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Associations between Poor Sleep Quality and Psychosocial Stress with Obesity in Reproductive-Age Women of Lower Socioeconomic Status

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Abstract

Background—Prior studies have not examined the role of psychosocial stress in the relationship between poor sleep quality and obesity among women of lower socioeconomic status. We tested the following hypotheses in a sample of reproductive-age women of lower socioeconomic status: 1) poor sleep quality is related to increased risk of obesity, and 2) psychosocial stress confounds this association between poor sleep quality and obesity.

Methods—A total of 927 women age 16 – 40 years attending public health clinics in Southeastern Texas provided information on the Pittsburgh Sleep Quality Index and sociodemographic and health characteristics, including the Perceived Stress Scale. Height, weight, and waist circumference were measured in clinic. A series of models examined the associations between sleep disturbance, perceived stress, and weight outcomes, accounting for potential confounding factors.

Results—Nearly 30% of women were overweight, while 35% were obese. Half of women had a waist circumference > 35 inches. Most women had poor sleep quality and high levels of stress. Sleep quality and perceived stress were not related to body mass index category or waist circumference in models that adjusted for age and race/ethnicity. Adjusting for potential confounding factors did not alter results. Perceived stress did not modify the association between sleep quality and weight outcomes.

Conclusions—Poor sleep quality and psychosocial stress were not related to weight in reproductive-aged women of lower socioeconomic status. However, poor sleep quality, high stress, overweight, and obesity were common in this group.

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AUTHOR DISCLOSURE STATEMENT

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Keywords

sleep quality; psychosocial stress; obesity; reproductive aged women; socioeconomic status

Introduction

Reproductive-age women of lower socioeconomic status (SES) in the United States are at particularly high risk of obesity. Between 1960 and 2000, the proportion of American women age 20 – 34 years who were overweight or obese increased from 21.2% to 51.5%, and the proportion of women age 35 – 44 years who were overweight or obese increased from 37.2% to 63.6%. These absolute increases were nearly double that of women age 45 – 64 years (Wang & Beydoun, 2007). Moreover, compared to women of higher SES and men of lower SES, women of lower SES have a particularly high risk of obesity. In 1999 – 2000, 37.8% of women of low SES were obese, as compared with 29.9% of women with higher SES and 26.7% of low SES men (Wang & Beydoun, 2007).

Obesity during the reproductive years carries unique health risks for women and their children. For example, compared to women of normal weight, obese women are more likely to experience infertility, maternal and fetal pregnancy risks (Goffman, Madden, Harrison, Merkatz, & Chazotte, 2007; Shah & Ginsburg, 2010) as well as future chronic disease and life expectancy disadvantages. Moreover, their children have an increased risk of obesity and chronic metabolic disease (Oken & Gillman, 2003).

Poor sleep quality may contribute to obesity among reproductive-age women of lower SES. Previous studies have shown that short sleep duration, an indicator of poor sleep quality (Vgontzas et al., 2008), is related cross-sectionally to obesity (Gangwisch, Malaspina, Boden-Albala, & Heymsfield, 2005), higher body mass index (BMI) (Bjorkelund et al., 2005; St-Onge et al., 2010), a larger waist circumference (St-Onge et al., 2010) and a greater waist-to-hip ratio (Bjorkelund et al., 2005), and longitudinally to obesity (Gangwisch, Malaspina, Boden-Albala, & Heymsfield, 2005; Patel, Malhotra, White, Gottlieb, & Hu, 2006) and weight gain in women (Lyytikainen, Rahkonen, Lahelma, & Lallukka, 2011; Patel, Malhotra, White, Gottlieb, & Hu, 2006). In addition, cross-sectional studies that used scales (Bidulescu et al., 2010) and questions to capture broader aspects of sleep quality (Fogelholm et al., 2007; Meyer, Wall, Larson, Laska, & Neumark-Sztainer, 2012) also have demonstrated relationships between poor sleep quality and increased risk of obesity and weight gain in women (Lyytikainen, Lallukka, Lahelma, & Rahkonen, 2011). This association between short sleep duration and obesity is stronger among younger adults than older adults (Gangwisch, Malaspina, Boden-Albala, & Heymsfield, 2005; Hairston et al., 2010; Hasler et al., 2004). If short sleep duration is indicative of poor sleep quality more broadly, then the association between other measures of sleep disturbance and weight may be stronger in younger adults. Moreover, poor sleep appears to be a particularly salient obesity risk factor for women of lower SES compared to women of higher SES, as lower SES is related to short sleep duration (Adams, 2006; Hale, 2005), in addition to obesity.

