Sex and race differences in the association between sleep duration and adiposity: the Bogalusa Heart Study ☆

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ABSTRACT

Background: Short sleep duration has been consistently associated with obesity. However, few studies in adults have assessed whether this association varies by sex and race.
Methods: In the 2013–2016 examination of 1116 participants from the biracial Bogalusa Heart Study, habitual sleep duration was measured in categories (<6 hours, 6–7 hours, 7–8 hours, > 8 hours) using self-report. Anthropometry was performed and adiposity was assessed using body mass index (BMI) and waist circumference. Linear regression models estimated the relationship between sleep duration and adiposity adjusting for age, education, employment, bed partner status, depressive symptoms, smoking status, physical activity, and the use of alcohol and sleeping pills. Effect modification by sex and race was examined using cross-product terms in the models and marginal means were reported.
Results: Of 1116 participants (mean age 48.2 years), 58.3% were female, and 31.7% were Black. In adjusted analyses, women sleeping <6 hours had a 3.2 (95% CI 1.4, 5.0) kg/m^2 greater BMI and 6.1 (1.8, 10.4) cm greater waist circumference compared to women sleeping 7–8 hours. In contrast, men had similar BMIs and waist circumferences regardless of sleep duration (p's for interaction = 0.04 & 0.11). There was no effect modification by race.
Conclusions: In this sample, lower habitual sleep duration was associated with greater adiposity among women compared to men. Further research is needed to understand the potential mechanisms of the adverse metabolic effects of short sleep in women.

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Introduction

Multiple professional organizations as well as the Centers for Disease Control and Prevention recommend that adults sleep at least 7 hours per night.[1–4] However, national survey data from 2014 indicate that only 65.2% of Americans are meeting this recommendation, with lower percentages among working age adults.[5] Failing to obtain recommended amounts of sleep has been associated with poor physical and mental health,[6,7] as well as low quality of life.[8–10] As a result, Healthy People 2020, a set of national objectives for improving health, has stated a public health goal to increase the proportion of adults who get sufficient sleep.[11]

Although short habitual sleep durations have been fairly consistently associated with greater adiposity, rate of subsequent weight gain, and incident obesity,[12] the data are inconsistent regarding the possible modification of this effect by characteristics such as sex and race. Some studies have found stronger associations among men,[13–15] while others find stronger associations in women,[16,17] or no effect modification.[18] Many of these studies, however, have relied on racially or ethnically homogenous populations, despite previous research demonstrating important differences in sleep duration by race and ethnicity.[19–21] A recent American Heart Association scientific statement identified the inclusion of more diverse populations to be a top sleep research priority.[22] Experimental studies suggest that women may be more susceptible to hedonic eating and food stimuli than men,[23,24] while short term sleep restriction in the lab leads to greater weight gain in Blacks than Whites.[25] As a result,

examining the relationship between sleep and obesity in diverse populations and by sex has the potential to give further insight into its mechanisms and allow for tailored interventions.

In this study, we examined the association between sleep and obesity in a biracial sample of working-age adults who participated in the Bogalusa Heart Study, an on-going, community-based, observational study. We sought to evaluate the association between sleep duration and adiposity in this cohort and further, the extent to which this association varies by sex and race. Based on previous research, we hypothesized that less sleep would be associated with more obesity, and that this association would be stronger in women than men and in Blacks rather than Whites.

Methods

The Bogalusa Heart Study is a series of long-term studies in a semirural biracial (65% White and 35% Black) community sample of residents from Bogalusa, Louisiana founded in 1973 by Dr. Gerald Berenson. The most recent examination, which was used for this cross-sectional analysis, occurred in 2013–2016 and consisted of 1298 adult men and women. All subjects in this study gave written informed consent and the study protocol was approved by the institutional review board at the Tulane University Health Sciences Center (New Orleans, Louisiana). In the present analysis, we excluded participants who were not White or Black (n = 2), those with missing covariate data (n = 22), those with any missing sleep variables (n = 118), and those with implausible sleep duration, defined as <3 hours or > 12 hours (n = 40). This left an analytic sample of 1116.

