SLEEP DISORDERS IN VETERANS

The National Veteran Sleep Disorder Study: Descriptive Epidemiology and Secular Trends, 2000–2010

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Study Objectives: A large proportion of individuals affected by sleep disorders are untreated and susceptible to accidents, injuries, long-term sequelae (e.g., risk of cardiovascular disease, cancer, psychiatric disorders), and increased mortality risk. Few studies have examined the scope and magnitude of sleep disorder diagnoses in the United States (US) or factors influencing them. Veterans are particularly vulnerable to factors that elicit or exacerbate sleep disorders.

Methods: This serial cross-sectional study characterized secular trends in diagnosed sleep disorders among veterans seeking care in US Veterans Health Administration facilities over an eleven-year span (FY2000–2010, n = 9,786,778). Electronic medical records from the national Veterans Administration Informatics and Computing Infrastructure database were accessed. Cases were defined using diagnostic codes specified by the American Academy of Sleep Medicine. Age-adjusted annual prevalence was summarized by sex, race, combat exposure, body mass index, and comorbid diagnoses (cardiovascular disease, cancer, mental disorders).

Results: Sleep apnea (47%) and insomnia (26%) were the most common diagnoses among patients with any sleep disorder. There was a six-fold relative increase in total sleep disorder prevalence over the study period. Posttraumatic stress disorder, which tripled over the same time period, was associated with the highest prevalence of sleep disorders (16%) among the comorbid conditions evaluated.

Conclusions: The results indicate a growing need for integration of sleep disorder management with patient care and health care planning among US veterans.

Commentary: A commentary on this article appears in this issue on page 1331.

Keywords: insomnia, military, posttraumatic stress disorder, sleep apnea, veteran

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Significance

Trends in diagnosed sleep disorders were characterized among United States veterans seeking care in Veterans Health Administration facilities between FY2000 and FY2010 (n = 9,786,778). A six-fold relative increase in the age-adjusted prevalence of any sleep disorder diagnosis was observed during the study period. The largest increases were observed among those with posttraumatic stress disorder, other mental health disorders, or combat experience. Veterans with cardiovascular disease, cancer, or other chronic diseases also experienced higher rates of sleep disorder diagnoses relative to those without such conditions. This study identified a growing need for integration of sleep disorder management with veteran care and health care planning.

INTRODUCTION

Sleep is considered a physiological necessity, and inadequate sleep has been associated with a wide range of adverse physical, mental and behavioral outcomes.[1] Previous studies have linked abnormal sleep duration or a sleep disorder diagnosis with an increased incidence of: obesity, hypertension or metabolic syndrome,[2–5] type 2 diabetes,[2,3,6] cardiovascular disease,[7–9] stroke,[10,11] and cancer[12–17] (although results for cancer have been less consistent). Other studies have linked inadequate sleep with an increased risk of psychiatric disorders (e.g., depression, posttraumatic stress disorder [PTSD]), suicides, accidents, injuries, reduced quality of life, and increased mortality.[1,9,18–26] The impacts of sleep disruption may be mediated by several pathophysiological processes. These include sympathetic nervous system hyperarousal, the disruption of circadian rhythms, neuroendocrine or immune system dysregulation, inflammation, or metabolic dysfunction.[27–30]

Military personnel are particularly vulnerable to sleep disturbances due to the irregularity of their sleep/wake schedules, austere living conditions (e.g., extremes in temperature, noise, physical exertion), the stress of combat, elevated rates of physical and psychological injury, and issues associated with post-deployment psychosocial reintegration.[23,31] Some of these conditions can have residual effects well after the period of service is over. Therefore, veterans can be plagued with multiple comorbidities and exposures that adversely influence sleep. Some of these are over-represented in this population (e.g., musculoskeletal pain, traumatic brain injury [TBI], smoking, substance abuse, hypertension, depression, PTSD), while others mirror trends in the general United States (US) population (e.g., obesity, aging-related chronic disease).[23,24,31–34] Consequently, sleep disruption tends to be more common among veterans than in the general population.[23,35–40] However, the national scope and characteristics of this problem have not been described previously.

Despite evidence indicating that a lack of recognition or poor management of sleep disorders can have myriad detrimental health consequences, many patients can remain undiagnosed or untreated.[41,42] For example, it was estimated that 80% to 90% of people with clinically significant sleep-disordered breathing

may remain undiagnosed.[43] In a representative sample of US adults, 26% of survey respondents met criteria for high-risk obstructive sleep apnea[44] in contrast to an estimated prevalence of ~4% to 10%.[45–47] An increasing trend in office visits for sleep disorders was reported among US adults from 1999 to 2010, although it is unclear whether this was due to a true increase in sleep disorder prevalence, increasing awareness among physicians or their patients, or a combination of both.[19] Differences in sleep disorder case definitions, diagnostic criteria, population demographics, or the presence of comorbid disease also can contribute to inconsistencies among population-based sleep disorder estimates.

