Social and Health Correlates of Sleep Duration in a US Hispanic Population: Results from the Hispanic Community Health Study/Study of Latinos

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Study Objectives: To define the prevalence of poor sleep patterns in the US Hispanic/Latino population, identify sociodemographic and psychosocial predictors of short and long sleep duration, and the association between sleep and cardiometabolic outcomes.
Design: Cross-sectional analysis.
Setting: Community-based study.
Participants: Adults age 18–74 y free of sleep disorders (n = 11,860) from the Hispanic Community Health Study/Study of Latinos baseline examination (2008–2011).
Interventions: N/A.
Measurements and Results: The mean self-reported sleep duration was 8.0 h per night with 18.6% sleeping less than 7 h and 20.1% sleeping more than 9 h in age- and sex-adjusted analyses. Short sleep was most common in individuals of Puerto Rican heritage (25.6%) and the Other Hispanic group (27.4%). Full-time employment, low level of education, and depressive symptoms were independent predictors of short sleep, whereas unemployment, low household income, low level of education, and being born in the mainland US were independent predictors of long sleep. After accounting for sociodemographic differences, short sleep remained significantly associated with obesity with an odds ratio of 1.29 [95% confidence interval 1.12–1.49] but not with diabetes, hypertension, or heart disease. In contrast, long sleep was not associated with any of these conditions.
Conclusions: Sleep duration is highly variable among US Hispanic/Latinos, varying by Hispanic/Latino heritage as well as socioeconomic status. These differences may have health consequences given associations between sleep duration and cardiometabolic disease, particularly obesity.
Keywords: disparities, epidemiology, Hispanic, sleep
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INTRODUCTION

An increasing body of literature implicates chronic sleep restriction as a prevalent risk factor for poor health outcomes including obesity, diabetes, cardiovascular disease and mortality.[1–4] Habitual long sleep duration may be an even stronger predictor of adverse health outcomes.[5] Most of this literature has come from developed nations and within the United States, with the focus predominantly on non-Hispanic whites and to a lesser extent, African Americans. The Hispanic/Latino population now represents the largest minority group in the United States,[6] but identification of risk factors for poor health in this population, in particular the role of sleep habits, has received relatively little attention. This is an important goal because Hispanic/Latinos are at elevated risk for such potential health consequences of impaired sleep as obesity, diabetes, and hypertension.[7] In addition, studies suggest important social factors such as acculturation may play a role in the adoption of unhealthy sleep habits among US Hispanic/Latinos.[8,9]

Prior studies on the prevalence and role of both short and long sleep durations on the health of Hispanics in the United States have been limited by relatively small samples and by underrepresentation of the full diversity of Hispanic/Latino groups living in the United States. Nevertheless, the existing literature does suggest that Hispanic/Latinos may be at risk for both short and long habitual sleep durations with heterogeneity in risk between Mexican and other Hispanic/Latino groups.[10]

Baseline data from the Hispanic Community Health Study/ Study of Latinos (HCHS/SOL) were analyzed to estimate the prevalence of short and long sleep durations, to explore variation by Hispanic/Latino heritage, to describe sociodemographic and psychosocial risk factors for each sleep pattern, and to describe the association between sleep duration and cardiometabolic disease.

METHODS

Sample

The HCHS/SOL is a community-based cohort study of 16,415 self-identified Hispanic/Latino persons 18–74 y old recruited from randomly selected households in four major metropolitan areas (Bronx, NY; Chicago, IL; Miami, FL; and San Diego, CA). The stratified two-stage area probability sample design and cohort selection procedures have been previously described.[11,12] Briefly, participants were recruited from

2008–2011 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 heritage. Oversampling at both stages of sample selection was used to increase the likelihood that a selected address yielded an eligible participant, and the study oversampled adults aged 45–74 y (n = 9,714, 59.2%) to facilitate examination of target outcomes. 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, reading center, and coordinating center. All participants provided written informed consent.

Protocol and Measurements

The baseline examination included questionnaires administered in Spanish or English based on the participant's language preference, anthropometry, a fasting blood draw, an oral glucose tolerance test, review of all medications, and other measurements as detailed previously.[11] Medical examination procedures included measurement of height, weight, and blood pressure. Laboratory testing included measurement of fasting glucose and hemoglobin A1c (HbA1c) levels. Blood was sampled 2 h following the oral glucose load and assayed for glucose. Questionnaires included inquiries into level of education, household income, employment status, health insurance status, and years lived in the United States mainland. In addition, the 10-item version of the Center for Epidemiological Studies – Depression (CES-D10) questionnaire was used to assess depressive symptoms,[13,14] and the 10-item trait subscale of the Spielberger State-Trait Anxiety Inventory (STAI-Trait) was used to assess anxiety symptoms.[15]

