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Original Contribution

Racial Disparities in Short Sleep Duration by Occupation and Industry

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Short sleep duration, which is associated with increased morbidity and mortality, has been shown to vary by occupation and industry, but few studies have investigated differences between black and white populations. By using data from a nationally representative sample of US adult short sleepers ($n = 41,088$) in the National Health Interview Survey in 2004–2011, we estimated prevalence ratios for short sleep duration in blacks compared with whites for each of 8 industry categories by using adjusted Poisson regression models with robust variance. Participants' mean age was 47 years; 50% were women and 13% were black. Blacks were more likely to report short sleep duration than whites (37% vs. 28%), and the black-white disparity was widest among those who held professional occupations. Adjusted short sleep duration was more prevalent in blacks than whites in the following industry categories: finance/information/real estate (prevalence ratio (PR) = 1.44, 95% confidence interval (CI): 1.30, 1.59); professional/administrative/management (PR = 1.30, 95% CI: 1.18, 1.44); educational services (PR = 1.39, 95% CI: 1.25, 1.54); public administration/arts/other services (PR = 1.30, 95% CI: 1.21, 1.41); health care/social assistance (PR = 1.23, 95% CI: 1.14, 1.32); and manufacturing/construction (PR = 1.14, 95% CI: 1.07, 1.20). Short sleep generally increased with increasing professional responsibility within a given industry among blacks but decreased with increasing professional roles among whites. Our results suggest the need for further investigation of racial/ethnic differences in the work-sleep relationship.

industry; occupation; race; sleep; work

Abbreviations: BMI, body mass index; CI, confidence interval; NAICS, North American Industrial Classification System; NHIS, National Health Interview Survey; PR, prevalence ratio.

Studies suggest that mean sleep duration among US adults has decreased over time (1), which is of public health concern because insufficient sleep has been linked to increased risk of poor health (self-reported), weight gain and obesity, hypertension, diabetes, coronary heart disease, and mortality (2–12). The prevalence of short sleep duration has been shown to vary by industry and occupation among US workers (13, 14), with work affecting sleep through several factors, including long/extended work hours, rotating or shift work, and job-related stress (14–18). The internet and email capabilities, cellular phones, and other communication devices have resulted in employees becoming perpetually available and capable of communicating and engaging in work in ways and during times that may displace sleep (19, 20).

US blacks may be at particularly high risk for insufficient sleep-related morbidity and mortality (21, 22), and racial differences in sleep duration by industry and occupation may arise for various reasons. For instance, blacks employed across various industries are more likely to work nontraditional shifts with nonstandard work schedules (especially night shifts) and to have long working hours, which can negatively affect health through insufficient sleep duration by, for example, disrupting circadian rhythms and increasing one's appetite for sweet and salty foods (22–31). Compared with whites, blacks are also more likely to report general job stress, to experience objective and perceived discrimination, to work in positions with low control/high demand and that involve low decision-making power, to work multiple low-wage jobs, and to live in poverty despite being employed (26, 27, 32–38).

Understanding the impact of occupation and industry of employment on sleep, as well as how blacks and whites may be differentially affected, can help identify racial disparities and enable the creation of tailored, mitigating interventions. However, few studies have investigated black-white differences in the work-sleep relationship. Therefore, we sought to examine racial/ethnic differences in short sleep duration by industry of employment by using a nationally representative sample of US adults reporting short sleep duration in the National Health Interview Survey (NHIS) from 2004 to 2011. We hypothesized that 1) the prevalence of short sleep duration would increase for both blacks and whites; 2) blacks compared with whites would have a consistently higher prevalence of short sleep duration across industries; and 3) these racial/ethnic disparities would persist over the study period.

MATERIALS AND METHODS

The National Health Interview Survey

We analyzed data from the NHIS, which is a series of cross-sectional, nationally representative surveys that use a 3-stage stratified cluster probability sampling design to conduct in-person interviews in households of noninstitutionalized US civilians. A detailed description of NHIS procedures is available elsewhere (39). Briefly, each week (on a continuous basis), a probability sample of households was interviewed by trained interviewers from the US Census Bureau (Spauldings, Maryland) to obtain information about health and other characteristics of each member of the sampled households. The data collection interviews were conducted through computer-assisted personal interviewing. From each sampled family, 1 adult and 1 child were randomly selected to provide additional health-related information. The final response rate for sampled adults, who were the basis for this analysis, was 67% (range, 61%–72%). Our study was approved by the Harvard School of Public Health's institutional review board.

Study participants

Participants included self-reported non-Hispanic white or non-Hispanic black (hereafter, white and black) adults aged 18 years and older. Participants were excluded if they 1) were born outside the US; 2) had an extreme body mass index (BMI) (calculated as weight (kg)/height $(m)^2$) value of less than 15 or greater than 70; or 3) had missing data on sleep, industry of employment, or employment status. Our final sample comprised 136,815 adults, of whom 41,088 (30%) were considered short sleepers (<7 hours/day), 41,495 (31%) were considered optimal sleepers (7 hours/day), and 54,232 (39%) were considered long sleepers (>7 hours/day) (Web Figure 1, available at http://aje.oxfordjournals.org/). We excluded non–US born participants because evidence suggests that sleep patterns among US immigrants differ from those among individuals born in the United States (40). Military personnel were excluded because the NHIS is not designed to provide accurate estimates in this population.

Measures

Sleep duration. Sampled adults who were 18 years of age or older reported how many hours they sleep, on average, in a 24-hour period. Interviewers were instructed to report the hours of sleep in whole numbers, rounding values of 30 minutes or more up to the nearest hour and rounding values less than 30 minutes down to the nearest hour. Short sleep duration was defined as a usual sleep duration of less than 7 hours; optimal sleep was defined as 7 hours; and long sleep was defined as more than 7 hours. Seven hours of sleep was used as the reference because it is associated with the lowest levels of morbidity and mortality (8, 12).

