NEW RESEARCH

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Sleep Disturbances, Quality of Life, and Ethnicity: The Sleep Heart Health Study

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Study Objectives: To compare health-related quality of life (HR-QOL) across subgroups defined by sleep disturbances and ethnicity.

Methods: Men (47%) and women (53%) Sleep Heart Health Study participants age 40 and older (N = 5237) underwent overnight polysomnography and completed self-report questionnaires on symptoms of sleep disturbances. The physical and mental composite scales (PCS and MCS) of the Medical Outcomes Study 36-item short form survey assessed HR-QOL and were compared to sleep data.

Results: Participants self-identified as Caucasian/White (n = 4482, 86%), African American/Black (n = 490, 9%), or Hispanic/Mexican American (n = 265, 5%). The prevalence of obstructive sleep apnea (OSA) was 17%, frequent snoring was 34%, difficulty initiating or maintaining sleep (DIMS; insomnia symptoms) was 30%, and excessive daytime sleepiness (EDS) was 25%. African American participants with frequent snoring, insomnia symptoms, or EDS had significantly poorer physical health compared to Caucasians ($p < 0.001$). Hispanics with frequent snoring, insomnia symptoms, or EDS had significantly poorer mental health than Caucasian participants ($p < 0.001$). Neither PCS nor MCS scores differed significantly across ethnic subgroups for participants with moderate to severe OSA (respiratory disturbance index ≥ 15, 4% desaturation).

Conclusions: Across ethnic/racial subgroups, sleep disturbances are associated with worse physical and better mental HR-QOL than the U.S. norm, but this relationship may be moderated by comorbid health conditions. This study replicates and extends prior research indicating differences among minority and non-minority participants and highlights the need for future studies of sleep disturbances with larger samples of minorities that control for comorbid health conditions.

Keywords: Health-Related Quality of Life, ethnicity/race, obstructive sleep apnea, sleep symptoms, Sleep Heart Health Study

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SCIENTIFIC INVESTIGATIONS

Sleep disturbances pose great risk to public safety, and contribute to increased healthcare utilization and associated morbidity.[1-7] Prevalence estimates of disturbed sleep range from 35% to 41% among adults.[1-4] The most common sleep disturbances are obstructive sleep apnea (OSA), frequent snoring, difficulty initiating or maintaining sleep (DIMS; insomnia symptoms), and excessive daytime sleepiness (EDS).[2-5,7] Insomnia symptoms have prevalence rates ranging from 23% to 34%.[2] OSA is reported to be 2% to 4% among working men and women and 20% among individuals over 65 years of age.[1,3,5] Snoring ranges from 48% to 59% in the general U.S. population.[4,5] Evidence suggests that sleep disorders are under-diagnosed by primary care physicians and indicate that as the U.S. population ages and becomes more obese, the risk of significant OSA will increase.[5] These and other interruptions in nighttime sleep may lead to EDS.[3,5,7,9] A substantial literature exists linking disturbed sleep with a number of comorbid conditions making it a significant contributor to disability, morbidity, and mortality.[1-7,9-13]

Several studies suggest there are ethnic and racial differences in sleep disturbances.[14-20] The majority of these studies have compared sleep disturbances across Caucasian/White and African American/Black racial groups. The African American participants appear to have a two-fold higher risk for OSA, higher mean respiratory disturbance index (RDI), reduced sleep satisfaction, greater difficulty falling asleep, and more frequent napping than Caucasian participants.[14,15] Longer total sleep time, more minutes in REM sleep, and reduced time in deep sleep have been seen for African Americans compared to Cauca-

BRIEF SUMMARY

Current Knowledge/Study Rationale: Little is known about disturbed sleep and health-related quality of life (HR-QOL) between and within racial/ethnic groups. Using the Short Form-36 Mental and Physical Composite Scales, this study examined the HR-QOL of African American, Caucasian and Hispanic participants in the Sleep Heart Health Study who do and do not have obstructive sleep apnea (OSA), snoring, insomnia symptoms and excessive daytime sleepiness.