The co-occurrence of a sleep disorder with another comorbid chronic disease can predict poor quality of life[48,49] and earlier mortality relative to those without a sleep disorder.[9,26,50] This suggests that appropriate sleep disorder management may improve quality of life and longevity. In some studies, psychiatric disorders were predictive of sleep problems,[51,52] but in other cases sleep disorders predicted increased risks for psychiatric disorders.[53–55] This apparent bi-directionality can complicate etiologic studies, but it also highlights the importance of disease prevention and control strategies that integrate appropriate sleep management.

The information described above suggests that sleep disorder surveillance can play an important role in patient care and long-term health care planning. The characterization of trends in sleep disorder diagnoses among population subgroups may allow clinicians to identify and target high-risk patients who would benefit from management of sleep disorders and their sequelae. Most epidemiologic studies examining sleep disorders have been limited to: selected study populations (e.g., those attending sleep clinics), relatively small sample sizes, or to a single type of sleep disorder or risk factor of interest. This study evaluated all diagnosed sleep disorders in a national sample of US veterans who utilized health services through the Veterans Health Administration (VHA) between FY2000 and FY2010. The VHA is the largest integrated health care system utilizing electronic medical records in the US.[56] The approach facilitated the examination of comorbid diseases that appear at higher rates among veterans relative to the general population (e.g., PTSD and other mental health disorders), as well as other individual or clinical factors that may influence the onset or severity of sleep disorders.

METHODS

Study Population

The study population consisted of all US veterans seeking care in the VHA system between FY2000 and FY2010. Following regulatory approvals, outpatient electronic medical records were accessed from MedSAS Dataset and Department of Veterans Affairs (VA) Corporate Data Warehouse files using the US Veterans Administration Informatics and Computing Infrastructure (VINCI) system. Requested data elements from different VA system files were linked via social security number by a system data manager, and then scrambled and replaced with a unique patient identification number. Unique identifiers were therefore inaccessible to the study investigators. Patients excluded were: < 18 years old on January 1 of each year, veterans who died in a given fiscal year, spouses of veterans receiving care, and non-veterans.

Case Ascertainment

De-identified outpatient sleep disorder diagnoses were grouped according to American Academy of Sleep Medicine International Classification of Sleep Disorder[57] categories based on the following ICD-9 (International Classification of Diseases, Ninth Revision) codes: sleep apneas (organic sleep apnea [327.20–327.29], unspecified sleep apnea [780.57]); insomnias (organic insomnias [327.00–327.09], insomnias, unspecified [780.51–780.52], nonorganic insomnias [307.41–307.42]); other sleep disorders (other organic sleep disorder [327.80], specific disorders of sleep of nonorganic origin [307.40–307.49], other sleep disturbances, unspecified [780.50, 780.56, 780.59], other sleep disorders [291.82, 292.85]); hypersomnias (organic hypersomnias [327.10–327.19], nonorganic hypersomnias [307.43–307.44], hypersomnias, unspecified [780.53–780.54], other hypersomnias [347.00–347.01, 347.10–347.11]); parasomnias (organic parasomnias [327.40–327.49], nonorganic parasomnias [307.46–307.47]); sleep disruption movement disorders (organic sleep related movement disorders [327.51–327.59], sleep related movement disorder, unspecified [780.58], Restless Legs Syndrome [333.94]); and circadian rhythm disorders (organic circadian rhythm sleep disorders [327.30–327.39], circadian rhythm sleep disorder of nonorganic origin [307.45], disruption of 24-hour sleep wake cycle, unspecified [780.55]). Veterans were assigned a specific sleep disorder diagnosis if their ICD-9 code occurred at least 2 times within a given fiscal year, and the codes occurred 30 or more days apart.[58] This method was used to reduce the chance of misclassification due to "rule out" diagnoses, which are ICD-9 codes that are entered by providers as the reason for ordering a diagnostic test. This more conservative approach may not have identified all cases (e.g., if their first visit occurred near the end of a FY), and may have underestimated case frequencies relative to other studies.