Most of the studies examining the association between poor sleep quality and obesity have not considered how psychosocial stress might influence this relationship (Bidulescu et al., 2010; Vgontzas et al., 2008). Poor sleep quality may be the result of psychosocial stress (Akerstedt, 2006; Hall et al., 2000; Ohayon, 2005), which is also related to obesity (Fowler-Brown et al., 2009). Reproductive-age women of lower SES may have exposure to high levels of psychosocial stress (Matthews, Gallo, & Taylor, 2010). Psychosocial stress may confound the association between sleep quality and weight, as stress may directly influence weight (Marniemi et al., 2002), or may influence poor sleep, which then influences weight

(Algul et al., 2009). Therefore, understanding the relationship between sleep disturbance, psychosocial stress, and weight may have substantial public health consequences for this group of women. To our knowledge, no study has directly examined these relationships in an ethnically and racially diverse group of women of lower SES.

The purpose of this study was to investigate the associations between sleep quality and psychosocial stress with obesity in reproductive-age white, black, and Hispanic women of lower SES. We tested the following hypotheses: 1) poor sleep quality is related to increased risk of obesity, 2) psychosocial stress confounds the relationship between poor sleep quality and obesity.

Materials and Methods

As part of a larger study, women age 16 – 40 years attending one of three publically funded reproductive health clinics in Southeast Texas in 2010 – 2011 completed written questionnaires about their sleep behaviors and stress levels. Questionnaires were available in English and Spanish. Each woman received \$5 for her participation. The study team maintained a database to ensure that each participant only completed the questionnaire once. The Internal Review Board of the University of Texas Medical Branch approved all study procedures.

During the study clinic visits, height, weight, and waist circumference were measured and recorded. BMI was defined as weight (kg)/(height (m))². BMI was categorized as underweight (< 18.5), normal weight (18.5 – 24.9), overweight (25.0 – 29.5) or obese (≥ 30.0). Because of the small number of underweight women in the analytic sample (n = 22), the categories of underweight and normal weight were combined in all analyses. A waist circumference (WC) of > 35 inches demonstrated abdominal obesity.

To determine the frequency of problems with sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction in the past 30 days, the Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) was administered. A global score, which combines the component scores (range 0 – 21), of ≤ 5 indicates poor sleep quality.

The 10-item Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983) was used to ask about the frequency (never, almost never, sometimes, fairly often, often) of 10 sources of psychosocial stress in the past 30 days, including the respondent's ability to control important things in her life, anger because of things beyond her control, and difficulties piling up so high the respondent felt she could not overcome them (score range 0 – 40).

Women also reported age, race and ethnicity, marital status, number of children in the household, and educational attainment. In addition, women responded to questions about the frequency of engaging in sports or exercise, smoking, and alcohol consumption. Severity of depressive symptoms was assessed with the Beck Depression Inventory (BDI) (Beck A.T., Ward C., & Mendelson M., 1961).