Race/ethnicity. Participants were asked, "What race or races do you consider yourself to be?" They then selected 1 or more of the following categories: white, black/African American, American Indian/Alaskan native, Asian, or multiple races. Our analysis focuses on blacks/African Americans and whites because the underlying biological and social mechanisms leading to differences in sleep duration are likely to vary by race/ethnicity, and whites are customarily used as the comparison group for greater statistical stability because they have the largest sample size.

Industry of occupation. We grouped the North American Industrial Classification System (NAICS) (NAICS Association, LLC, Rockaway, New Jersey) codes into 8 meaningful industry categories as follows: 1) agriculture, forestry, fishing, and hunting (NAICS code 11); mining (NAICS code 21); utilities (NAICS code 22); construction (NAICS code 23); manufacturing (NAICS codes 31–33); wholesale trade (NAICS code 42); and transportation and warehousing (NAICS codes 48–49); 2) retail trade (NAICS codes 44–45); 3) information (NAICS code 51); finance and insurance (NAICS code 52); and real estate rental and leasing (NAICS code 53); 4) professional, scientific, and technical services (NAICS code 54); management of companies and enterprises (NAICS code 55); and administrative and support and waste management and remediation services (NAICS code 56); 5) educational services (NAICS code 82); 6) health care and social assistance (NAICS code 62); 7) accommodation and food services (NAICS code 72); and 8) other services (except public administration) (NAICS code 81); public administration (NAICS code 92); and arts, entertainment, and recreation (NAICS code 71).

Employment and socioeconomic status. Employment status in the week prior to the interview was ascertained for all adults and was categorized as "working for pay," "working without pay," "job not at work" (meaning the subject held a job but did not work in the week prior to the interview), "unemployed," or "not in the labor force." Educational attainment was categorized as less than high school (no high school diploma), high school (high school or general equivalency diploma), and greater than high school (any education beyond high school). Annual household income was dichotomized as above or below $35,000, and poverty status was based on being below the poverty line after the participants' best estimates of total income of all family members from all sources before taxes. Adults who were working at a paying or nonpaying job during the week prior to the survey, those who had a job or business but were not at work during the prior week,

and those who ever worked were asked about their occupations, which were categorized on the basis of the Standard Occupational Classification System (http://www.bls.gov/soc/). We combined occupations into categories of professional/management, support services, or laborers on the basis of type of work. Class of work/occupation (based on current, longest held, or most recently held job or work situation) was classified as either 1) an employee of a private company, business, or individual for wages, salary, or commission; 2) a federal, state, or local government employee; 3) self-employed in own business, professional practice, or farm; or 4) working without pay in a family-owned business or farm.

Health behaviors. Smoking status and lifetime alcohol drinking status were categorized as "ever" or "never." Leisure-time physical activity was categorized as "none," "low," or "high." Participants who engaged in at least some level of activity and who provided a specific number of activity bouts were dichotomized at the midpoint of these bouts and classified as having activity levels of "low" or "high." Participants reporting "never" or "unable to do this type activity" were categorized as "none."

Medical conditions. Sampled adults were asked if they had ever been told by a doctor or other health professional that they had "hypertension, also called high blood pressure" and, separately, if they had "diabetes or sugar diabetes." Participants were also asked if a doctor or other health professional had ever diagnosed them as having any kind of heart condition or disease other than coronary heart disease, angina pectoris, or a myocardial infarction, as well as if a doctor or other health professional had ever diagnosed them as having coronary heart disease. We combined these variables to adjust for heart disease.

Covariates. Self-reported height and weight were used to calculate BMI. Obesity was defined as a BMI value of 30 or higher, overweight as 25.0–29.9, normal weight as 18.5–24.9, and underweight as less than 18.5 (19). Marital status was categorized as married/living with a partner, divorced/separated/widowed, or never married. Regions of the country were categorized as South, Midwest, Northeast, or West. Self-reported general health status was categorized as excellent/very good, good, or fair/poor.

Statistical analysis

We pooled 8 survey years (2004–2011) of NHIS data merged by the Integrated Health Interview Series (https://www.ihis.us/ihis/). For all analyses, we used sampling weights that account for the unequal probabilities of selection resulting from the sample design, nonresponse, and oversampling of certain subgroups. Standard errors or variance estimations were calculated by using Taylor series linearization (41). Stata, version 12, software (StataCorp LP, College Station, Texas) was used for all analyses.

Continuous variables were expressed as means and standard errors, whereas categorical variables were presented as absolute values with corresponding percentages. We used Rao-Scott second-order corrected Pearson statistics that take survey weights into account to test for differences in prespecified sociodemographic, clinical, and behavioral characteristics of interest between whites and blacks, as well as sleep duration (41).

To estimate prevalence ratios for short sleep duration among blacks compared with whites by industry, we used 5 different Poisson regression models with a robust variance estimator (43). Prespecified socioeconomic, health behavior, demographic, and clinical characteristics were entered into the model as a group in an inclusive stepwise manner, and white participants were used as the reference for the black-white comparisons. For models stratified by race for blacks and whites, as well as for a separate model with an interaction term for race and sleep, we first adjusted for age in 3 categories (18–49 years, 50–64 years, or ≥65 years) and then for demographic factors (i.e., sex, marital status, and educational attainment) in our second model. We subsequently adjusted for health behaviors, including smoking status, alcohol consumption, and leisure-time physical activity in the third model before adjusting for self-reported health status, hypertension, heart disease, diabetes, cancer, and 4 standard BMI categories in the fourth model. The final model adjusted for living in poverty, class of occupation, occupation, and annual household income above or below $35,000.

To test for race-specific temporal trends in short sleep duration over time by industry of employment, we again used Rao-Scott second-order corrected Pearson statistics for each industry among blacks and whites, separately. To test for potential black-white differences in the prevalence of short sleep duration in a pooled analysis, we introduced interaction terms for race and survey year with 2 years combined for separate linear regression models.

