

Prevalence and impact of sleep disorders and sleep habits in the United States

Saravanan Ram · Hazem Seirawan ·
Satish K. S. Kumar · Glenn T. Clark

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Abstract

Purpose Epidemiologic studies on sleep disorders in the USA have mostly focused on specific disorders in specific groups of individuals. Most studies on sleep habits and sleep-related difficulties have focused on children and adolescents. The authors describe the prevalence of the three common physician-diagnosed sleep disorders (insomnia, sleep apnea, and restless legs syndrome (RLS)) by age, gender, and race in the US population. In addition, the authors describe the sleep habits and sleep-related difficulties in carrying routine daily activities. The authors also investigate the impact of the sleep disorders on performing routine daily activities.

Methods Data from the 2005–2006 National Health and Nutrition Examination Survey for 6,139 individuals over the age of 16 was analyzed for sleep-related parameters.

Results The prevalence was highest for sleep apnea (4.2%), followed by insomnia (1.2%) and RLS (0.4%). Hispanics and Whites reported longer sleep duration than Blacks by 24 to 30 min. The predominant sleep habits were snoring while sleeping (48%), feeling unrested during the day (26.5%), and not getting enough sleep (26%). Difficulty concentrating (25%) or remembering (18%) were the main sleep-related difficulties in our sample. Insomnia, sleep apnea, and RLS had the highest impact on concentration and memory.

Conclusions Our findings suggest that the prevalence of sleep disorders in the USA is much lower than previously reported in the literature suggesting under diagnosis of sleep disorders by primary care physicians.

Keywords NHANES · Epidemiology · Sleep · Sleep apnea · Insomnia · Restless legs syndrome · Sleep habits

Introduction

Sleep disorders are common, and at least 10% of the population suffers from a sleep disorder that is clinically significant and of public health importance. Insomnia is the most common sleep disorder, followed by sleep apnea and then restless legs syndrome (RLS) [1]. Narrower definitions in terms of severity and frequency of insomnia have decreased the prevalence from 40% to 15–20% in the population [2]. In the USA, a large epidemiologic polysomnographic (PSG) study conducted in Madison, Wisconsin, found that 2% of women and 4% of men had sleep apnea, defined as an apnea-hypopnea index of 5 and daytime hypersomnolence [3]. The results from larger population-based studies on sleep apnea are close to these figures [4, 5]. The prevalence of RLS has been reported to be between 5% and 15% with higher prevalence among elderly [1].

Epidemiologic studies in the USA that provide data on ethnic differences in sleep have focused on sleep duration or other characteristics such as sleep latency (time required to fall asleep) and sleep efficiency (percentage of time in bed spent sleeping) [6–8]. Based on the National Health and Nutrition Examination Survey (NHANES) data from 1990 and 2005, researchers have assessed the racial differences in sleep duration in the USA. Blacks were

S. Ram (✉) · S. K. S. Kumar · G. T. Clark
Division of Diagnostic Sciences,
Orofacial Pain and Oral Medicine Center,
USC School of Dentistry,
925 West 34th Street,
Los Angeles, CA 90089-0641, USA
e-mail: saravanr@usc.edu

H. Seirawan
Division of Health Promotion, Disease Prevention,
and Epidemiology, USC School of Dentistry,
Los Angeles, USA

shown to be associated with more sleep problems than Whites. The Coronary Artery Risk Development in Young Adults (CARDIA) found that Blacks had lower mean sleep duration, lower sleep efficiency, and higher sleep latency than Whites [7]. To further understand sleep disorders, the ethnic differences that exist, and how they might change over time, additional epidemiologic studies are needed [1].

In 2005–2006, NHANES conducted its first survey specific for sleep disorders in the USA. In this paper, we analyzed the NHANES 2005–2006 data to describe sleep measurements, prevalence of three physician-diagnosed sleep disorders (insomnia, sleep apnea, and RLS), sleep habits, and sleep-related difficulties by age, gender, and race in the US population.

Materials and methods

NHANES is designed to evaluate the health and nutritional status of adults and children in the USA. One of the specific objectives of NHANES is to determine the prevalence and risk factors of major diseases. Further details of the NHANES program are available at the NHANES website at http://www.cdc.gov/nchs/about/major/nhanes/intro_mec.htm.