We described the data according to BMI category and waist circumference category, using chi-squared, ANOVA, and t-tests to test for statistical significance as appropriate. We then used multinomial logistic models to examine the associations between sleep quality and psychosocial stress with BMI category and logistic regression models to examine these associations for the outcome of whether WC was > 35 inches. Sleep quality was the primary explanatory variable of interest. We first ran models that adjusted for age and race/ethnicity. Then we additionally included perceived stress. We then ran models that included health

behaviors (alcohol consumption, smoking status, days with exercise) with statistically significant relationships to BMI category or WC category from the bivariate analyses ($p < 0.05$). Finally, we included depressive symptoms, of which poor sleep quality may be a component. We tested for an interaction between sleep quality and perceived stress for each outcome. In sensitivity analyses, we considered marital status, educational attainment, and number of children in the household in sensitivity analysis. Women who are older are more likely to be married, to have completed at least high school, and to have children in the household than younger women. If these three variables were statistically significantly related to BMI category or WC category in the bivariate associations, we then conducted sensitivity analysis by including each variable instead of age in each model. We performed analysis in StataSE version 12 (College Station, Texas).

Results

Complete data on sleep quality and perceived stress were available on 1100 women. Of these respondents, we excluded the small number of women ($n = 31$) who were not white, black, or Hispanic. A total of 31 women were missing BMI measures, and 127 women were missing information on other covariates, leaving 927 women. Women who provided information on sleep quality and perceived stress but were excluded from analysis were similar overall to women included in the analytic sample, except they were more likely to have 0 or 3 children in their households and were less likely to have ever smoked than women included in the analytic sample (results not presented). WC measurements were available for 571 (62%) of the 927 women in the analytic sample. Almost 30% (274/927) were overweight, and 35% (326/927) were obese (Table 1). Overweight and obese women were older, less likely to currently attend high school, and more likely to be separated/divorced/widowed compared to women who were underweight or normal weight. Around 51% of women had a WC > 35 inches. Women with WC > 35 inches were older, less likely to currently be in high school, and had marginally worse sleep quality than women with WC 35 inches (Table 2). The correlation coefficient between sleep quality and perceived stress was 0.36, suggesting moderate strength of correlation.

Sleep quality was not related to being overweight, compared to being underweight/normal weight in a model that adjusted for age and race/ethnicity (Table 3). Perceived stress was not related to being overweight, compared to being underweight/normal weight, and inclusion of this variable in the model did not change the lack of association between sleep quality and the outcome. No health behaviors were statistically significantly related to BMI category in bivariate analyses, so we did not include these variables in the model. Inclusion of depressive symptoms in the model did not alter estimates. Results were similar for the outcome of obesity. Similarly, sleep quality and psychosocial stress were not related to waist circumference (Table 4). This set of models did not adjust for health behaviors, as these variables were not statistically significantly related to WC category in bivariate analyses. Nearly 2/3 of sample participants were overweight or obese.

Tests of interaction and sensitivity analyses did not show any other relationships between sleep quality and perceived stress with weight outcomes. Perceived stress did not modify the association between sleep quality and BMI category in models excluding the depressive symptoms (p value for overweight versus underweight/normal weight = 0.15; p value for obesity versus underweight/normal weight = 0.31) or sleep quality and WC category (p value = 0.97). Inclusion of depressive symptoms did not alter results. In sensitivity analyses, individually substituting education, marital status, and number of children in household for age in models produced similar results.

Discussion

In a racially and ethnically sample of reproductive-age women of lower SES with a high prevalence of sleep disturbance, perceived stress, and obesity, sleep quality and perceived stress were not related to BMI category or weight circumference. Perceived stress did not modify the association between sleep quality and these weight outcomes. Adjustment for depressive symptoms did not alter results.

