



# Race/ethnic differences in educational gradients in sleep duration and quality among U.S. adults

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## ABSTRACT

At the population level, those with more education tend to report better sleep, mirroring the education gradient found in other health outcomes. But research has shown that higher educational attainment does not always confer the same health benefits for Non-Hispanic Black (Black) and Hispanic adults as it does for Non-Hispanic White (White) adults. It is therefore possible that the educational gradient in sleep varies across racial/ethnic groups in the United States. Using the 2004–2018 National Health Interview Survey (N = 356,048), we examined differences in self-reported sleep duration and sleep quality by level of educational attainment and race/ethnicity. Utilizing multinomial (sleep duration) and negative binomial (times in the past week with difficulty falling asleep and staying asleep) regression models, we found that, compared to their less educated counterparts, college or more educated Whites were more likely to report ideal sleep compared to short or long sleep, and also reported fewer times with difficulty falling or staying asleep. The education-sleep association was generally reversed for Black and Hispanic adults, with the worst sleep being reported by those with college-level education. These patterns remained after adjusting for health behaviors, health outcomes, and socioeconomic status. Our study suggests that education does not yield the same protective benefit for sleep among Black and Hispanic adults as it does for White adults, and that highly educated Black and Hispanic adults in particular experience a sleep disadvantage. The differential education gradient in sleep may, therefore, be an important factor underlying current racial and ethnic health disparities.

## 1. Introduction

Sleep is critical for well-being. Insufficient and poor sleep quality are associated with a variety of adverse health outcomes, including cardiovascular disease (Cappuccio et al., 2011), obesity (Liu et al., 2013), decreased cognitive functioning (Tworoger et al., 2006), and premature mortality (Cappuccio et al., 2010). Adequate sleep duration and quality sleep, however, are distributed unevenly across the population in ways that reflect broader patterns of structural inequality (Burgard & Ailshire, 2013; Clark et al., 2019; Hicken et al., 2013). For instance, at the population level, compared to less educated adults, more highly educated adults sleep more and report higher quality sleep (Grandner et al., 2010; Krueger & Friedman, 2009; Stamatakis et al., 2007). This general pattern - that increasing education is related to ideal sleep duration and better sleep quality - is widely observed in other health outcomes at the population level (Hummer & Lariscy, 2011) and is often referred to as

the educational gradient in health (Kimbrow et al., 2008).

However, educational attainment does not always result in similar health advantages for Black and Hispanic adults as it does for White adults across a range of health conditions and these outcomes both predict and result from poor sleep (Ailshire & House, 2011; Farmer & Ferraro, 2005; Hummer & Hernandez, 2013; Walsemann et al., 2012). Indeed, whereas the educational gradient in health is consistently beneficial for White adults, it is often null or detrimental for Black and Hispanic adults (Pearson, 2008). Sleep researchers have documented worse sleep among Black and Hispanic adults (Hicken et al., 2013; Petrov & Lichstein, 2016; Sheehan et al., 2018) and have called for greater attention to the complex association between education, race/ethnicity, and sleep disturbances (Grandner et al., 2016). No studies to our knowledge, however, have examined if the educational gradient in sleep quality and duration varies across race/ethnic groups. Here we document if the educational gradient in self-reported sleep duration and

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quality is smaller, or reversed, for Black and Hispanic compared to White individuals using a nationally representative sample of U.S. adults and multiple measures of sleep.

### 1.1. Background

Prior studies have consistently documented an educational gradient across several sleep outcomes, including self-reported sleep duration and sleep problems. Compared to less educated adults, more highly educated adults are more likely to report sleeping 7–9 hours, which is considered ideal for adults (Badr et al., 2015; Krueger & Friedman, 2009; Stamatakis et al., 2007), and are less likely to report experiences of sleep disturbances (Grandner et al., 2010). This mirrors findings from the broader health literature that documents that more educated individuals experience longer lives, have better physical and mental health, and engage in more health-promoting behaviors (Mirowsky & Ross, 2015). Past work suggests that the highly educated report greater autonomy at their jobs, higher wages, and have more fulfilling, supportive, and high-quality relationships (Hummer & Hernandez, 2013; Lunau et al., 2015; Mirowsky & Ross, 2015; Niemeyer et al., 2019) and these factors are linked to sleep.

The educational gradient in health, however, is not uniform across the U.S. population. The gradient appears most consistently among White adults but is sometimes smaller, or even reversed, for Black and Hispanic adults (Farmer & Ferraro, 2005; Kimbro et al., 2008; Walsemann et al., 2012; Williams et al., 2010). For example, Hummer and Lariscy (2011) found that Black and Hispanic adults received relatively less of a longevity benefit from education than their White counterparts. Others have also documented weaker or reversed gradients for self-rated health (Farmer & Ferraro, 2005; Kimbro et al., 2008), body mass index (Walsemann et al., 2012), and smoking status (Kimbro et al., 2008) among Black and/or Hispanic adults.