Study Impact: Greater emphasis toward improving health outcomes is being taken into consideration in evidence-based clinical care, health care utilization and cost. Contributions to clinical sleep medicine from this study include 1) mapping the relative importance of sleep disorders within and across African Americans, Caucasians and Hispanics, 2) establishing HR-QOL norms for these racial/ethnic groups with and without OSA, frequent snoring, insomnia symptoms and daytime sleepiness, and 3) providing effect size estimates for use in future HR-QOL racial/ethnic sleep studies.

sians;[16] however, this literature is not entirely consistent, which may be due to the failure to control for comorbid physical and mental health conditions and disparities in socioeconomic status.[17,18] Only a few studies have included Hispanic participants. Hispanics, as well as African Americans showed a higher prevalence of snoring[19] and reported more frequent snoring.[20] Differences in sleep architecture have been noted; Hispanics and Caucasians had a lower percentage of stage 2 sleep compared to African Americans, while Hispanics and African Americans had lower arousal indices compared to Caucasians.[21]

Studies exploring associations between disturbed sleep and health-related quality of life (HR-QOL) have examined the role of comorbid conditions,[22-24] gender,[25] and race/ethnicity.[26-30] As with studies of sleep disturbances, the majority of HR-QOL research focused on differences between African American and Caucasian participants. Elderly African Americans with mild sleep apnea had significantly poorer physical and mental HR-QOL than African Americans without OSA.[29] African American, Hispanic, and other minority participants had both worse quality of sleep and poorer well-being than Caucasian participants.[27] However, when sex, education, age, marital status, and healthcare coverage were controlled for, Caucasians were more likely to report not getting enough sleep than African Americans and Hispanics; [26] when mood, medication use, socioeconomic status and perceived health were controlled for, Caucasians reported more restless sleep than African Americans.[28]

The SF-36 and its physical and mental composite scales (PCS and MCS) have been used to study OSA, insomnia symptoms or EDS alone or in combination with patient or general populations in the U.S.,[6,22,30-33] Brazil,[34] and Turkey.[35] To date, one study has provided normative data for the 8 SF-36 subscales for SHHS participants with OSA, insomnia symptoms, and EDS.[22] A more recent work examined changes in HR-QOL that presented baseline and follow-up mean composite scores for men, women, ethnic groups, OSA, insomnia symptoms, and EDS; however, these data were a subset of the full SHHS population and did not characterize sleep disturbances and HR-QOL by ethnicity.[32]

These inconsistencies in the literature could best be resolved by a systematic, large-scale investigation of health disparities associated with sleep disturbances and their relationship to HR-QOL, while controlling for race/ethnicity, socioeconomic status, and comorbidities. The Sleep Heart Health Study (SHHS), a multi-center examination of OSA as a risk factor in the development of cardiovascular disease (CVD), presents an opportunity to explore these issues in a large multi-ethnic/multi-racial group. Thus, the purpose of this study was to use a secondary analysis of SHHS data to compare HR-QOL across subgroups defined by sleep disturbances and ethnicity.

METHODS

Sleep Heart Health Study

Methods used in the SHHS have been described in detail in other publications.[36,37] The SHHS cohort included 6,441 men and women 40 years of age and older.[37] Participants were recruited from existing longitudinal studies in seven regions of the country (Arizona, California, Massachusetts, Maryland, Minnesota, New York, and Washington). Participants were concurrently enrolled in the Atherosclerosis Risk in Communities Study, the Framingham Heart Study, the Strong Heart Study, the New York Hypertension Cohorts, the Tucson Epidemiologic Study of Airway Obstructive Diseases, the Cardiovascular Health Study, or the Tucson Health and Environment Study. The SHHS was approved by the institutional review board at each site and participants provided written informed consent.

The SHHS participants completed a demographics questionnaire, a health history form, the Sleep Habits Questionnaire,[36] the Epworth Sleepiness Scale (ESS),[38] and the Medical Outcomes Study (MOS) 36 item short form survey (SF-36).[39] Directly measured height and weight were used to calculate body mass index (BMI). Participants underwent overnight, in-home polysomnography (PSG) to determine the presence of OSA. The PSG was completed using the Compumedics Portable PS-2 System (Abbottsville, Victoria, AU).The recording montage included C3/O2 and C4/O1 electroencephalography leads; right and left electro-oculograms; a bipolar submental electromyogram; thoracic and abdominal excursions (inductive plethysmography bands); airflow (detected by a nasal-oral thermocouple [Protec, Woodinville, WA]); oximetry (finger pulse oximetry [Nonin, Minneapolis, MN]); electrocardiogram (ECG) and heart rate (using a bipolar ECG lead); body position (using a mercury gauge sensor); and ambient light (on/off, by a light sensor secured to the recording garment). Sensors were placed and equipment was calibrated during an evening home visit by a certified technician. Data were stored in real time on memory cards. Following equipment retrieval, the data were downloaded to the computers of each respective clinical site, locally reviewed and forwarded to a central reading center (Cleveland, OH).