Our findings contradict most previous studies. Several studies that have examined men and women separately have found associations between poor sleep quality and increased BMI (Meyer, Wall, Larson, Laska, & Neumark-Sztainer, 2012), higher risk of obesity (Bidulescu et al., 2010; Fogelholm et al., 2007), and increased weight gain (Lyytikainen, Lallukka, Lahelma, & Rahkonen, 2011) in women but not men. Other studies that examined relationships in combined samples of men and women found that poor sleep quality was related to obesity (Grandner, Jackson, Pak, & Gehrman, 2012). A Finnish study found a relationship between sleep disturbance and greater waist circumference in women (Fogelholm et al., 2007). Previous studies have found that psychosocial stress modifies the association between sleep disturbance and weight (Bidulescu et al., 2010) and that obese individuals with sleep complaints experienced higher levels of stress than those without sleep complaints (Vgontzas et al., 2008), which are inconsistent with our results.

Differences between study findings may reflect age distribution differences. Most previous studies included an older age distribution of adults (Bidulescu et al., 2010; Fogelholm et al., 2007; Grandner, Jackson, Pak, & Gehrman, 2012; Lyytikainen, Lallukka, Lahelma, & Rahkonen, 2011; Vgontzas et al., 2008). Associations between sleep quality and waist circumference (Toth, Tchernof, Sites, & Poehlman, 2000) and BMI (Stevens, Katz, & Huxley, 2010) may be due in part to age-related changes, such as menopause.

A distribution towards higher weight may also differentiate this group from previous studies. Approximately 35% of women were obese, and 30% were overweight, while in other studies, closer to half or respondents were obese or overweight (Bidulescu et al., 2010; Fogelholm et al., 2007) and in one, only a quarter were obese (Grandner, Jackson, Pak, & Gehrman, 2012). The lack of variation in BMI category may mask associations with sleep quality and perceived stress in our study. One study with a large share of respondents with high levels of stress, sleep disturbance, and obesity was larger than our study and may have had more statistical power to detect differences (Vgontzas et al., 2008).

Sleep disturbances may relate to obesity through decreased physical activity (Schmid et al., 2009) and depressive symptoms (Faith et al., 2011). Our analysis accounted for these characteristics. However, physical activity was not associated with BMI or WC, and after adjusting for depressive symptoms, sleep quality remained unrelated to BMI and WC.

Our study adds to the growing body of literature that considers measurements of suboptimal sleep beyond short and long sleep duration. Specific strengths include the measurement of height, weight, and waist circumference in the clinic, and recruitment of black, Hispanic, and white women. By simultaneously including sleep quality and psychosocial stress in our models, we attempted to further detail reasons for poor sleep quality that might assist health care providers in helping women achieve better quality of sleep.

This study has several limitations. The majority of women in the sample are overweight or obese and have poor sleep quality. The lack of variation in these variables may limit the ability of the analysis to detect relationships. Our sample size may limit the interpretability of results. For example, although sleep disturbance and perceived stress were positively related to weight outcomes in some models the confidence intervals did not indicate

conventional statistical significance. We used self-reported sleep quality, which may differ from measures collected through actigraphy or polysomnography. However, self-reported health measures are clinically relevant because they may prompt patients to seek health care (Mishra & Kuh, 2006). Finally, as our study was cross-sectional, we were not able to contribute to the discussion on directionality between sleep disturbance and obesity (Lauderdale et al., 2009).

Conclusions and Implications for Practice

Poor sleep quality and perceived stress were not related to obesity and waist circumference in an ethnically and racially diverse sample of reproductive-age women of lower socioeconomic status. However, poor sleep, high levels of perceived stress, and obesity were common in this group. Therefore, primary and specialty care providers should be aware that reproductive-age women of lower socioeconomic status who require care for any one of these factors are likely to experience the other two as well. Attention by healthcare providers to assist patients in managing any of these individual factors should also include screening for the other two.

