% were white and 56% were women.

Results: Univariate logistic regression analysis showed that individuals sleeping < 6 h were 3.55 times more likely than those sleeping 6-8 h to be functionally impaired (34% vs 13%; $p < 0.001$). Likewise, those sleeping > 8 h were 3.77 times

more likely to be functionally impaired (36% vs 13%; $p < 0.001$). Individuals of the black race/ethnicity were more likely to be functionally impaired than their white counterparts (23% vs 19%; $p < 0.001$). Multivariate-adjusted regression analyses showed significant interactions between individuals' race/ethnicity and short sleep with respect to functional capacity (black: OR = 2.78, $p < 0.0001$; white: OR = 2.30, $p < 0.0001$). Significant interactions between race/ethnicity and long sleep were also observed (black: OR = 2.43, $p < 0.001$; white: OR = 2.63, $p < 0.001$).

Conclusion: Our findings suggest that individuals' habitual sleep duration and their race/ethnicity are significant predictors of their functional capacity.

Keywords: Sleep duration, functional capacity, race/ethnicity
Citation: Brimah P; Oulds F; Olafiranye O; Ceide M; Dillon S; Awoniyi O; Nunes J; Jean-Louis G. Sleep duration and reported functional capacity among black and white US adults. *J Clin Sleep Med* 2013;9(6):605-609.

Functional capacity is an important diagnostic and prognostic factor among healthy individuals and patients with cardiovascular disease.¹⁻⁴ Indeed, evidence suggests that it may be a greater predictor of cardiovascular risks and mortality than demographics and traditional risk factors.^{1,3,5} Studies have documented several factors that can engender reduced functional capacity. These include obesity,⁶ diabetes and hypertension,⁷ heart disease,⁸ arthritis,^{9,10} and depression.¹¹⁻¹³ However, there is a dearth of data examining whether habitual sleep duration, an important medical and psychological correlate,¹⁴⁻¹⁸ is directly linked to reduced functional capacity. Indeed, until recently there was no evidence suggesting that individuals' race/ethnicity might be a significant contributory factor. According to a report based on data from the Sleep Heart Health Study, blacks reporting insomnia symptoms exhibited significantly more functional impairment compared with individuals from other ethnic groups.¹⁹

Findings from the Sleep Heart Health Study are important inasmuch as they bring into focus the need to investigate disparities in impaired sleep and its associated consequences. Epidemiologic data indicates that both short and long sleep durations are disproportionately more common among blacks.²⁰ In a previous study, we showed that blacks were more likely to

BRIEF SUMMARY

Current Knowledge/Study Rationale: Abnormally short and long sleep durations are associated with various chronic health conditions. However, there is dearth of evidence regarding relationships of sleep durations with functional capacity - an important clinical diagnostic and prognostic factor. Blacks may be at greatest risk of experiencing impaired functional capacity because of the higher prevalence of chronic health conditions as well as short and long sleep durations in that population.

Study Impact: Understanding of the relationship between sleep duration and functional capacity and the role of health disparities is vital to potentially modifying the determinants of sleep-related diseases. Consideration of influences of race/ethnicity is crucial in analysis of epidemiologic sleep data.

experience both short sleep (< 6 h, 12% vs 8%) and long sleep (> 9 h, 11% vs 9%).²⁰ Furthermore, various medical conditions (e.g., obesity, hypertension, diabetes) that are associated with reduced functional capacity are also more prevalent among individuals of the black race/ethnicity.²¹⁻²³ Using data from the National Health Interview Survey, we assessed whether short and long sleep durations are associated with functional capacity, defined as the ability to walk a quarter of a mile without as-

sistance. We also explored whether individuals' race/ethnicity has an effect on those associations.

METHODS

Participants

The study draws data from the 2005 National Health Interview Survey (NHIS), which collected data from 102,467 persons of different ethnicities, in 36,509 households. We confined our sample to a total of 29,818 black and white Americans (age range: 18-85 years) who participated in the survey, and provided valid data for the present analysis. Of the sample, 85% were of white race/ethnicity and 15% of black race/ethnicity. Adults of both sexes were represented; 44% of the volunteers were men and 56% were women.

Procedures

NHIS is an ongoing, cross-sectional, in-person household interview survey conducted annually by the National Center for Health Statistics of the Centers for Disease Control and Prevention. The NHIS uses a multistage area probability design sampling of non-institutionalized representatives of the US civilian population. Probability samples of the adult population of all 50 states and the District of Columbia were obtained. The final sample was characterized by a response rate of 69%. As the response rate was relatively low, we compared demographic characteristics between responders and non-responders, finding no significant differences. Details on sample design can be found in Design and Estimation for the National Health Interview Survey, 1995-2005.²⁴

