



Sleep-disordered Breathing in Hispanic/Latino Individuals of Diverse Backgrounds

The Hispanic Community Health Study/Study of Latinos

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Abstract

Rationale: Hispanic/Latino populations have a high prevalence of cardiovascular risk factors and may be at risk for sleep-disordered breathing (SDB). An understanding of SDB among these populations is needed given evidence that SDB increases cardiovascular risk.

Objectives: To quantify SDB prevalence in the U.S. Hispanic/Latino population and its association with symptoms, risk factors, diabetes, and hypertension; and to explore variation by sex and Hispanic/Latino background.

Methods: Cross-sectional analysis from the baseline examination of the Hispanic Community Health Study/Study of Latinos.

Measurements and Main Results: The apnea-hypopnea index (AHI) was derived from standardized sleep tests; diabetes and hypertension were based on measurement and history. The sample of 14,440 individuals had an age-adjusted prevalence of minimal SDB

(AHI ≥ 5), moderate SDB (AHI ≥ 15), and severe SDB (AHI ≥ 30) of 25.8, 9.8, and 3.9%, respectively. Only 1.3% of participants reported a sleep apnea diagnosis. Moderate SDB was associated with being male (adjusted odds ratio, 2.7; 95% confidence interval, 2.3–3.1), obese (16.8; 11.6–24.4), and older. SDB was associated with an increased adjusted odds of impaired glucose tolerance (1.7; 1.3–2.1), diabetes (2.3; 1.8–2.9), and hypertension. The association with hypertension varied across background groups with the strongest associations among individuals of Puerto Rican and Central American background.

Conclusions: SDB is prevalent in U.S. Latinos but rarely associated with a clinical diagnosis. Associations with diabetes and hypertension suggest a large burden of disease may be attributed to untreated SDB, supporting the development and evaluation of culturally relevant detection and treatment approaches.

Keywords: sleep-disordered breathing; Hispanic; epidemiology; disparities

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At a Glance Commentary

Scientific Knowledge on the

Subject: The prevalence of sleep-disordered breathing (SDB) has not been defined in U.S. Hispanic/Latino groups using rigorous population sampling strategies. It is also not known whether risk of SDB varies across different Hispanic/Latino groups.

What This Study Adds to the Field:

This report from the largest study of cardiovascular risk factors and sleep traits in the U.S. Hispanic/Latino population identifies a high prevalence of sleep apnea in U.S. Latinos, which is only rarely associated with a clinical diagnosis. Furthermore, the study showed significant variation in prevalence of SDB and related symptoms across Hispanic/Latino groups, particularly in men. In this population at high risk for cardiometabolic morbidity, this study also shows a significant association of SDB with diabetes and hypertension, independent of obesity. The high prevalence of SDB and its associations with hypertension and diabetes, together with the low prevalence of diagnosed sleep apnea, suggests a large burden of disease may be attributed to untreated sleep apnea, indicating a need to develop and evaluate culturally relevant detection and treatment approaches for this common disorder.

Sleep-disordered breathing (SDB), characterized by recurrent episodic partial and complete pharyngeal obstruction in sleep, snoring, sleep fragmentation, and daytime somnolence is prevalent in many populations worldwide, with increasing rates of SDB attributed to a rising prevalence of obesity (1). SDB is associated with numerous health problems, including cardiovascular disease (CVD), diabetes, and stroke (2–4). A causal role for SDB in the pathogenesis of cardiometabolic disorders is supported by evidence that sleep apnea and intermittent nocturnal hypoxemia augment sympathetic activation and

contribute to the development of hypertension, endothelial dysfunction, and dyslipidemia (5); furthermore, SDB treatment may improve insulin sensitivity (6) and hypertension (7, 8). Hispanic/Latino populations have a high prevalence of CVD risk factors, including obesity, diabetes, and hypertension (9), and thus may be particularly at risk for SDB. SDB is also prevalent among individuals from disadvantaged neighborhoods (10), and thus it may be a common, albeit understudied, CVD risk factor in the U.S. Hispanic/Latino population. Prior studies on the prevalence and role of SDB in the health of Hispanics in the United States have been limited by relatively small samples, reliance on questionnaires for assessment of SDB, and by underrepresentation of the various Hispanic groups living in the United States. A further understanding of SDB among Hispanic/Latino populations is needed given evidence that SDB increases risk of conditions common in the Hispanic population, is amenable to treatment, but is often unrecognized and undertreated (11, 12).

Baseline data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) were analyzed to estimate the prevalence of SDB and SDB symptoms, to describe associations with risk factors and diabetes and hypertension, and to explore variation in SDB by sex and Hispanic/Latino background. We hypothesized that SDB would be more prevalent in Hispanic/Latino groups with higher rates of obesity, and associated with an increased prevalence of hypertension and diabetes. Some of the results of these studies have been previously reported in the form of abstracts (13–15).

Methods

The online supplement provides detailed methods and additional results.

Sample

The HCHS/SOL is a community-based cohort study of 16,415 self-identified Hispanic/Latino persons 18–74 years old recruited from randomly selected households in four U.S. field centers (Bronx, NY; Chicago, IL; Miami, FL; San Diego, CA). The multistage sampling design and cohort selection procedures

have been described (16, 17). Briefly, participants were recruited between 2008 and 2011 from defined geographic areas selected to provide a representative sample of the target population and diversity among participants with regard to socioeconomic status and national origin or background. Of individuals who were screened and selected and who met eligibility criteria, 41.7% were enrolled, representing 16,415 persons from 9,872 households. This study was approved by the Institutional Review Boards at each field center where all participants gave written consent and by the study's Reading and Coordinating Centers.

Protocol and Measurements

The baseline examination included questionnaires administered in Spanish or English based on the participant's language preference, anthropometry, a blood draw, an oral glucose tolerance test, and other measurements as detailed previously (16). Sleep history and symptoms were assessed using the Sleep Heart Health Study Sleep Habits Questionnaire (18) and the Epworth Sleepiness Scale (ESS) (19). Participants were instructed on use of a sleep apnea monitor for overnight recording (ARES Unicorder 5.2; B-Alert, Carlsbad, CA) (20). This self-applied device measures airflow using a nasal pressure cannula and transducer, hemoglobin oxygen saturation and pulse rate (reflectance oximetry), head movement and position (actigraphy), and a microphone to record snoring levels. Sleep records were scored at a central sleep reading center. Certified polysomnologists manually edited artifacts, identified periods of sleep, and annotated each respiratory event with its associated oxyhemoglobin desaturation. Respiratory events were identified as a 50% or greater reduction in airflow lasting greater than or equal to 10 seconds. The apnea-hypopnea index (AHI) is the number of respiratory events per estimated sleep hour, with the AHI0, AHI3, and the AHI4 comprised of hypopneas scored without a desaturation requirement (AHI0) or with associated desaturations of greater than or equal to 3% (AHI3) or greater than or equal to 4% (AHI4). Overall, 84.4% of sleep studies were graded as "excellent" quality (≥ 3.8 h of interpretable signals), whereas 5.8% of studies were of insufficient quality for analysis (< 30 min of recording).