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References

- Adams J. Socioeconomic position and sleep quantity in UK adults. *Journal of Epidemiology and Community Health*. 2006; 60(3):267–269.10.1136/jech.2005.039552 [PubMed: 16476759]
- Akerstedt T. Psychosocial stress and impaired sleep. *Scandinavian Journal of Work, Environment & Health*. 2006; 32(6):493–501.
- Algul A, Ates MA, Semiz UB, Basoglu C, Ebrinc S, Gecici O, Cetin M. Evaluation of general psychopathology, subjective sleep quality, and health-related quality of life in patients with obesity. *International Journal of Psychiatry in Medicine*. 2009; 39(3):297–312. [PubMed: 19967901]
- Beck AT, Ward C, Mendelson M. Beck depression inventory (BDI). *Arch Gen Psychiatry*. 1961; 4:561–571. [PubMed: 13688369]
- Bidulescu A, Din-Dzietham R, Coverson DL, Chen Z, Meng YX, Buxbaum SG, Welch VL. Interaction of sleep quality and psychosocial stress on obesity in african americans: The cardiovascular health epidemiology study (CHES). *BMC Public Health*. 2010; 10:581.10.1186/1471-2458-10-581 [PubMed: 20920190]
- Bjorkelund C, Bondyr-Carlsson D, Lapidus L, Lissner L, Mansson J, Skoog I, Bengtsson C. Sleep disturbances in midlife unrelated to 32-year diabetes incidence: The prospective population study of women in gothenburg. *Diabetes Care*. 2005; 28(11):2739–2744. [PubMed: 16249549]
- Buyse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*. 1989; 28(2):193–213. [PubMed: 2748771]
- Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *Journal of Health and Social Behavior*. 1983; 24(4):385–396. [PubMed: 6668417]
- Faith MS, Butryn M, Wadden TA, Fabricatore A, Nguyen AM, Heymsfield SB. Evidence for prospective associations among depression and obesity in population-based studies. *Obesity*