NHANES 2005–2006 sample, interview methods, and data

The NHANES sample is selected to represent the civilian, non-institutionalized US population of all ages. Informed consent was obtained from all participants according to the guidelines set forth in the Declaration of Helsinki. A special emphasis in NHANES 2005–2006 was on the health of adolescent (15–19 years) and older (60 years) Americans who were oversampled to enable accurate estimates for these groups. African-Americans, Mexican-Americans, and low-income persons were also oversampled for accurate estimates. The sample is a stratified multistage probability with the primary sampling units being counties or small groups of contiguous counties. Only subjects 16 years of age or older were eligible for an interview about sleep disorders. Generally, the interviews take place in the participants' homes and are conducted by trained interviewers. The details of the interview process are described in the NHANES website at http://www.cdc.gov/nchs/about/major/nhanes/intro_mec.htm.

NHANES 2005–2006 contains data for 10,348 individuals of all ages collected between January 2005 and December 2006 and is the first NHANES survey data with a complete questionnaire about physician-diagnosed sleep disorders. The sleep questionnaire and data are posted on the NHANES website (http://www.cdc.gov/nchs/about/major/nhanes/nhanes2005-2006/nhanes05_06.htm) and are

available to the public without prior permission. The data was downloaded from the NHANES website. The dependent variables were patient-reported: hours of sleep, time to sleep, sleep habits (11 indicators), sleep-related difficulties performing activities (eight indicators); and physician-diagnosed sleep disorders. These variables were analyzed by age, gender, and race. Age was used as a categorical variable. Mexican-Americans and other Hispanics were merged in one category as “Hispanics”. Races other than Caucasian, Black, and Hispanics were grouped as “Others”.

Statistical analysis

SAS software version 9.1.3 (SAS Institute, Inc., Cary, NC, USA) was used to conduct all statistical analyses. The analyses considered the complex design of the NHANES sample using a Taylor series approach to calculate the standard errors and adjust for the sample weights to reflect the unequal probabilities of selection, non-response adjustments, and adjustments to independent population controls [9]. Descriptive statistics, frequency tables, and univariate odds ratios (OR) with 95% confidence interval were generated. Chi-square tests and regression analyses were used.

Results

The NHANES 2005–2006 had 6,139 subjects who were at least 16 years old and responded to the sleep disorder interview. The sample had a mean age of 44.5 years; 48% were males; the sample was composed mainly of White subjects (71%). African-Americans (12%) and Hispanics (12%) were minority in the sample. The sociodemographic characteristics, sleep duration and latency measurements of the sample are presented in Table 1. The sleep duration was higher among younger and older adults compared to middle-aged adults. Females reported 12 min of extra daily sleep compared to males. Hispanics and Whites reported similar hours of daily sleep which were higher than that reported by Blacks by about 24 to 30 min (Table 1).

Prevalence of physician-diagnosed sleep disorders

The prevalence of physician-diagnosed sleep disorders (Table 2) was the highest for sleep apnea (4.2%) and the lowest for RLS (0.4%). Although the prevalence of self-reported, physician-diagnosed insomnia was 1.2% in the sample, 7% (SE=0.4) of the sample reported having trouble falling asleep, and 6.9% (SE=0.5) of the sample reported waking up at night and had difficulty going back to sleep (data not shown).

Table 1 Sociodemographic characteristics and sleep measurements in the NHANES sample

Characteristic	Percent (SE)	Sleep duration (daily hours of sleep; h)		Sleep latency (minutes needed to fall asleep; min)	
		Mean	SE	Mean	SE
Age ^a					
15–19	7.1 (0.4)	7.4	0.08	22.5	0.5
20–29	17.6 (0.8)	7.0	0.05	23.2	0.6
30–39	17.7 (1.0)	6.8*	0.06	20.6**	0.4
40–49	19.8 (1.1)	6.7	0.06	19.9	1.0
50–59	16.4 (0.8)	6.8	0.05	19.6	1.1
60–69	10.3 (0.6)	7.1	0.08	19.2	1.3
70–79	7.0 (0.8)	7.1	0.08	19.7	1.1
80+	4.0 (0.5)	7.4	0.1	22.0	1.2
Gender					
Male	48.3 (0.5)	6.8***	0.03	19.0***	0.5
Female	51.7 (0.5)	7.0	0.04	22.4	0.6
Race					
Black	11.8 (2.0)	6.5****	0.05	24.5****	0.7
Hispanic	11.6 (1.4)	6.9*****	0.06	21.7*****	0.7
Other	5.4 (0.6)	6.9	0.15	21.6	1.1
White	71.2 (2.8)	7.0	0.04	19.9	0.5
Total	100	6.9	0.03	20.7	0.4