Interscorer and intrascorer reliability was excellent (AHI intraclass correlation coefficient, 0.99). Good agreement between the AHI3 measured by this monitor and by polysomnography has been demonstrated in a prior validation study ($\rho_c = 0.70$; 95% confidence interval [CI], 0.47–0.92) (21).

The sensitivity and specificity for detecting an AHI greater than or equal to 5 were 80 and 88%, respectively; median difference in the AHI between the two devices was 3.8 (standard error, 1.2).

Definitions

SDB severity was defined using AHI thresholds of AHI greater than or equal to 5, 15, and 30, indicating minimal, moderate, and severe SDB, respectively. The primary metric of interest was “moderate or more severe” SDB based on an AHI3 greater than or equal to 15. Alternative definitions used the AHI0 and AHI4. Sleep apnea syndrome (SAS) was defined as having both an AHI3 greater than or equal to 5 and sleepiness defined by an ESS score greater than or equal to 10. Habitual snoring and episodic breathing cessation (“stopped breathing”) were considered present if reported as occurring greater than or equal to three times weekly. Sleep duration was computed using self-reported bed and wake times on weekdays and weekends. Adiposity was assessed from measured weight and height (deriving body mass index [BMI]) and waist circumference. Hypertension was defined as a systolic blood pressure greater than or equal to 140 and/or diastolic blood pressure greater than or equal to 90 mm Hg, or use of antihypertensive medications. Impaired glucose tolerance and diabetes were based on American Diabetes Association definitions using fasting glucose, oral glucose tolerance testing, hemoglobin A_{1C} levels, and use of hypoglycemic medications (22).

Statistical Methods

Analyses accounted for the complex survey design and sampling weights, which are the product of a “base weight” (reciprocal of the probability of selection) and three adjustments: (1) nonresponse adjustments made relative to the sampling frame; (2) trimming to handle extreme values; and (3) calibration to the 2010 U.S. Census according to age, sex, and Hispanic background. Prevalence rates by

background were estimated using complex survey linear models (23) to produce design-based estimates stratified by sex, and with adjustment for age, or for age and BMI (41.1 yr and 29.3 kg/m², respectively). We statistically tested the null hypothesis that all backgrounds have the same prevalence (i.e., a 6 df test because there are seven Hispanic/Latino backgrounds); when significant, we performed pairwise comparisons and adjusted pairwise comparisons for multiple comparisons using Tukey-Kramer method (unplanned and unbalanced design). The association between each risk factor and SDB was assessed using survey logistic regression models, with adjustment for demographic characteristics. We also included interactions of main effects with Hispanic/Latino background or sex to test for effect modification. Similarly, the associations of SDB with hypertension or diabetes prevalence were assessed using survey logistic regression with adjustment for demographic factors plus adiposity and cigarette and alcohol use. We evaluated confounding between Hispanic/Latino background and field center, and conducted site-specific analyses as appropriate.

Results

Sample Characteristics

Of the 16,415 participants, 1,138 did not undergo a sleep study and 808 had insufficient sleep data for analysis. An additional 29 participants were excluded for other missing data, yielding an analytical sample of 14,440. This sample consisted of 60.2% females and had a mean age of 45.9 years because of oversampling the 45–74 age group.

Tables 1 and 2 show the age-adjusted distributions of demographic, anthropometric, and health characteristics by sex and background. A higher percentage of women than men were obese (41.9% vs. 36.4%). Hypertension and diabetes were observed in approximately 20 and 15% of the cohort, respectively. For both men and women, the age-adjusted prevalence of obesity, diabetes, and hypertension was lowest among individuals of South American background. Among women, the age-adjusted prevalence of obesity, diabetes, and hypertension was highest among individuals of Puerto Rican background.

SDB

Overall, 25.8% of the study population met minimal criteria for SDB; 9.8% for moderate or more severe SDB; 3.9% for severe SDB; and 5.6% for SAS. Only 1.3% (95% CI, 1.1–1.6) of participants reported receiving a physician diagnosis of sleep apnea (5% of those with AHI3 \geq 15).

Tables 3 and 4 show the age-adjusted and age and BMI-adjusted prevalence rates of SDB by background and sex. SDB prevalence rates were approximately 30–40% higher in men than in women. Although not statistically significant, age-adjusted prevalence of moderate or more severe SDB was highest among women of Puerto Rican background and lowest among women of South American background. Among men, SDB prevalence was highest among men of Cuban and “mixed/other” backgrounds and least prevalent among men of Puerto Rican and South American backgrounds. After adjusting for multiple comparisons, age and BMI-adjusted rates of moderate or more severe SDB were significantly higher in Cuban men compared with Puerto Rican men.

Because prior studies have used a wide range of SDB definitions, Figure E1 in the online supplement presents age-adjusted prevalence rates according to different AHI definitions. Prevalence rates are higher for definitions that use less stringent desaturation criteria for hypopnea and lower thresholds of abnormality.

Sleep Symptoms and SDB Risk Factors

Among women, the overall age-adjusted prevalence of habitual snoring was 31.1% and did not vary much by background (Table 5). “Stopped breathing” was reported by 5.4% women and varied significantly by background group, with the highest prevalence among Puerto Rican (7.9%) and the lowest among Mexican (3.9%) women. Daytime sleepiness was reported by 18.5% of women, with sleepiness scale scores significantly lower among women of Cuban background compared with all other groups. Weekday and weekend average sleep durations were 7.9 and 8.5 hours per night, respectively. Among women, average sleep duration varied significantly across background

Table 1: Age-adjusted Demographic, Anthropometric, and Health Characteristics by Hispanic/Latino Background, for Women*