Sleep Measures

Sleep history and symptoms were assessed using a questionnaire that included items from the Sleep Heart Health Study Sleep Habits Questionnaire[16] and the Epworth Sleepiness Scale (ESS).[17] Spanish translation of this questionnaire was certified by a professional service (RTI International, Research Triangle Park, NC) using culturally sensitive translation to ensure the use of language that could be interpreted correctly by all Hispanic/Latino backgrounds in the HCHS/SOL cohort. To ensure reliability and validity, one way translation, back-translation, and double translation methods were used. Focus groups in each field center were then conducted to evaluate the accuracy of questions that were translated from English into Spanish, including individuals of different ages, acculturation levels (i.e., first-, second-, and third-generation (or higher) residents) and heritage groups (i.e., Cuban, Dominican, Mexican, etc.). Excessive daytime sleepiness was defined as an ESS ≥ 10.[18] Weekday and weekend sleep durations were defined as the difference between habitual wake time and bedtime. Average sleep duration was computed as the weighted average of weekday and weekend sleep (5/7 weekday + 2/7 weekend). Average sleep duration was categorized into three levels: short sleep duration (< 7 h), intermediate sleep duration (7 to 9 h) and long duration (> 9 h). The cutoffs for short and long sleep duration were selected based on distributional features of this population with a goal of identifying roughly the lowest and highest quintile of sleep duration. A sensitivity analysis was performed dividing the short sleep duration further into individuals sleeping < 6 h and individuals sleeping at least 6 h but less than 7 h.

Participants underwent limited channel sleep apnea monitoring at home using the ARES Unicorder 5.2 (B-Alert, Carlsbad, CA).[19] Use of this device and the process for centralized scoring in HCHS/SOL has been previously described.[20] Respiratory events, identified based on a 50% or greater reduction in airflow lasting 10 sec or more and associated with a 3% oxyhemoglobin desaturation, were used to compute the apnea-hypopnea index (AHI).

Cardiometabolic Measures

Hypertension was defined as a systolic blood pressure ≥ 140 mm Hg, diastolic blood pressure ≥ 90 mm Hg, or use of antihypertensive medication.[21] Obesity was defined as a body mass index (BMI) of 30 kg/m² or greater.[22] Diabetes mellitus was defined as a fasting plasma glucose ≥ 126 mg/dL, 2-h postload plasma glucose ≥ 200 mg/dL, HbA$_{1c}$ ≥ 6.5%, or use of antihyperglycemic medications.[23] Prevalent coronary heart disease was defined as a physician diagnosis of heart attack or history of coronary artery bypass surgery, balloon angioplasty, or stent placement in one or more coronary arteries based on self-report.[7]

Statistical Methods

All reported values (means and prevalence rates) were estimated for the target population, defined as all noninstitutionalized Hispanic/Latino adults age 18–74 y living in the four metropolitan areas. Estimates were weighted to account for disproportionate selection probabilities and to at least partially adjust for any bias effects due to differential nonresponse in the selected sample at the household and person levels (according to age, sex, and Hispanic/Latino heritage). All analyses also accounted for cluster sampling and stratification using complex survey procedures in SAS version 9.3 (Cary, NC) and SAS-callable SUDAAN version 10 (RTI International). Prevalence rates by heritage were estimated using complex survey linear models to produce design-based estimates adjusted internally for age and sex to account for differences across Hispanic/Latino heritage. Similarly, for continuous variables, age- and sex-adjusted means were estimated using survey linear regression. We statistically tested the null hypothesis that all heritages have the same mean or prevalence (i.e., a 6 degrees of freedom [df] test because there are seven Hispanic/Latino heritages); when significant, we performed pairwise comparisons and adjusted for multiple comparisons using Tukey-Kramer method (unplanned and unbalanced design).

The association between risk factors and sleep duration was assessed using survey multinomial logistic regression with sleep duration modeled as a three-level categorical variable. Each risk factor (Hispanic/Latino heritage, household income, level of education, employment status, home ownership, years in United States mainland, and depressive symptoms) was assessed separately and jointly adjusting for age, sex, and field center. Last, we included interactions of risk factors with Hispanic/Latino heritage to test for effect modification. Similarly, associations of sleep duration with obesity, hypertension, diabetes, and cardiovascular disease prevalence were assessed

Table 1—Demographic characteristics and cardiometabolic outcomes by sleep duration, Hispanic Community Health Study/Study of Latinos 2008–2011.

	Overall (n = 11,860)	Short Sleepers (< 7 h) (n = 2,343)	Intermediate Sleepers (7–9 h) (n = 7,263)	Long Sleepers (> 9 h) (n = 2,254)	P
Age (y)	40.4 (0.3)	41.8 (0.5)	41.1 (0.3)	37.2 (0.5)	< 0.0001
Male	43.8%	49.4%	43.6%	39.4%	< 0.0001
Employed	42.7%	49.4%	45.7%	27.4%	< 0.0001
Hours worked per week[a]	37.7 (0.3)	39.3 (0.5)	37.8 (0.3)	34.1 (0.8)	< 0.0001
US born	23.1%	25.0%	20.5%	29.2%	< 0.0001
Years lived in mainland US[b]	16.7 (0.4)	18.4 (0.6)	16.5 (0.4)	16.0 (0.5)	0.0019
Health insurance	50.6%	55.7%	48.6%	51.8%	0.0001
CES-D10 score	7.1 (0.1)	7.9 (0.3)	6.7 (0.1)	7.4 (0.2)	< 0.0001
STAI-Trait score	17.1 (0.1)	17.6 (0.2)	16.8 (0.1)	17.5 (0.2)	0.0003
BMI (kg/m^2)	28.9 (0.1)	29.7 (0.2)	28.8 (0.1)	28.5 (0.2)	< 0.0001
Obese	36.1%	41.9%	34.8%	34.4%	0.0002
Diabetes	13.4%	14.7%	12.9%	13.7%	0.1343
Hypertension	19.6%	22.0%	19.5%	17.6%	0.0076
Coronary Heart Disease	2.2%	2.6%	2.2%	2.0%	0.4531