* $p < 0.001$ mid-aged adults compared to younger or older adults

** $p < 0.01$ mid-aged adults compared to younger adults only

*** $p < 0.001$ compared to female

**** $p < 0.001$ compared to White

***** $p < 0.001$ compared to Black

***** $p < 0.01$ compared to Hispanic

^a Younger adults 15–39, mid-aged adults 40–59, older adults 60+

Sleep habits and sleep-related difficulties

Tables 3 and 4 describe the prevalence and OR of sleep habits and sleep-related difficulties by age, gender, and race. About half of the sample reported snoring at night (48%), and one tenth of the sample reported snoring, gasping, or stop breathing (11%). Both of the above parameters were for at least three nights a week. In general, good sleep characteristics were more likely to be reported among younger and older adults compared to middle-aged adults. For example, younger adults were less likely to report taking pills to help with sleep or waking up during the night with trouble getting back to sleep at least five times a month (OR, 0.3 and 0.7, respectively) compared to middle-aged adults; also, older adults were less likely to report leg jerks while trying to sleep and not getting enough sleep at least five times a month (OR, 0.6 and 0.5, respectively) compared to middle-aged adults. Differences were noticed by gender and ethnicity. Blacks and Hispanics were less likely to report taking pills to help with sleep at

least five times a month compared to Whites (OR, 0.6 and 0.4, respectively). In general, sleep-related difficulties were more likely to be reported among middle-aged adults compared to older adults, among females compared to males. Difficulty eating and difficulty on the phone in relation to sleep were more likely to be reported among Blacks compared to Whites (OR, 2.6 and 2.2, respectively).

Impact of sleep disorders on performing routine daily activities

Table 5 describes the impact of the three common sleep disorders on performing routine daily activities. Insomnia had the greatest impact on memory, 45% of those with insomnia reported having moderate or extreme difficulty remembering compared to 40% with RLS and 30% with sleep apnea. Prevalence of moderate or extreme difficulty performing any routine daily activities was the lowest among those with sleep apnea compared to the other two sleep disorders.

Table 2 Prevalence of physician-diagnosed sleep disorders by age, gender, and race in the NHANES sample

Characteristics	Sleep apnea		Insomnia		Restless legs syndrome		Other		
	Percent	SE	Percent	SE	Percent	SE	Percent	SE	
Age									
15–19	0.5	0.3	*	0.7	0.4	0.2	0.2	0.8	0.3
20–29	1.2	0.3		1.2	0.4	0.1	0.1	1.2	0.5
30–39	1.6	0.5		1.2	0.3			0.8	0.2
40–49	6.2	0.9		1.7	0.4	0.8	0.4	1.4	0.4
50–59	7.1	1.2		1.7	0.6	0.5	0.2	2.2	0.8
60–69	6.9	1.4		1	0.4	0.6	0.5	0.8	0.5
70–79	6.4	1.1		0.1	0.1	1	0.5	1.7	0.8
80+	3	1		0.6	0.4	0.8	0.4	0.2	0.2
Gender									
			**			***			
Male	5.7	0.6		0.7	0.2	0.3	0.1	1	0.2
Female	2.8	0.4		1.7	0.3	0.6	0.1	1.5	0.3
Race									
			**			*			
Black	3.4	0.5		1.5	0.5	0.4	0.2	0.4	0.2
Hispanic	1.7	0.6		1.8	0.5	0.1	0.1	1	0.3
Other	2.2	0.9		4.1	1.3	0.7	0.4	1.4	0.9
White	4.9	0.5		0.8	0.2	0.5	0.1	1.4	0.3
Total	4.2	0.3		1.2	0.2	0.4	0.1	1.3	0.2