RESULTS

Characteristics of the study population

Among the 136,815 participants, the mean age was 47 years; 50% were women; 13% were black; 28% (for whites, 30%; for blacks, 17%) had at least a college education; and 29% reported short sleep duration. Table 1 shows weighted estimates of the age-adjusted prevalence of short sleep duration by sociodemographic, health behavior, and clinical characteristics among black and white participants. Web Table 1 displays the mean or prevalence of these characteristics by race/ethnicity among those with short sleep duration. Blacks were more likely than whites to experience short sleep duration (37% vs. 28%). For both blacks and whites, there were no apparent differences in short sleep duration by sex. Regarding education, the greatest prevalence of short sleep duration was among white high school graduates (36%) and among blacks with some college (41%). The prevalence of short sleep duration among individuals living in poverty was similar for both blacks and whites. The overall percentage point difference in short sleep duration between blacks and whites was 16 for those in professional/administrative/management positions, 11 for those in support services, and 4 for laborers.

Black-white differences in short sleep duration by industry and occupation

Table 2 shows the adjusted prevalence ratios of short sleep duration for blacks and whites by industry of employment.

Table 1. Age-adjusted Prevalence of Short Sleep Duration[a] by Sociodemographic, Health Behavior, and Clinical Characteristics Among 136,815 Black and White Participants, United States, 2004–2011

Characteristic	Whites		Blacks		Both Races Combined	
	No.	%	No.	%	No.	%
Short duration sleepers (sample)	31,752	28	9,336	37	41,088	29
Age group, years						
18–49	17,305	31	5,649	40	22,954	33
50–64	8,905	29	2,456	40	11,361	31
≥65	5,542	21	1,231	29	6,773	22
Women	16,450	28	5,602	38	22,052	29
Men	15,302	28	3,734	37	19,036	29
Educational attainment						
Less than high school	10,053	31	2,882	34	12,935	31
High school graduate	3,132	36	1,342	35	4,474	36
Some college	10,656	30	3,461	41	14,117	31
≥College degree or higher	7,911	22	1,651	39	9,562	24
Marital status						
Married	14,842	26	2,464	37	17,306	27
Divorced/separated/ widowed	10,361	35	3,281	38	13,642	36
Never married	6,482	28	3,558	37	10,040	30
Region of country						
Northeast	5,797	30	1,205	40	7,002	31
Midwest	9,477	28	1,944	40	11,421	29
South	10,806	28	5,294	36	16,100	30
West	5,672	26	893	39	6,565	27
Living in poverty	3,341	37	2,085	38	5,426	37
Household income <$35,000/year	17,392	27	3,618	38	21,010	28
Class of worker						
Private wage	23,627	29	6,682	36	30,309	30
Government	5,176	26	2,193	39	7,369	28
Self-employed	2,773	25	408	37	3,181	26
Occupation						
Professional/ management	5,957	25	1,106	41	7,063	27
Support services	14,092	27	4,446	38	18,538	28
Laborer	11,461	32	3,704	36	15,165	33
Industry						
Manufacturing/ construction[b]	10,133	30	2,343	37	12,476	31
Retail trade	3,576	29	793	34	4,369	30
Finance/ information/real estate[c]	2,769	25	722	38	3,491	27
Professional/ administrative/ management[d]	2,932	25	842	38	3,774	27
Educational services	2,661	23	858	37	3,519	24
Health care/social assistance	3,986	29	1,814	39	5,800	31
Accommodation/ food services	1,926	33	592	34	2,518	33
Public administration/ arts/other services[e]	3,649	27	1,329	38	4,978	29
Health behavior						
Smoking status						
Never	14,732	26	5,492	36	20,224	27
Current	8,034	28	1,551	39	9,585	29
Former	8,958	34	2,283	37	11,241	35
Alcohol consumption						
Never	3,546	27	1,862	33	5,408	28
Current	18,376	27	4,528	39	22,904	28
Former	4,731	32	1,382	36	6,113	33
Leisure-time physical activity						
Never/unable	10,950	31	4,057	36	15,007	32
Low	10,298	27	2,813	38	13,111	28
High	10,391	27	2,436	38	12,827	28
Clinical characteristic						
Overweight/ obese[f]	20,957	30	7,129	38	28,086	30
Obese[g]	9,783	33	4,030	39	13,813	34
Hypertension (yes)	10,425	32	3,978	39	14,403	33
Diabetes (yes)	2,747	33	1,239	40	3,986	35
Heart disease (yes)	4,269	32	991	39	5,260	34
Cancer (yes)	3,335	31	459	42	3,794	32
Health status						
Excellent/very good	17,800	25	4,145	34	21,945	26
Good	8,751	31	2,933	37	11,684	32
Fair/poor	5,184	40	2,255	44	7,439	41

Abbreviation: NAICS, North American Industrial Classification System.

[a] Weighted estimates.

[b] Includes the following NAICS (NAICS Association, LLC, Rockaway, New Jersey) industry categories: agriculture, forestry, fishing, and hunting; mining; utilities; construction; manufacturing; wholesale trade; and transportation and warehousing.

[c] Includes the following NAICS industry categories: information; finance and insurance; and real estate rental and leasing.

[d] Includes the following NAICS industry categories: professional, scientific, and technical services; management of companies and enterprises; and administrative support and waste management and remediation services industries.

[e] Includes the following NAICS industry categories: public administration; arts, entertainment, and recreation; and other services (except public administration).

[f] Overweight/obese is defined as a body mass index (weight (kg)/ height $(m)^2$) value of 25 or higher.

[g] Obese is defined as a body mass index value of 30 or higher.