Values provided are mean (standard error) or percentage. [a]Hours worked per week calculated only among individuals working either full- or part-time. [b]Years lived in mainland US calculated only among individuals not born in the mainland US. BMI, body mass index; CES-D10, Center for Epidemiological Studies–Depression 10 item scale; STAI-Trait, Spielberger State-Trait Anxiety Inventory 10 item trait scale.

using survey logistic regression with adjustment for previously mentioned covariates and tested for effect modification by daytime sleepiness and by Hispanic/Latino heritage.

We carefully assessed whether Hispanic/Latino heritage was confounded by field center because by design in HCHS/SOL they are highly collinear (individuals of Dominican heritage are predominantly in the Bronx, individuals of Cuban heritage in Miami, and the San Diego site mostly has individuals of Mexican heritage). Specifically, we tested the effect of field center (3 df) at a conservative significance level of 0.15 because some of the effect for field center could be absorbed by the estimates for heritage resulting in loss of power. Because field center was not significant in any model at this threshold, this was interpreted as no evidence that the effect of Hispanic/Latino heritage was confounded by field center. Thus, models assessing the effect of Hispanic/Latino heritage on sleep duration simply included field center as a covariate.

RESULTS

Of the 16,415 participants in the HCHS/SOL, 394 were excluded because they self-reported a physician diagnosis of a primary sleep disorder (sleep apnea or narcolepsy), 1,537 because they had moderate to severe sleep apnea (AHI ≥ 15 events/hr) on home sleep testing, 1,957 because they were night shift-workers, and 667 because they did not respond to questions on habitual sleep duration, yielding an analytic sample of 11,860.

Mean age was 40.4 y and 43.8% were men (Table 1). Overall, 18.6% reported less than 7 h for sleep per night (short sleepers), 61.3% reported 7–9 h for sleep per night (intermediate sleepers) and 20.1% reported more than 9 h for sleep per night (long sleepers). On average, long sleepers were 4 y younger than short and intermediate sleepers (P < 0.0001). In addition, the proportion of men decreased with increasing sleep category, falling from 49.4% in short sleepers to 39.4% in long sleepers.

Sleep and Hispanic/Latino Heritage

Table 2 displays sleep characteristics by Hispanic/Latino heritage adjusted for age and sex. Overall, habitual sleep durations averaged 7.9 h on weekdays and 8.4 h on weekends, for an overall mean of 8.0 h per night. Individuals of Cuban, Dominican, and Mexican heritage tended to sleep more whereas individuals of Puerto Rican and South American heritage as well as the Other Hispanic group (individuals of another, more than one or missing heritage) slept the least. Similarly, Cubans and Mexicans had the lowest prevalence of short sleep whereas Puerto Ricans and Other Hispanics had the highest prevalence. After further adjustment for field center, socioeconomic factors, years lived in the mainland United States, and depressive symptoms, differences in the prevalence of short sleep by Hispanic/Latino heritage remained (Table 3). Compared to Mexicans, the adjusted odds ratio (OR) for short sleep in Puerto Ricans was 1.6 (95% confidence interval [CI]: 1.2, 1.7) and in Other Hispanics was 2.1 (95% CI: 1.2, 3.5). In contrast, no differences were apparent across Hispanic/Latino heritages in long sleep risk.

Regarding sleepiness, the mean ESS score was lowest in individuals of Cuban heritage and greatest in individuals of South American heritage. Overall, 17.3% reported excessive daytime sleepiness but the prevalence varied widely by Hispanic/Latino heritage, ranging from 11.3% in Cubans up to 22.9% in South Americans after adjusting for age and sex.

Other Sociodemographic and Psychosocial Predictors

Among socioeconomic measures, employment status was the strongest predictor of long sleep. In adjusted analyses, retired individuals were more than three times more likely to be a long sleeper than individuals working full time (Table 3). The OR for unemployed individuals who were not retired was 2.4, and for part-time workers it was 1.6 as compared to full-time

Table 2—Age- and sex-adjusted sleep characteristics by Hispanic/Latino Heritage, Hispanic Community Health Study/Study of Latinos 2008–2011.