p values are based on the Rao–Scott chi-square test

* $p \leq 0.001$; ** $0.001 < p \leq 0.01$; *** $0.01 < p \leq 0.05$

Discussion

We compared the NHANES data on sleep duration with three epidemiologic studies: (a) the CARDIA study ($n=669$; mean age/SD, 43.4/3.6; 58% female; 56% Whites, and 44% Blacks), (b) the 1990 National Health Interview Survey (NHIS; $n=32,749$; mean age, 43.2; 52% females; 79% Whites, 10% Blacks, and 4% Mexican-Americans), and (c) the National Sleep Foundation (NSF) 2005 Sleep in America Poll ($n=1,506$ telephone interviews; mean age, 49; 51% Females; 84% Whites and 16% minorities). The mean sleep duration in the CARDIA study measured using wrist actigraphy of 6.1 h was lower compared to NHANES data with reported sleep duration of 6.9 h [7]. Also, measured sleep duration among Blacks was lower in the CARDIA study compared to reported sleep duration in NHANES data (5.1–5.9 vs 6.5 h). This does not come as a surprise, as studies have clearly shown that self-reports of sleep duration were longer than actual measurements [10, 11]. Similar results were seen in the 1990 NHIS study where Blacks had higher odds for being short and long sleepers compared to Whites. The NHANES data showed that Non-Hispanic “others” and non-Mexican Hispanics also had increased odds of being short sleepers than Whites [8]. This is in contrast to the NHANES data where Hispanics and others had mean sleep duration similar to Whites. This

variation may be due to the different sampling populations and methodological differences between the two studies. The mean sleep duration was similar between the NHANES data and the 2005 NSF Sleep in America Poll data (6.9 h) [12]. The sleep latencies for both Blacks and Whites in the CARDIA study (28 m for Black women, 36 m for Black men, 13 m for White women, and 19 m for White men) were much higher than the NHANES data (25 m for Blacks and 20 m for Whites) [7]. Also, in the CARDIA study, females had lower sleep latency compared to males; whereas, in the NHANES study, the opposite was true.

Although insomnia is considered to be the most common sleep disorder [1], the NHANES data showed that self-reported sleep apnea (4.2%) was more prevalent in the USA than self-reported insomnia (1.2%) or self-reported RLS (0.4%). The NHANES questionnaire requires that the sleep disorder must be diagnosed by a doctor or other health professional. One of the primary findings from this data is that sleep disorders, as diagnosed by physicians, are still underdiagnosed when one considers the frequency of symptoms. In the case of obstructive sleep apnea (OSA), while 4.2% of the participants report having OSA, 48% report snoring and 11% report stop breathing at least 3 nights per week, 27% are unrested during the day, and 19% have excessive daytime sleepiness at least 5 times per month. In the case of insomnia, while 1.2% report having

Table 3 Prevalence of sleep habits and sleep-related difficulties performing routine daily activities by age, gender, and race