We draw from the Shine Sociocultural and Structural Framework of Race/Ethnicity and Health (Pearson, 2008) to conceptualize how and why educational gradients in sleep may vary by race/ethnicity. This conceptual framework posits that while worse health among highly resourced race/ethnic minorities is seemingly paradoxical, it is in fact the expected outcome of having to engage in the high-effort coping necessary to overcome the daily stressors and obstacles they encounter within a racialized social system and predominantly White institutions. Striving to succeed within systems or institutions that were not designed to support Black and Hispanic Americans, and are often antagonist towards them, takes both a physical and psychological toll in part by increasing stress (Geronimus & Thompson, 2004). As a result, highly educated Black and Hispanic Americans may be required to engage more often in persistent, active, and effortful coping than their less educated peers because their achieved social status requires them to interact with White social institutions. Prior work finds that greater stress is associated with poorer sleep (Kim & Dimsdale, 2007) and that high-effort coping in response to stress, such as racial vigilance, is associated with sleep difficulties (Hicken et al., 2013).

Attendance at predominantly-White colleges, for instance, presents unique challenges for Black and Hispanic adults, including experiences of alienation (Suen, 1983) and overt racism (Feagin et al., 2014; Von Robertson & Chaney, 2017) from their professors and their peers (Suarez-Balcazar et al., 2003) that result in high-effort coping, greater stress, and poorer mental health (Chao et al., 2012). College-educated Black and Hispanic adults also go on to often secure jobs in predominantly-White professional spaces that have historically excluded them and may continue to be inherently hostile and discriminatory to their presence (Anderson, 2015; Pearson, 2008). Indeed, research has found that the benefit of educational attainment for reducing occupational stress is smaller for Black and Hispanic adults (Assari & Bazargan, 2019) and could be one reason why college educated Black adults report more discrimination than Black adults with less education (Cole & Omari, 2003; Everson-Rose et al., 2015; Mouzon,

Taylor, Nguyen, Ifatunji, & Chatters, 2019). This is especially important given the link between occupational stress and sleep problems (Querstret & Cropley, 2012). The elevated reports of discrimination may also be due to smaller scale acts of inter-personal discrimination such as micro-aggressions that result from exposure to White institutions (Sue et al., 2007) and also greater awareness of these micro-aggressions that may accompany educational attainment. For example, Black adults who work in predominantly White occupational sectors, report significantly higher odds of short sleep than White adults (Jackson et al., 2013), which may reflect the general finding that racial discrimination and unfair treatment increase poor and inadequate sleep (Petrov & Lichstein, 2016).

The financial hardships associated with attending college may also have disproportionate impacts on Black and Hispanic adults. Black students and parents, for instance, are more likely than their White peers to acquire student debt (Addo et al., 2016; Houle, 2014; Jackson & Reynolds, 2013), and this additional debt can lead to increased financial strain, distress, and poor mental health throughout adulthood (Kim & Chatterjee, 2019; Walsemann et al., 2015; Walsemann, Ailshire, & Hartnett, 2020). Black and Hispanic adults may be particularly at risk for poor or inadequate sleep from holding large amounts of student debt because they receive less of an economic return to their education (Pew, 2016; Walsemann et al., 2013) and their families have less wealth to draw upon to repay these loans (Kochhar et al., 2011). A recent study using a nationally representative sample of young adults found that greater student debt was associated with shorter sleep duration, but only among Black young adults (Walsemann et al., 2016).

Research also finds Black and Hispanic adults, who often pay a physical price for attending college, receive diminished social and economic returns from a college education. That is, college educated Black and Hispanic adults earn less and accumulate less wealth over the life course compared to their White counterparts (DeNavas-Walt, 2010; Hummer et al., 2013; Pew, 2016). This is, in part, a result of discrimination faced by Black and Hispanic adults throughout their occupational careers: greater difficulty finding work (Bertrand & Mullainathan, 2004), lower levels of pay at baseline, and lower odds of promotion once hired (Becton et al., 2008; Maume Jr, 1999). Furthermore, being aware of racial disparities in earnings (Pew, 2016) has been referred to as “status incongruence,” which can undermine health (Dressler, 1996; Pearson, 2008) and potentially sleep. Striving for the American Dream but acquiring significant debt, having opportunities for advancement systemically blocked, and being aware of these blocked opportunities may increase stress and lead to poor sleep (Pearson, 2008).