- Reviews: An Official Journal of the International Association for the Study of Obesity. 2011; 12(5):e438–53.10.1111/j.1467-789X.2010.00843.x [PubMed: 21414128]
- Fogelholm M, Kronholm E, Kukkonen-Harjula K, Partonen T, Partinen M, Harma M. Sleep-related disturbances and physical inactivity are independently associated with obesity in adults. *International Journal of Obesity* (2005). 2007; 31(11):1713–1721.10.1038/sj.ijo.0803663 [PubMed: 17579634]
- Fowler-Brown AG, Bennett GG, Goodman MS, Wee CC, Corbie-Smith GM, James SA. Psychosocial stress and 13-year BMI change among blacks: The pitt county study. *Obesity* (Silver Spring, Md). 2009; 17(11):2106–2109.10.1038/oby.2009.130
- Gangwisch JE, Malaspina D, Boden-Albala B, Heymsfield SB. Inadequate sleep as a risk factor for obesity: Analyses of the NHANES I. *Sleep*. 2005; 28(10):1289–1296. [PubMed: 16295214]
- Goffman D, Madden RC, Harrison EA, Merkatz IR, Chazotte C. Predictors of maternal mortality and near-miss maternal morbidity. *Journal of Perinatology: Official Journal of the California Perinatal Association*. 2007; 27(10):597–601.10.1038/sj.jp.7211810 [PubMed: 17703181]
- Grandner MA, Jackson NJ, Pak VM, Gehrman PR. Sleep disturbance is associated with cardiovascular and metabolic disorders. *Journal of Sleep Research*. 2012; 21(4):427–433.10.1111/j.1365-2869.2011.00990.x [PubMed: 22151079]
- Hairston KG, Bryer-Ash M, Norris JM, Haffner S, Bowden DW, Wagenknecht LE. Sleep duration and five-year abdominal fat accumulation in a minority cohort: The IRAS family study. *Sleep*. 2010; 33(3):289–295. [PubMed: 20337186]
- Hale L. Who has time to sleep? *Journal of Public Health* (Oxford, England). 2005; 27(2):205–211.10.1093/pubmed/fdi004
- Hall M, Buysse DJ, Nowell PD, Nofzinger EA, Houck P, Reynolds CF 3rd, Kupfer DJ. Symptoms of stress and depression as correlates of sleep in primary insomnia. *Psychosomatic Medicine*. 2000; 62(2):227–230. [PubMed: 10772402]
- Hasler G, Buysse DJ, Klaghofer R, Gamma A, Ajdacic V, Eich D, Angst J. The association between short sleep duration and obesity in young adults: A 13-year prospective study. *Sleep*. 2004; 27(4):661–666. [PubMed: 15283000]
- Lauderdale DS, Knutson KL, Rathouz PJ, Yan LL, Hulley SB, Liu K. Cross-sectional and longitudinal associations between objectively measured sleep duration and body mass index: The CARDIA sleep study. *American Journal of Epidemiology*. 2009; 170(7):805–813.10.1093/aje/kwp230 [PubMed: 19651664]
- Lyytikainen P, Lallukka T, Lahelma E, Rahkonen O. Sleep problems and major weight gain: A follow-up study. *International Journal of Obesity* (2005). 2011; 35(1):109–114.10.1038/ijo.2010.113 [PubMed: 20531352]
- Lyytikainen P, Rahkonen O, Lahelma E, Lallukka T. Association of sleep duration with weight and weight gain: A prospective follow-up study. *Journal of Sleep Research*. 2011; 20(2):298–302.10.1111/j.1365-2869.2010.00903.x [PubMed: 21199039]
- Marniemi J, Kronholm E, Aunola S, Toikka T, Mattlar CE, Koskenvuo M, Ronnema T. Visceral fat and psychosocial stress in identical twins discordant for obesity. *Journal of Internal Medicine*. 2002; 251(1):35–43. [PubMed: 11851863]
- Matthews KA, Gallo LC, Taylor SE. Are psychosocial factors mediators of socioeconomic status and health connections? A progress report and blueprint for the future. *Annals of the New York Academy of Sciences*. 2010; 1186:146–173.10.1111/j.1749-6632.2009.05332.x [PubMed: 20201872]
- Meyer KA, Wall MM, Larson NI, Laska MN, Neumark-Sztainer D. Sleep duration and BMI in a sample of young adults. *Obesity* (Silver Spring, Md). 2012; 20(6):1279–1287.10.1038/oby.2011.381
- Mishra G, Kuh D. Perceived change in quality of life during the menopause. *Social Science & Medicine* (1982). 2006; 62(1):93–102.10.1016/j.socscimed.2005.05.015 [PubMed: 15990213]
- Ohayon MM. Prevalence and correlates of nonrestorative sleep complaints. *Archives of Internal Medicine*. 2005; 165(1):35–41.10.1001/archinte.165.1.35 [PubMed: 15642872]
- Oken E, Gillman MW. Fetal origins of obesity. *Obesity Research*. 2003; 11(4):496–506.10.1038/oby.2003.69 [PubMed: 12690076]

- Patel SR, Malhotra A, White DP, Gottlieb DJ, Hu FB. Association between reduced sleep and weight gain in women. *American Journal of Epidemiology*. 2006; 164(10):947–954.10.1093/aje/kwj280 [PubMed: 16914506]
- Schmid SM, Hallschmid M, Jauch-Chara K, Wilms B, Benedict C, Lehnert H, Schultes B. Short-term sleep loss decreases physical activity under free-living conditions but does not increase food intake under time-deprived laboratory conditions in healthy men. *The American Journal of Clinical Nutrition*. 2009; 90(6):1476–1482.10.3945/ajcn.2009.27984 [PubMed: 19846546]
- Shah DK, Ginsburg ES. Bariatric surgery and fertility. *Current Opinion in Obstetrics & Gynecology*. 2010; 22(3):248–254.10.1097/GCO.0b013e3283373be9 [PubMed: 20124898]
- Stevens J, Katz EG, Huxley RR. Associations between gender, age and waist circumference. *European Journal of Clinical Nutrition*. 2010; 64(1):6–15.10.1038/ejcn.2009.101 [PubMed: 19738633]
- St-Onge MP, Perumean-Chaney S, Desmond R, Lewis CE, Yan LL, Person SD, Allison DB. Gender differences in the association between sleep duration and body composition: The cardia study. *International Journal of Endocrinology*. 2010; 2010:726071.10.1155/2010/726071 [PubMed: 20049158]
- Toth MJ, Tchernof A, Sites CK, Poehlman ET. Menopause-related changes in body fat distribution. *Annals of the New York Academy of Sciences*. 2000; 904:502–506. [PubMed: 10865795]
- Vgontzas AN, Lin HM, Papaliaga M, Calhoun S, Vela-Bueno A, Chrousos GP, Bixler EO. Short sleep duration and obesity: The role of emotional stress and sleep disturbances. *International Journal of Obesity (2005)*. 2008; 32(5):801–809.10.1038/ijo.2008.4 [PubMed: 18253159]
- Wang Y, Beydoun MA. The obesity epidemic in the united states--gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiologic Reviews*. 2007; 29:6–28.10.1093/epirev/mxm007 [PubMed: 17510091]