Sleep habits and sleep-related difficulties	Age (years)				Gender		Race			Total (%)	
	16–39	40–59	60+		Male	Female	White	Black	Hispanic		
Sleep habits (percentage of those with at least three nights/week)											
Snore while sleeping?	38.4	58.1	49.2	*	56.3	39.7	*	48.5	46.9	46.8	47.9
Snort, gasp, or stop breathing while asleep?	6.7	15.4	12.2	*	14.8	7.4	*	11.1	11.7	8.8	11
Sleep habits (percentage of those at least five times/month)											
Have trouble falling asleep?	15.3	16.9	15.4		12.5	19.1	*	16.4	15.3	13.4	15.9
Wake up during the night with trouble getting back to sleep?	15.8	22.3	23.3	*	15.8	23.5	*	21.3	17.8	13.7	* 19.8
Wake up too early in the morning, not able to get back to sleep?	14.2	19.2	18.9	*	15.4	18.5	**	17.7	15.9	14.7	17
Feel unrefreshed during the day regardless of hours of sleep?	30.2	26.5	19.1	*	21.9	30.8	*	28.3	23.7	17.1	* 26.5
Feel excessively or overly sleepy during the day?	19.1	19	16.1		15.6	21.1	**	19.1	18.3	13.6	*** 18.5
Not getting enough sleep?	29.2	27.8	16.9	*	24.2	27.9	***	26.2	26.3	22.3	26.1
Take sleeping pills or other medications to help with sleep?	3.8	11.5	13	*	5.2	11.7	*	9.7	5.8	3.8	* 8.6
Have leg jerks while trying to sleep?	4.5	7.9	5.1	**	4.9	6.8	***	6.2	3.9	5	5.9
Have leg cramps while trying to sleep?	3.5	6.5	8.3	*	4.3	6.9	***	5.9	4.4	5.1	5.6
Sleep-related difficulties (percentage of those with moderate or extreme difficulty)											
Difficulty concentrating?	26.1	26.9	18	*	21	28.1	*	24.5	25.7	20.8	** 24.7
Difficulty remembering?	18.9	20	13.6	**	15.5	20.7	**	17.1	21	18.8	** 18.2
Difficulty eating?	3.9	3.7	1.8	***	2.5	4.3	**	2.7	6.8	3	* 3.4
Difficulty with a hobby?	14.3	17.5	9.3	*	11.6	17.1	*	14.9	15.2	9.8	** 14.4
Difficulty getting things done?	12.6	14.4	7.5	*	10.4	14	**	11.6	16.7	9.6	* 12.2
Difficulty with finance?	15	15.1	5.9	*	12.6	13.7		13.1	14.6	9.7	** 13.2
Difficulty at work?	12.6	11.3	3.8	*	9.3	11.7		10.5	12.4	7.5	*** 10.5
Difficulty on the phone?	11.9	8.6	3.3	*	7.5	10.2	***	7.6	15.1	8.8	* 8.9

p values are based on the Rao–Scott chi-square test, * $p \leq 0.001$; ** $0.001 < p \leq 0.01$; *** $0.01 < p \leq 0.05$

this diagnosis, 16% has trouble falling asleep and 20% have trouble staying asleep at least five nights per month. This implies that sleep disorders are significantly underdiagnosed by physicians or patients fail to seek primary care for sleep disorders. A 1991 poll, for example, showed that only 5% of all insomnia sufferers surveyed saw their physicians specifically for their sleep problems; whereas, only 30% of all insomnia sufferers surveyed ever discussed their sleep problems with their doctors [13]. Unfortunately, health care providers confound this problem, as they often fail to question their patients sufficiently about their sleep habits [14, 15]. It has been estimated that 10–15% of all primary care patients suffer from chronic insomnia, and that up to 49% of all adults suffer sleep impairment of one form or another during their lifetime [2, 13, 16–19].

An international survey of insomnia reported the prevalence to be 27% in the USA [20]. PSG studies of a sample in Central Pennsylvania showed that the prevalence of insomnia was 7.5% [21]. Epidemiological findings

indicate that insomnia is more common in women, lower-status socioeconomic groups, the unemployed, the unmarried, and the elderly, occurring in 50% of individuals aged >65 years [22–24]. NHANES data showed that self-reported insomnia was more prevalent among females and in the ages between 40 to 59 years. Bixler et al. [21] found that chronic insomnia is more common among Non-White minorities while Riedel et al. [25] found that the reverse is true. Ancoli-Israel et al. [13] found no significant differences between Whites and Non-Whites with regard to insomnia. In the NHANES data, “Others” had the highest prevalence of self-reported insomnia (4.1%), followed by Hispanics (1.8%), Blacks (1.5%), and Whites (0.8%). Further studies are needed to clarify the data on the racial prevalence of insomnia.