Educational attainment is thought to confer status, resources, and opportunities and thus should be associated with better sleep. But for Black and Hispanic adults it may be a “double-edged sword” because it can lead to unique sources of institutional stressors and increased exposure to racial discrimination, which in turn require sustained high-effort coping (Hudson et al., 2012, 2013; Pearson, 2008). The greater physiological and psychological burdens experienced by highly educated Black and Hispanic adults necessitates high-effort coping and may diminish or reverse the education gradient in sleep in these populations, similar to what has been observed with other health outcomes (Farmer & Ferraro, 2005). Thus, the inverse education gradient previously observed in sleep (Stamatakis et al., 2007) may only exist among White adults.

## 2. Materials and methods

### 2.1. Data

Data came from the years 2004–2018 of the National Health Interview Survey (NHIS) Integrated Public Use Microdata Series (IPUMS) (Blewett et al., 2018). The NHIS is a nationally representative survey of non-institutionalized adults conducted annually to gauge the health of Americans. The NHIS began collecting information on sleep duration in

2004 and sleep quality in 2013. Our sample consisted of White, Black, and Hispanic adults aged 25–84 (the NHIS top codes age at 84) with non-missing responses on the sleep measures. About 2.0% were missing sleep duration from 2004 to 2018 and about 1.0% were missing any sleep quality measure from 2013 to 2018). The 2004–2018 sleep duration sample included 356,048 adults. The 2013–2018 sleep quality sample included 151,020 adults.

## 2.2. Measures

### 2.2.1. Self-reported sleep

To assess sleep, we utilized three self-reported measures: one measure of sleep duration and two measures of sleep quality. For sleep duration, respondents were asked to report how many hours they slept in a 24-h period. Interviewers were instructed to write down the response verbatim but later rounded the response to the hour. We coded these responses into three groups based on the consensus recommendations given by the Sleep Research Society due to the increased risk of health conditions for those who sleep short durations (Badr et al., 2015): six or fewer reported hours were coded as “short sleep,” seven to 9 h were coded as “normal sleep” (the base category for the multinomial models), and ten or more hours were coded as “long sleep.” To assess sleep quality, respondents were asked 1) how many times in the past week that they had trouble falling asleep and 2) how many times they had difficulty staying asleep. We used the count reports (i.e., 0–7 days) of these two measures.

### 2.2.2. Respondent characteristics

We categorized educational attainment based on the credential-based report available in the NHIS as less than high school, high school, some college, and college or more (reference, hereafter “ref”). We classified self-reported race/ethnicity as non-Hispanic White (ref), non-Hispanic Black, and Hispanic. We also included a set of demographic, socioeconomic, behavioral health, and health covariates that may confound the relationship between education and sleep. Demographic covariates included respondents’ age and age<sup>2</sup> to adjust for the non-linear association between age and sleep (we also tested a cubic measure which was not significant), gender (male = 1, female = 0), marital status (married (ref), divorced/separated, widowed, and never married), nativity status (Foreign born = 1, U.S. born = 0), count of number of children present in the household (ranging from 0 to 9 or more), and Census region of residence (Northeast (ref), Midwest, South, and West; Sheehan, Montez, & Sasson 2018). Behavioral health covariates included smoking status (never smoker (ref), former smoker, current someday smoker, and daily smoker) and alcohol consumption (never drinker (ref), former drinker, and current drinker). Health covariates included body mass index (BMI) categorized as underweight (BMI less than 18.5), normal weight (18.5–29.9, ref), and obese (30+), self-reported health coded as fair or poor versus good, very good, or excellent (ref), and the Kessler-6 psychological distress scale (range 0–20; Cronbach’s Alpha = 0.84). Socioeconomic covariates included self-reported household income categorized as \$0–\$34,999 (ref), \$35,000–\$74,000, and \$75,000 or more, the number of hours worked in the past week (0 h, 1–39 h, 40 h (ref), and more than 40 h), homeownership (1 = owns home, 0 = does not own home), and occupational status which we categorized similar to prior work (Krieger et al., 2005) as white collar (ref), blue collar, service sector, or not working.