Sleep assessment

Sleep duration was measured via self-report using items from the Sleep Habits Questionnaire of the Sleep Heart Health Study. Questions on bedtimes and wake times on weekdays and weekends, sleep latency, and wake after sleep onset were used to obtain a measure of sleep duration. Habitual time in bed was calculated as a weighted average of the difference between wake time and bedtime on weekdays and weekends using the formula: habitual time in bed = 5/7*(week or workday time in bed) + 2/7*(weekend or nonworkday time in bed). Sleep latency was measured with the question: "How many minutes does it usually take for you to fall asleep at bedtime?" Wake after sleep onset was measured with the question: "How many minutes of wake time (waking up in the middle of the night) do you have during a typical night's sleep?" Habitual sleep duration was calculated as habitual time in bed – sleep latency – wake after sleep onset. Participants with calculated habitual sleep durations <3 hours or >12 hours were excluded from analysis. This variable was modeled categorically using four categories: <6 hours, 6–<7 hours, 7–8 hours, and >8 hours per night in primary analyses. The 7–8 hour category was used as the referent category because it represents the amount of sleep recommended by several organizations.[1-4] In secondary analyses, habitual sleep duration was also modeled continuously and a quadratic relationship was tested with a sleep duration squared term.

Adiposity

Standardized protocols were used by trained staff to measure height, weight, and waist circumference in all participants in light clothing without shoes. Height was measured to the nearest 0.1 cm while weight was measured to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight in kilograms divided by square of height in meters. Waist circumference was measured in the horizontal plane at 1 cm below the umbilicus to the nearest 0.1 cm. All measurements were made in duplicate and averaged. BMI was used as a measure of overall adiposity and waist circumference as a measure of central adiposity.

Covariates

Demographic characteristics including age, sex, race (White, Black), education (less than high school, high school, some college, college or more), employment (current employment, no current employment), and bed partner status (partner in the same bed, no partner in same bed) were self-reported. Depressive symptoms were assessed via the 10 item version of the Center for Epidemiological Studies Depression Scale (CES-D).[26] All 10 items were summed and categorized into two groups: ≥10 vs <10. Other self-reported covariates included smoking status (current, former, never), alcohol use (current, not current), and sleeping pill use (not in the past 4 weeks, less than once a week, 1 or 2 times a week, 3 or 4 times a week, 5 or more times a week). Physical activity was defined as self-reported weekly minutes of moderate or vigorous leisure time activity and was modeled continuously.

Statistical analysis

Means and frequencies were calculated to examine sociodemographic and behavioral characteristics by sleep category for both adiposity variables. Linear regression was used to model the cross-sectional relationship between sleep and measures of overall and central adiposity, BMI and waist circumference, respectively. Model 1 adjusted for age, sex, race, education, employment, and bed partner status, while Model 2 added potential mediators, including depressive symptoms, smoking status, alcohol use, sleeping pill use, and leisure time physical activity. Effect modification by sex and race was examined on the additive scale by using cross-product interaction terms in the models. The association between sleep duration and both BMI and waist circumference within each race and sex subgroup was calculated as the marginal effects in the full model fixing race and/or sex in models with a three-way sex x race x sleep duration category interaction as well as all two-way interactions. All analyses were completed in Stata 15 (StataCorp, College Station, TX).

Results

The mean age in the analytic sample was 48.2 (SD 5.3) years, 58.3% were female, and 31.7% were Black. Mean habitual sleep duration was 7.3 (SD 1.6) hours per night, and 40.7% slept less than 7 hours per night. The mean BMI in the sample was 31.4 (SD 7.6) kg/m², 50.9% had a BMI ≥30 kg/m², and mean waist circumference was 96.1 (SD 18.7) cm. Mean BMI was 35.3 kg/m² in Black women while mean BMI was 30.5 kg/m² in White men, 30.1 kg/m² in White women, and 31.2 kg/m² in Black men. Mean waist circumference was 90.0 cm among White women (100.8 cm in White men, 99.0 cm in Black men, and 99.2 cm in Black women.