Secondary Analysis Procedures

Participants in the SHHS who had completed the SF-36 and who had self-identified as Caucasian/White (n = 4482, 86%), African American/Black (n = 490, 9%), or Hispanic (n = 265, 5%) were included in the current analysis. The Hispanic participants were predominantly of Mexican heritage residing in Arizona with a smaller number of Puerto Rican participants from the New York cohort. Other ethnic/racial subgroups were excluded because of small sample size or low return rates for the SF-36.

Three items on the SHHS Sleep Habits Questionnaire that assessed trouble falling asleep, staying asleep, and waking too early were used to define DIMS (insomnia symptoms).[35] Each item was rated on a 5-point scale from 1 = Never [0 times per month] to 5 = Almost Always [16–30 times per month]. A rating of 4 or 5 was interpreted as positive for the symptom and a rating of 1, 2, or 3 was interpreted as negative. Participants who were positive for ≥ 1 of the 3 symptoms were defined as having DIMS. Participants also rated their frequency of snoring on the SHHS Sleep Habits Questionnaire using a 5-point scale from 0 = Never to 4 = Almost Always (6 or 7 nights a week).[35] A rating of 3 or 4 was interpreted as positive for frequent snoring; and a rating of 0, 1, or 2 was interpreted as negative. On the ESS, participants rated the likelihood of dozing in 8 routine situations. Scores were totaled across the 8 items, yielding a score that ranged from 0 to 24. A score > 10 indicated EDS.[8] The ESS

Table 1—Demographic and health characteristics.

	Total n (%)	Caucasian n (%)	African American n (%)	Hispanic n (%)
Gender				
Male	2478 (47)	2157 (48)	203 (41)	118 (45)
Female	2759 (53)	2325 (52)	*287 (59)	147 (55)
Smoking				
Non-smoker	2463 (47)	2062 (46)	233 (48)	168 (63)
Former smoker	2271 (43)	2017 (45)	187 (38)	67 (25)
Current smoker	503 (10)	403 (9)	*70 (14)	30 (11)
Respiratory Condition				
No	4366 (86)	3754 (86)	382 (82)	230 (89)
Yes	715 (14)	601 (14)	*85 (18)	†29 (11)
Cardiovascular Disease				
No	4091 (83)	3549 (82)	308 (78)	234 (92)
Yes	866 (17)	758 (18)	*89 (22)	*†19 (8)
Diabetes				
No	4597 (93)	4021 (93)	357 (85)	219 (94)
Yes	377 (8)	298 (7)	*64 (15)	†15 (6)
	Total M ± SD	**Caucasian M ± SD**	**African American M ± SD**	**Hispanic M ± SD**
Age (years)	63.5 ± 11.3	64.2 ± 10.8	†63.4 ± 13.3	*52.0 ± 9.8
Education (years)	14.4 ± 3.4	14.5 ± 3.3	*†13.1 ± 3.2	*13.7 ± 3.3
Body Mass Index (kg/m²)	28.2 ± 5.2	28.0 ± 5.0	*29.2 ± 6.0	*29.2 ± 5.5

n, number of participants; M, mean; SD, standard deviation
*p values ranged from 0.02 to < 0.0001 for pairwise comparison with the Caucasian reference group
†p values ranged from 0.02 to < 0.0001 for pairwise comparison of African Americans and Hispanics

is a unitary scale with a Cronbach α = 0.88 and a test-retest reliability over 5 months of $r = 0.82$.[38]

The SF-36 measure was developed as part of a cross-sectional and longitudinal study of variations in health care practices and outcomes in over 10,000 outpatients and has been shown to have excellent psychometric properties.[39,40] Low scores on the SF-36 Physical Composite Scale (PCS) suggest limitations in self-care, physical, social and role activities, severe bodily pain, and frequent tiredness. A low score on the SF-36 Mental Composite Scale (MCS) indicates frequent psychological distress and social and role disability due to emotional problems. The PCS and MCS scores have been found to account for 80% to 85% of the variance in the 8 SF-36 scales in patient, as well as general populations.[39]