## 2.3. Analytic approach

We first estimated descriptive statistics for the sleep duration and sleep quality samples, which are presented in Supplemental Table 1. Next, we examined the distribution of sleep duration and quality by race/ethnicity and educational attainment. We then fit multinomial regression models predicting sleep duration categories of six or fewer

hours, seven to 9 h (base category), and ten or more hours. Multinomial regression is ideal for modeling sleep duration (Sheehan et al., 2018; Xiao & Hale, 2018) given that the determinants and consequences of sleep duration vary between short (Matricciani et al., 2017) and long (Patel et al., 2006) sleep compared to normal sleep. We first fit a model with educational attainment and race/ethnicity as well as demographic controls. In the second model, we included interactions between educational attainment with race/ethnicity to determine if the gradient differs by race/ethnicity. In the third model, we additionally adjusted for behavioral health, health, and socioeconomic covariates to determine if these factors explain race/ethnic differences in education gradients in sleep. To account for documented trends in reported sleep duration (Sheehan et al., 2018) all models controlled for survey year. For sleep quality we estimated negative binomial models to predict the counts of times of sleep disturbances in the past week. We also estimated sleep quality using zero-inflated Poisson regression, however the results were similar and thus we present the negative binomial results as they have less strict assumptions than the Poisson models (e.g., over dispersion) and generally provide more conservative results (Hoffmann, 2004). We followed the same model building procedure when estimating sleep quality using negative binomial regression. There were relatively little missing data on covariates (household income had the highest percentage at 8.3%). Missing data were handled with the Stata’s *mi impute* command which used chained equations to create ten imputed datasets and then the analyses were replicated across datasets using the *mi estimate* command (Allison, 2001). All results were weighted to adjust for the complex sampling design of the NHIS and were conducted using Stata v.15.

## 3. Results

### 3.1. Descriptive differences

Table 1 presents weighted estimates of sleep duration and sleep quality by race/ethnicity and level of education. Among White adults, individuals with less education reported higher levels of short sleep duration, less than a high school had the highest proportion of short sleep (34.7%), whereas individuals with a college education had the lowest (24.7%). The pattern was reversed for Black and Hispanic adults, where the lowest proportion of short sleep was reported among individuals with less than a high school education (34.6% and 25.9%, respectively) and the highest among those with some college or a college education. For long sleep, we found an inverse educational gradient (i.e., higher educated had lower levels of long sleep) for each race/ethnic group. The results were somewhat similar for sleep quality as for risk of short sleep. Specifically, among White adults, those with more education generally reported fewer times with difficulty falling asleep and reported fewer times with difficulty staying asleep compared to those with less education. However, the educational gradient in sleep quality was less pronounced for Black and Hispanic adults.

### 3.2. Sleep duration

Table 2 presents estimated log odds from multinomial regression models that predicted the categories of sleep duration. Results from Model 1 indicated that, compared with the college educated, those with less than high school, high school, and some college education all had significantly higher log odds of reporting short sleep compared to sleeping 7–9 h. This same pattern was also found for long sleep relative to normal sleep. In Model 2, we added interactions between educational attainment and race/ethnicity. For short sleep, all interaction terms were statistically significant, suggesting there was significant racial/ethnic variation in the association between education and short sleep relative to normal sleep. These associations remained relatively similar with the inclusion of additional socioeconomic and health characteristics in Model 3. For long sleep, in Model 2 the interaction terms were

**Table 1**  
Sleep Duration and Quality by Race/Ethnicity and Educational Attainment. National Health Interview Survey, Sample Adults aged 25–84, 2004–2018.

	White Adults				Black Adults				Hispanic Adults			
	< HS	HS	SC	Coll+	< HS	HS	SC	Coll+	< HS	HS	SC	Coll+
<b>Self-Reported Hours of Sleep per Night<sup>a</sup></b>												
≤6 Hours	34.7%	31.9%	32.5%	24.7%	34.6%	35.7%	43.8%	42.6%	25.9%	29.0%	36.4%	31.1%
7 - 9 Hours	56.7%	63.7%	64.5%	73.8%	55.4%	58.0%	51.9%	55.5%	69.8%	68.0%	61.4%	67.3%
≥10 Hours	8.6%	4.4%	3.0%	1.6%	10.1%	6.3%	4.3%	1.9%	4.4%	3.0%	2.2%	1.6%
<b>Number of Times in the Past Week<sup>b</sup></b>												
Difficulty Falling Asleep	2.0	1.6	1.5	1.1	1.6	1.3	1.5	1.1	1.2	1.3	1.4	1.0
Difficulty Staying Asleep	2.5	2.1	2.2	1.7	1.8	1.6	1.8	1.5	1.2	1.3	1.5	1.2

Source: National Health Interview Survey, 2004–2018.

Notes: Data are Weighted to be representative of the Population. < HS = Less than High School, HS = High School, SC = Some College, Coll+ = College+.

<sup>a</sup> Question asked 2004–2018. N = 356,048.

<sup>b</sup> Questions asked 2013–2018. N = 151,020.