Table 1 shows descriptive characteristics by categories of habitual sleep duration. A total of 39.3% of those sleeping <6 hours a night reported depressive symptoms, compared to 24.6% of those sleeping 7–8 hours a night. Table 2 shows descriptive characteristics by race-sex groupings. Both Black and White men reported sleeping 7.1 hours per night, while Black women reported sleeping 7.6 hours and White women reported 7.4 hours.

In crude analyses in the overall cohort, mean BMI was 2.0 kg/m² (95% CI 0.7, 3.3) and mean waist circumference was 4.5 cm (1.2, 7.7) greater in those sleeping <6 hours per night compared to those sleeping 7–8 hours. After adjustment for age, sex, race, education, employment and bed partner status, mean BMI was 1.5 kg/m² (0.2, 2.8) greater and mean waist circumference was 2.7 cm (−0.5, 5.9) greater in those sleeping <6 hours per night compared to those

Table 1
Descriptive characteristics by categories of habitual sleep duration: the Bogalusa Heart Study 2013–2016

N	<6 hours	6–7 hours	7–8 hours	>8 hours
	206	248	333	329
Age (y), mean ± SD	48.3 ± 5.2	48.5 ± 5.2	48.0 ± 5.2	48.0 ± 5.5
Female, n (%)	104 (50.5)	134 (54.0)	198 (59.5)	215 (65.4)
Black, n (%)	80 (38.8)	70 (28.2)	80 (24.0)	124 (37.7)
Years of education, n (%)*				
Less than High School	27 (20.6)	22 (16.8)	35 (26.7)	47 (35.9)
High School	79 (19.7)	80 (19.9)	109 (27.1)	134 (33.3)
Some College	62 (20.6)	65 (21.6)	92 (30.6)	82 (27.2)
College or more	38 (13.5)	81 (28.7)	97 (34.4)	66 (23.4)
Employed, n (%)	126 (61.2)	204 (82.3)	229 (68.8)	184 (55.9)
Bed partner, n (%)	114 (55.3)	159 (64.1)	223 (67.0)	189 (57.5)
Depressive symptoms, n (%)	81 (39.3)	65 (26.2)	82 (24.6)	89 (27.1)
Regular sleeping pill use, n (%)	20 (9.7)	10 (4.0)	28 (8.4)	33 (10.0)
Smoking status, n (%)*				
Current	64 (21.6)	52 (17.5)	90 (30.3)	91 (30.6)
Former	47 (18.7)	56 (22.3)	73 (29.1)	75 (29.9)
Never	95 (16.7)	140 (24.7)	170 (29.9)	163 (28.7)
Current alcohol use, n (%)	103 (50.0)	163 (65.7)	206 (61.9)	169 (51.4)
Moderate-vigorous physical activity (min/wk), mean ± SD	121.2 ± 395.4	130.1 ± 373.0	117.1 ± 381.6	90.5 ± 303.1
Body Mass Index (kg/m^2), mean ± SD	32.5 ± 8.1	31.6 ± 7.4	30.5 ± 7.2	31.3 ± 8.0
Obesity, n (%)	120 (58.3)	138 (55.7)	150 (45.1)	160 (48.6)
Waist circumference (cm), mean ± SD	98.8 ± 19.0	97.0 ± 18.4	94.4 ± 18.7	95.4 ± 18.7

Depressive symptoms defined as CES-D ≥10. Regular sleeping pill use defined as 5 or more times per week. Obesity defined as BMI ≥30 kg/m^2.