Apnea was defined as a complete or partial cessation of airflow (≤ 25% of baseline) as measured by the amplitude of the thermocouple signal, ≥ 10 seconds. Hypopneas were identified if the amplitude of an index of flow or effort (detected by the thermocouple or thorax or abdominal inductance band signals) clearly decreased, but did not meet the criteria of apneas, and were < 70% of the amplitude of baseline breathing ≥ 10 sec. Only apneas or hypopneas associated with ≥ 4% desaturation were considered in the calculation of the respiratory disturbance index (RDI 4%). An RDI 4% that occurred < 5 times per hour was considered negative for OSA; 5 to 15 times per hour was defined as mild to moderate OSA; and ≥ 15 times per hour was defined as severe OSA.

Statistical analyses were performed using SAS v8 (SAS Institute Inc., Cary, NC), GraphPad (GraphPad Software, Inc., La Jolla, CA), and PASS (NCSS, Kaysville, UT). The chi-square (χ^2) test was used to compare ethnic subgroups on nominal level variables. Statistically significant multi-level χ^2 results were followed with pairwise χ^2 comparisons. Analysis of variance was used to compare ethnic subgroups on interval level variables. A p value ≤ 0.05 was considered statistically significant.

Comparisons of ethnic groups were presented using effect size and 95% confidence interval statistics (a measure of the clinical meaning of the difference between 2 groups).[41,42] For example, if one group of patients has a mean of 50 and another group as a mean and of 53 on HR-QOL, the difference between the 2 group means is an effect size of 3 points. If the 95% confidence interval around that difference is 2 to 4, the clinician should expect that in a series of similar studies the difference between the 2 groups would consistently fall within the range of 2 to 4 points.[43] A wider confidence interval or one that includes 0 indicates that the difference seen between groups might not be replicable or clinically meaningful. Given the national norms for the means and standard deviations (SD) on the SF-36 PCS and MCS measures of HR-QOL (mean = 50, SD = 10),[39] an effect size of 2 points with a 95% confidence interval that does not include 0 would be considered a small, yet clinically meaningful effect size.[44]

RESULTS

Demographic and Health Characteristics

There were significant differences in the demographic and health profiles of ethnic subgroups (**Table 1**). African Americans and Hispanics had significantly fewer years of education and significantly higher BMIs than Caucasians. African Americans were significantly more likely than Caucasians to be female (59% vs. 52%), current smokers (14% vs. 9%), to have a respiratory condition (18% vs. 14%), CVD (22% vs. 18%), or diabetes (15% vs. 7%, all p < 0.05). Caucasians were significantly more likely to be married and past smokers than both the African American and Hispanic participants. Caucasians were significantly more likely to report CVD (18% vs. 8%) and respiratory problems (14% vs. 11%, each p < 0.05) than Hispanics. Alternatively, Hispanics were significantly younger and significantly less likely to have cardiovascular or respiratory disease than Caucasian and African American participants. Hispanics were significantly more likely to be married, and significantly less likely to report diabetes than African Americans (6% vs. 15%, p < 0.05), although their BMIs did not differ significantly (each = 29.2).

Distribution of Sleep Disturbances

Sleep disturbances were a common health condition in this sample; prevalence rates ranged from 17% to 41% depending on the type of sleep disturbance and ethnic subgroup (**Table 2**). There were no statistically significant differences in the distri-

bution of OSA or insomnia symptoms across ethnic subgroups. Frequent snoring was significantly more common among Hispanics (41%) than Caucasians and significantly less common among African Americans (30%) than Caucasians (34%, each $p < 0.05$). Although the difference between African Americans and Caucasians is small, the comparison has high statistical power due to the large sample size. Given that the sample of Caucasians is geographically diverse, it is likely that these results would be replicated in other national samples. African American and Hispanic participants were not significantly different from each other despite the noticeable absolute difference in snoring prevalence. EDS was significantly more common among African Americans (32%, $p < 0.05$) compared to Caucasians or Hispanics, but Hispanics were not significantly different from Caucasians (each 24%).