**Table 2**  
Multinomial Logistic Regression Models Predicting Self-Reported Sleep Duration, Adults aged 25–84 in the National Health Interview Survey, 2004–2018, n = 356,048.

table	≤6 vs. 7-9						≥10 vs. 7-9					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	b	p	b	p	b	p	b	p	b	p	b	p
<b>Race/Ethnicity</b>												
Non-Hispanic White (Ref)												
Non-Hispanic Black	0.37	**	0.79	**	0.83	**	0.51	**	0.46	**	0.45	**
Hispanic	0.00		0.35	**	0.34	**	-0.09		0.29	*	0.19	
<b>Educational Attainment</b>												
Less than High School	0.35	**	0.67	**	0.33	**	1.49	**	1.65	**	0.66	**
High School	0.29	**	0.43	**	0.27	**	1.03	**	1.03	**	0.47	**
Some College	0.36	**	0.40	**	0.28	**	0.74	**	0.73	**	0.34	**
College+ (Ref)												
<b>Race/Ethnicity X Education</b>												
Black X Less than High School			-0.85	**	-0.82	**			-0.28	*	-0.25	*
Black X Some College			-0.68	**	-0.67	**			0.05		0.00	
Black X High School			-0.35	**	-0.35	**			0.14		0.13	
Hispanic X Less than High School			-0.82	**	-0.66	**			-0.64	**	-0.39	**
Hispanic X High School			-0.51	**	-0.45	**			-0.37	**	-0.27	**
Hispanic X Some College			-0.18	**	-0.14	**			-0.34	*	-0.27	*
Constant	-2.05	**	-2.18	**	-1.94	**	-3.37	**	-3.42	**	-3.17	**

\*p < 0.05 \*\*p < 0.01.

Source: National Health Interview Survey, 2004–2018.

Model 1 and Model 2 adjust for Demographic Characteristics: Age, Age<sup>2</sup>, Region, Marital Status, Number of Children, Nativity, and Survey Year. Model 3 additionally adjusts for Health and Socioeconomic Characteristics: Smoking status, Alcohol consumption, Body Mass Index, Self-reported Health, Kessler-6 Scale, Household income, Occupational class, Hours worked per week, and Home Ownership. Full results presented in [Supplemental Table 2](#).

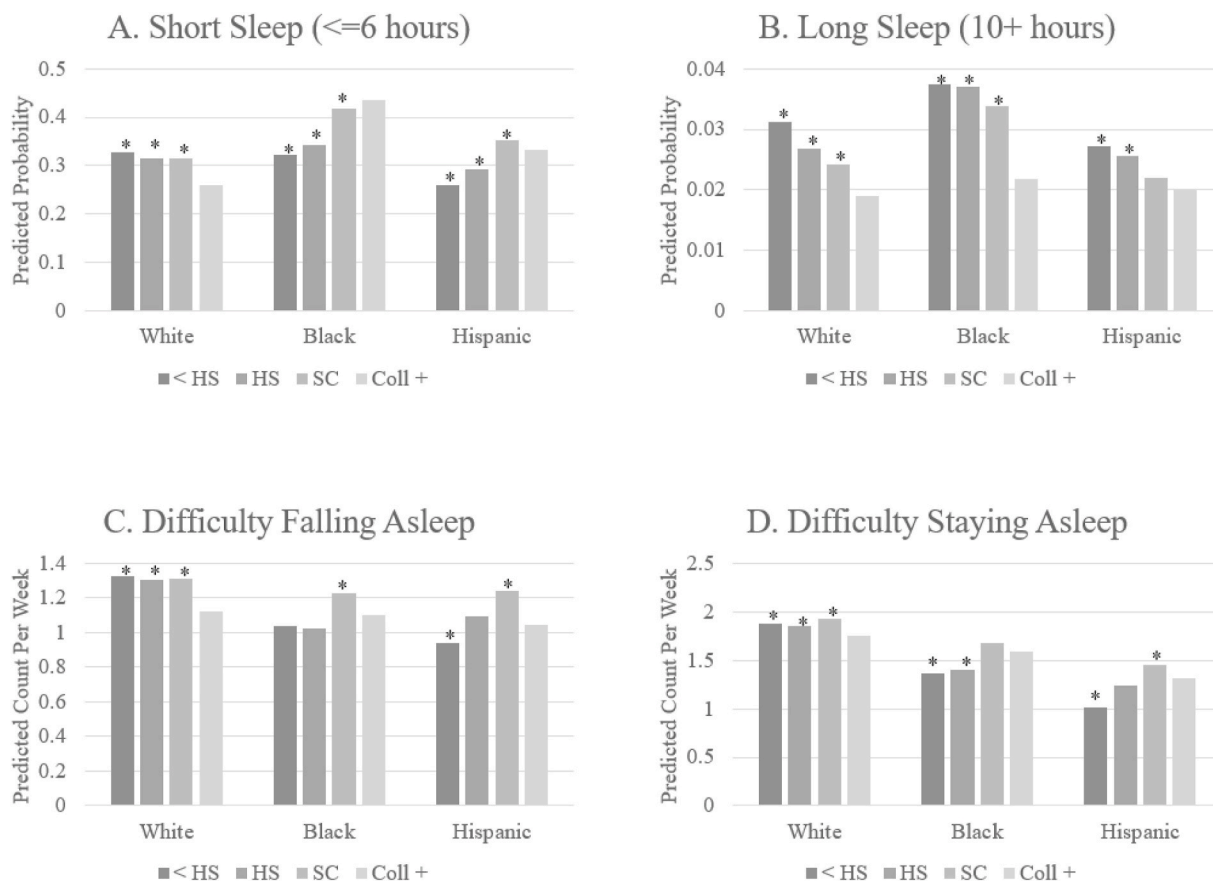
statistically significant for all education groups among Hispanic adults. Among Black adults the only statistically significant interaction was found for those with less than high school education. After adjustment for additional characteristics in Model 3 the only remaining statistically significant interactions were among Hispanic and Black adults with less than high school education.