Table continues

Table 2. Adjusted Prevalence Ratios of Short Sleep Duration for Blacks Compared With Whites by Industry of Employment ($n = 41,088$), National Health Interview Survey, 2004–2011

Industry of Employment	Model 1[a] (Age)		Model 2[b] (Demographic Characteristics)		Model 3[c] (Health Behaviors)		Model 4[d] (Medical Conditions)		Model 5[e] (Occupational Characteristics)	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Manufacturing/construction[f]	1.20	1.15, 1.25	1.19	1.13, 1.25	1.20	1.14, 1.27	1.16	1.09, 1.22	1.14	1.07, 1.20
Retail trade	1.11	1.02, 1.21	1.12	1.03, 1.23	1.12	1.01, 1.24	1.07	0.96, 1.18	1.07	0.96, 1.18
Finance/information/real estate[g]	1.54	1.42, 1.67	1.49	1.37, 1.63	1.51	1.37, 1.67	1.44	1.31, 1.59	1.44	1.30, 1.59
Professional/administrative/management[h]	1.38	1.28, 1.49	1.33	1.22, 1.45	1.39	1.26, 1.52	1.32	1.20, 1.46	1.30	1.18, 1.44
Educational services	1.60	1.48, 1.73	1.52	1.39, 1.66	1.51	1.36, 1.67	1.38	1.24, 1.53	1.39	1.25, 1.54
Health care/social assistance	1.32	1.25, 1.40	1.30	1.22, 1.38	1.31	1.22, 1.40	1.23	1.15, 1.32	1.23	1.14, 1.32
Accommodation/food services	1.06	0.96, 1.17	1.05	0.94, 1.17	1.09	0.96, 1.23	1.06	0.94, 1.20	1.05	0.93, 1.19
Public administration/arts/other services[i]	1.37	1.28, 1.46	1.39	1.29, 1.49	1.41	1.30, 1.52	1.30	1.20, 1.40	1.30	1.21, 1.41

Abbreviations: CI, confidence interval; NAICS, North American Industrial Classification System; PR, prevalence ratio.

[a] Model 1 is adjusted for age categories.

[b] Model 2 is adjusted for age categories plus sex, marital status, educational attainment, and living in poverty.

[c] Model 3 is adjusted for model 2 variables plus smoking status, alcohol consumption, and physical activity.

[d] Model 4 is adjusted for model 3 variables plus health status, body mass index (weight (kg)/height $(m)^2$), hypertension, diabetes, heart disease, and cancer.

[e] Model 5 is adjusted model 4 variables plus class of occupation, occupation, and household income.

[f] Includes the following NAICS (NAICS Association, LLC, Rockaway, New Jersey) industry categories: agriculture, forestry, fishing, and hunting; mining; utilities; construction; manufacturing; wholesale trade; and transportation and warehousing.

[g] Includes the following NAICS industry categories: information; finance and insurance; and real estate rental and leasing.

[h] Includes the following NAICS industry categories: professional, scientific, and technical services; management of companies and enterprises; and administrative support and waste management and remediation services industries.

[i] Includes the following NAICS industry categories: public administration; arts, entertainment, and recreation; and other services (except public administration).

The adjusted prevalence of short sleep duration was higher among blacks employed in the following industries than among whites employed in the same industries: finance/information/real estate (prevalence ratio (PR) = 1.44, 95% confidence interval (CI): 1.30, 1.59), professional/administrative/management (PR = 1.30, 95% CI: 1.18, 1.44), educational services (PR = 1.39, 95% CI: 1.25, 1.54), public administration/arts/other services (PR = 1.30, 95% CI: 1.21, 1.41), health care/social assistance (PR = 1.23, 95% CI: 1.14, 1.32), and manufacturing/construction (PR = 1.14, 95% CI: 1.07, 1.20). Prevalence of short sleep duration, however, was not different between blacks and whites in the retail trade industry (PR = 1.07, 95% CI: 0.96, 1.18) or in the accommodation/food services industry (PR = 1.05, 95% CI: 0.93, 1.19). Web Tables 2 and 3 display trends in the adjusted prevalence ratios of short sleep duration in blacks compared with whites across the aforementioned industries of employment and occupations, respectively. Web Figure 2 shows a black-white comparison of age-adjusted prevalence of short sleep duration by class of work and employment status.

Trends in sleep duration by industry of employment

Figure 1 illustrates temporal trends in the age-adjusted prevalence of short sleep duration by industry of employment among both blacks and whites. Trends in short sleep prevalence were different for blacks and whites for the finance/information/real estate industry (P for interaction = 0.02) and for the professional/administrative/management industry (P for interaction = 0.04). The prevalence estimates of short sleep duration did not differ over the study period by race in any other industry. The consistently widest disparities in short sleep duration by race were observed among those in the educational services and finance/information/real estate industries.

Among whites in most industries (except health care/social assistance), laborers had the greatest prevalence of short sleep duration compared with individuals employed in support services or professional/administrative/management positions (see Table 3). Blacks had a consistently higher prevalence of short sleep duration than that of their white counterparts except for laborers in retail trade (for blacks, 26%; for whites, 34%) and in accommodation/food services (for blacks, 34%; for whites, 34%). Blacks in the professional/administrative/management industry category had the same prevalence of short sleep duration (38%) regardless of occupation. For blacks, the prevalence of short sleep duration was higher among professional workers compared with others in most industries; in contrast, among whites, the prevalence of short sleep duration was lower for those in professional roles compared with other occupational roles. Web Table 4 lists the prevalence of short sleep duration