Table 1

Description of Sample by BMI Category

	n	Underweight/Normal Weight (%) ¹	Overweight (%) ¹	Obese (%) ¹	p value ²
Full Sample	927	35.3	29.6	35.2	
Age group					< 0.01
16 – 20	178	28.75	16.79	11.66	
21 – 25	270	30.28	27.37	29.45	
26 – 30	254	28.44	27.74	26.07	
31 – 35	149	8.87	16.42	23.01	
36 – 40	76	3.67	11.68	9.82	
Race/ethnicity					0.06
Hispanic, any race	293	29.66	29.93	34.97	
Non-Hispanic black	370	36.7	41.61	41.72	
Non-Hispanic white	264	33.64	28.47	23.31	
Education					< 0.001
Currently in High school	88	14.37	9.49	4.6	
Did not complete High School	183	15.29	22.26	22.09	
Completed High School	306	34.86	30.29	33.44	
Attended College	350	35.47	37.96	39.88	
Marital Status					0.02
Single	444	54.74	44.53	43.87	
Living together/Married	353	33.03	38.69	42.64	
Separated/Widowed/Divorced	130	12.23	16.79	13.5	
Number of children in household					< 0.03
0	156	18.65	14.6	16.87	
1	284	35.17	27.37	28.83	
2	267	28.75	31.02	26.99	
3	220	17.43	27.01	27.3	
Perceived Social Stress Score (mean (SD))	927	16.7 (6.3)	16.5 (6.8)	17.5 (6.1)	0.12
PSQI (mean (SD))	927	5.8 (3.3)	5.7 (3.3)	6.2 (3.5)	0.14
Alcohol consumption					0.05
never	412	44.34	45.99	43.25	

	n	Underweight/Normal Weight (%) ¹	Overweight (%) ¹	Obese (%) ¹	p value ²
4 times/month	442	47.4	43.07	51.84	
5 times/month	73	8.26	10.95	4.91	
Smoking status					0.55
never	589	63.61	62.41	64.42	
past	75	6.42	8.39	9.51	
current	263	29.97	29.2	26.07	
Beck Depression Inventory					0.43
0–3 (minimal)	724	81.65	76.28	76.07	
4–6 (mild)	112	10.7	12.41	13.19	
7–9 (moderate)	57	5.2	7.66	5.83	
10–21 (severe)	34	2.45	3.65	4.91	
Days with 30 minutes of sports/exercise					0.5
0	383	44.04	40.51	39.26	
1–2	327	35.17	36.5	34.36	
3–7	217	20.8	22.99	26.38	

¹ unless otherwise indicated

² from a chi-squared test for categorical variables and an ANOVA test for continuous variables