The results from Model 3 in [Table 2](#) are presented as predicted probabilities in [Fig. 1](#). Panel A shows the results for short sleep. Among White adults, the probability of short sleep was significantly higher for those without a college degree than for those with a college degree. In contrast, among Black adults, those with high school and less than high school education had a *lower* predicted probability of short sleep than those with college education. Similarly, the probability of short sleep was higher among more educated Hispanic adults than lower educated Hispanic adults. Results for long sleep are plotted in Panel B. Regardless of race/ethnicity, the probability of long sleep was higher among those with less education, likely reflecting differences in access to employment.

### 3.3. Sleep quality

[Table 3](#) presents estimates from negative binomial regression models predicting the number of times in the past week respondents reported having difficulty falling or staying asleep. In Model 1, those with lower levels of education had significantly more days with reported sleep problems compared to those with college or more education and Black and Hispanic adults had significantly fewer times with difficulty falling or staying asleep than White adults. Model 2 introduced the interaction term between educational attainment and race/ethnicity, and consistent with short sleep duration, the results suggested there was significant variation in the educational gradient in sleep quality (falling asleep and staying asleep) between Black and Hispanic adults compared to White adults. One notable difference compared to the results for short sleep, however, was that there were no significant differences in sleep quality for the interaction between some college for Black and Hispanic adults. Model 3 added the remaining controls. The substantive results were generally similar across models and continued to suggest variation in the educational gradient in sleep for Hispanic and Black adults compared to White adults.

The predicted counts of times with difficulty falling asleep and



**Fig. 1.** Predicted Probability of Sleep Duration and Sleep Difficulty by Race/Ethnicity and Education, Adults aged 25–84 in the National Health Interview Survey, 2004–2018. Notes: Predicted probability and counts calculated for sleep duration from Model 3 estimates in Table 3 and for sleep quality from Model 3 estimates in Table 3, with covariates held at mean values. LTHS = Less than High School, HS = High School, SC = Some College, Coll+ = College or more (Reference). \* significant difference relative to College +.

**Table 3**

Negative Binomial Models Predicting the Number of Days in the Past Week with Sleep Difficulty, Adults aged 25–84, National Health Interview Survey, 2013–2018, n = 151,020.

table	Times with Difficulty Falling Asleep						Time with Difficulty Staying Asleep					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	b	p	b	p	b	p	b	p	b	p	b	p
<b>Race/Ethnicity</b>												
Non-Hispanic White (Ref)												
Non-Hispanic Black	-0.13	**	-0.01		0.04		-0.19	**	-0.12	**	-0.06	
Hispanic	-0.09	**	0.02		-0.03		-0.24	**	-0.14	**	-0.18	**
<b>Educational Attainment</b>												
Less than High School	0.48	**	0.63	**	0.11	**	0.24	**	0.38	**	0.02	
High School	0.34	**	0.38	**	0.13	**	0.17	**	0.20	**	0.03	
Some College	0.32	**	0.32	**	0.13	**	0.20	**	0.20	**	0.08	**
College+ (Ref)												
<b>Education X Race/Ethnicity</b>												
Black X Less than High School			-0.31	**	-0.29	**			-0.24	**	-0.23	**
Black X High School			-0.23	**	-0.30	**			-0.15	**	-0.18	**
Black X Some College			-0.06		-0.08				-0.03		-0.04	
Hispanic X Less than High School			-0.37	**	-0.17	**			-0.35	**	-0.19	**
Hispanic X High School			-0.14	*	-0.04				-0.13	*	-0.05	
Hispanic X Some College			-0.04		0.00				-0.03		0.00	
Constant	-0.44	**	-0.49	**	-0.71	**	-0.75	**	-0.79	**	-1.10	**

\*p < 0.05 \*\*p < 0.01.