* Row percentages.

sleeping 7–8 hours (Table 3). Results were similar after further adjustment for depressive symptoms, smoking, alcohol, sleeping pill use, and physical activity. When sleep duration was modeled continuously with a quadratic term, the amount of sleep at which BMI and waist circumference were minimized was 8.6 and 8.3 hours respectively. Using this model, those sleeping 5.5 hours a night had 1.1 kg/m^2 (0.4, 1.7) larger BMI and 2.1 cm (0.4, 3.8) larger waist circumferences after adjustment for all covariates.

Table 3 also shows the association between sleep and adiposity stratified by sex. Although men had similar BMIs and waist circumferences across sleep categories, women sleeping <6 hours per night had 3.2 kg/m^2 (1.4, 5.0) larger BMIs and 6.1 cm (1.8, 10.5) larger waist circumferences compared to those sleeping 7–8 hours per night (p for interaction = 0.04 and 0.11, respectively). When

measured continuously in a quadratic model, women sleeping 5.5 hours a night had 1.6 kg/m^2 (0.7, 2.6) greater BMI and 3.3 cm (1.0, 5.6) greater waist circumference compared to women sleeping 7.5 hours a night, adjusting for age, race, education, employment and bed partner status. In contrast, men had similar BMIs and waist circumferences across sleep duration categories. Similar results were found after further adjustment for depressive symptoms, smoking, alcohol, sleeping pill use, and physical activity.

For race, effect modification was not statistically significant and confidence intervals were wide (p-interaction = 0.50 and 0.81, for BMI and waist circumference respectively). After adjustment for demographics, Blacks sleeping <6 hours per night had 2.2 kg/m^2 (−0.1, 4.6) larger BMIs and a 3.5 cm (−2.1, 9.1) larger waist circumference than Blacks sleeping 7–8 hours per night while Whites sleeping <6 hours per

Table 2
Descriptive characteristics by race/sex group: the Bogalusa Heart Study 2013–2016

N	White men	White women	Black men	Black women
	329	433	136	218
Age (y), mean ± SD	48.9 ± 5.0	48.2 ± 5.1	47.4 ± 6.1	47.4 ± 5.4
Years of education, n (%)*				
Less than High School	27 (20.6)	39 (29.8)	34 (26.0)	31 (23.7)
High School	124 (30.9)	122 (30.4)	61 (15.2)	95 (23.6)
Some College	83 (27.6)	132 (43.9)	29 (9.6)	57 (18.9)
College or more	95 (33.7)	140 (49.7)	12 (4.3)	35 (12.4)
Employed, n (%)	248 (75.4)	300 (69.3)	67 (49.3)	128 (58.7)
Bed partner, n (%)	216 (65.7)	313 (72.3)	73 (53.7)	83 (38.1)
Depressive symptoms, n (%)	70 (21.3)	136 (31.4)	34 (25.0)	77 (35.3)
Regular sleeping pill use, n (%)	15 (4.6)	50 (11.6)	7 (5.2)	19 (8.7)
Smoking status, n (%)*				
Current	83 (28.0)	105 (35.4)	60 (20.2)	49 (16.5)
Former	82 (32.7)	106 (42.2)	30 (12.0)	33 (13.2)
Never	164 (28.9)	222 (39.1)	46 (8.1)	136 (23.9)
Current alcohol use, n (%)	208 (63.2)	248 (57.3)	80 (58.8)	105 (48.2)
Moderate-vigorous physical activity (min/wk), mean ± SD	113.6 ± 315.8	78.8 ± 259.7	183.0 ± 442.0	135.9 ± 506.3
Sleep duration (h)	7.1 ± 1.3	7.4 ± 1.5	7.1 ± 2.0	7.6 ± 1.8
Body Mass Index (kg/m^2), mean ± SD	30.5 ± 6.1	30.1 ± 7.2	31.2 ± 8.2	35.3 ± 8.9
Obesity, n (%)	152 (46.2)	188 (43.4)	66 (48.5)	162 (74.3)
Waist circumference (cm), mean ± SD	100.8 ± 15.6	90.0 ± 18.2	99.0 ± 20.7	99.2 ± 19.6

Depressive symptoms defined as CES-D ≥10. Regular sleeping pill use defined as 5 or more times per week. Obesity defined as BMI ≥30 kg/m^2.