Sleep-related medical procedures were ascertained using the following current procedural technology (CPT) codes: 0203T (sleep study, unattended, simultaneous recording of: heart rate, oxygen saturation, respiratory analysis and sleep type; type II device), 0204T (sleep study, unattended, simultaneous recording of: heart rate, oxygen saturation, respiratory analysis and sleep type; type IV device), 95805 (multiple sleep latency or maintenance of wakefulness testing, recording analysis and interpretation of physiological measurements of sleep during multiple trials to assess sleepiness), 95806 (sleep study, unattended, simultaneous recording of heart rate, oxygen saturation, respiratory airflow and respiratory effort [electroencephalogram [EEG], thoracoabdominal movement] with type III device), 95807 (sleep study, simultaneous recording of ventilation, respiratory effort, electrocardiogram [ECG] or heart rate, and oxygen saturation, attended by a technologist), 99508 (home visit for polysomnography and sleep studies), 95810 (polysomnography with sleep staging and $\geq$ 4 sleep parameters, attended by technologist), 95811 (polysomnography for initiation of continuous positive airway pressure therapy or bilevel ventilation, attended by technologist), G0398 (home

sleep test [HST] with type II portable monitor, unattended; minimum of 7 channels: EEG, electrooculogram, electromyogram, ECG/heart rate, airflow, respiratory effort and oxygen saturation), G0399 (HST with type III portable monitor, unattended; minimum of 4 channels: 2 respiratory movement/airflow, 1 ECG/heart rate, and 1 oxygen saturation), and G0400 (HST with type IV portable monitor, unattended; minimum of 3 channels).

Covariates

Data on covariates (age, race/ethnicity, sex, smoking status, body mass index [BMI], income, comorbid diagnoses, sleep-related medical procedures, service period [World War II, Korean War, Vietnam War, Persian Gulf War, Operation Enduring Freedom/Operation Iraqi Freedom, and other], and combat deployment) were retrieved from the VHA's Vital Status and MedSAS databases. Income was divided into 3 categories: less than $20,000 a year, $20,000 or more, or unknown.[59] Race and ethnicity were categorized as: Non-Hispanic White, Non-Hispanic Black, Hispanic or Mexican, or "Other" (includes American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or more than one race). Missing race may be associated with lower rates of utilization and fewer comorbid diseases,[60] and thus was included as a separate category. Age, in years, was calculated by subtracting the year of birth from the fiscal year of contact with the VHA system and grouped into the following categories: 18–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years, 70–79 years, and 80 years or older. The 21 Veterans Integrated Service Networks (VISNs) were collapsed into US census regions (VISNs 1–5 = Northeast; 10–15 and 23 = Midwest; 6–9, 16, 17 = South; 18–22 = West). Those with missing or infrequent VISN assignment were coded as unknown. BMI was calculated using height and weight after excluding biologically implausible values; height was restricted to 48–84 inches (122–213 cm), and weight was restricted to 75–500 pounds (34–227 kg).[61] If a value for height was missing for a given record, any appearance of height across the study period was used. Multiple entries for biologically plausible values of weight were averaged within the fiscal year. BMI was categorized into the following groups: underweight (< 18.5 kg/m^2), normal (18.5 to < 25 kg/m^2), overweight (≥ 25 and < 30 kg/m^2), and obese (≥ 30 kg/m^2). The underweight BMI category (< 1% of study population) was combined with the normal BMI group. Smoking status was assessed as described previously[62]; data extracted from electronic medical records were compared to self-reported smoking data found in the Veterans Aging Cohort Study (VACS-8) and VACS Virtual Cohort study, which yielded kappa (κ) statistics of 0.66 and 0.61, respectively.

ICD-9 codes for comorbid disease were grouped into the following categories: asthma (493), cancer (150–151, 153–155, 157, 162, 172, 174, 183, 185, 188–189, 191, 200, 202, 204–208.9), chronic obstructive pulmonary disease (COPD) (496.0), cardiovascular disease (CVD) (390–459), diabetes (249–250), fibromyalgia (729.1), gastrointestinal (GI) disease (520–579), human immunodeficiency virus (HIV) (042–044), any mental disorder (290–319), renal disease (508–589), and stroke (434.91) using the same criteria as described for sleep disorders. Diagnoses of any mental disorder/mental disability was broken down into the following subgroups for further analyses: depression (296.3), posttraumatic stress disorder (PTSD) (309.81), other mental health disorders with the exception of PTSD and depression (e.g., psychosis [290–299], neurotic disorders, personality disorders, and other nonpsychotic mental disorders [300–316], mental disability [317–319]).