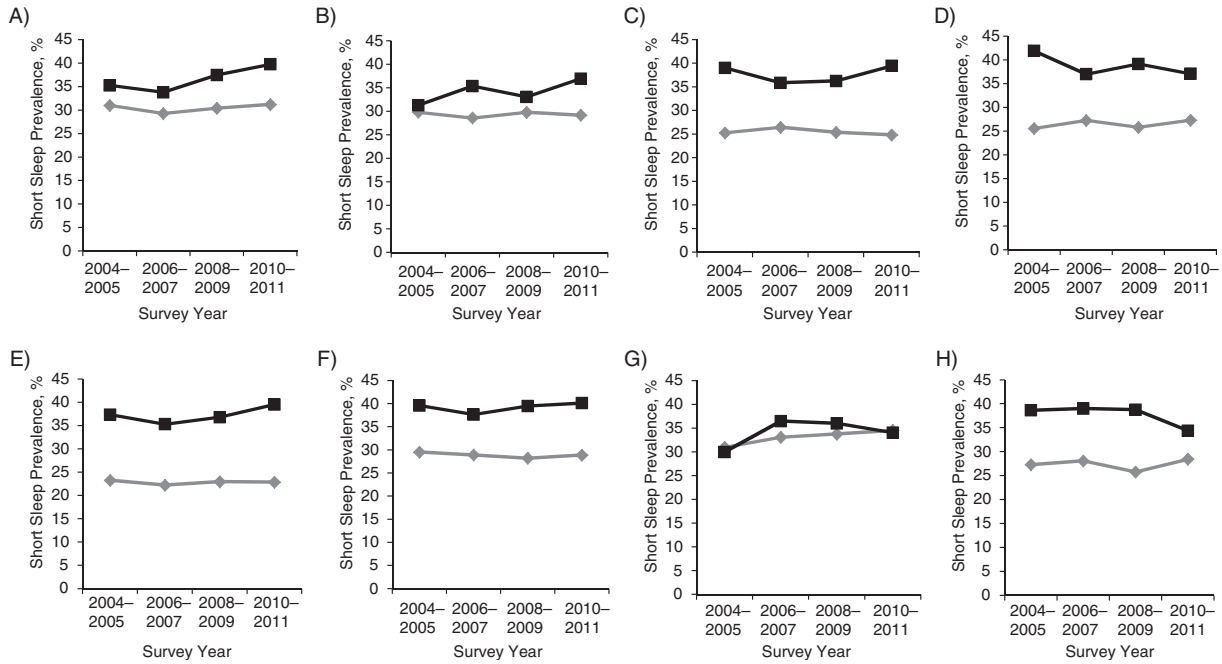

Figure 1. Trends in the age-adjusted prevalence of short sleep duration by industry of employment among blacks and whites, National Health Interview Survey, 2004–2011. A) Agriculture, forestry, fishing, and hunting; mining; utilities; construction; manufacturing; wholesale trade; and transportation and warehousing industries (*P* for interaction = 0.54; for whites, *P* for trend = 0.28; for blacks, *P* for trend = 0.65). B) Retail trade industry (*P* for interaction = 0.88; for whites, *P* for trend = 0.94; for blacks, *P* for trend = 0.84). C) Information; finance and insurance; and real estate rental and leasing industries (*P* for interaction = 0.02; for whites, *P* for trend = 0.55; for blacks, *P* for trend = 0.31). D) Professional, scientific, and technical services; management of companies and enterprises; and administrative and support and waste management and remediation services industries (*P* for interaction = 0.04; for whites, *P* for trend = 0.73; for blacks, *P* for trend = 0.41). E) Educational services industry (*P* for interaction = 0.06; for whites, *P* for trend = 0.90; for blacks, *P* for trend = 0.40). F) Health care and social assistance industry (*P* for interaction = 0.99; for whites, *P* for trend = 0.86; for blacks, *P* for trend = 0.45). G) Accommodation and food services industry (*P* for interaction = 0.10; for whites, *P* for trend = 0.86; for blacks, *P* for trend = 0.83). H) Public administration; other services; and arts, entertainment, and recreation industries (*P* for interaction = 0.75; for whites, *P* for trend = 0.32; for blacks, *P* for trend = 0.11). Diamonds represent whites and squares represent blacks.

by occupation within industry among both black and white participants without reported diabetes, heart disease, or cancer. Furthermore, the results (main and interaction) for race and survey year by industry of employment are shown for optimal sleep duration in Web Table 5 and for short sleep duration in Web Table 6.

DISCUSSION

We found that blacks had an overall age-adjusted prevalence of short sleep duration that was 9 percentage points higher than that for whites, and the difference in prevalence of short sleep duration between blacks and whites varied by both industry and occupation. We also found that, for most industries, differences in the prevalence of short sleep duration between blacks and whites narrowed among laborers but increased among professional workers; therefore, the prevalence of short sleep duration was more comparable among black and white individuals with lower socioeconomic status. Specifically, the prevalence of short sleep duration generally increased with increasingly professional roles within a given industry among blacks, whereas short sleep prevalence decreased with increasing professional roles for whites. Interestingly, blacks in the professional/administrative/management industry category had the same prevalence of short sleep duration regardless of occupation, and whites who were laborers in the retail trade industry were the only group to have a higher prevalence of short sleep duration than blacks, at 34% versus 26%, respectively (Table 3).

Our study, in combination with previous investigations, suggests that population patterns of sleep duration are likely influenced by complex aspects of the social and work environments, including features that are inequitably distributed (13, 44). A previous study found a high prevalence of short sleep duration among workers in the transportation/warehousing, manufacturing, and public administration industries and identified specific occupational groups within these industries with the highest prevalence of short sleep duration (13). The study adjusted for race and did not report on black-white differences. Sleep restriction, however, is a potential source of health inequity among races and is a modifiable population health determinant that deserves further investigation.