Physical Composite Scale

Mean PCS scores for each sleep disturbance type and ethnic subgroup (**Table 3**) demonstrated that this sample had physical HR-QOL substantially below the general U.S. population norms (mean = 50; SD = 10).[39] Despite the lower levels of physical HR-QOL overall, the effect sizes for pairwise comparisons of participants with or without sleep disturbances (presented in columns 2 to 4 of **Table 3**) clearly demonstrated that for OSA, insomnia symptoms, and EDS there was an additional clinically meaningful reduction in physical HR-QOL associated with having a sleep disturbance. This pattern of differences was the same

Table 2—Distribution of sleep disturbances.

RDI at 4%	Total n (%)	Caucasian n (%)	African American n (%)	Hispanic n (%)
No OSA	2848 (54)	2421 (54)	274 (56)	153 (58)
5-14	1473 (28)	1286 (29)	121 (25)	66 (25)
15+	916 (17)	775 (17)	95 (19)	46 (17)
Non-Snorer				
Frequent Snoring	1795 (34)	1446 (32)	245 (50)	104 (39)
No (not frequent)	1677 (32)	1527 (34)	98 (20)	52 (20)
Yes	1765 (34)	1509 (34)	*147 (30)	*109 (41)
DIMS (Insomnia symptoms)				
No	3599 (70)	3095 (70)	336 (72)	168 (64)
Yes	1576 (30)	1353 (30)	129 (28)	94 (36)
Excessive Daytime Sleepiness (ESS > 10)				
No	3793 (75)	3294 (76)	306 (68)	193 (76)
Yes	1256 (25)	1053 (24)	*†142 (32)	61 (24)

n, number of participants; RDI, respiratory disturbance index (4% desaturation); OSA, obstructive sleep apnea; DIMS, difficulty initiating or maintaining sleep; ESS, Epworth Sleepiness Scale
*p < 0.01 for pairwise comparison with the Caucasian reference group
†p = 0.03 for pairwise comparison of African Americans and Hispanics

Table 3—Health-related quality of life: mean physical composite scale scores and effect sizes within and between ethnic groups.

RDI at 4%	Caucasian (C) M ± SD	African American (A) M ± SD	Hispanic (H) M ± SD	A vs. C Effect Size (95% CI)	H vs. C Effect Size (95% CI)	A vs. H Effect Size (95% CI)
No OSA	48.7 ± 9.3	46.1 ± 10.4	48.4 ± 9.6			
5-14	47.2 ± 9.6	42.9 ± 11.7	46.8 ± 10.0			
15+	45.4 ± 10.5	43.6 ± 12.1	43.2 ± 10.3	−1.8 (−4.1,0.5)	−2.2(−5.3,0.9)	0.4 (−3.7,4.5)
No OSA vs. RDI 4% 15+ **Effect Size (95% CI)**	*3.3 (2.5, 4.1)	*2.5 (0.0, 5.0)	*5.2 (2.0, 8.4)			
Frequent Snoring						
No	48.7 ± 9.3	46.4 ± 9.7	47.5 ± 9.7			
Yes	47.7 ± 9.4	44.8 ± 11.8	46.6 ± 9.7	†−2.9 (−4.5,−1.3)	−1.1 (−2.9,0.7)	−1.8 (−4.5,0.9)
Frequent Snoring No vs. Yes **Effect Size (95% CI)**	*1.0 (0.3, 1.7)	1.6 (−1.2, 4.4)	0.9 (−2.3, 4.1)			
DIMS (Insomnia Symptoms)						
No	48.6 ± 9.2	45.8 ± 10.4	48.1 ± 9.7			
Yes	45.7 ± 10.5	41.5 ± 12.6	45.3 ± 10.2	†−4.2 (−6.1,−2.3)	−0.4 (−2.6,1.8)	†−3.8 (−6.9,−0.7)
DIMS No vs. Yes **Effect Size (95% CI)**	*2.9 (2.3,3.5)	*4.3 (2.1,6.6)	*2.8 (0.3,5.3)			
Excessive Daytime Sleepiness (EDS)						
No	48.1 ± 9.5	45.6 ± 10.7	47.7 ± 9.7			
Yes	46.6 ± 10.3	42.6 ± 11.9	45.7 ± 10.7	†−4.0 (−5.8,−2.2)	−0.9 (−3.6,1.8)	−3.1 (−6.6,0.4)
EDS No vs. Yes **Effect Size (95% CI)**	*1.5 (0.8,2.2)	*3.0 (0.8,5.2)	2.0 (−0.1,4.1)			