Statistical Analyses

Annual sleep disorder prevalence was calculated as the proportion of total sleep disorder diagnoses among eligible patients seeking care in the VHA system each fiscal year of the study. The numerator was defined as the total number of primary sleep disorder diagnoses (or specific sleep disorder subtype) that occurred during each fiscal year, and the denominator was the total number of veterans seeking care through the VHA during in the same fiscal year. Annual prevalence was adjusted for possible changes in the age distribution over time via direct age standardization using the 2000 US standard population and the following age groups: 18–29, 30–39, 40–49, 50–59, 60–69, 70–79, and ≥ 80 years old.[63] Absolute change in prevalence across the study period was defined as the age-adjusted prevalence estimate for FY2000 subtracted from the age-adjusted prevalence for a given fiscal year. Relative changes were described as well, where the age-adjusted prevalence estimate for FY2000 was subtracted from the age-adjusted prevalence for a given fiscal year and divided by the age-adjusted prevalence estimate for FY2000. Prevalence and absolute change in prevalence of sleep disorders were stratified by comorbid CVD and cancer diagnoses, as they represent the top causes of mortality in the US, PTSD (a common diagnosis among US veterans), and other selected factors (sex, race, BMI, combat exposure). Two-sample proportion tests were used to compare proportions of select factors in FY2000 and FY2010.

RESULTS

Data for 9,786,778 veteran patients were included in the analysis (Table 1). Figure 1 summarizes inclusions and exclusions among patients who sought care through the VHA during the study period. The study population consisted primarily of men (93%) who were married (54%). Differences in the characteristics of veterans seeking care through the VHA from FY2000 to FY2010 are presented in Table S1 in the supplemental material. At the beginning of the study period, veterans 70–79 years of age constituted the largest group (~24%, standard error [SE]: ± 0.02); and by FY2010, the 60–69 age group was the largest (~30%, ± 0.02, Table S1). Among veteran patients diagnosed with at least one sleep disorder (n of unique individuals: 751,502; n of diagnoses: 953,575), sleep apneas made up the plurality of the diagnoses (47%); followed by insomnias (26%), other sleep disorders (11%), hypersomnias (10%), movement disorders (4%), parasomnias (3%), and circadian rhythm sleep disorders (0.1%). A majority of those diagnosed with a sleep disorder were prescribed at least one sleep medication (91%, data not shown). The proportion of veterans with a sleep disorder who were prescribed a sleep medication for the entire time they sought care within the VHA during the study period ranged from 24% to 64% (average: 37%) based on the number of years of follow-up (data not shown).

Table 1—Characteristics of United States veterans who sought care through the Veterans Health Administration System: FY2000 to FY2010.

Characteristic	Categories	Total Population (n = 9,786,778)[a] n (%)
Sex	Female	664,880 (6.8)
	Male	9,121,898 (93.2)
Race	White	2,730,235 (27.9)
	Black or African American	575,770 (5.9)
	Hispanic	241,914 (2.5)
	Other	162,966 (1.7)
	Unknown	6,075,893 (62.1)
Marital Status	Married	5,272,298 (53.9)
	Not Married	3,755,025 (38.4)
	Unknown	759,455 (7.8)
Sleep Disorder Diagnoses	Sleep Apneas	443,060 (4.5)
	Insomnias	242,774 (2.5)
	Other Sleep Disorders	106,729 (1.1)
	Hypersomnias	96,180 (1.0)
	Movement Disorders	37,210 (0.4)
	Parasomnias	26,479 (0.3)
	Circadian Rhythm Disorders	1,143 (0.01)
Comorbid diseases[b]	Asthma	263,306 (2.7)
	Cancer	768,351 (7.9)
	CVD	5,088,157 (52.0)
	COPD	875,006 (8.9)
	Diabetes	1,873,235 (19.1)
	Fibromyalgia	114,406 (1.2)
	GI Disease	3,077,094 (31.4)
	HIV	33,755 (0.3)
	Hypertension	4,258,724 (43.5)
	Mental disorder	3,469,637 (35.5)
	Depression	420,284 (4.3)
	PTSD	757,673 (7.7)
	Other mental disorder	3,224,565 (33.0)
	Renal Disease	430,010 (4.4)
	Stroke	11,324 (0.1)

[a]Number of veterans entering the system with age and gender information. [b]Disease categories are not mutually exclusive. COPD, chronic pulmonary obstructive disease; CVD, cardiovascular disease; HIV, human immunodeficiency virus; PTSD, posttraumatic stress disorder.