Several potential mechanisms may connect one's job (a marker of socioeconomic position) with one's overall health, because occupation influences specific sleep conditions through power, prestige, and access to resources (45, 46). There are also pathways that likely produce racial/ethnic disparities in health, with shorter, lower quality sleep among blacks being an

Table 3. Prevalence of Short Sleep Duration[a] by Occupation Within Industries Overall and Among Blacks and Whites, National Health Interview Survey, 2004–2011

Occupation by Industry	Blacks			Whites			Total		
	No.	%	Short Sleep Prevalence, %	No.	%	Short Sleep Prevalence, %	No.	%	Short Sleep Prevalence, %
Manufacturing/construction[b]							39,555		
Professional/management	426	7	39	7,004	21	26	7,430	19	27
Support services	1,100	17	40	6,959	21	27	8,059	20	28
Laborers	4,767	76	36	19,299	58	33	24,066	61	34
Retail trade							14,678		
Professional/management	63	3	35	727	6	24	790	5	24
Support services	1,822	78	37	9,528	77	29	11,350	77	30
Laborers	452	19	26	2,086	17	34	2,538	17	32
Finance/information/real estate[c]							12,655		
Professional/management	521	29	40	3,827	35	23	4,348	34	25
Support services	972	54	38	6,062	56	26	7,034	56	27
Laborers	323	18	35	950	9	30	1,273	10	31
Professional/administrative/management[d]							12,586		
Professional/management	444	20	38	5,013	48	25	5,457	43	26
Support services	736	34	38	3,279	32	26	4,015	32	28
Laborers	1,004	46	38	2,110	20	30	3,114	25	32
Educational services							13,763		
Professional/management	208	9	45	1,204	11	26	1,412	10	28
Support services	1,526	65	35	8,939	78	21	10,465	76	23
Laborers	597	26	38	1,289	11	31	1,886	14	32
Health care/social assistance							17,878		
Professional/management	292	6	43	1,390	10	26	1,682	9	28
Support services	3,624	79	40	10,925	82	29	14,549	81	31
Laborers	692	15	35	955	7	28	1,647	9	30
Accommodation/food services							7,615		
Professional/management	120	7	42	898	15	31	1,018	13	32
Support services	339	19	30	692	12	29	1,031	14	29
Laborers	1,301	74	34	4,265	73	34	5,566	73	34
Public administration/arts/other services[e]							16,905		
Professional/management	581	16	42	2,814	21	26	3,395	20	28
Support services	1,633	45	36	6,297	47	26	7,930	47	28
Laborers	1,398	39	37	4,182	31	30	5,580	33	31
Total	24,941			110,694			135,635		
Professional/management	2,655	11	41	22,877	21	25	25,532	19	27
Support services	11,752	47	38	52,681	48	27	64,433	48	28
Laborers	10,534	42	36	35,136	32	32	45,670	34	33

Abbreviation: NAICS, North American Industrial Classification System.

[a] Weighted estimates.

[b] Includes the following NAICS (NAICS Association, LLC, Rockaway, New Jersey) industry categories: agriculture, forestry, fishing, and hunting; mining; utilities; construction; manufacturing; wholesale trade; and transportation and warehousing.

[c] Includes the following NAICS industry categories: information; finance and insurance; and real estate rental and leasing.

[d] Includes the following NAICS industry categories: professional, scientific, and technical services; management of companies and enterprises; and administrative support and waste management and remediation services industries.

[e] Includes the following NAICS industry categories: public administration; arts, entertainment, and recreation; and other services (except public administration).

important contribution. For instance, occupational status is influenced by educational attainment that creates differential access to and use of information and knowledge (health-related and other), and income creates differences through differential access to quality education, as well as to material goods and services. Stress related to limited social and material resources may negatively affect sleep.

Furthermore, racial/ethnic disparities in sleep may be propagated through differential exposure to social hazards in the workplace that produce or further exacerbate stressors that impair sleep. For instance, exposure to historical and contemporary forms of discrimination/harassment in the workplace and in society may play an important role in producing psychosocial stress, in addition to job strain or limited control over job demands/prestige, as illustrated by the well-known Karasek and Theorell demand-control model (38, 47–49). Additionally, shift work is more common in racial/ethnic minorities than in other groups (50, 51) and may help explain the observed racial differences in the prevalence of short sleep duration by industry and occupation, as well as the commonly observed flatter inverse gradients between some measures of socioeconomic status and various health outcomes among blacks compared with whites (52). Blacks have also been shown to have more risk factors for comorbid conditions (e.g., obesity, type 2 diabetes, sleep apnea) that may result in less, poorer quality sleep, and these health conditions have been shown to influence one's working conditions (53, 54).

With an increasing number of blacks entering into professional and management roles within any given industry, it would be useful to further investigate structural or macro-level social factors that contribute to the increasing prevalence of short sleep duration with increasingly professional roles among blacks. This is in contrast to the apparent decrease in prevalence of short sleep duration with increasingly professional roles for whites. Perhaps, the high prevalence of short sleep duration among professional blacks can be attributed, in part, to limited professional/social networks that can provide emotional and financial support, discrimination in the workplace, the perceived high work ethic needed to succeed, and/or greater levels of stress at home. An extraordinarily strong work ethic may emerge as a coping strategy in response to psychosocial and environmental stressors (e.g., career concerns, racism) when effort is not supported by potentially mitigating resources (e.g., financial and emotional support). This phenomenon is potentially damaging to health through, among other factors, shorter sleep duration, and has been referred to as John Henryism in the epidemiologic literature (55–57).

Our study has several limitations. For instance, we had a cross-sectional study design and were unable to investigate prospective associations between type of employment and sleep duration. We also relied on self-reported data, including data for sleep duration, whereas actigraphy and polysomnography (the "gold standard") would provide more objective measures (58). A previous study has shown a moderate correlation ($r = 0.45$) between reported and measured sleep duration and (although more research is necessary) did not find that blacks differed appreciably in their sleep duration reporting error compared with whites (58). We did not have data on the number of children (neither young nor adolescent) living in the household, which could influence sleep and could differ by race. We also did not have access to data on medication use that may affect sleepiness. Further, employment status was based on participants being employed during the week prior to the interview, which can be more variable for lower–socioeconomic status, minority groups (59); therefore, studies capable of exploring the influence of job security on sleep disparities would be particularly useful. Lastly, our occupational categories may include considerable heterogeneity and likely correlate with wealth. Our categories may also include a disproportionate number of shift workers, a variable for which we were unable to adjust, although shift work has been shown to differ by race and to negatively affect sleep (16, 32, 60).