* Row percentages.

Table 3
β-Coefficients (95% confidence interval) for obesity by categories of habitual sleep duration: the Bogalusa Heart Study 2013–2016

N	< 6 hours 206	6- < 7 hours 248	7–8 hours 333	>8 hours 329	
BMI (kg/m²)					
Model 1	1.5* (0.2, 2.8)	1.0 (−0.3, 2.2)	Ref.	0.2 (−1.0, 1.3)	
Model 2	1.3* (0.0, 2.6)	0.8 (−0.4, 2.1)	Ref.	−0.1 (−1.2, 1.1)	
Waist circumference (cm)					
Model 1	2.7 (−0.5, 5.9)	2.0 (−1.0, 5.0)	Ref.	0.4 (−2.4, 3.2)	
Model 2	2.3 (−0.9, 5.5)	1.8 (−1.2, 4.7)	Ref.	−0.2 (−3.0, 2.5)	
Sex-stratified	**<6 hours**	**6- < 7 hours**	**7–8 hours**	**>8 hours**	**P for interaction**
BMI (kg/m²)					
Model 1					0.04
Men	−0.4 (−2.3, 1.5)	0.7 (−1.2, 2.6)	Ref.	−0.3 (−2.2, 1.5)	
Women	3.2** (1.4, 5.0)	1.1 (−0.6, 2.7)	Ref.	0.6 (−0.9, 2.0)	
Model 2					0.08
Men	−0.4 (−2.3, 1.5)	0.5 (−1.4, 2.3)	Ref.	−0.7 (−2.5, 1.2)	
Women	2.9** (1.1, 4.7)	1.1 (−0.6, 2.7)	Ref.	0.4 (−1.1, 1.8)	
Waist circumference (cm)					
Model 1					0.11
Men	−1.2 (−5.9, 3.5)	1.8 (−2.8, 6.3)	Ref.	−0.6 (−5.1, 3.9)	
Women	6.1** (1.8, 10.4)	1.9 (−2.1, 5.9)	Ref.	1.1 (−2.5, 4.6)	
Model 2					0.20
Men	−1.1 (−5.8, 3.5)	1.3 (−3.2, 5.8)	Ref.	−1.3 (−5.8, 3.2)	
Women	5.4* (1.1, 9.7)	1.9 (−2.0, 5.9)	Ref.	0.5 (−3.0, 4.0)	
Race-stratified	**< 6 hours**	**6- < 7 hours**	**7–8 hours**	**>8 hours**	**P for interaction**
BMI (kg/m²)					
Model 1					0.50
White	1.2 (−0.4, 2.8)	1.1 (−0.3, 2.5)	Ref.	−0.3 (−1.6, 1.1)	
Black	2.2 (−0.1, 4.6)	0.7 (−1.7, 3.1)	Ref.	1.1 (−1.0, 3.2)	
Model 2					0.59
White	1.1 (−0.4, 2.7)	1.0 (−0.4, 2.4)	Ref.	−0.5 (−1.8, 0.9)	
Black	1.9 (−0.4, 4.1)	0.6 (−1.8, 2.9)	Ref.	0.8 (−1.3, 2.9)	
Waist circumference (cm)					
Model 1					0.81
White	2.4 (−1.5, 6.3)	2.1 (−1.4, 5.6)	Ref.	−0.4 (−3.8, 2.9)	
Black	3.5 (−2.1, 9.1)	1.8 (−4.1, 7.6)	Ref.	2.1 (−3.0, 7.2)	
Model 2					0.80
White	2.3 (−1.6, 6.2)	1.9 (−1.6, 5.4)	Ref.	−1.0 (−4.4, 2.3)	
Black	2.7 (−2.9, 8.3)	1.5 (−4.3, 7.4)	Ref.	1.4 (−3.7, 6.5)	