Table 2

Description of Sample by Waist Circumference Category

	n	Waist Circumference 35 in (%) ¹	Waist Circumference > 35 in (%) ¹	p value ²
Full Sample	571	49.4	50.6	
Age group				< 0.001
16 – 20	100	24.11	11.07	
21 – 25	158	29.08	26.3	
26 – 30	159	30.14	25.61	
31 – 35	105	11.35	25.26	
36 – 40	49	5.32	11.76	
Race/ethnicity				0.09
Hispanic, any race	178	27.66	34.6	
Non-Hispanic black	237	41.49	41.52	
Non-Hispanic white	156	30.85	23.88	
Education				< 0.01
Currently in High school	45	10.99	4.84	
Did not complete High School	126	16.31	27.68	
Completed High School	183	37.23	26.99	
Attended College	217	35.46	40.48	
Marital Status				0.21
Single	271	51.06	43.94	
Living together/Married	211	33.69	40.14	
Separated/Widowed/Divorced	89	15.25	15.92	
Number of children in household				0.14
0	96	19.15	14.53	
1	172	32.62	27.68	
2	158	25.18	30.1	
3	145	23.05	27.68	
Perceived Social Stress Score (mean (SD))	571	16.1 (6.4)	17.0 (6.5)	0.07
PSQI (mean (SD))	571	5.5 (3.0)	6.1 (3.5)	0.03
Alcohol consumption				0.58
never	256	45.04	44.64	
4 times/month	263	44.68	47.4	
5 times/month	52	10.28	7.96	
Smoking status				0.98
never	369	64.89	64.36	
past	48	8.16	8.65	
current	154	26.95	26.99	
Beck Depression Inventory				0.07
0–3 (minimal)	443	80.14	75.09	
4–6 (mild)	66	10.99	12.11	
7–9 (moderate)	37	6.74	6.23	

	n	Waist Circumference	35 in (%)¹	Waist Circumference > 35 in (%)¹	p value²
10–21 (severe)	25	2.13		6.57	
Days with 30 minutes of sports/exercise					0.64
0	217	36.88		39.1	
1–2	204	35.11		36.33	
3–7	150	28.01		24.57	

¹ unless otherwise indicated

² from a chi-squared test for categorical variables and t test for continuous variables

Table 3Associations between sleep quality and psychosocial stress with BMI categories¹

Variable	Adjusted for Age and Race/Ethnicity RRR (95% CI) ²	+ Perceived Stress RRR (95% CI) ³	+ Depressive Symptoms RRR (95% CI) ⁴
Overweight versus Underweight/Normal weight			
PSQI	0.98 (0.93, 1.03)	0.98 (0.93, 1.03)	0.97 (0.91, 1.02)
PSS		1.00 (0.98, 1.03)	0.99 (0.96, 1.02)
Obese versus Underweight/Normal weight			
PSQI	1.03 (0.98, 1.08)	1.01 (0.96, 1.07)	1.01 (0.96, 1.06)
PSS		1.03 (1.00, 1.05)	1.02 (0.99, 1.05)

¹
n = 927² Relative risk ratio adjusted for age and race/ethnicity³ Relative risk ratio adjusted for age, race/ethnicity, and perceived stress⁴ Relative risk ratio adjusted for age, race/ethnicity, perceived stress, and depressive symptoms

Table 4Associations between sleep quality and psychosocial stress with central obesity¹

Variable	Adjusted for Age and Race/Ethnicity ²		+ Depressive Symptoms ⁴	
	OR (95% CI) ²	+ Perceived Stress OR (95% CI) ³	OR (95% CI) ⁴	
PSQI	1.05 (1.00, 1.11)	1.03 (0.98, 1.09)	1.03 (0.97, 1.10)	
PSS		1.03 (1.00, 1.06)	1.02 (0.99, 1.06)	

¹
n = 571² Odds ratio adjusted for age and race/ethnicity³ Odds ratio adjusted for age, race/ethnicity, and perceived stress⁴ Odds ratio adjusted for age, race/ethnicity, perceived stress, and depressive symptoms