Risk factors	Dominican (n = 840)	Central American (n = 905)	Cuban (n = 1,011)	Mexican (n = 3,807)	Puerto Rican (n = 1,348)	South American (n = 550)	Mixed or Other (n = 232)	Overall (n = 8,693)
Age, yr	39.6 (0.8)	41.4 (0.7)	47.1 (0.7)	39.4 (0.4)	44.9 (0.7)	44.5 (1.1)	35.3 (1.5)	41.8 (0.3)
Marital status, %								
Single	42.0 (2.4)	36.4 (2.0)	28.9 (1.8)	23.0 (1.1)	48.9 (2.3)	27.9 (2.4)	35.4 (3.6)	31.7 (0.8)
Married or living with a partner	37.4 (2.7)	45.9 (2.3)	48.8 (2.0)	58.9 (1.5)	28.9 (1.8)	50.2 (2.9)	33.1 (4.8)	47.8 (1.0)
Separated, divorced, or widowed	20.6 (1.4)	17.7 (1.3)	22.3 (1.5)	18.1 (1.1)	22.2 (2.1)	21.9 (2.4)	31.5 (4.1)	20.5 (0.7)
Education, %								
No high school diploma or GED	33.6 (2.1)	36.4 (1.9)	18.8 (1.7)	37.4 (1.5)	35.2 (2.4)	19.1 (2.4)	21.4 (3.9)	32.0 (0.9)
At most a high school diploma or GED	24.5 (2.6)	26.0 (1.9)	32.0 (2.0)	27.1 (1.1)	25.3 (1.7)	27.6 (2.4)	20.1 (6.7)	27.1 (0.8)
Greater than high school diploma or GED	41.9 (2.6)	37.6 (1.9)	49.1 (2.4)	35.5 (1.7)	39.5 (2.4)	53.3 (2.6)	58.6 (5.7)	40.9 (1.0)
Household yearly income, %								
<\$30K	68.2 (3.0)	68.2 (2.4)	63.5 (2.1)	62.3 (1.7)	67.7 (2.0)	64.6 (2.7)	59.6 (4.9)	64.3 (1.0)
≥\$30K	23.8 (2.6)	21.4 (2.2)	20.5 (1.8)	33.4 (1.7)	27.3 (1.9)	30.1 (2.6)	38.4 (4.9)	28.4 (1.0)
Missing	7.9 (1.3)	10.4 (1.4)	16.1 (1.6)	4.3 (0.5)	5.0 (0.8)	5.3 (1.3)	2.1 (0.7)	7.3 (0.5)
Employment status, %								
Retired and not currently employed	8.8 (1.1)	4.7 (0.8)	7.2 (1.1)	5.3 (0.4)	14.7 (1.5)	4.7 (1.5)	13.2 (4.4)	7.6 (0.4)
Not retired and not currently employed	43.9 (3.0)	37.1 (2.1)	55.9 (1.9)	48.5 (1.4)	51.8 (2.2)	39.2 (2.9)	44.6 (5.2)	48.2 (0.9)
Employed part-time (≤35 h/wk)	20.5 (2.1)	25.9 (1.9)	13.5 (1.1)	23.1 (1.1)	10.6 (1.1)	24.5 (2.3)	15.2 (3.7)	19.4 (0.6)
Employed full-time (>35 h/wk)	26.8 (2.2)	32.4 (1.9)	23.4 (1.6)	23.1 (1.2)	22.9 (1.6)	31.6 (2.8)	27.0 (3.8)	24.8 (0.7)
Current cigarette smoker, %	11.0 (2.3)	7.6 (1.0)	21.5 (1.5)	9.8 (1.0)	29.1 (1.9)	10.9 (1.6)	19.9 (3.8)	15.0 (0.7)
BMI, kg/m ²	30.0 (0.5)	29.5 (0.2)	29.0 (0.2)	29.5 (0.2)	31.4 (0.3)	28.0 (0.4)	30.1 (0.6)	29.7 (0.1)
BMI, %								
<18.5: underweight	0.5 (0.3)	1.2 (0.4)	2.2 (0.6)	1.5 (0.4)	1.2 (0.4)	0.9 (0.5)	0.3 (0.5)	1.3 (0.2)
18.5–25: normal	22.3 (2.2)	21.2 (1.9)	26.0 (1.6)	22.2 (1.2)	18.1 (1.5)	33.6 (3.0)	22.7 (4.4)	22.7 (0.7)
25–30: overweight	33.7 (2.6)	36.2 (1.9)	34.6 (1.7)	35.4 (1.3)	30.0 (2.0)	35.9 (2.7)	27.5 (4.1)	34.0 (0.8)
≥30: obese	43.5 (3.1)	41.4 (2.0)	37.3 (1.7)	40.9 (1.6)	50.7 (2.2)	29.6 (2.6)	49.4 (5.5)	41.9 (0.9)
Waist circumference, cm	95.1 (1.2)	94.5 (0.5)	94.1 (0.5)	97.3 (0.4)	98.9 (0.6)	91.3 (0.8)	98.0 (1.9)	96.3 (0.3)
Diabetes, %	15.0 (1.4)	14.3 (1.3)	10.9 (1.2)	16.1 (0.8)	17.5 (1.6)	6.3 (1.4)	18.0 (4.0)	14.8 (0.5)
Hypertension, %	22.5 (1.6)	20.0 (1.4)	24.4 (1.2)	16.9 (0.8)	26.0 (1.7)	13.4 (1.8)	21.3 (3.8)	20.4 (0.5)

Definition of abbreviations: BMI = body mass index; GED = general education degree.

*For continuous variables other than age, statistic is age-adjusted weighted mean (SE); adjusted to overall mean age (41.1 yr). For categorical variables, statistic is age-adjusted weighted percent (SE). Estimates refer to the target population because sampling weights were applied.

groups by as much as 28 minutes per night, with the shortest sleep duration reported by women of South American and Puerto Rican backgrounds and the longest by women of Cuban background.

Among men, the age-adjusted prevalence of habitual snoring was 39.9%, and did not vary significantly by background (Table 6). In contrast, “stopped breathing,” reported by 7.6% of men, varied significantly by background, with prevalence highest among Cuban and Puerto Rican men and lowest among South American and Mexican background men. Daytime sleepiness was reported by 18.2% of men, with the highest prevalence in

Puerto Rican and South American and the lowest prevalence among Cuban men. Weekday and weekend sleep durations were reported to average 7.7 and 8.3 hours per night, respectively. Across background groups, average sleep duration varied by as much as 26 minutes per night by Hispanic/Latino background, with the shortest sleep duration reported by South American men and highest among Cuban men.

Similar patterns were observed in age and BMI-adjusted models (see Tables E1a and E1b) other than the finding of a significantly lower prevalence of snoring in both Puerto Rican men and women

compared with individuals of Mexican and South American backgrounds.

Table 7 shows the association between demographic factors, SDB symptoms, acculturation, diabetes, and hypertension with SDB. Men had a 2.7 increased adjusted odds of SDB compared with women. The odds of SDB were higher in overweight and obese individuals and increased progressively across ages 18–69, when a plateau was observed (see Figure E2). Neither language preference nor immigration generation was associated with SDB.