Habitual sleep duration was calculated from bedtimes and wake times and subtracting sleep latency and wake after sleep onset.
Model 1 adjusted for age, sex, race, education, employment, and bed partner status, where appropriate.
Model 2 added depressive symptoms, sleeping pill use, smoking, alcohol, and moderate-vigorous physical activity.
* $P < .05$,
** $P < .01$.

night had 1.2 kg/m² (−0.4, 2.8) larger BMI and a 2.4 cm (−1.5, 6.3) larger waist circumference than Whites sleeping 7–8 hours per night.

Fig. 1 shows differences in BMI and waist circumference by sleep duration category for each race/sex group. Although confidence intervals are wide due to limited sample sizes in each of these strata, White men had similar BMIs and waist circumferences across sleep duration categories while White women, Black men, and Black women who slept <6 hours per night had larger BMIs and waist circumferences than those who slept 7–8 hours per night.

Discussion

In a biracial community-based sample, we found an inverse association between self-reported habitual sleep duration and measures

BMI
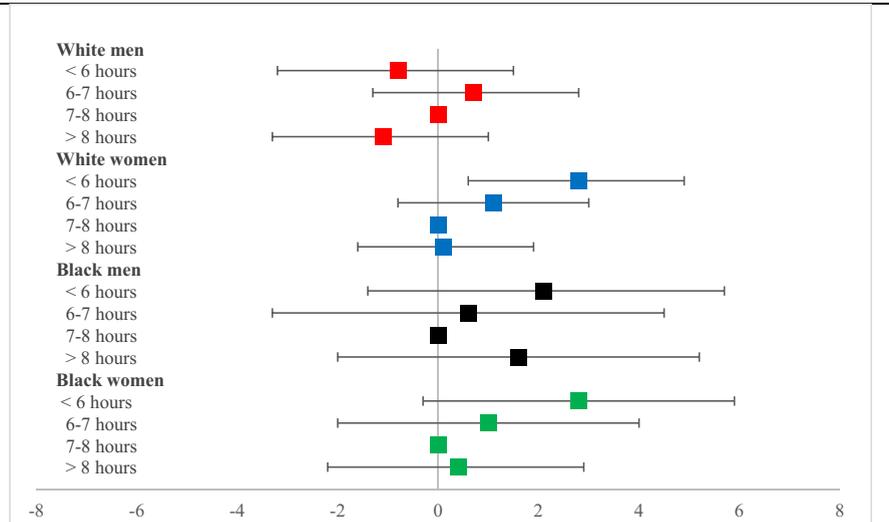
Waist circumference
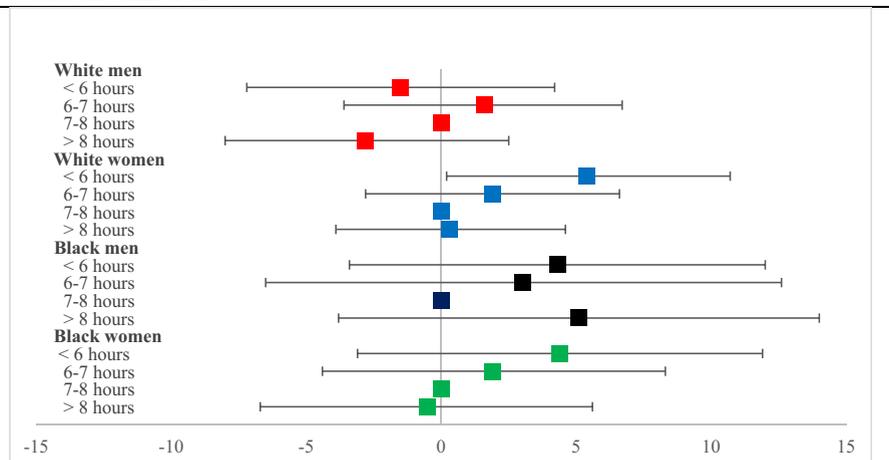
Sleep time was calculated from bedtimes and waketimes and subtracting sleep latency and wake after sleep onset