Total sleep disorder diagnoses increased nearly 6-fold over the 11-year study period (Figure 2). Sleep apnea and insomnia prevalence exhibited more than a 7-fold relative increase; age-adjusted sleep apnea prevalence increased from 0.4% in FY2000 to 3.0% in FY2010 (a relative increase of 650%); and age-adjusted insomnia prevalence increased from 0.2% in FY2000 to 1.5% in FY2010 (also a 650% relative increase). The prevalence of other sleep disorders rose from 0.4% in FY2000 to 0.6% in FY2010 (a relative increase of 50%). Less prevalent sleep disorder subtypes also increased over time (the relative increases were: movement disorders: 1,048%; hypersomnias: 50%; parasomnias: 750%; circadian rhythm disorders: 900%).

When the pattern of CPT codes for sleep procedures over time was inspected, there was an approximate 3-fold increase in the proportion of veteran patients receiving a sleep-related procedure during the study period (0.5% in FY2000, 1.7% by FY2010). These proportions were considerably lower than diagnosed sleep disorders; one-third to one-half of the observed prevalence of sleep disorder diagnoses (Figure 3). CPT codes 95810 and 95811 (polysomnography for sleep staging, sleep parameters, or airways therapy, attended by a technologist) were the most common sleep procedures in FY2000 (0.35%) and FY2010 (1.24%), corresponding to an almost four-fold relative increase during the study period. CPT code 95807 (sleep study, simultaneous recording of ventilation, respiratory effort, ECG or heart rate, and oxygen saturation, attended by a technologist) was the second most common code in FY2000 (0.09%) and exhibited a small increase in prevalence by the end of the study period (0.11%).

Veterans diagnosed with CVD had a larger absolute increase in sleep apnea prevalence over time compared to veterans without CVD (5.8% and 1.6%, respectively, Figure 4). Veterans with a CVD diagnosis also experienced an absolute increase of insomnia prevalence (2.6%) more than double the absolute increase among veterans without CVD (1.1%). Less common sleep disorder subtypes also exhibited greater increases in sleep disorder prevalence among those with CVD compared to those without CVD.

Figure 5 presents changes in sleep disorder prevalence stratified by cancer diagnosis. From FY2000 to FY2010, absolute increases in sleep apnea and insomnia prevalence were 3.7% and 2.0%, respectively, among veterans with cancer. These

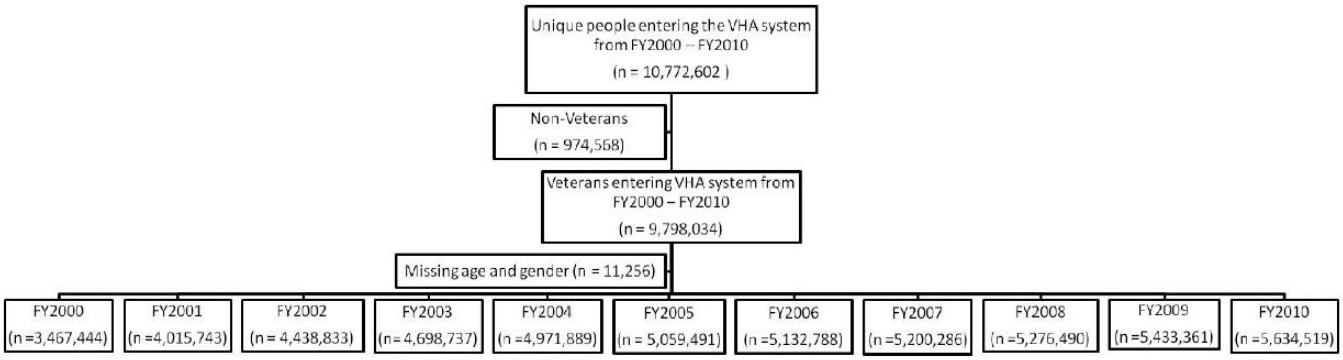

Figure 1—Flowchart of United States veterans who entered the Veterans Health Administration (VHA) system from FY2000 to FY2010.