Sleep Characteristic	Overall (n = 11,860)	Cuban (n = 1,618)	Dominican (n = 1,077)	Mexican (n = 4,833)	Puerto Rican (n = 1,997)	Central American (n = 1,256)	South American (n = 715)	Mixed, Other, or Missing (n = 364)	P
Weekday bedtime, hh:mm (min)	23:06 (1.8)	23:18 (3.6)[ab]	23:18 (3.6)[a]	22:42 (1.8)[c]	23:24 (3.6)[a]	23:00 (4.2)[b]	23:12 (4.2)[ab]	23:36 (9.0)[a]	< 0.0001
Weekday wake time, hh:mm (min)	06:54 (1.8)	07:18 (3.6)[a]	07:12 (4.8)[a]	06:36 (2.4)[c]	07:12 (4.2)[a]	06:48 (4.8)[bc]	06:54 (5.4)[ab]	07:24 (10.2)[a]	< 0.0001
Weekend bedtime, hh:mm (min)	23:54 (1.8)	00:06 (4.8)[b]	00:12 (5.4)[ab]	23:24 (2.4)[c]	00:30 (4.8)[a]	23:54 (4.8)[b]	23:54 (5.4)[b]	00:42 (9.6)[a]	< 0.0001
Weekend wake time, hh:mm (min)	08:24 (1.8)	08:36 (4.2)[a]	08:42 (6.0)[a]	08:00 (3.0)[b]	08:42 (4.8)[a]	08:24 (4.8)[a]	08:18 (6.0)[a]	08:48 (10.8)[a]	< 0.0001
Weekday sleep duration, h	7.9 (0.02)	8.0 (0.05)[a]	7.9 (0.07)[abc]	7.9 (0.03)[ab]	7.8 (0.07)[bc]	7.8 (0.05)[abc]	7.7 (0.06)[c]	7.8 (0.19)[abc]	< 0.0001
Weekend sleep duration, h	8.4 (0.02)	8.5 (0.05)[a]	8.4 (0.07)[ab]	8.5 (0.04)[a]	8.2 (0.07)[b]	8.5 (0.07)[a]	8.4 (0.07)[ab]	8.2 (0.13)[b]	0.0006
Average sleep duration, h	8.0 (0.02)	8.2 (0.04)[a]	8.1 (0.06)[ab]	8.1 (0.03)[ab]	7.9 (0.06)[b]	8.0 (0.04)[b]	7.9 (0.06)[b]	7.9 (0.15)[b]	< 0.0001
Short sleeper (< 7 h), %	18.6 (0.5)	15.0 (1.1)[b]	20.6 (1.6)[ab]	15.7 (0.8)[b]	25.6 (1.6)[a]	18.9 (1.4)[ab]	20.2 (1.9)[ab]	27.4 (3.9)[a]	< 0.0001
Intermediate Sleeper (7–9 h), %	61.3 (0.7)	62.9 (1.6)	57.8 (2.1)	65.0 (1.1)	53.7 (1.8)	62.7 (1.8)	62.2 (2.4)	53.3 (4.0)	
Long Sleeper (> 9 h), %	20.1 (0.5)	22.0 (1.4)	21.6 (1.6)	19.3 (0.9)	20.7 (1.3)	18.4 (1.4)	17.6 (2.0)	19.3 (3.1)	
Epworth Sleepiness Scale score	5.4 (0.1)	4.3 (0.2)[c]	5.4 (0.2)[ab]	5.6 (0.1)[a]	6.0 (0.2)[a]	5.0 (0.2)[bc]	6.3 (0.3)[a]	5.5 (0.4)[ab]	< 0.0001
Excessive daytime sleepiness, %	17.3 (0.5)	11.3 (1.0)[d]	18.1 (1.8)[abc]	18.3 (0.7)[abc]	20.6 (1.6)[ab]	14.7 (1.3)[bcd]	22.9 (2.0)[a]	18.4 (2.8)[abcd]	< 0.0001

All values are age- and sex-adjusted weighted means or percentages with standard errors in parentheses adjusted to the overall mean age (40.4 y) and male percentage (43.8%). P values are for global test of heterogeneity. Means in the same row with different superscript letters are significantly different, P < 0.05 (analysis of covariance and Tukey-Kramer paired comparisons adjusting to the overall mean age and male percentage). For example, for weekday bedtime, all five groups with the subscript a (Cuban, Dominican, Puerto Rican, South American, and Other) are significantly different from each other in pairwise comparisons. Average sleep duration calculated as 5/7 * Weekday sleep duration + 2/7 * Weekend sleep duration. Excessive Daytime Sleepiness defined as Epworth Sleepiness Scale score ≥ 10.

workers. Conversely, both retired (OR = 0.7) and unemployed but not retired (OR = 0.7) individuals were less likely to be short sleepers. Among participants who were employed, an inverse relationship was found between time spent working and time spent sleeping. Short sleepers spent on average 39.3 h working per week while long sleepers spent only 34.1 h (P < 0.0001).

Long sleep was also associated with lower household income with an OR of 1.7 in individuals with a household income below $10,000 compared to individuals with a household income more than $75,000. In contrast, no significant association was identified between income and short sleep risk. In adjusted analyses, individuals with less than a high school education were at higher risk for being at both short and long extremes of sleep duration. In contrast, home ownership was not associated with either short or long sleep.