Body mass index (BMI) was measured in kg/m^2 and waist circumference was measured in centimeters

Models adjusted for age, education, employment, bed partner status, depressive symptoms, sleeping pill use, smoking, alcohol, and physical activity

Fig. 1. β-Coefficients for BMI and waist circumference (95% confidence interval) by habitual sleep duration in race/sex sub groups: The Bogalusa Heart Study 2013–2016 Sleep time was calculated from bedtimes and wake times and subtracting sleep latency and wake after sleep onset Body mass index (BMI) was measured in kg/m^2 and waist circumference was measured in centimeters Models adjusted for age, education, employment, bed partner status, depressive symptoms, sleeping pill use, smoking, alcohol, and physical activity.

of overall and central adiposity. When examining subgroups, we found sex differences in the association between sleep and adiposity with stronger associations in women compared to men. In contrast, effect modification by race was not statistically significant. In race-sex subgroup analyses, White men had similar BMIs and waist circumferences regardless of sleep duration, while White women, Black men, and Black women had greater differences in adiposity between short sleepers and average sleepers.

In this study, men had similar overall and central adiposity regardless of sleep duration, while female short sleepers had larger BMIs and waist circumferences compared to their counterparts getting adequate sleep. These findings are supported by previous research, including the MIDUS study, which found that actigraphy-assessed sleep was associated with BMI and waist circumference in women, but not men.[16] Although some studies have reported the

opposite finding, (i.e., that there is an association between sleep and obesity in men but not women), these studies often have limitations such as small effect sizes for both men and women,[13,27] very few women in the sample,[15] or adjustment for mediating variables. Importantly, a week-long experimental laboratory study of sleep restriction did find that men gained more weight than women,[25] but it is unclear whether sex differences in a controlled setting would apply to habitual behaviors among free-living adults. Some studies also report no differences by sex, though these studies may have relied solely on significance testing and did not have the power to detect differences. Interpretation of effect modification analyses can sometimes be unclear, such as in an analysis from the Multi-Ethnic Study of Atherosclerosis (MESA) on sleep and obesity where statistical tests for effect modification by sex were around the threshold for significance, but no appreciable differences were found.[28] In general,

sex differences in sleep have been documented in both normal sleep and sleep disorders.[29] On average, women sleep longer than men,[30,31] which was found in our sample (21 minute difference). Sex differences have also been found in obesity, with National Health and Nutrition Examination Survey (NHANES) data from 2013–2014 suggesting that the prevalence of obesity is higher in women (40.5%) than men (35.2%).[32] A similar sex difference was found in this sample with an obesity prevalence of 53.7% in women vs 46.9% in men.

There are several potential mechanisms by which sleep duration may influence obesity more strongly in women than in men.[33] One pathway is through increased food intake. In experimental studies, sleep deprivation has been associated with self-reported and biological changes in hunger and appetite. Women in particular may be more sensitive to feelings of hunger than men,[23] potentially explaining a stronger sleep-obesity association. As a result, hedonic eating, rather than a homeostatic mechanism, may be a more plausible explanation.[34] Functional magnetic resonance imaging (fMRI) data also suggest that insufficient sleep may increase central neuronal responses to high caloric foods, increasing behaviors that may lead to overeating.[35] In particular, hungry women who view pictures of high caloric food display higher activation in the superior medial frontal lobe, a part of the brain linked to reward-seeking behavior.[36] Women are also more sensitive to food stimuli and fasting compared to men.[24]