Individuals reporting habitual snoring or “stop breathing” had higher odds of SDB compared with individuals free of

Table 2: Age-adjusted Demographic, Anthropometric, and Health Characteristics by Hispanic/Latino Background, for Men*

Risk factors	Dominican (N = 448)	Central American (N = 588)	Cuban (N = 897)	Mexican (N = 2,297)	Puerto Rican (N = 943)	South American (N = 390)	Mixed or Other (N = 184)	Overall (N = 5,747)
Age, yr	38.9 (1.1)	38.2 (0.7)	45.7 (0.7)	38.0 (0.5)	42.0 (0.7)	40.2 (0.9)	34.4 (1.2)	40.3 (0.3)
Marital status, %								
Single	49.0 (2.3)	36.9 (2.4)	35.3 (1.9)	25.5 (1.3)	52.5 (2.4)	33.0 (2.7)	36.7 (4.9)	35.6 (0.9)
Married or living with a partner	40.8 (2.4)	51.4 (2.6)	50.5 (2.3)	65.3 (1.5)	35.0 (2.3)	54.7 (3.1)	50.0 (5.1)	52.8 (1.1)
Separated, divorced, or widowed	10.2 (1.5)	11.7 (1.5)	14.2 (1.4)	9.2 (0.8)	12.6 (1.3)	12.3 (1.9)	13.3 (2.5)	11.6 (0.6)
Education, %								
No high school diploma or GED	42.3 (2.9)	40.2 (2.5)	19.2 (1.5)	38.1 (1.8)	33.0 (2.3)	22.0 (2.7)	22.1 (3.5)	32.4 (1.0)
At most a high school diploma or GED	19.7 (2.4)	25.1 (2.4)	33.9 (1.9)	30.4 (1.5)	31.6 (2.2)	29.4 (3.2)	20.3 (4.9)	29.7 (0.9)
Greater than high school diploma or GED	37.9 (2.9)	34.7 (2.6)	46.9 (2.0)	31.5 (2.1)	35.4 (2.5)	48.6 (3.3)	57.6 (5.5)	37.9 (1.1)
Household yearly income, %								
<\$30K	63.9 (2.8)	63.5 (2.9)	61.6 (2.0)	54.8 (2.5)	52.3 (2.5)	58.0 (3.4)	40.0 (5.0)	56.7 (1.3)
≥\$30K	29.7 (2.7)	30.4 (2.7)	30.7 (2.0)	42.9 (2.5)	43.3 (2.5)	38.0 (3.4)	53.1 (5.1)	38.6 (1.4)
Missing	6.4 (1.7)	6.0 (1.2)	7.6 (1.2)	2.3 (0.5)	4.4 (0.8)	4.0 (1.7)	6.9 (2.1)	4.7 (0.4)
Employment status, %								
Retired and not currently employed	10.3 (1.3)	6.7 (0.9)	5.8 (0.9)	7.9 (0.7)	13.8 (1.3)	4.7 (1.0)	11.2 (1.7)	8.5 (0.4)
Not retired and not currently employed	39.8 (2.9)	31.5 (2.7)	42.1 (2.1)	23.9 (1.4)	38.0 (2.5)	24.7 (3.0)	35.9 (5.0)	32.3 (1.1)
Employed part-time (≤35 h/wk)	13.0 (2.1)	19.4 (2.3)	12.3 (1.1)	15.0 (1.1)	13.4 (1.7)	22.7 (2.8)	17.6 (4.2)	14.8 (0.6)
Employed full-time (>35 h/wk)	36.9 (3.0)	42.4 (2.7)	39.8 (1.9)	53.2 (1.7)	34.8 (2.4)	47.9 (3.2)	35.4 (5.3)	44.5 (1.1)
Current cigarette smoker, %	9.5 (1.8)	18.9 (2.0)	32.0 (2.0)	24.0 (1.5)	34.3 (2.2)	15.4 (2.6)	23.1 (4.3)	25.4 (0.9)
BMI, kg/m ²	28.9 (0.4)	28.6 (0.3)	28.4 (0.2)	29.1 (0.2)	29.4 (0.3)	27.9 (0.3)	29.4 (0.5)	28.9 (0.1)
BMI, %								
<18.5: underweight	2.8 (1.1)	0.8 (0.6)	1.7 (0.6)	0.4 (0.2)	0.3 (0.2)	1.1 (0.8)	−0.2 (0.2)	0.9 (0.2)
18.5–25: normal	15.4 (1.9)	24.1 (2.6)	26.1 (1.8)	17.1 (1.1)	25.6 (2.0)	23.3 (2.7)	21.5 (4.3)	21.1 (0.7)
25–30: overweight	43.4 (2.8)	42.4 (3.0)	37.7 (1.9)	45.6 (1.7)	34.4 (2.4)	48.4 (3.6)	40.7 (5.2)	41.6 (1.0)
≥30: obese	38.5 (3.0)	32.7 (2.4)	34.5 (1.7)	36.8 (1.9)	39.7 (2.3)	27.2 (2.9)	38.0 (4.7)	36.4 (0.9)
Waist circumference, cm	97.6 (1.1)	96.3 (0.6)	98.1 (0.6)	99.1 (0.5)	98.5 (0.7)	95.6 (0.8)	99.9 (1.4)	98.3 (0.3)
Diabetes, %	16.1 (1.6)	14.1 (1.4)	10.4 (1.2)	16.9 (1.1)	14.4 (1.4)	8.9 (1.4)	15.6 (2.2)	14.5 (0.6)
Hypertension, %	30.0 (2.4)	21.8 (1.7)	27.2 (1.5)	19.2 (1.1)	24.9 (1.9)	18.0 (1.9)	24.3 (2.6)	23.1 (0.7)

Definition of abbreviations: BMI = body mass index; GED = general education degree.

*For continuous variables other than age, statistic is age-adjusted weighted mean (SE); adjusted to overall mean age (41.1 yr). For categorical variables, statistic is age-adjusted weighted percent (SE). Estimates refer to the target population because sampling weights were applied.

these symptoms. The odds of SDB for those who answered “don’t know” to “stop breathing” were also significantly elevated compared with those who denied this symptom. No significant interactions were observed for these symptoms with sex or background. However, there was a significant interaction between ESS and background ($P < 0.05$); sleepiness increased the odds of SDB by approximately twofold among individuals of Central American or Cuban background, but was not associated with SDB among individuals of other background groups. The interaction

remained significant with adjustment for language preference.

Hypertension and Diabetes as Dependent Variables

After adjusting for potential confounders, including BMI and waist circumference, moderate or more severe SDB (AHI3 ≥ 15) compared with less severe SDB was associated with a 50% higher odds of impaired glucose tolerance and a 90% higher odds of prevalent diabetes (Table 8). A significant interaction between SDB and background was demonstrated for

hypertension; the association between SDB and hypertension was strongest among individuals of Puerto Rican (adjusted odds ratio, 2.4; 95% CI, 1.6–3.6) and Central American backgrounds (adjusted odds ratio, 1.9; 95% CI, 1.1–3.4) (see Table E2).