The two major epidemiologic studies on OSA conducted in the USA were performed using PSG [3, 5]. The prevalence in these studies for men ranged from 3.9–4.0% and for women from 1.2–2%. This is slightly lower than our results where 5.7% of males and 2.8% of females

Table 4 Odds ratios of sleep habits and sleep-related difficulties performing routine daily activities by age, gender, and race

Sleep habits and sleep-related difficulties	Young vs mid-aged adults		Older vs mid-aged adults		Female vs males		Black vs White		Hispanic vs White	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sleep habits (those with at least three nights/week)										
Snore while sleeping?	0.4	0.4–0.5	0.7	0.6–0.8	0.5	0.5–0.6	0.9	0.8–1.1	0.9	0.8–1.1
Snort, gasp, or stop breathing while asleep?	0.4	0.3–0.5	0.8	0.6–1.0	0.5	0.3–0.6	1.1	0.8–1.4	0.8	0.6–1.1
Sleep habits (those at least five times/month)										
Have trouble falling asleep?	0.9	0.7–1.1	0.9	0.7–1.2	1.7	1.4–2.0	0.9	0.8–1.1	0.8	0.6–1.0
Wake up during the night with trouble getting back to sleep?	0.7	0.6–0.7	1.1	0.9–1.2	1.6	1.3–2.0	0.8	0.7–0.9	0.6	0.5–0.7
Wake up too early in the morning, not able to get back to sleep?	0.7	0.6–0.8	1.0	0.8–1.2	1.2	1.1–1.4	0.9	0.8–1.0	0.8	0.6–1.0
Feel unrested during the day regardless of hours of sleep?	1.2	1.0–1.4	0.7	0.5–0.8	1.6	1.4–1.8	0.8	0.7–0.9	0.5	0.4–0.6
Feel excessively or overly sleepy during the day?	1.0	0.8–1.3	0.8	0.6–1.1	1.4	1.2–1.8	0.9	0.8–1.2	0.7	0.5–0.9
Not getting enough sleep?	1.1	0.9–1.3	0.5	0.4–0.7	1.2	1.0–1.4	1.0	0.9–1.1	0.8	0.6–1.1
Take sleeping pills or other medications to help with sleep?	0.3	0.2–0.4	1.1	0.9–1.4	2.4	2.0–2.9	0.6	0.4–0.8	0.4	0.3–0.5
Have leg jerks while trying to sleep?	0.5	0.4–0.8	0.6	0.5–0.9	1.4	1.1–1.9	0.6	0.4–0.9	0.8	0.6–1.1
Have leg cramps while trying to sleep?	0.5	0.4–0.7	1.3	0.9–1.9	1.6	1.2–2.3	0.7	0.5–1.0	0.9	0.5–1.4
Sleep-related difficulties (those with moderate or extreme difficulty)										
Difficulty concentrating?	1.0	0.8–1.1	0.6	0.5–0.7	1.5	1.3–1.6	1.1	0.9–1.2	0.8	0.7–1.0
Difficulty remembering?	0.9	0.8–1.1	0.6	0.5–0.8	1.4	1.1–1.8	1.3	1.1–1.5	1.1	0.9–1.4
Difficulty eating?	1.1	0.8–1.4	0.5	0.3–0.9	1.7	1.2–2.5	2.6	1.7–4.1	1.1	0.7–1.8
Difficulty with a hobby?	0.8	0.6–1.0	0.5	0.4–0.6	1.6	1.3–1.9	1.0	0.8–1.3	0.6	0.5–0.8
Difficulty getting things done?	0.9	0.7–1.1	0.5	0.4–0.6	1.4	1.1–1.7	1.5	1.3–1.8	0.8	0.6–1.1
Difficulty with finance?	1.0	0.8–1.3	0.4	0.3–0.4	1.1	0.8–1.5	1.1	0.9–1.3	0.7	0.5–1.0
Difficulty at work?	1.1	0.9–1.4	0.3	0.2–0.5	1.3	1.0–1.6	1.2	0.9–1.5	0.7	0.5–0.9
Difficulty on the phone?	1.4	1.2–1.7	0.4	0.2–0.6	1.4	1.1–1.9	2.2	1.6–2.9	1.2	0.9–1.5

reported physician-diagnosed sleep apnea. The prevalence of sleep apnea may be increasing due to the rise in contributory co-morbid conditions such as obesity, diabetes, and hypertension [26–30]. In a probability sample from Pennsylvania, OSA prevalence was shown to progressively