Much of the research on sex differences in the association between sleep and obesity has occurred in predominantly White samples. Given the biracial nature of the Bogalusa Heart Study, we decided to examine our results both stratified by race and in race-sex subgroups. We found that the sleep duration x race interaction term was not statistically significant. Previous findings on Black-White disparities in the sleep-obesity relationship have been inconsistent and studies have been of varying quality.[28,37–40] In a cross-sectional analysis of NHANES data, the odds of obesity was higher for Black/African-Americans who slept less than 5 hours per night while it was slightly lower for Whites who slept the same amount (2.14 vs 1.50).[37] However, a MESA analysis found no effect modification by race across four racial/ethnic groups, including Blacks and Whites.[28] In general, Blacks sleep less than Whites. In this study, we found that Blacks were more likely to be both short and long sleepers, which has been previously reported.[19,41] Discrepancies between this study and previous research may be due to differences in environment and study population. However, even if the obesogenic effect of short sleep is the same in Blacks and Whites, the public health impact of short sleep on obesity may be greater in Blacks than Whites, but longitudinal research is necessary for confirmation of this hypothesis.

Although confidence intervals were wide, in the race-sex subgroup analyses White men had similar BMIs and waist circumferences regardless of sleep duration, short sleep was associated with greater adiposity in White women, Black men and particularly Black women. Like NHANES,[32] our study found that the prevalence of obesity was similar among White women, White men, and Black men, while Black women have a much higher prevalence. Similar to analyses from the MESA and Coronary Artery Risk Development in Young Adults Study (CARDIA) cohorts,[31,42] our study found that White women slept longer than White men and Black women slept longer than Black men; however, Black women in the Bogalusa sample reported the most sleep. Although these findings are interesting, they need to be confirmed in a larger sample with multiple measures of sleep that may have less measurement error.

For over 20 years, the National Institutes of Health has required that women and minorities be included in clinical research involving human subjects.[43] Although the inclusion of underrepresented groups has increased, few observational studies across fields explicitly report subgroup analyses. It is possible that these analyses are performed but not reported because they are not statistically significant, either due to low power or a lack of a true association. However, reporting subgroup findings from secondary data analyses even if underpowered allows for the possibility of pooling in future meta-analyses. Future research should plan for large enough samples to detect clinically important differences in race and sex subgroups.

This study has several limitations, including measurement error in the exposure. Sleep in this study was measured via self-report, and validation studies of subjective and objective sleep have found moderate correlations that vary by key demographic characteristics such as sex and race.[44,45] However, measurement error is unlikely to explain either the findings in this paper because the correlations in validation studies are similar or stronger in men compared to women and consistently stronger among Whites compared to Blacks.[44–47] Additionally, evidence suggests that the correlation between self-reported and objectively measured actigraphy-based sleep duration does not vary by adiposity, further reducing concerns for spurious findings due to measurement error. Nondifferential measurement error, as is likely to exist, would tend to lead to an underestimate of the true magnitude of association between sleep and adiposity. Nevertheless, the cross-sectional nature of this study does not allow for any conclusions about the temporality of the sleep-adiposity association. Although most models posit that insufficient sleep precedes the onset of obesity, obesity may itself influence aspects of sleep, such as excessive daytime sleepiness.[48–50] Lastly, this study was not powered to detect differences among race-sex subgroups and thus many of the stratified analyses were lacking in precision. Despite these limitations, this study has several strengths. Multiple objective and validated measures of adiposity were used which demonstrated associations that were consistent in magnitude and direction. This study also used a biracial community-based sample, in line with the American Heart Association's call for more diverse populations in sleep research.[22]

Overall, this cross-sectional study found that the association between habitual sleep duration and measures of adiposity such as BMI and waist circumference was larger among women than men. However, longitudinal studies that utilize objective and validated measures of sleep are needed to clarify the temporality and effect size of the sleep–adiposity association in race-sex subgroups. If future research demonstrates a causal relationship, interventions and policies to achieve recommended sleep duration may prove useful to reduce the burden of obesity, especially in relevant subgroups.

Disclosure

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