Discussion

This community-based study of health in U.S. Hispanics/Latinos provides new information on the prevalence of objectively measured SDB, SDB symptoms, and

Table 3: Age- and Age/BMI-adjusted* Indices of Sleep-disordered Breathing by Hispanic/Latino Background, Women

	Dominican (n = 840)	Central American (n = 905)	Cuban (n = 1,011)	Mexican (n = 3,807)	Puerto Rican (n = 1,348)	South American (n = 550)	Mixed or Other (n = 232)	Overall (n = 8,693)	P Value†
AHI ≥ 5, %									
Age-adjusted	17.8 (15.0–20.5)	16.6 (14.0–19.2)	20.3 (17.6–22.9)	17.9 (16.2–19.5)	22.1 (18.7–25.5)	18.2 (14.8–21.7)	19.2 (13.9–24.6)	18.8 (17.7–19.8)	0.1514
Age/BMI-adjusted	16.7 (13.8–19.5)	16.4 (13.7–19.0)	20.8 (18.2–23.4)	17.5 (16.1–19.0)	19.0 (15.9–22.0)	20.2 (16.8–23.6)	18.0 (11.9–24.1)	18.0 (17.0–19.0)	0.2215
AHI ≥ 15, %									
Age-adjusted	5.4 (3.6–7.3)	5.0 (3.4–6.5)	5.9 (4.3–7.5)	5.9 (4.9–6.9)	8.4 (5.3–11.5)	4.6 (2.5–6.7)	5.1 (3.0–7.3)	6.0 (5.2–6.7)	0.4555
Age/BMI-adjusted	4.9 (3.0–6.9)	4.9 (3.3–6.4)	6.1 (4.5–7.7)	5.8 (4.8–6.8)	7.0 (4.2–9.8)	5.5 (3.4–7.6)	4.6 (2.1–7.1)	5.6 (4.9–6.3)	0.6849
AHI ≥ 30, %									
Age-adjusted	2.0 (0.7–3.3)	1.8 (1.0–2.7)	1.9 (1.1–2.7)	1.9 (1.3–2.5)	2.1 (1.2–3.0)	1.3 (0.3–2.2)	1.2 (0.3–2.0)	1.8 (1.4–2.2)	0.6631
Age/BMI-adjusted	1.8 (0.4–3.1)	1.8 (0.9–2.6)	2.0 (1.1–2.9)	1.9 (1.2–2.5)	1.4 (0.6–2.3)	1.7 (0.8–2.6)	0.9 (0–1.9)	1.6 (1.2–2.0)	0.7692

Definition of abbreviations: AHI = apnea-hypopnea index; BMI = body mass index.

*Age- or age/BMI-adjusted weighted mean and 95% confidence interval. Adjusted to mean age (41.1 yr) and mean BMI (29.3).

†Global test (6 df) testing all seven Hispanic/Latino background prevalences equal.

associated risk factors in this large and growing segment of the population. The study shows that SDB and SDB symptoms are common but vary by background and sex in U.S. Latinos. In particular, among men, SDB was most prevalent in men of Cuban background and least common in Puerto Ricans. The distribution of sleep symptoms and sleep duration also varied across groups, with the lowest prevalence of “stop breathing” found in individuals of Mexican background. Longer sleep duration and less sleepiness were reported more frequently in individuals of Cuban background, whereas men and women of South American background reported shorter sleep durations and more sleepiness. SDB also was associated with an increased prevalence of diabetes and hypertension, although the strength of associations of SDB with hypertension, as well as sleepiness, varied significantly by Hispanic/Latino group.

Epidemiologic studies of SDB in the United States have consisted predominantly of non-Hispanic white populations. Prior research in Hispanic/Latino populations has

mostly relied on questionnaire responses and/or has been based on relatively small samples and has not specifically examined variation in SDB by Hispanic/Latino background. A prior study of residents in the San Diego area that used overnight oximetry demonstrated an almost threefold increased prevalence of SDB among minorities (24). However, only 44 Hispanic individuals were studied. The Sleep Heart Health Study, which studied 296 individuals of Hispanic background, reported that Hispanics compared with non-Hispanic white individuals had an approximately twofold greater odds of habitual snoring; objectively measured SDB, however, did not vary by ethnicity (25). However, this study did not use a representative frame. Other questionnaire surveys that have compared the prevalence of SDB symptoms between Hispanic and non-Hispanic individuals have provided inconsistent results, with some studies reporting no differences (26–28) and others reporting a higher prevalence in Hispanics compared with other groups (28, 29).

In HCHS/SOL, assembled to provide a representative sample of individuals from seven Latino backgrounds for whom objective assessment of SDB was conducted, we observed a high prevalence of SDB. Using recent definitions of SDB (30), we estimate that approximately 19% of women and 33% of men had minimal or more SDB and 6 and 14% of women and men, respectively, had moderate or more severe SDB. These rates are remarkably similar to recent U.S. prevalence rates estimated using model-based prevalence estimation procedures similar to those used in this study (31). A direct comparison with prior studies is limited, however, by differences in measurement approaches. The use of in-home monitoring in the HCHS/SOL study may have modestly underestimated SDB severity compared with in-laboratory assessments.

The twofold to threefold higher prevalence of SDB in men compared with women in the HCHS/SOL is similar to what has been observed in other populations (1, 32). An increasing prevalence of SDB with increasing age from 18 to 69 years also

Table 4: Age- and Age/BMI-adjusted* Indices of Sleep-disordered Breathing by Hispanic/Latino Background, Men

	Dominican (n = 448)	Central American (n = 588)	Cuban (n = 897)	Mexican (n = 2,297)	Puerto Rican (n = 943)	South American (n = 390)	Mixed or Other (n = 184)	Overall (n = 5,747)	P Value†
AHI ≥ 5, %									
Age-adjusted	34.3 (29.8–38.8)	34.3 (30.1–38.4)	33.5 (30.7–36.3)	34.9 (32.3–37.4)	29.7 (25.9–33.4)	28.4 (23.6–33.2)	39.0 (30.9–47.1)	33.4 (32.0–34.8)	0.0733
Age/BMI-adjusted	35.6 (31.4–39.7)	36.2 (32.2–40.1)	36.0 (33.2–38.8)	35.6 (33.3–38.0)	29.4 (25.5–33.2)	32.4 (27.7–37.1)	38.9 (31.5–46.3)	34.3 (32.9–35.6)	0.0830
AHI ≥ 15, %									
Age-adjusted	15.1 (11.4–18.7)	13.8 (10.6–17.1)	16.1 (13.4–18.8)	13.9 (11.8–15.9)	11.8 (9.3–14.2)	10.3 (7.3–13.3)	16.5 (11.7–21.3)	14.0 (12.8–15.1)	0.0673
Age/BMI-adjusted	16.0 AB (12.6–19.3)	15.2 AB (12.0–18.3)	17.8 A (15.2–20.4)	14.4 AB (12.4–16.4)	11.7 B (9.1–14.2)	13.0 AB (9.9–16.1)	16.4 AB (11.8–21.1)	14.4 (13.3–15.6)	0.0419
AHI ≥ 30, %									
Age-adjusted	4.5 (2.7–6.4)	6.1 (4.2–7.9)	7.0 (5.1–8.8)	6.6 (5.2–7.9)	5.2 (3.6–6.8)	5.1 (2.8–7.3)	7.3 (3.9–10.8)	6.1 (5.4–6.9)	0.3699
Age/BMI-adjusted	5.0 (3.4–6.7)	6.8 (5.0–8.7)	8.0 (6.1–9.8)	6.9 (5.5–8.3)	5.1 (3.5–6.8)	6.7 (4.3–9.0)	7.3 (4.0–10.5)	6.4 (5.6–7.1)	0.1956

Definition of abbreviations: AHI = apnea-hypopnea index; BMI = body mass index.