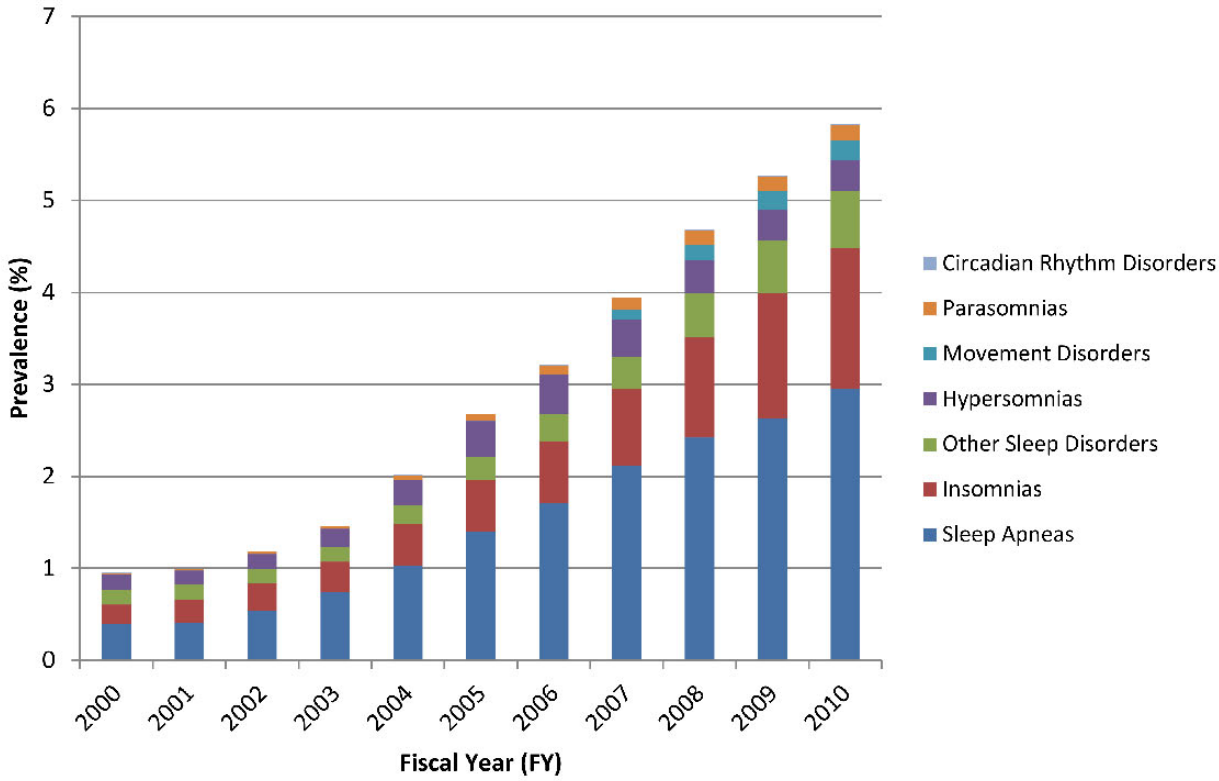

Figure 2—Age-adjusted prevalence of sleep disorders among United States veterans seeking care through the Veterans Health Administration, FY2000–2010 (n = 9,786,778).

increases were greater than those recorded among veteran patients without a cancer diagnosis (2.5% and 1.3%, respectively). The remaining sleep disorders, with the exception of other sleep disorders, exhibited larger increases in prevalence among those diagnosed with cancer compared to those who were not.

Absolute changes in sleep apnea and insomnia over the study period were the largest among veterans with PTSD (5.7% and 4.3% from FY2000 to FY2010, respectively, Figure 6). Smaller absolute increases in prevalence were observed for the other sleep disorder subtypes, ranging from 0.02% (circadian rhythm disorders) to 1.4% (other sleep disorders). Increases in sleep disorder subtypes over time also were observed when the data were stratified by any mental health disorder diagnosis (Figure S1 in the supplemental material), any depression diagnosis (Figure S2 in the supplemental material), or by mental health disorders other than PTSD or depression (Figure S3 in the supplemental material), the largest absolute increases were observed among those with sleep apnea.

Because combat experience can be related to development of PTSD and mental health disorders, the prevalence of sleep disorder subtypes also was stratified by combat exposure (Figure S4 in the supplemental material). In FY2010, the prevalence of sleep apnea and insomnia was 7.6 times and 6.3 times greater among combat veterans than noncombat veterans, respectively. A similar pattern was observed for other sleep