Source: National Health Interview Survey, 2013–2018.

Model 1 and Model 2 adjust for Demographic Characteristics: Age, Age<sup>2</sup>, Region, Marital Status, Number of Children, Nativity, and Survey Year. Model 3 additionally adjusts for Health and Socioeconomic Characteristics: Smoking status, Alcohol consumption, Body Mass Index, Self-reported Health, Kessler-6 Scale, Household income, Occupational class, Hours worked per week, and Home Ownership.

staying asleep from the fully adjusted model (Model 3) are presented in Fig. 1 Panels C and D. Overall, these figures suggested that White adults reported more times with sleep problems than Black or Hispanic adults (difficulty falling and staying asleep). For difficulty falling asleep (Panel C), we found that among White adults, those with college or more education had significantly lower levels of difficulty falling asleep compared to the other levels of education. For Hispanic and Black adults, the educational gradients were generally non-existent or reversed. Indeed, for Black and Hispanic adults there was a significant difference between college or more and some college as some college had *higher* predicted times with difficulty falling asleep in the past week than college or more. Additionally, Hispanic adults with less than high school had significantly *fewer* predicted times with difficulty falling asleep compared to Hispanic adults with college or more. For difficulty staying asleep (Panel D), we found a similar pattern to difficulty falling asleep among White adults; those with college or more education had significantly fewer predicted times with difficulty staying asleep than those with less education. However, for Black adults, those with less than high school or high school had significantly *fewer* predicted times with difficulty falling asleep than those with college or more. For Hispanic adults, those with some college had significantly more predicted times with difficulty falling asleep than Hispanic adults with college education while Hispanic adults with less than high school education had significantly fewer predicted times with difficulty falling asleep than those with college or more.

### 3.4. Sensitivity analyses

We also conducted additional analyses to check the sensitivity of our results. First, to test for period trends, we replicated the analyses of sleep duration using two smaller samples: 2004–2009 and 2013–2018 (the sleep quality sample) and found similar patterns in both periods. Second, given the meaning of and access to education has changed over time and by birth cohort we fit three-way interaction models between race/ethnicity, education, and birth cohort (specified as 5-year age groups). We found little evidence of cohort differences in the gradient for Black, Hispanic, or White adults. Third, we tested an additional categorical specification of educational attainment of less than high school, high school, and more than high school and found similar findings. Fourth, we fit models with 7–8 h as the base category for sleep duration rather than 7–9 h and found similar substantive results.

## 4. Discussion

While more education is often found to be an important predictor of better health (e.g., Hummer et al., 2013; Mirowsky & Ross, 2015), it is increasingly clear that the educational gradient is not uniform across racial/ethnic groups or health outcomes (Walsemann et al., 2013). Although sleep researchers have called for greater attention to the relationships between education and race/ethnicity (Grandner et al., 2016), no study to our knowledge has determined how education gradients in sleep duration and quality vary by race/ethnicity. Our overall objective was to systematically investigate if the educational gradient in sleep duration and quality was similar among Black, Hispanic, and White adults. We found that the educational gradient in self-reported short sleep duration and sleep quality was reversed or muted in Black and Hispanic adults compared to White adults.

More specifically, we found that for White adults, having higher levels of educational attainment, especially college or more, was associated with reduced odds of reporting short sleep (six or fewer hours), long sleep (ten or more hours), and fewer sleep disruptions (difficulty falling asleep or staying asleep). Thus, for White adults, increased educational attainment, especially college or more, was associated with healthier sleep. However, for Black and Hispanic adults, higher levels of educational attainment (some college and college) was generally associated with greater likelihood of short sleep and higher frequency of

sleep problems compared to their counterparts with less educational attainment. The reversed or muted educational gradient in short sleep for Black and Hispanic adults was generally not explained by accounting for demographic characteristics, health status, health behaviors, or other measures of socioeconomic status. Notably, for White, Black, and Hispanic adults we found a consistent inverse educational gradient in the risk of reporting long-sleep. This is not surprising as past research has shown that one of the strongest predictors of long sleep is unemployment (Patel et al., 2006) and educational attainment can increase the likelihood of employment. We also replicated the findings of past research that found Black and Hispanic adults reported fewer sleep problems than White adults (Grandner et al., 2010). However, past research using objective measurement of sleep has found worse sleep quality among Black adults (Petrov & Lichstein, 2016), but the extent to which this may vary by level of educational attainment remains less clear.