*Age- or age/BMI-adjusted weighted mean and 95% confidence interval. Adjusted to mean age (41.1 yr) and mean BMI (29.3).

†Global test (6 df) testing all seven Hispanic/Latino background prevalences equal. Prevalences with the same letter are not significantly different after adjusting for multiple comparisons with Tukey-Kramer's method.

Table 5: Age-adjusted Prevalence Rates (95% Confidence Interval) for Sleep-disordered Breathing Symptoms and Sleep Duration by Hispanic/Latino Background, for Women

	Dominican (n = 840)	Central American (n = 905)	Cuban (n = 1,011)	Mexican (n = 3,807)	Puerto Rican (n = 1,348)	South American (n = 550)	Mixed or Other (n = 232)	Overall (n = 8,693)	P Value*
Snoring, %									
0-2 nights a week	38.6 (34.0-43.2)	36.6 (32.4-40.9)	38.9 (35.6-42.2)	41.0 (38.4-43.7)	33.7 (30.0-37.4)	40.6 (35.5-45.7)	37.9 (28.1-47.8)	38.8 (37.2-40.4)	0.1699
3-7 nights a week	30.8 (26.8-34.8)	30.6 (26.9-34.3)	31.9 (28.8-34.9)	30.5 (28.3-32.7)	30.8 (26.8-34.7)	33.8 (29.2-38.5)	33.1 (22.4-43.8)	31.1 (29.8-32.5)	
Don't know	30.6 (25.6-35.6)	32.7 (29.0-36.5)	29.2 (25.7-32.8)	28.4 (26.1-30.8)	35.6 (30.8-40.3)	25.6 (20.2-31.0)	29.0 (19.6-38.3)	30.1 (28.5-31.6)	
Stop breathing, %									
0-2 nights a week	48.4 (42.2-54.7)	63.1 (58.8-67.4)	67.6 (64.1-71.1)	49.4 (47.1-51.8)	46.5 (42.0-50.9)	60.1 (54.1-66.2)	53.5 (42.5-64.4)	53.6 (51.7-55.4)	<0.0001
3-7 nights a week	7.0 (5.0-9.1)	6.9 (4.7-9.1)	5.6 (4.1-7.1)	3.9 (3.1-4.6)	7.9 (5.8-10.0)	4.4 (2.5-6.4)	4.7 (1.7-7.6)	5.4 (4.7-6.0)	
Don't know	44.5 (38.4-50.6)	30.0 (25.6-34.3)	26.8 (23.7-29.9)	46.7 (44.2-49.2)	45.6 (41.0-50.1)	35.4 (29.3-41.6)	41.9 (31.6-52.2)	41.1 (39.2-43.0)	
ESS	5.4 (4.9-5.8)	5.4 (5.0-5.9)	4.4 (4.1-4.7)	5.9 (5.7-6.1)	5.9 (5.6-6.3)	6.3 (5.7-6.9)	5.7 (5.0-6.4)	5.6 (5.4-5.7)	<0.0001
Excessive sleepiness (ESS ≥ 10), %	18.6 (14.8-22.3)	18.5 (15.0-22.1)	12.0 (9.5-14.5)	20.3 (18.3-22.3)	18.9 (15.2-22.6)	22.0 (17.2-26.9)	20.3 (13.6-27.1)	18.5 (17.3-19.6)	<0.0001
Sleep duration, h/d									
Weekday	8.0 (7.8-8.1)	7.8 (7.7-8.0)	8.1 (8.0-8.3)	8.0 (7.9-8.0)	7.7 (7.5-7.9)	7.7 (7.5-7.9)	7.8 (7.5-8.1)	7.9 (7.9-8.0)	0.0003
Weekend	8.4 (8.3-8.6)	8.5 (8.3-8.6)	8.7 (8.6-8.8)	8.6 (8.5-8.7)	8.2 (8.0-8.4)	8.5 (8.3-8.7)	8.4 (8.1-8.7)	8.5 (8.5-8.6)	0.0002
Average	8.1 (8.0-8.2)	8.0 (7.9-8.1)	8.3 (8.2-8.4)	8.2 (8.1-8.2)	7.8 (7.7-8.0)	7.9 (7.8-8.1)	8.0 (7.7-8.2)	8.1 (8.0-8.1)	<0.0001

Definition of abbreviation: ESS = Epworth Sleepiness Scale.

Adjusted to mean sample age of 41.1 yr.

*P value from the global test for the null hypothesis that all backgrounds have the same prevalence (i.e., a 6 df test because there are seven Hispanic/Latino backgrounds) and when significant ($P < 0.05$) pairwise comparisons were performed adjusting for multiple comparisons using Tukey-Kramer method.

Significant pairwise comparisons for snoring are not conducted.

Significant pairwise comparisons for "stop breathing" are Dominican vs. Central American, Cuban, and Mexican; Mexican vs. Dominican, Central American, Cuban, and Puerto Rican; Cuban vs. Puerto Rican; and Puerto Rican vs. Central American and South American.

Significant pairwise comparisons for ESS score are Cuban vs. all other six backgrounds.

Significant pairwise comparisons for excessive sleepiness (ESS ≥ 10) are Cuban vs. Mexican, South American, and Puerto Rican.

Significant pairwise comparisons for weekday sleep duration are Cuban vs. Puerto Rican and South American.

Significant pairwise comparisons for weekend sleep duration are Puerto Rican vs. Cuban and Mexican.