RDI, respiratory disturbance index (4% desaturation); OSA, obstructive sleep apnea; DIMS, difficulty initiating or maintaining sleep; M, Mean; SD, Standard deviation; CI, confidence interval
*p values ranged from 0.05 to < 0.0001 for pairwise comparison of participants with or without sleep disturbance
†p values ranged from 0.02 to < 0.0001

for all 3 ethnic groups; participants with sleep disturbances had poorer HR-QOL than participants without sleep disturbances. This reduction was statistically significant in all but one case (EDS among Hispanic participants). The pattern of differences for frequent snoring was the same, but the difference between groups was small in each case and was not statistically significant for African Americans or Hispanics. The statistical significance for the comparison of frequent to infrequent snorers in the Caucasian group is likely due to the large sample size.

Comparison of mean differences across ethnic subgroups within each sleep disturbance type (Effect Sizes in columns 5 to 7 of **Table 3**) showed that African Americans had significantly poorer physical HR-QOL than Caucasians for frequent snoring, insomnia symptoms, and EDS (but not OSA). For insomnia symptoms, African Americans also showed significantly poorer physical HR-QOL than Hispanics. Hispanics and Caucasians were not significantly different from each other on any sleep disturbance for physical HR-QOL.

Mental Composite Scale

Mean MCS scores for each sleep disturbance and ethnic subgroup (**Table 4**) demonstrated that the sample had mental HR-QOL at or above the general U.S. population norms (mean = 50, SD = 10).[39] Comparisons of group means for participants with or without OSA or frequent snoring (presented in columns 2 to 4 of **Table 4**) provide no evidence that these sleep disturbances were associated with reduced mental health. In contrast, comparison of participants with or without insomnia symptoms or EDS showed that these sleep disturbances were associated with significantly reduced mental health. Comparison of mean differences across ethnic subgroups within each sleep disturbance (presented in columns 5 to 7 of **Table 4**) showed that Hispanics had significantly poorer mental health than Caucasians for frequent snoring, insomnia symptoms, and EDS (but not OSA). Similar to Hispanics, African Americans had significantly worse mental health than Caucasians, but these differences were statistically significant only for insomnia symptoms. Hispanics had consistently poorer mental health than African Americans; however, Hispanics and African Americans did not differ significantly on any sleep disturbance.

DISCUSSION

Systematically examining associations between sleep disturbances, comorbidities and HR-QOL among ethnic subgroups is an important step in advancing tailored care in clinical sleep medicine and improving health outcomes. Traditionally, studies have assessed relationships between sleep disturbances and HR-QOL while controlling for race/ethnicity, limiting comparisons to Caucasians and African Americans, or Caucasians and "Other."[6,22,27,30,32] Our findings make three unique contributions to the literature regarding sleep disturbances and HR-QOL of racial/ethnic groups: (1) mapping the relative importance of sleep disturbances within and across ethnic subgroups, (2) es-

Table 4—Health-related quality of life: mean mental composite scale scores and effect sizes within and between ethnic groups.