Despite the limitations, our study has important strengths. For instance, our data were based on a large sample size with a large minority population in which robust racial, industry, and occupational stratification, as well as modification testing for a priori factors of interest, was possible. We had sleep data from 8 consecutive years, which enhanced our power to investigate sleep disparities. Also, our data are nationally representative and recently collected. We also directly estimated prevalence ratios rather than odds ratios for easier interpretation.

In conclusion, differences in short sleep duration among blacks and whites varied by industry of employment and occupation and did not appear to change over the study period. High socioeconomic status among blacks does not appear to be protective against short sleep duration, but it does for whites. These findings suggest the need for further investigation of racial/ethnic disparities in the work-sleep relationship to develop strategies for management, as well as tailored interventions that address disparities and improve sleep for optimal health among US workers.

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REFERENCES

1. Knutson KL, Van Cauter E, Rathouz PJ, et al. Trends in the prevalence of short sleepers in the USA: 1975–2006. *Sleep*. 2010;33(1):37–45.
2. Buxton OM, Marcelli E. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States. *Soc Sci Med*. 2010;71(5):1027–1036.
3. Hammond EC. Some preliminary findings on physical complaints from a prospective study of 1,064,004 men and women. *Am J Public Health Nations Health*. 1964;54:11–23.
4. Gangwisch JE, Heymsfield SB, Boden-Albala B, et al. Sleep duration associated with mortality in elderly, but not middle-aged, adults in a large US sample. *Sleep*. 2008;31(8):1087–1096.
5. Gangwisch JE, Heymsfield SB, Boden-Albala B, et al. Sleep duration as a risk factor for diabetes incidence in a large U.S. sample. *Sleep*. 2007;30(12):1667–1673.
6. Gottlieb DJ, Punjabi NM, Newman AB, et al. Association of sleep time with diabetes mellitus and impaired glucose tolerance. *Arch Intern Med*. 2005;165(8):863–867.
7. Gottlieb DJ, Redline S, Nieto FJ, et al. Association of usual sleep duration with hypertension: the Sleep Heart Health Study. *Sleep*. 2006;29(8):1009–1014.
8. Alvarez GG, Ayas NT. The impact of daily sleep duration on health: a review of the literature. *Prog Cardiovasc Nurs*. 2004;19(2):56–59.
9. Ayas NT, White DP, Al-Delaimy WK, et al. A prospective study of self-reported sleep duration and incident diabetes in women. *Diabetes Care*. 2003;26(2):380–384.
10. Steptoe A, Peacey V, Wardle J. Sleep duration and health in young adults. *Arch Intern Med*. 2006;166(16):1689–1692.
11. Taheri S, Lin L, Austin D, et al. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *PLoS Med*. 2004;1(3):e62.
12. Grandner MA, Hale L, Moore M, et al. Mortality associated with short sleep duration: the evidence, the possible mechanisms, and the future. *Sleep Med Rev*. 2010;14(3):191–203.
13. Luckhaupt SE, Tak S, Calvert GM. The prevalence of short sleep duration by industry and occupation in the National Health Interview Survey. *Sleep*. 2010;33(2):149–159.
14. Kuhn P, Lozano F. The expanding workweek? Understanding trends in long work hours among U.S. men, 1979–2004. *J Labor Econ*. 2008;26(2):311–343.
15. Tucker P, Smith L, Macdonald I, et al. The impact of early and late shift changeovers on sleep, health, and well-being in 8- and 12-hour shift systems. *J Occup Health Psychol*. 1998;3(3):265–275.
16. Pilcher JJ, Lambert BJ, Huffcutt AI. Differential effects of permanent and rotating shifts on self-report sleep length: a meta-analytic review. *Sleep*. 2000;23(2):155–163.
17. Ota A, Masue T, Yasuda N, et al. Association between psychosocial job characteristics and insomnia: an investigation using two relevant job stress models—the demand-control-support (DCS) model and the effort-reward imbalance (ERI) model. *Sleep Med*. 2005;6(4):353–358.
18. Ruggiero JS, Redeker NS. Effects of napping on sleepiness and sleep-related performance deficits in night-shift workers: a systematic review [published online ahead of print February 13, 2013]. *Biol Res Nurs*. 2013. (doi:10.1177/1099800413476571).
19. Costa G. The 24-hour society between myth and reality. *J Hum Ergol (Tokyo)*. 2001;30(1-2):15–20.
20. Presser HB. Toward a 24-hour economy. *Science*. 1999;284(5421):1778–1779.
21. Nunes J, Jean-Louis G, Zizi F, et al. Sleep duration among black and white Americans: results of the National Health Interview Survey. *J Natl Med Assoc*. 2008;100(3):317–322.
22. Ruiter ME, Decoster J, Jacobs L, et al. Normal sleep in African-Americans and Caucasian-Americans: a meta-analysis. *Sleep Med*. 2011;12(3):209–214.
23. Hale L, Do DP. Racial differences in self-reports of sleep duration in a population-based study. *Sleep*. 2007;30(9):1096–1103.
24. Durrence HH, Lichstein KL. The sleep of African Americans: a comparative review. *Behav Sleep Med*. 2006;4(1):29–44.
25. Krueger PM, Friedman EM. Sleep duration in the United States: a cross-sectional population-based study. *Am J Epidemiol*. 2009;169(9):1052–1063.
26. Thomas KS, Bardwell WA, Ancoli-Israel S, et al. The toll of ethnic discrimination on sleep architecture and fatigue. *Health Psychol*. 2006;25(5):635–642.
27. Tomfohr L, Pung MA, Edwards KM, et al. Racial differences in sleep architecture: the role of ethnic discrimination. *Biol Psychol*. 2012;89(1):34–38.
28. Zizi F, Pandey A, Murrray-Bachmann R, et al. Race/ethnicity, sleep duration, and diabetes mellitus: analysis of the National Health Interview Survey. *Am J Med*. 2012;125(2):162–167.
29. Stepnowsky CJ Jr, Moore PJ, Dimsdale JE. Effect of ethnicity on sleep: complexities for epidemiologic research. *Sleep*. 2003;26(3):329–332.
30. Spiegel K, Tasali E, Penev P, et al. Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Ann Intern Med*. 2004;141(11):846–850.
31. Spiegel K, Leproult R, L'Hermite-Baleriaux M, et al. Leptin levels are dependent on sleep duration: relationships with sympathovagal balance, carbohydrate regulation, cortisol, and thyrotropin. *J Clin Endocrinol Metab*. 2004;89(11):5762–5771.
32. Ertel KA, Berkman LF, Buxton OM. Socioeconomic status, occupational characteristics, and sleep duration in African/Caribbean immigrants and US white health care workers. *Sleep*. 2011;34(4):509–518.
33. Harma M, Tenkanen L, Sjoblom T, et al. Combined effects of shift work and life-style on the prevalence of insomnia, sleep deprivation and daytime sleepiness. *Scand J Work Environ Health*. 1998;24(4):300–307.
34. Rao U, Poland RE, Lutchmansingh P, et al. Relationship between ethnicity and sleep patterns in normal controls: implications for psychopathology and treatment. *J Psychiatr Res*. 1999;33(5):419–426.
35. Stamatakis KA, Kaplan GA, Roberts RE. Short sleep duration across income, education, and race/ethnic groups: population prevalence and growing disparities during 34 years of follow-up. *Ann Epidemiol*. 2007;17(12):948–955.
36. Kmec JA, Trimble LB. Does it pay to have a network contact? Social network ties, workplace racial context, and pay outcomes. *Soc Sci Res*. 2009;38(2):266–278.
37. Hughes D, Dodge MA. African American women in the workplace: relationships between job conditions, racial bias at work, and perceived job quality. *Am J Community Psychol*. 1997;25(5):581–599.
38. Grandner MA, Hale L, Jackson N, et al. Perceived racial discrimination as an independent predictor of sleep disturbance and daytime fatigue. *Behav Sleep Med*. 2012;10(4):235–249.