Sleep duration may also be impacted by years in the United States and immigrant status. Among participants who had immigrated to the mainland United States, short sleepers had lived an average of 18.4 y in the United States compared to 16.5 y for intermediate sleepers and 16.0 y for long sleepers (P = 0.002). In analyses adjusted for age, sex, and field center, Hispanic/Latinos who migrated to the mainland United States were less likely to be short sleepers than their US born counterparts. Compared to US-born Hispanic/Latinos, immigrants in the United States for less than 10 y were 30% less likely to be short sleepers and immigrants in the United States for 10 y or more were 22% less likely. After adjusting for socioeconomic differences, short sleep was no longer more common in immigrants. However, even after adjusting for socioeconomic differences, Hispanic/Latino immigrants were less likely to be long sleepers. Compared to US-born Hispanic/Latinos, immigrants in the United States for less than 10 y were 29% less likely to be long sleepers and immigrants in the United States for 10 y or more were 22% less likely to be long sleepers.

Health insurance was more common in those who were short or long sleepers but this association was no longer statistically significant after adjustment for age, sex, and field center. A U-shaped association was observed between sleep duration and mood such that intermediate duration sleepers had the lowest level of symptoms of both depression and anxiety (Table 1). In multivariable analyses, greater depressive symptoms remained significantly associated with short sleep.

Sleep and Cardiometabolic Outcomes

In terms of medical conditions, reduced sleep was associated with greater weight. An inverse relationship was found between sleep duration and adiposity with a mean BMI of 29.7 kg/m^2 in short sleepers, 28.8 kg/m^2 in intermediate sleepers, and 28.5 kg/m^2 in long sleepers (P < 0.0001). Similarly, the prevalence of obesity fell with increasing sleep duration in unadjusted analyses (Table 1). In multivariable models, short sleep was associated with a 29% increased odds of obesity relative to intermediate sleep whereas no effect was found for long sleep (Table 4). A dose response relationship was found such that the odds of obesity compared to intermediate (7–9 h) sleepers was 1.4 (95% CI [1.1–1.9]) in individuals with less than 6 h of sleep and 1.3 (95% CI [1.1–1.5]) in individuals sleeping 6 to 6.9 h. Short sleep overall was not associated with increased diabetes risk (Table 4). However, there was a trend for individuals sleeping the least (less than 6 h) to be at higher risk than intermediate sleepers (OR = 1.3, 95% CI [1.0–1.6]). In contrast, individuals sleeping 6 to 6.9 h were not different from intermediate sleepers (OR = 1.1, 95% CI [0.9–1.3]). Long sleep was associated with a 33% increased risk of diabetes in age, sex, field center, and Hispanic/Latino heritage-adjusted analyses but this relationship was no longer significant after additional adjustment for socioeconomic factors, years in mainland United States, and depressive symptoms. There was no evidence of heterogeneity in the effect of sleep duration on either obesity or diabetes based on sleep duration and Hispanic/Latino heritage interaction analyses (P = 0.10 for obesity and P = 0.19 for diabetes). In analyses stratified by the presence or absence of excessive daytime sleepiness, the association between short

Table 3—Predictors of sleep duration, Hispanic Community Health Study/Study of Latinos 2008–2011.