Significant pairwise comparisons for average sleep duration are Cuban vs. Puerto Rican and South American.

was observed. Although the number of individuals older than age 70 was limited, there seems to be a plateau of SDB prevalence after age 69 years, similar

to what has been described in other populations (1). Overweight and obesity were also strong risk factors for SDB in HCHS/SOL, associated

with an approximately fivefold and 17-fold increased adjusted odds of SDB, respectively. Two prior cohort studies have estimated that each standard deviation in

Table 6: Age-adjusted Prevalence Rates (95% Confidence Interval) for Sleep-disordered Breathing Symptoms and Sleep Duration by Hispanic/Latino Background, for Men

	Dominican (n = 448)	Central American (n = 588)	Cuban (n = 897)	Mexican (n = 2,297)	Puerto Rican (n = 943)	South American (n = 390)	Mixed or Other (n = 184)	Overall (n = 5,747)	P Value*
Snoring, %									
0-2 nights a week	37.8 (31.8-43.7)	33.1 (27.8-38.4)	33.5 (29.2-37.8)	35.0 (32.0-38.0)	37.9 (32.8-43.0)	32.3 (26.7-37.9)	36.8 (26.3-47.3)	35.0 (33.2-36.8)	0.1568
3-7 nights a week	38.3 (32.6-43.9)	36.7 (31.6-41.8)	40.9 (37.2-44.7)	41.9 (38.9-44.8)	35.1 (30.6-39.6)	44.0 (38.0-49.9)	36.2 (26.0-46.4)	39.9 (38.1-41.6)	
Don't know	24.0 (18.7-29.2)	30.2 (25.6-34.8)	25.6 (22.2-29.0)	23.2 (20.8-25.6)	27.0 (22.7-31.2)	23.7 (17.9-29.6)	27.0 (18.4-35.7)	25.1 (23.5-26.7)	
Stop breathing, %									
0-2 nights a week	50.2 (44.0-56.3)	63.3 (58.1-68.5)	65.5 (61.2-69.7)	51.2 (48.5-53.9)	48.6 (43.9-53.3)	55.7 (49.4-62.0)	56.4 (46.7-66.0)	55.0 (53.2-56.8)	0.0198
3-7 nights a week	6.8 (4.9-8.7)	7.2 (5.0-9.3)	10.0 (7.7-12.2)	6.5 (5.2-7.8)	9.2 (7.0-11.5)	4.2 (1.4-7.0)	6.6 (3.1-10.0)	7.6 (6.7-8.5)	
Don't know	43.0 (37.0-49.1)	29.5 (24.6-34.5)	24.6 (20.1-29.0)	42.3 (39.7-45.0)	42.2 (37.7-46.7)	40.1 (33.9-46.4)	37.1 (27.4-46.7)	37.4 (35.6-39.3)	
ESS	5.7 (5.1-6.2)	5.3 (4.8-5.8)	4.9 (4.5-5.3)	5.7 (5.4-6.0)	6.4 (5.9-6.8)	6.3 (5.7-6.8)	6.4 (5.1-7.6)	5.6 (5.5-5.8)	<0.0001
Excessive sleepiness (ESS ≥ 10), %	18.3 (13.9-22.7)	17.0 (13.0-21.1)	14.6 (11.7-17.6)	17.3 (15.1-19.5)	23.7 (19.2-28.2)	22.1 (16.6-27.6)	22.1 (11.6-32.6)	18.2 (16.7-19.6)	0.0363
Sleep duration, h/d									
Weekday	7.5 (7.3-7.8)	7.7 (7.5-7.8)	7.8 (7.7-7.9)	7.8 (7.7-7.8)	7.7 (7.5-7.9)	7.5 (7.3-7.7)	7.9 (7.6-8.2)	7.7 (7.7-7.8)	0.0154
Weekend	8.3 (8.0-8.5)	8.4 (8.2-8.6)	8.3 (8.2-8.4)	8.3 (8.2-8.5)	8.2 (8.0-8.4)	7.9 (7.7-8.2)	7.8 (7.4-8.1)	8.3 (8.2-8.3)	0.0013
Average	7.8 (7.6-7.9)	7.9 (7.7-8.0)	8.0 (7.9-8.1)	7.9 (7.9-8.0)	7.9 (7.7-8.0)	7.6 (7.5-7.8)	7.8 (7.5-8.1)	7.9 (7.8-7.9)	0.0229

Definition of abbreviation: ESS = Epworth Sleepiness Scale.

Adjusted to mean sample age of 41.1 yr.

*P value from the global test for the null hypothesis that all backgrounds have the same prevalence (i.e., a 6 df test because there are seven Hispanic/Latino backgrounds) and when significant ($P < 0.05$) pairwise comparisons were performed adjusting for multiple comparisons using Tukey-Kramer method.

Significant pairwise comparisons for snoring are not conducted.

Significant pairwise comparisons for "stop breathing" are Cuban vs. Mexican, Puerto Rican, and Dominican; Dominican vs. Central American; and Central American vs. Puerto Rican.

Significant pairwise comparisons for ESS score are: Cuban vs. South American and Mexican; and Puerto Rican vs. Central American.

Significant pairwise comparisons for excessive sleepiness (ESS ≥ 10) are: Puerto Rican vs. Cuban.

Significant pairwise comparisons for weekday sleep duration are: Cuban vs. South American.

Significant pairwise comparisons for weekend sleep duration are: South American vs. Central American, Mexican, and Cuban; and Mexican vs. more than one/other.

Significant pairwise comparisons for average sleep duration are: South American vs. Cuban and Mexican.

Table 7: AOR (95% CI) of Demographic Factors, Acculturation, and Symptoms with Sleep-disordered Breathing (AHI3 \geq 15)

	Crude OR (95% CI)	Adjusted OR (95% CI)
Sex*		
Female	1	1
Male	2.32 (1.98–2.71)	2.69 (2.30–3.14)
Age group, yr*		
18–29	1	1
30–39	2.63 (1.69–4.08)	2.68 (1.70–4.22)
40–49	5.03 (3.39–7.48)	5.07 (3.33–7.73)
50–59	8.81 (5.90–13.15)	9.63 (6.28–14.77)
60+	15.56 (10.29–23.51)	16.96 (10.93–26.29)
BMI group*		
Underweight and normal (BMI < 25)	1	1
Overweight (BMI 25 to <30)	5.98 (4.09–8.74)	4.55 (3.07–6.73)
Obese (BMI \geq 30)	16.76 (11.76–23.90)	16.84 (11.64–24.38)
Language preference*		
Spanish	1	1
English	0.69 (0.53–0.88)	1.15 (0.87–1.52)
Immigration generation		
First generation	1	1
Second generation	0.6 (0.5–0.7)	1.0 (0.8–1.3)
Habitual snoring*		
0–2 nights a week	1	1
3–7 nights a week	5.43 (4.35–6.78)	3.88 (3.05–4.92)
Don't know	1.40 (1.07–1.83)	1.16 (0.88–1.52)
Stop breathing*		
0–2 nights a week	1	1
3–7 nights a week	5.10 (4.08–6.39)	3.86 (3.00–4.96)
Don't know	1.70 (1.44–1.99)	1.60 (1.34–1.91)
Sleepiness (ESS \geq 10) by Hispanic/Latino background†		
Dominican	0.63 (0.35–1.12)	0.57 (0.31–1.05)
Central American	2.23 (1.39–3.57)	2.00 (1.16–3.44)
Cuban	2.33 (1.59–3.41)	2.23 (1.52–3.28)
Mexican	1.27 (0.97–1.66)	1.27 (0.94–1.71)
Puerto Rican	1.32 (0.81–2.15)	1.16 (0.69–1.95)
South American	1.49 (0.82–2.69)	1.41 (0.75–2.64)
More than one/other	1.35 (0.53–3.40)	1.23 (0.47–3.18)

Definition of abbreviations: AHI = apnea-hypopnea index; AOR = adjusted odds ratio; BMI = body mass index; CI = confidence interval; ESS = Epworth Sleepiness Scale; OR = odds ratio.