During face-to-face interviews conducted by trained interviewers from the US Census Bureau, volunteers provided sociodemographic data and information about physician-diagnosed chronic conditions. The chronic conditions included hypertension, heart disease, cancer, diabetes, and arthritis. Participants also estimated habitual sleep duration (using full-hour increments i.e., 5 h, 6 h, 7 h, with instructions to round 30 min or more up to the next whole hour, and dropping ≤ 29 min. Self-reported sleep duration was assessed with the following question: "On average, how many hours of sleep do you get in a 24-hour period?" No information on specific sleep disorders was elicited during the interview. Participants also reported depressed moods (i.e., feeling of sadness, hopelessness, or worthlessness, and poor effort) experienced in the past 30 days. Functional capacity was assessed by asking respondents whether they were able to walk a quarter of a mile without assistance; respondents were classified as "limited" if they answered "very difficult" or "unable" to perform this activity, or "not limited" if they were able to do it. Obesity was defined as BMI ≥ 30 kg/m².

Surveys were conducted using computer-assisted personal interviewing (CAPI), which utilizes a computer program for data collection that guides the interviewer through the questionnaire. The interviewer enters survey responses directly into the computer. The program determines through a computer algorithm whether data entered by the user match against all possible responses to specific questions; the program also checks for consistency against other data collected during the interview and saves the responses into a survey data file.²⁵

Statistical Analysis

Since the NHIS dataset includes data from different samples using a multistage area probability sampling design, all analyses in this study were performed using weighted statistics based on the final weights provided with the NHIS dataset. These weights represent a product of weights for corresponding units computed in each of the sampling stages.

Frequency and measures of central tendency were used to describe the sample. In preliminary analyses, Pearson and Spearman correlations were used to explore relationships between variables of interest; only factors showing a p value < 0.05 were considered in the final regression model.²⁶ ANOVA was used for group mean comparisons, and χ^2 test was employed to assess differences in categorical variables. For descriptive purposes, the sleep measure classified participants into 3 groups: those reporting short sleep (< 6 h) or long sleep (> 8 h) referenced to those reporting sleeping 6 to 8 h. These cutoff points were chosen based on previous research showing health risk associated with short and long sleep durations. The dependent variable was also a binary measure, categorizing participants into 2 groups: "functionally limited" vs. "not functionally limited."

To test the hypothesis that short sleep (< 6 h) and long sleep (> 8 h) were associated with functional capacity, we utilized multivariate logistic regression modeling. In preliminary analyses, univariate logistic regressions were performed to assess associations between sleep factors and functional capacity. Subsequently, analyses were performed to determine interactions between sleep factors and race/ethnicity (dummy-coded) on functional capacity, adjusting for effects of confounders. Covariates entered in the models were: sex, age, income, education, obesity, depression, and a history of hypertension, diabetes, arthritis, and heart disease. All analyses were performed using SPSS 18.0.

RESULTS

Individuals of black race/ethnicity were slightly younger than their white counterparts (**Table 1**). During the face-to-face interview, fewer blacks reported that they completed at least high school, and fewer blacks reported household income \geq \$35,000 than their white counterparts. White Americans were more likely to report a diagnosis of arthritis and heart disease, while black Americans were characterized by a greater likelihood of reporting a diagnosis of hypertension or diabetes, depressed moods, or being obese. Altogether, 20% of the sample reported sleeping < 6 h, and 22% reported sleeping longer than 8 hours.

Results of univariate logistic regression analysis showed that individuals sleeping < 6 h were 3.55 times more likely than those sleeping 6-8 h to be functionally impaired (34% vs 13%; $p < 0.001$). Likewise, those sleeping > 8 h were 3.77 times more likely to be functionally impaired (36% vs 13%; $p < 0.001$). Individuals of black race/ethnicity were more likely to be functionally impaired than their white counterparts (23% vs 19%; $p < 0.001$).

In the multivariate-adjusted regression models, we ascertained independent associations of short sleep (Model A) and long sleep (Model B) with functional capacity, while examining potential interactions between race/ethnicity and sleep duration. As shown in **Table 2**, significant interactions between race/ethnicity and short sleep with respect to function-

Table 1—Comparison of sociodemographic and health data of black and white Americans participating in the 2005 National Health Interview Survey

Variable	Black (15%)	White (85%)	F/ χ^2
Age (\pm SD)	46 \pm 17	48 \pm 18	72*
Female Sex (%)	61	56	52*
Completed High School (%)	76	81	53*
Household income > \$35,000 (%)	16	24	140*
Hypertension (%)	36	27	133*
Diabetes (%)	12	8	62*
Heart Disease (%)	6	8	29*
Arthritis (%)	22	24	11*
Obesity (%)	34	24	164*
Depression (%)	29	26	27*

* $p < 0.01$.

al capacity were noted (black: OR = 2.78, $p < 0.0001$; white: OR = 2.30, $p < 0.0001$). Results also showed significant interactions between race/ethnicity and long sleep (black: OR = 2.43, $p < 0.001$; white: OR = 2.63, $p < 0.001$). Associations of each of the adjusted sociodemographic and medical factors in the models are also provided in **Table 2**.