	Short Sleep (< 7 h)		Long Sleep (> 9 h)	
	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)
Heritage				
Cuban	1.02 (0.72, 1.45)	1.09 (0.75, 1.57)	0.98 (0.69, 1.40)	0.87 (0.60, 1.26)
Dominican	1.26 (0.89, 1.77)	1.38 (0.98, 1.96)	1.18 (0.83, 1.68)	1.18 (0.81, 1.72)
Mexican	Reference	Reference	Reference	Reference
Puerto Rican	1.72 (1.30, 2.27)	1.63 (1.22, 2.17)	1.21 (0.92, 1.59)	0.99 (0.73, 1.34)
Central American	1.22 (0.88, 1.69)	1.24 (0.89, 1.74)	0.86 (0.63, 1.19)	0.85 (0.61, 1.19)
South American	1.29 (0.92, 1.82)	1.38 (0.98, 1.95)	0.84 (0.59, 1.20)	0.93 (0.65, 1.35)
Other/More than one/Missing	2.03 (1.27, 3.26)	2.07 (1.24, 3.45)	1.12 (0.75, 1.67)	0.98 (0.63, 1.53)
Household Income				
Less than $10,000	1.02 (0.68, 1.52)	0.97 (0.64, 1.48)	2.40 (1.48, 3.92)	1.71 (1.00, 2.93)
$10,001–$20,000	0.77 (0.54, 1.12)	0.80 (0.55, 1.17)	1.82 (1.14, 2.91)	1.51 (0.90, 2.53)
$20,001–$40,000	0.84 (0.59, 1.20)	0.88 (0.62, 1.24)	1.32 (0.83, 2.10)	1.22 (0.74, 2.00)
$40,001–$75,000	0.86 (0.59, 1.26)	0.89 (0.62, 1.28)	1.17 (0.71, 1.94)	1.20 (0.71, 2.03)
More than $75,000	Reference	Reference	Reference	Reference
Missing	0.61 (0.41, 0.91)	0.66 (0.44, 0.99)	1.98 (1.21, 3.27)	1.45 (0.84, 2.48)
Level of Education				
< High school	1.23 (1.03, 1.46)	1.35 (1.11, 1.66)	1.45 (1.23, 1.71)	1.23 (1.03, 1.46)
High school graduate	0.95 (0.79, 1.14)	1.03 (0.85, 1.25)	1.26 (1.06, 1.51)	1.15 (0.96, 1.38)
> High school	Reference	Reference	Reference	Reference
Employed				
Retired and not currently employed	0.78 (0.58, 1.03)	0.68 (0.51, 0.90)	3.94 (2.84, 5.48)	3.34 (2.40, 4.66)
Not retired and not currently employed	0.84 (0.72, 0.98)	0.74 (0.62, 0.88)	2.77 (2.27, 3.39)	2.43 (1.96, 3.00)
Employed part-time (≤ 35 h/w)	0.88 (0.69, 1.13)	0.88 (0.69, 1.12)	1.70 (1.28, 2.26)	1.60 (1.20, 2.13)
Employed full-time (> 35 h/w)	Reference	Reference	Reference	Reference
Home ownership	0.99 (0.83, 1.18)	0.99 (0.81, 1.20)	0.87 (0.72, 1.04)	0.98 (0.81, 1.19)
Years lived in mainland US				
US born	Reference	Reference	Reference	Reference
Foreign born and ≥ 10 y in US	0.78 (0.64, 0.96)	0.84 (0.68, 1.03)	0.74 (0.61, 0.90)	0.78 (0.62, 0.99)
Foreign born and < 10 y in US	0.70 (0.56, 0.88)	0.82 (0.64, 1.04)	0.69 (0.56, 0.86)	0.71 (0.56, 0.90)
CES-D10 score (per 1 SD change)	1.21 (1.12, 1.30)	1.18 (1.10, 1.27)	1.12 (1.06, 1.18)	1.04 (0.98, 1.10)

The odds ratios displayed are per 1 standard deviation increase in CES-D10 score (5.16 units). Model 1 adjusted for age, sex, and field center. Model 2 adjusted for age, sex, field center, Hispanic/Latino heritage, household income, education, employment status, home ownership, years in mainland US, and depressive symptoms. CES-D10, Center for Epidemiological Studies–Depression 10 item scale; CI, confidence interval; SD, standard deviation.

Table 4—Sleep duration as a predictor of cardiometabolic outcomes.

	Short Sleep (< 7 h)		Long Sleep (> 9 h)	
Outcome	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)
Obesity	1.32 (1.14, 1.53)	1.28 (1.11, 1.49)	1.02 (0.88, 1.18)	0.98 (0.84, 1.14)
Diabetes	1.14 (0.96, 1.34)	1.13 (0.95, 1.35)	1.33 (1.09, 1.62)	1.19 (0.98, 1.45)
Hypertension	1.11 (0.92, 1.33)	1.12 (0.93, 1.34)	1.06 (0.89, 1.26)	1.05 (0.88, 1.25)
Coronary heart disease	0.96 (0.66, 1.38)	0.94 (0.64, 1.39)	1.08 (0.76, 1.53)	0.92 (0.63, 1.34)

Model 1 adjusted for age group, sex, field center and Hispanic/Latino heritage. Model 2 adjusted for age group, sex, field center, Hispanic/Latino heritage, household income, level of education, employment status, home ownership, years in mainland US, and depressive symptoms. CI, confidence interval.

sleep and obesity appeared weaker in individuals with excessive daytime sleepiness (OR = 1.1 versus 1.4), whereas the association between long sleep and diabetes appeared stronger in individuals with excessive daytime sleepiness (OR = 1.8 versus 1.3). However, formal tests for effect modification by daytime sleepiness were again not significant for either outcome.

Although the prevalence of hypertension decreased from 22.0% in short sleepers to 17.6% in long sleepers in unadjusted analyses, no clear relationship was identified in adjusted analyses (Table 4). In addition, no heterogeneity in the sleep and hypertension relationship was found by Hispanic/Latino heritage (P = 0.16). Overall, sleep duration was also not associated

with coronary heart disease. Sensitivity analyses showed no evidence for elevated risk of hypertension or coronary heart disease, even in individuals sleeping less than 6 h. However, evidence for effect modification of the sleep duration and coronary heart disease relationship by Hispanic/Latino heritage was identified (P < 0.05 for sleep duration and Hispanic/Latino heritage interaction) after adjusting for age, sex and field center. Long sleep was significantly associated with lower coronary heart disease risk compared to intermediate sleep duration in individuals of Central American heritage (OR = 0.1, 95% CI [0.0–0.8]) but with a higher risk in individuals of Cuban heritage (OR = 1.9, 95% CI [1.1–3.2]). In contrast, long sleep had no effect on Dominicans, Mexicans, Puerto Ricans, and South Americans.