*AOR from a logistic regression model for AHI3 \geq 15 and each risk factor assessed individually, adjusted for age, sex, Hispanic/Latino background, education, marital status, and site, not including the variable being modeled.

†Interaction between sleepiness and Hispanic/Latino background was significant.

BMI is associated with an approximately 50% increased odds of SDB (33, 34). The high prevalence of obesity in the HCHS/SOL and its strong association with SDB underscores the importance of efforts to achieve healthy weight in this population.

Only 1.3% of study participants reported a physician diagnosis of sleep apnea. The high prevalence of SDB and low prevalence of diagnosed sleep apnea suggests a large burden of disease may be attributed to untreated SDB in this population.

Habitual snoring and “stop breathing” are SDB symptoms that often are used in statistical prediction equations and

in clinical settings to enhance SDB identification (35). The association between these symptoms and SDB in the U.S. Latino population is similar to prior studies (36, 37), supporting their relevance as markers of SDB risk across ethnic backgrounds. Of note, 80% of the participants in HCHS/SOL completed questionnaires in Spanish, supporting the feasibility of assessing SDB symptoms with translated questionnaires.

Prior research has not specifically addressed variation in sleep across different Hispanic groups. As described before (9), CVD risk factors vary across U.S. Hispanic groups, with Puerto Ricans having the highest risk factor burden. In the current

analyses, variation in SDB symptoms and SDB also was observed across background groups. Among women, Puerto Ricans, who also had the highest prevalence of obesity, had the highest prevalence of moderate-severe SDB, SAS, and “stopped breathing.” In contrast, in men, moderately severe SDB was most prevalent among Cuban and least prevalent among South American and Puerto Rican backgrounds. Similar patterns were seen in analyses adjusted for BMI. The fact that sex-specific analysis showed that Puerto Rican women have the highest SDB prevalence while Puerto Rican men have the lowest prevalence indicates a need to examine biologic and environmental risk factors that may influence men and women differently. Furthermore, the high age and BMI-adjusted prevalence of SDB among men of Cuban background requires further study.

Sleepiness was least prevalent among women and men of Cuban background, who also reported the longest sleep duration. In contrast, individuals of South American background reported shorter sleep durations and higher levels of sleepiness. These contrasts underscore background differences in sleep patterns, which may contribute to health differences across groups. Significant differences in the association between sleepiness and SDB also were observed across background groups, with stronger associations observed among individuals of Central American and Cuban backgrounds. These differences, however, were not explained by differences in sleep duration, suggesting that sociocultural factors may influence perceptions of sleepiness. Alternatively, sleepiness may be influenced by such factors as visceral obesity, genetic susceptibility, and other factors that might vary across groups (38).

SDB has been associated with hypertension and diabetes (39–43). Mechanisms include intermittent hypoxemia and altered autonomic nervous system activity, causing surges in blood pressure, endothelial damage, and insulin resistance (44–46). However, associations of SDB with hypertension and diabetes have not been specifically addressed among U.S. Hispanics, who have been shown to experience a high burden of these chronic conditions (9). In HCHS/SOL we identified associations between SDB and hypertension, and glucose impairment and diabetes, which remained significant after

Table 8: Association (AOR, 95% CI) Between Sleep Apnea (AHI3 \geq 15) and Hypertension or Diabetes

	Adjusted* AOR (95% CI)	BMI Adjusted† AOR (95% CI)	BMI and Waist Circumference Adjusted‡ AOR (95% CI)
Hypertension [§]	2.1 (1.7–2.5)	1.4 (1.2–1.7)	1.4 (1.2–1.7)
Diabetes			
Normal glucose regulation	1	1	1
Impaired glucose tolerance	2.3 (1.8–2.9)	1.7 (1.3–2.1)	1.5 (1.2–1.9)
Diabetes	3.6 (2.8–4.5)	2.3 (1.8–2.9)	1.9 (1.5–2.4)

Definition of abbreviations: AHI = apnea-hypopnea index; AOR = adjusted odds ratio; BMI = body mass index; CI = confidence interval.

*AOR from a logistic regression model for hypertension or diabetes and AHI3 \geq 15 adjusted for age, sex, Hispanic/Latino background, education, marital status, cigarette use, alcohol use, and site.

†Adjusted for BMI too.

‡Adjusted for BMI and waist circumference too.

§Interaction between AHI3 \geq 15 and Hispanic/Latino background was significant (see Table E2).

adjusting for BMI and waist circumference. Although the overall strength of these associations was similar to estimates from studies of non-Hispanic white populations (39, 47), there was evidence of variation in the association between SDB and hypertension by background, with stronger associations observed in Puerto Ricans and individuals of Central American background. Although this may reflect chance findings, they suggest the possibility of background-specific susceptibility to SDB exposures.

Study strengths include the large sample and representative sampling frame, inclusion of diverse Hispanic/Latino groups, strict quality control procedures, and use of standardized measurements, including objective measurements of SDB. Questionnaires were chosen based on

published validity studies and available in Spanish and English. Sleep data were scored blinded to the clinical status of participants by a central reading center with high scorer reliability. The study also had several limitations, including the limited number of signals available for SDB assessment, precluding evaluation of arousal, sleep architecture, and central sleep apnea. Night-to-night variability also may cause some misclassification. This analysis is based on cross-sectional data, limiting causal inferences. Because multiple comparisons were conducted, some findings may have been observed by chance. However, the consistency in distributions of SDB severity and symptoms across background groups and sex provide corroboratory information on the background differences identified.

Conclusions

The results of this large study provide evidence of a high prevalence of symptoms and objectively measured SDB in seven U.S. Latino groups. Although overall prevalence rates seem comparable with those estimated in the general U.S. population, the very low prevalence of clinically recognized sleep apnea suggests disparities in the recognition and management of SDB in the U.S. Hispanic population. Furthermore, the association of SDB with hypertension and diabetes supports the potential importance of SDB as a target for CVD reduction and a need for further development of culturally relevant detection and treatment approaches. The variation in the distributions of SDB prevalence and presenting symptoms, and variation in the strength of associations of SDB with sleepiness and hypertension, across background groups suggests that screening approaches for SDB may need to be modulated for use across diverse samples and suggests opportunities to further evaluate sociocultural and biologic risk factors that modify the presentation, severity, and comorbidity of SDB. ■

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