DISCUSSION

A plethora of studies have evidenced that sleep loss is associated with daytime performance decrements, excessive daytime sleepiness, negative moods, weight gain, and poor quality of life.²⁷⁻³² One expectation from the gradual sleep reduction in population sleep time has been a commensurate increase in daytime functional impairment among US adults. Indeed, a recent report has indicated that the number of Americans reporting sleeping eight hours habitually, the recommended sleep amount according to the National Sleep Foundation, has decreased from 38% in 2001 to 28% in 2009.³³ The main finding of our study is that individuals' habitual sleep duration, as well as their race/ethnicity is a significant predictor of their functional capacity.

Our analyses indicated that both short (< 6 h) and long sleepers (> 8 h) were more likely to be functionally impaired, compared with individuals sleeping 6-8 hours. These findings are in tandem with epidemiologic evidence showing a U-shaped relationship between sleep duration and medical/psychological health, indicating that both short and long sleepers are at increased risk for adverse health outcomes.³⁴⁻³⁶

Evidently, directionality cannot be established given the correlational nature of these observations. The findings of the present study indicating that black short and long sleepers were more likely to be functionally impaired than their white counterparts corroborate previous observations suggesting that blacks show greater functional impairment than their white counterparts.^{19,37} Further, they point to two other important observations. First, after adjusting all the factors that are known to cause functional impairment, both short and long sleep remained associated with reduced functional capacity. Hence, one could reasonably expect that a substantial variability in functional capacity may

Table 2—Regression coefficients of the functional capacity measure on sociodemographic and medical factors

Variable	Model A: Short Sleep		Model B: Long Sleep	
	OR	95% CI	OR	95% CI
Sleep by black race/ ethnicity	2.78	2.05-3.78	2.43	1.74-3.39
Sleep by white race/ ethnicity	2.30	1.92-2.75	2.63	2.21-3.13
Age	1.04	1.04-1.05	1.05	1.04-1.05
Sex	1.11	0.94-1.31	1.17	1.00-1.37
Income	2.07	1.66-2.59	2.11	1.67-2.66
Education	1.55	1.28-1.86	1.29	1.07-1.55
Hypertension	1.43	1.21-1.70	1.37	1.15-1.62
Diabetes	1.84	1.45-2.33	1.98	1.57-2.49
Heart Disease	1.97	1.56-2.49	2.21	1.76-2.78
Arthritis	3.24	2.75-3.82	2.82	2.39-3.33
Obesity	2.21	1.87-2.61	2.18	1.85-2.56
Depression	2.75	2.34-3.23	2.87	2.44-3.38

The sleep duration measure included individuals who reported short sleep durations (< 6 h) or long sleep (> 8 h) vs those sleeping 6-8 h habitually; all results were statistically significant ($p < 0.001$).

be uniquely associated with sleep duration itself. Second, black short sleepers had greater odds of being functionally impaired than their white counterparts. Conversely, white long sleepers had greater odds of being functionally impaired, although ORs for black and white long sleepers were less discrepant than they were for short sleep. These findings are very interesting, warranting further analysis in large-scale studies. While waiting for replication of these findings, one can reasonably posit that short and long sleep might have differential race/ethnic-based effects on individual functional capacity.

Available data provides ample evidence supporting our observation of an interaction between race/ethnicity and short sleep with regard to functional capacity. Epidemiologic evidence shows that individuals of black race/ethnicity are three times as likely as those of white race/ethnicity to meet criteria for obstructive sleep apnea.³⁸⁻⁴⁰ Individuals with obstructive sleep apnea, a condition that causes significant nocturnal sleep disturbances and excessive daytime sleepiness, have shown worse functional capacity than healthy controls.^{41,42} Among 5,301 African American adults, a recent report from Jackson Heart study showed an independent association between sleep disordered breathing symptoms and sleep duration.⁴³ It is conceivable that a significant number of blacks reporting short sleep might have untreated sleep apnea, likely causing daytime functional impairment either directly or through exacerbation of comorbid conditions (e.g., hypertension, diabetes, heart disease).⁴⁴⁻⁴⁷ However, the relationship between sleep apnea and sleep duration in blacks has not been well studied, suggesting the need for further research in this area.

In conclusion, our data suggest that individuals' habitual sleep duration and their race/ethnicity are significant predictors of their reported functional capacity. One important limitation of our study is that the influence of sleep apnea on our analy-

sis could not be determined since the NHIS did not screen respondents for the presence of sleep apnea. Another limitation relates to the fact that the measure we used to assess functional capacity, the ability to walk a quarter mile without assistance, is highly subjective. Future studies should attempt to verify our results using objective methods of assessing functional capacity and sleep duration.

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ACKNOWLEDGMENTS

This research was supported by funding from the NIH (R25HL105444, R01HL095799 and R01MD004113).

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication April, 2012

Submitted in final revised form November, 2012

Accepted for publication December, 2012

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DISCLOSURE STATEMENT

This was not an industry supported study. The authors have indicated no financial conflicts of interest.