DISCUSSION

This study of more than 11,000 individuals represents the largest evaluation of sleep in Hispanic/Latinos in the United States to date. Our findings suggest overall that Hispanic/Latinos in the United States have an average self-reported sleep duration of 8.0 h, but that duration varies by heritage and is greatest in general among Cubans, Dominicans, and Mexicans and least in Puerto Ricans, South Americans, and Other/Mixed Hispanic heritages. This finding likely reflects sociocultural constraints on sleep rather than intrinsic differences in sleep need because the groups with the highest prevalence of short sleep also had the highest prevalence of daytime sleepiness.

Prior research has suggested that individuals of Mexican heritage in the United States sleep longer than non-Mexican US Hispanic/Latinos, although no attempt was made to further classify the non-Mexican groups.[10,24] Our results suggest this contrast is true for US Hispanic/Latinos of Puerto Rican or South American heritage but not for individuals of Cuban, Dominican, or Central American heritage. After adjusting for socioeconomic differences, Puerto Ricans remain more likely to be short sleepers. The Study of Women's Health Across the Nation (SWAN) found among middle-aged women, Puerto Ricans had more sleep complaints than other Hispanic/Latino groups and this was related to more depressive and anxiety symptoms.[25] In our cohort, sleep duration was shorter in Puerto Ricans even after adjusting for psychological symptoms.

In terms of socioeconomic determinants of sleep duration, employment status appeared to be the most important predictor of both short and long sleep durations. Even among the employed, hours spent sleeping correlated inversely with hours spent working. The strong inverse association between time spent working and sleeping has been previously reported in large nationally representative cohorts of multiracial populations.[24,26] In the American Time Use Survey, work time and commuting time had the strongest reciprocal relationships with time spent sleeping.[26] Our results demonstrate that this relationship exists in a Hispanic/Latino population as well.

In contrast to our findings regarding employment status, low education level was associated with a greater risk for both short and long sleep duration. This is consistent with findings from the multiethnic Alameda County Health and Ways of Living Study where low educational level was associated with shorter sleep duration.[27] That study did not specifically examine the relationship between education and long sleep. However, data from the National Health Interview Survey (NHIS) support the contention that low levels of education are associated with both short and long sleep durations.[24] Again, our results extend previous findings to a Hispanic/Latino population.

Another socioeconomic association identified in this analysis was that individuals with the lowest household income (< $10,000/y) were most likely to be long sleepers. This level of household income may reflect a lack of employment by everyone in the household, which may provide greater opportunity to sleep later because not only is there no need to wake up early to get ready for work, there is no need to wake up early to help one's spouse or others in the home prepare for work either. Alternatively, low household income may create a state of hopelessness that leads to extended periods of time in bed. Given the strong associations between long sleep and comorbid health conditions, there is also the possibility that poorer health status leads to both lower income and long sleep. In NHIS, low household income was independently associated with both short sleep and long sleep.[24] In contrast, in the Coronary Artery Risk Development in Young Adults (CARDIA) study, which used actigraphy to assess sleep duration objectively, education status and household income were not independent predictors of sleep duration after accounting for employment status.[28] Of note, the CARDIA cohort does not include any Hispanic/Latino individuals.

Home ownership, a measure of wealth, was not found to be independently associated with sleep duration in our cohort. Work from a Latin-American slum demonstrates that providing a minimal quality of housing increases the sense of security sufficiently to improve sleep.[29] However, the quality of housing for the US Hispanic/Latino population participating in HCHS/SOL is likely above the minimum level needed to achieve this basic level of safety and security.

Previous studies of US Mexicans suggest sleep duration is reduced in individuals born in the United States versus those born in Mexico.[8,9] In the HCHS/SOL cohort, this same relationship was found in the US Hispanic/Latino population as a whole. Furthermore, among individuals born outside the United States, a longer duration of residence in the United States was associated with a greater likelihood of short sleep, strongly supporting an adverse effect of acculturation on sleep habits. Of note, the relationship between immigrant status and short sleep weakened after adjusting for socioeconomic factors, suggesting socioeconomic status may mediate some of this relationship. The effect of acculturation may also be related to increased levels of acculturative stress that adversely affect sleep, increased adoption of unhealthy habits such as use of tobacco or caffeine products that prevent sleep, or increased adoption of a belief system that undervalues sleep. In the SWAN cohort, insomnia symptoms were more common among Hispanic/Latina women with greater levels of acculturation supporting a greater role of stress or stimulant use as opposed to voluntary sleep restriction as an explanation for our findings.[30] A similar association has been noted in data from the National Health and Nutrition Examination Survey (NHANES).[9] Our results also suggest that Hispanics/Latinos born in the United States are at greater risk for long sleep. This also may be a reflection of greater insomnia symptoms in more acculturated populations with poor sleep quality resulting in increases in time spent trying to sleep.