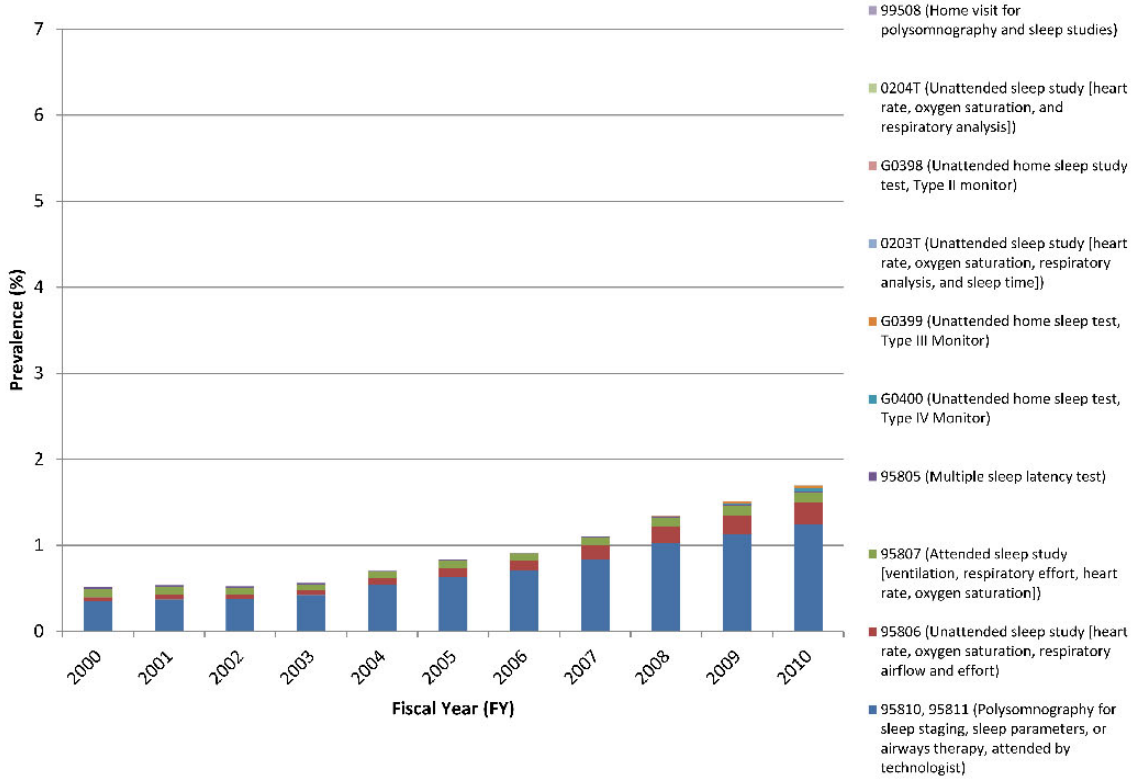

Figure 3—Age-adjusted prevalence of CURRENT PROCEDURAL TERMINOLOGY (CPT) CODES for sleep procedures among United States veterans seeking care through the Veterans Health Administration (FY2000–2010, n = 9,786,778).