RDI at 4%	Caucasian (C) M ± SD	African American (A) M ± SD	Hispanic (H) M ± SD	A vs. C Effect Size (95% CI)	H vs. C Effect Size (95% CI)	A vs. H Effect Size (95% CI)
No OSA	53.3 ± 8.0	52.4 ± 9.1	50.6 ± 9.9			
5-14	53.9 ± 7.7	51.5 ± 9.0	51.6 ± 9.3			
15+	53.6 ± 8.6	53.5 ± 8.9	51.6 ± 9.6	−0.1 (−1.9, 1.7)	−2.0 (−4.6, 0.6)	1.9 (−1.3, 5.1)
No OSA vs. RDI 4% 15+ **Effect Size (95% CI)**	−0.3 (−1.0, 0.4)	−1.1 (−3.2, 1.0)	−1.0 (−4.3, 2.3)			
Frequent Snoring						
No	54.0 ± 7.3	53.4 ± 9.2	51.3 ± 9.4			
Yes	53.7 ± 8.0	52.5 ± 8.9	50.4 ± 9.9	−1.2 (−2.6, 0.2)	†−3.3 (−4.9, −1.7)	2.1 (−0.2, 4.4)
Frequent Snoring No vs. Yes **Effect Size (95% CI)**	0.3 (−0.3, 0.8)	0.9 (−1.4, 3.2)	0.9 (−2.3, 4.1)			
DIMS (Insomnia Symptoms)						
No	54.4 ± 7.4	53.9 ± 8.1	53.2 ± 8.5			
Yes	51.7 ± 9.5	49.2 ± 10.0	47.0 ± 10.6	†−2.5 (−4.2, −0.8)	†−4.7 (−6.7, −2.7)	2.2 (−0.5, 4.9)
DIMS No vs. Yes **Effect Size (95% CI)**	*2.7 (2.2, 3.2)	*4.7 (2.9, 6.5)	*6.2 (3.8, 8.6)			
Excessive Daytime Sleepiness (EDS)						
No	54.1 ± 7.7	53.6 ± 8.4	51.9 ± 9.3			
Yes	52.1 ± 8.7	50.9 ± 9.8	48.1 ± 10.9	−1.2 (−2.8, 0.4)	†−4.0 (−6.3, −1.7)	2.8 (−0.3, 5.9)
EDS No vs. Yes **Effect Size (95% CI)**	*2.0 (1.4, 2.6)	*2.7 (0.9, 4.5)	*3.8 (1.0, 6.6)			

RDI, respiratory disturbance index (4% desaturation); OSA, obstructive sleep apnea; DIMS, difficulty initiating or maintaining sleep; M, Mean; SD, Standard deviation; CI, confidence interval

*p values ranged from 0.01 to < 0.0001 for pairwise comparison of participants with or without sleep disturbance

†p values ranged from 0.01 to < 0.0001

tablishing HR-QOL norms for OSA, frequent snoring, insomnia symptoms and EDS for three racial/ethnic groups, and (3) providing effect size estimates for use in future HR-QOL racial/ethnic sleep studies.

The results for OSA and HR-QOL for Caucasians, African Americans and Hispanics in our work replicate prior studies that suggest at least two possibilities: (1) RDI may not be the most relevant measure to determine associations with HR-QOL no matter which racial/ethnic group is being studied, or (2) the degree of OSA across racial/ethnic groups must be quite severe in order to affect HR-QOL. Moore noted that sleep quality and sleep continuity were better PSG indices that correlated with several SF-36 subscales compared to RDI.[31] SHHS participants with severe OSA reported decrements in the SF-36 physical, general health, vitality and social functioning scales.[22] In their Brazilian study of OSA, Lopes reported severity of RDI to be associated with poorer HR-QOL on all eight domains of the SF-36;[34] this study included activity level as a mediating variable and found that patients with moderate apnea who were physically active reported better HR-QOL compared to non-active participants, suggesting that exercise become an adjunct to the management of OSA.

These findings indicate future avenues for health disparities sleep research and clinical practice. Future studies of OSA, frequent snoring, insomnia symptoms, EDS, and other sleep disturbances, including restless legs syndrome, that incorporate greater ethnic diversity (e.g., Americans of Asian and Middle Eastern descent), should include lifestyle and activity patterns to determine if these behaviors can become interventions to improve sleep and enhance HR-QOL. Studies that include PSG should examine indices in addition to RDI to determine associations between OSA and HR-QOL by ethnicity.

Findings suggest that the physical HR-QOL of African Americans with frequent snoring, insomnia symptoms, or EDS is poor and the differences are clinically meaningful. Hispanics who report snoring, insomnia symptoms or EDS are more likely to have poorer mental health outcomes that are clinically meaningful. Notably, each ethnic group with moderate to severe OSA showed clinically meaningful reductions in physical HR-QOL compared to their ethnic counterparts without SDB. These clinically meaningful findings hold true for Caucasians, African Americans, and Hispanics with insomnia symptoms and EDS for both physical and mental health compared to their ethnic counterparts without these symptoms. The failure to find statistically significant differences may be due to problems with statistical power or measurement error that could be resolved in a primary, prospective study that stratifies by race/ethnicity and comorbidity.