Table 5 Impact of sleep disorders on performing routine daily activities

Sleep-related difficulties (those with moderate or extreme difficulty)	Sleep apnea (%)	Insomnia (%)	RLS (%)
Difficulty concentrating?	44.1*	56.0*	63.7*
Difficulty remembering?	29.5***	44.6*	39.9***
Difficulty eating?	4.9	13.9*	9.7***
Difficulty with a hobby?	25.1*	38.6*	45.4*
Difficulty getting things done?	21.6**	31.3*	31.5***
Difficulty with finance?	23.4**	44.2*	42.1**
Difficulty at work?	18.9**	33.5*	27.8
Difficulty on the phone?	14.1	29.3*	24.2

p values are based on the Rao–Scott chi-square test, **p*≤0.001; **0.001<*p*≤0.01; ***0.01<*p*≤0.05

increase with age [4, 5]. Data from the community-based Sleep Heart Health Study have shown that the prevalence of OSA increased steadily with age and reached a plateau after the age of 60 years [31]. The NHANES sample showed a peak in the prevalence among the 50–59 year-olds (7.1%), but among those at least 80 years old, the prevalence decreased to about 3%. Most epidemiologic studies on sleep apnea have focused on Blacks or Caucasians resulting in a paucity of data on Hispanics in the USA [32–34]. The NHANES data showed that physician-diagnosed sleep apnea was the least reported among Hispanics.

The exact prevalence of RLS is not known due to important methodological differences in epidemiologic studies. When only studies with validated criteria are taken into consideration, prevalence of RLS ranged from 0.1% to 12%, with women being twice as likely affected than men [35]. The NHANES data showed a prevalence of 0.4% with females (0.6%) being more commonly affected than males (0.3%). Participants in the age group of 70–79 years reported the highest prevalence of RLS (0.9%). This is in concordance with reports in the literature of increased prevalence of RLS in the elderly [35, 36].

There is a lack of data regarding sleep habits and sleep-related difficulties in the USA [37–41]. Most of published studies have focused on the effects of sleep on driving or sleep habits in children and adolescents. In our study, the predominant reported sleep habits were snoring while sleeping (48%), feeling unrested during the day (27%), and not getting enough sleep (26%). Only 20% of the sample reported waking up during the night with difficulty going back to sleep at least five times a month; in comparison, a population-based study found that 36% of US adults reported awakening at least three nights per week [42]. Difficulty concentrating (25%) or remembering (18%) were the main reported sleep-related difficulties in the NHANES sample. Insomnia, sleep apnea, and RLS had the highest impact on concentration and memory.

This study has several limitations. First, NHANES sample design excludes non-civilians and institutionalized individuals, and it is unclear to what extent the NHANES definitions for sleep disorders reflect Diagnostic and Statistical Manual-IV diagnostic criteria or American Academy of Sleep Medicine criteria. Second, the data was collected by personal interview without physical examinations or medical chart reviews, thus, the NHANES data may not be directly comparable to other studies. Third, some individuals with sleep disorders may not have been diagnosed by their primary care providers and, therefore, our reported prevalence of these disorders might be lower than the actual prevalence. Fourth, smaller ethnic groups could not be analyzed separately as they were clumped by the NHANES into the category “Others”. Fifth, individuals may have experienced problems recollecting their diagnoses leading to recall bias. Finally, though the associations between sleep disorders and daily activities are interpreted as an impact in this study, causality relationship cannot be confirmed in a cross-sectional study such as NHANES. Longitudinal studies are needed to confirm our interpretation of these associations. Nonetheless, this study of sleep disorders and sleep habits is from a large and representative US sample.

Understanding disease prevalence is critical to anticipating health care needs and allocating appropriate resources. Additionally, comparison of prevalence by sociodemographic factors may provide etiological clues and identify subgroups at high risk. This study describes the prevalence of the three physician-diagnosed sleep disorders: sleep apnea, insomnia, and RLS. The study suggests that the prevalence of sleep disorders in the USA is much lower than previously reported in the literature, suggesting underdiagnosis of sleep disorders by primary care physicians. The prevalence of physician-diagnosed sleep apnea is much higher than previously reported, and this observation may be due to the rise of chronic co-morbid conditions in the USA such as obesity, diabetes, and hypertension [26–30].

Future studies of the NHANES data should consider these co-morbidities as possible confounders.

Conflict of interest statement None of the authors have a conflict of interest to declare in relation to this work.

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