The finding that highly educated Black and Hispanic adults reported greater levels of short sleep and, compared to their peers with lower levels of education, higher levels of sleep problems is consistent with past research that has found reversed educational gradients in other health outcomes (Farmer & Ferraro, 2005; Walsemann et al., 2013). It also provides empirical support for the theories arguing that the health benefits of acquiring “conventional” social and economic resources can be blunted among racial and ethnic minorities who must engage with dominant social systems in ways that necessitate using concerted, effortful coping responses (Pearson, 2008). Previous research has found that Black adults with higher levels of educational attainment reported greater levels of discrimination than Black adults with lower levels of education (Everson-Rose et al., 2015; Mouzon et al., 2019) and that this increased discrimination can undermine their own health (Cohen et al., 2006; Colen et al., 2018; Farmer & Ferraro, 2005; Hudson et al., 2012, 2013) and even the health of their offspring (Colen et al., 2006). Black and Hispanic adults with more educational attainment may not only notice the increased discrimination, they face unique forms of discrimination throughout their educational experiences and may face forms of discrimination that those with lower levels of socioeconomic status are not exposed to including greater exposure to White adults and White spaces (Aronson et al., 2013; Hudson et al., 2012).

Past research has discussed how racial vigilance, the notion that Black adults are constantly attentive and stressed about facing discrimination, negatively influences the sleep of Black adults (Hicken et al., 2013). Racial/ethnic differences in sleep duration and quality may reflect disparate exposures to psychosocial stressors (Hall et al., 2009; Mezick et al., 2009) and effortful coping (Geronimus & Thompson, 2004), which may be more acute or qualitatively different for highly educated Black and Hispanic adults compared to their less educated peers. While we lack measures of discrimination, discrimination and racial vigilance is especially concentrated among highly educated Black and Hispanic adults who face and report greater levels of discrimination and social injustice in White institutions (Everson-Rose et al., 2015; Mouzon et al., 2019; Pearson, 2008). As poor sleep is associated with a host of mental and physical health conditions, it could at least partially explain why Black and Hispanic adults with higher levels of educational attainment do not receive similar benefits from education for other health outcomes (Colen et al., 2018; Farmer & Ferraro, 2005; Hudson et al., 2012, 2013; Hummer & Hernandez, 2013).

This research has important limitations. We relied on self-reports of sleep duration. These reports are biased and may overestimate racial/ethnic inequality in sleep duration compared to more objective measures such as actigraphy (Lauderdale et al., 2008). We are aware of no evidence that this bias varies by race and educational attainment, however. While the duration results may not be less accurate than objective measures of sleep, we are reassured that the results from the sleep quality analysis were largely similar to the reports of sleep duration despite White adults differing from Black and Hispanic adults in overall measures of sleep quality. While we controlled for nativity in our

models, due to small cell sizes, we could not examine educational gradients by country of origin, and thus were unable to determine if there was additional heterogeneity in the association between education and sleep. Finally, we lacked detailed measures of other factors that are important for the educational process, such as racial composition of the schools, neighborhood characteristics, perceived discrimination, exposure to White spaces, or student loan debt that may help us better understand why we find race/ethnic variation in the educational gradient in sleep.

## 5. Conclusions

This study has important implications for understanding racial/ethnic health disparities more broadly. Sleep is considered a key risk factor for a number of poor health outcomes and may be a key mechanism through which social and environmental stressors impact well-being. Thus, poor sleep among highly educated Black and Hispanic adults could be one reason for the persistence of racial/ethnic health disparities in the population (Hummer & Lariscy, 2011). Sleep is not only important for health but can also directly influence occupational performance, social engagement, and parenting (Slopen et al., 2016) potentially inhibiting future upward mobility as well. Overall, poor sleep may both reinforce and reproduce social inequality, which can also lead to differential health outcomes by race and ethnicity.

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## Availability of data

The data are publicly available but we would also be happy to make the data available upon request.

## Code availability

The analysis was conducted in Stata and the code is available upon request.

## Originality

This is an original work, not under review anywhere else, and we have cited credit where credit is due.

## CRedit authorship contribution statement

**Connor M. Sheehan:** Conceptualization, Software, Formal analysis, Data curation, Writing - original draft. **Katrina M. Walsemann:** Conceptualization, Writing - original draft, Writing - review & editing, Supervision. **Jennifer A. Ailshire:** Conceptualization, Writing - original draft, Methodology, Writing - review & editing, Visualization, Supervision.

## Declaration of competing interest

We have no conflicts of interest to report.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2020.100685>.

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