Prior SHHS studies may provide clues as to the causes of HR-QOL differences among the African American and Hispanic groups. Redline[15] reported that African American men spent more time in lighter stages of sleep compared to other ethnic subgroups. This finding could explain, at least in part, the decrements in physical HR-QOL of African Americans in the present study. Future HR-QOL assessments with larger samples of African American and Hispanic men and women with and without sleep disorders are needed in order to explore differences in sleep architecture in tandem with DIMS status, comorbid conditions and HR-QOL. O'Connor[20] reported that Hispanics were significantly more likely to snore than Caucasian participants. This finding was consistent with a population-based survey of New Mexico Hispanics.[19] Notably, Hispanic children 4 to 11 years of age were significantly more likely to have parental reports of snoring and EDS compared to reports of Caucasian parents in the Tucson Children's Assessment of Sleep Apnea.[45] Although the elevated rate of snoring among SHHS Hispanics cannot be explained by BMI or other factors, it could provide a possible explanation for the decrement in mental health of the Hispanic participants with insomnia symptoms and EDS. Potential venues for research to examine higher rates of snoring among Hispanics include the influence of spicy foods on night time thermoregulation,[46] as well as environmental factors that may contribute to increased nasal inflammation or congestion.[47,48]

In addition to within- and between-group findings, our study provides mean PCS and MCS scores for Caucasian, African American, and Hispanic SHHS participants with and without OSA, frequent snoring, insomnia symptoms, and EDS. The between-group PCS and MCS scores should inform future cross-sectional and longitudinal sleep and HR-QOL culture care research. The MCS and PCS mean score profiles for OSA and sleep symptoms are similar to those of MOS patients with hypertension and type 2 diabetes and suggest that these sleep disorders influence activities of daily living and general well-being akin to other chronic conditions.[33] Interestingly, whether they were SHHS participants with OSA or MOS patients with hypertension or type 2 diabetes, their MCS scores were above the norm, suggesting better mental health compared to the U.S. general population. Future sleep and mental HR-QOL research should include income, social support, access to care, and other psychosocial and demographic covariates known to influence differences in mental health scores by ethnicity. Reports of comorbidities that may contribute to mental health problems by ethnicity, including depression or anxiety,[2,6,9,30] should be included in studies of work capacity and health care utilization to delineate more the association between sleep disorders on quality of work life and need for health services.

Limitations

There are limitations that must be addressed when interpreting these findings. First, the correlational nature of these secondary analyses does not permit one to infer cause and effect relationships. The possibility that poorer HR-QOL could lead to insomnia symptoms vs. insomnia symptoms leading to poorer HR-QOL (reverse causality) cannot be discounted. Second, the possibility that race/ethnicity are proxies for less easily measured demographic, ethnographic, and health variables dictates that prospective, controlled studies of these relationships be completed. Third, future studies should include standardized assessment for depression, anxiety and mood, so that their relationship to the interaction of sleep disturbances and physical versus mental health can be assessed. Although the ESS is a well-validated measure and commonly used in sleep medicine, this measure may be more likely to identify men than women with EDS.[25] The validity of the ESS when assessing the joint effects of gender and race/ethnicity has not been demonstrated. Studies to determine the relevance of this and other self-report measures for assessing gender differences of participants from various ethnic/racial backgrounds are warranted. Finally, future

studies need to include larger samples of ethnically diverse populations, assess changes in HR-QOL that occur as sleep disturbances remit or intensify and control for comorbid conditions in order to propose potential cause and effect relationships.

CONCLUSIONS

In the past decade, HR-QOL has become of increasing interest in sleep medicine diagnosis and treatment. It is of growing importance toward improving health outcomes and is being taken into consideration in clinical care, health care utilization, and cost. Studies of sleep and HR-QOL, however, have primarily investigated sleep disturbances of Caucasian participants, or used Caucasians as the comparison group with African Americans. Very little is known about the HR-QOL of Hispanics or other racial/ethnic minorities with sleep disorders. The results of this secondary analysis can be utilized for future HR-QOL comparison and intervention studies that are ethnic specific. The ethnic differences reported in this study, however, underscore the need to examine social support, socioeconomic status, access to care, and cultural factors to guide future HR-QOL sleep and ethnicity research, as well as to assist primary care providers in assessing sleep disorders and their impact on HR-QOL outcomes in ethnically diverse populations.

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