In terms of health consequences of poor sleep habits, our cross-sectional data suggest that short sleep is independently associated with obesity in Hispanic/Latinos, increasing the odds of obesity 29% and even more so in the most extreme short sleepers. This association has been previously reported in US Mexicans participating in the Hispanic Health and Nutrition Examination Survey (HHANES), but only nonsignificant trends were observed among individuals of Cuban or Puerto Rican heritage.[31] In HCHS/SOL, we did not find any evidence of a difference in the effect of short sleep on obesity between Mexicans and other Hispanic/Latino heritages. Although no significant association between sleep duration and obesity was found in Hispanic/Latino heritages in an analysis of NHANES data, the number of Hispanic/Latinos in that study was limited and the effect size observed in our analysis was within the confidence intervals reported.[32]

In contrast to the robust relationship between short sleep and obesity, diabetes was not associated with either short or long sleep durations in adjusted analyses. Sensitivity analyses, however, suggested a trend may exist for an increased risk in the most extreme short sleepers – individuals sleeping less than 6 h. In contrast to these metabolic outcomes, neither hypertension nor coronary heart disease was independently associated with either extreme of sleep duration in HCHS/SOL. In NHANES, a sleep duration of 5–6 h compared to 7–8 h was associated with a protective effect on diabetes among non-Mexican Hispanic/Latinos but this effect was not observed in individuals sleeping less than 5 h.[32] In contrast, a sleep duration less than 5 h was associated with increased risk of hypertension in non-Mexican Hispanic/Latinos and no association between sleep duration and either diabetes or hypertension was observed among US Mexicans. In contrast to the NHANES findings, no evidence for heterogeneity in the relationship between sleep duration and diabetes or hypertension by Hispanic/Latino heritage was found in HCHS/SOL. However, differences were found in the association between sleep and heart disease risk with long sleep being protective among Central Americans, having no effect in Mexicans and being a risk factor in Cubans. The reasons for these differences are unclear. Further investigation is warranted using objective measures of sleep to verify these findings.

Mean duration of sleep was greater in this study than has been previously reported in other cohorts. This likely is due at least in part to differences in how questions about sleep duration were framed. By relying on the difference between habitual wake time and bedtime, our study may have overestimated sleep time by including sleep onset latency and wake after sleep onset. Nevertheless, previous studies using actigraphy suggest a strong correlation between time in bed and total sleep time.[33]

Prior cross-ethnic studies of sleep patterns have suggested that US Hispanic/Latinos are less likely to be chronically sleep deprived, which may contribute to the healthy immigrant effect observed among Hispanic/Latino immigrants.[27,34] However, over time it is clear that the prevalence of restricted sleep has grown among Hispanic/Latinos potentially increasing disparities in health outcomes.[27] The extent to which these longitudinal changes can be explained by acculturation effects is unclear and requires further investigation.

Strengths of this study include the large sample size and representative sampling of the underlying Hispanic/Latino population. In addition, we were able to exclude shift workers and individuals with sleep disorders such as sleep apnea and narcolepsy from the analysis. These groups have atypical sleep patterns that may reflect reverse causation (e.g., obesity-induced sleep apnea may lead to an association between obesity and extreme sleep durations). In addition, the accuracy of self-reporting of sleep habits has been shown to differ substantially from populations without sleep disorders leading to biases from differential measurement error.[35] Thus, the careful exclusion of individuals with sleep disorders may explain differences in findings from this cohort as opposed to prior studies.

Limitations of this study include the reliance on self-reported sleep duration, although this has been an issue with other population-based surveys as well. Other details about sleep habits such as regularity of sleep schedule and frequency of naps were not assessed. Although the overall cohort is large, the smaller sample sizes when stratified by Hispanic/Latino heritage may have affected power to assess effects within certain smaller groups. In addition, some of the cardiometabolic outcomes, particularly cardiovascular disease, were based on self-report. Some of the social determinants of sleep also relied on surrogate indices, resulting in inexact measurement. For example, acculturation is a complex and multidimensional process and our measure based on nativity and length of residence in the United States provides, at best, an inexact assessment. Similarly, access to health care was assessed solely based on health insurance status, neglecting other aspects such as access to transportation and ability to overcome language barriers. Disparities in these and other social determinants of health such as health literacy, discrimination, and neighborhood safety are known to exist among Hispanics/Latinos and potentially affect sleep.[36–39] As such, future studies with more detailed assessments of these social determinants and their effects on sleep are needed. The cross-sectional nature of the analysis does not allow inference of causality either in terms of causes of short or long sleep duration or the potential health consequences of these sleeping patterns. Finally, as with all observational studies, we cannot exclude the possibility of residual confounding due to unmeasured or poorly measured factors such as comorbid conditions.

Despite these limitations, this work represents an important advance in understanding sleep patterns in a representative US Hispanic/Latino population, identification of heritages such as Puerto Ricans at higher risk for short sleep, and a better definition of the potential health effects of short sleep in this population, in particular on obesity. Given that Hispanic/Latinos in the United States are at particularly high risk for obesity,[40] further research on strategies to improve sleep habits in high risk Hispanic/Latino populations may provide a novel strategy to improve this health disparity.

ACKNOWLEDGMENTS

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