39. National Center for Health Statistics, Centers for Disease Control and Prevention. National Health Interview Survey. Hyattsville, MD: National Center for Health Statistics; 2013. (http://www.cdc.gov/nchs/nhis.htm). (Accessed June 10, 2013).
40. Voss U, Tuin I. Integration of immigrants into a new culture is related to poor sleep quality. *Health Qual Life Outcomes*. 2008;6:61.
41. Wolters KM. *Introduction to Variance Estimation*. New York, NY: Springer-Verlag; 1990.
42. Rao JN, Scott AJ. A simple method for the analysis of clustered binary data. *Biometrics*. 1992;48(2):577–585.
43. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol*. 2003;3:21.
44. Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. *Health Aff (Millwood)*. 2002;21(2): 60–76.
45. Shavers VL. Measurement of socioeconomic status in health disparities research. *J Natl Med Assoc*. 2007;99(9):1013–1023.
46. Berkman LF, Macintyre S. The measurement of social class in health studies: old measures and new formulations. *IARC Sci Publ*. 1997;(138):51–64.
47. Hall MH, Matthews KA, Kravitz HM, et al. Race and financial strain are independent correlates of sleep in midlife women: the SWAN Sleep Study. *Sleep*. 2009;32(1):73–82.
48. Karasek RA, Theorell T. *Healthy Work: Stress, Productivity, and the Reconstruction of Working Life*. New York, NY: Basic Books, Inc; 1992.
49. Krieger N, Waterman PD, Hartman C, et al. Social hazards on the job: workplace abuse, sexual harassment, and racial discrimination—a study of black, Latino, and white low-income women and men workers in the United States. *Int J Health Serv*. 2006;36(1):51–85.
50. Lieu SJ, Curhan GC, Schernhammer ES, et al. Rotating night shift work and disparate hypertension risk in African-Americans. *J Hypertens*. 2012;30(1):61–66.
51. Presser HB. Race-ethnic and gender differences in nonstandard work shifts. *Work Occup*. 2003;30:412–439.
52. Braveman PA, Cubbin C, Egerter S, et al. Socioeconomic disparities in health in the United States: what the patterns tell us. *Am J Public Health*. 2010;100(1 suppl):186S–196S.
53. Mensah GA, Mokdad AH, Ford ES, et al. State of disparities in cardiovascular health in the United States. *Circulation*. 2005;111(10):1233–1241.
54. Villaneuva AT, Buchanan PR, Yee BJ, et al. Ethnicity and obstructive sleep apnea. *Sleep Med Rev*. 2005;9(6):419–436.
55. Markovic N, Bunker CH, Ukoli FA, et al. John Henryism and blood pressure among Nigerian civil servants. *J Epidemiol Community Health*. 1998;52(3):186–190.
56. Flaskerud JH. Coping and health status: John Henryism. *Issues Ment Health Nurs*. 2012;33(10):712–715.
57. James SA. John Henryism and the health of African-Americans. *Cult Med Psychiatry*. 1994;18(2):163–182.
58. Lauderdale DS, Knutson KL, Yan LL, et al. Self-reported and measured sleep duration: How similar are they? *Epidemiology*. 2008;19(6):838–845.
59. Muntaner C, Hadden WC, Kravets N. Social class, race/ethnicity and all-cause mortality in the US: longitudinal results from the 1986–1994 National Health Interview Survey. *Eur J Epidemiol*. 2004;19(8):777–784.
60. Ohayon MM, Smolensky MH, Roth T. Consequences of shiftworking on sleep duration, sleepiness, and sleep attacks. *Chronobiol Int*. 2010;27(3):575–589.