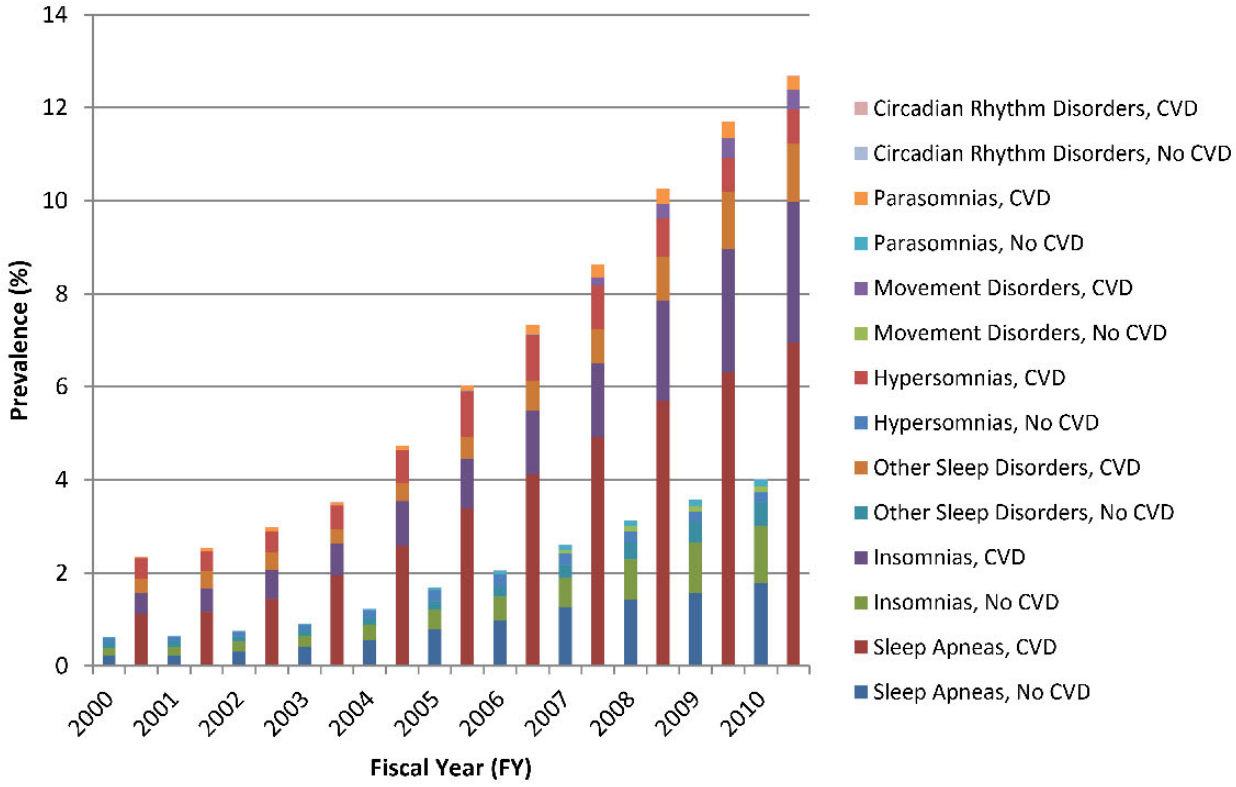

Figure 4—Age-adjusted prevalence of sleep disorders by CARDIOVASCULAR DISEASE (CVD) status among United States veterans seeking care through the Veterans Health Administration (FY2000–2010, n = 9,786,778).

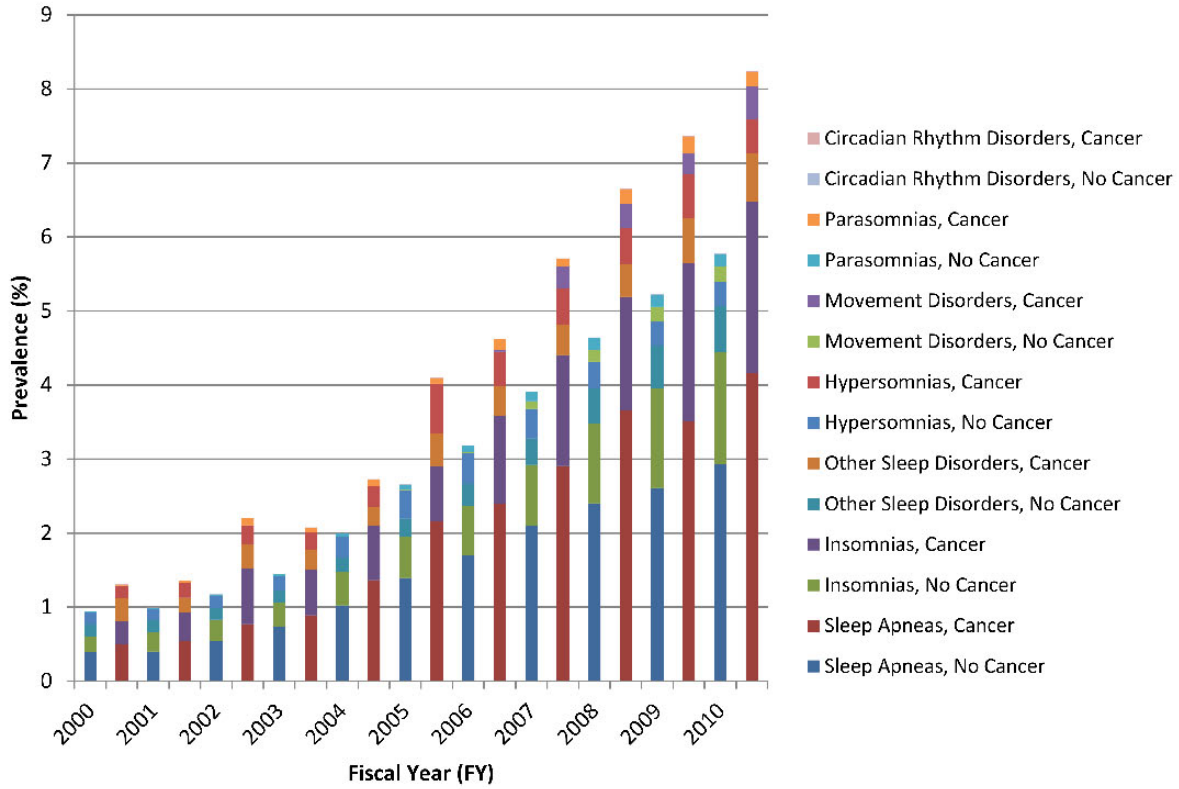

Figure 5—Age-adjusted prevalence rate of sleep disorders by CANCER status among United States veterans seeking care through the Veterans Health Administration (FY2000–2010, n = 9,786,778).

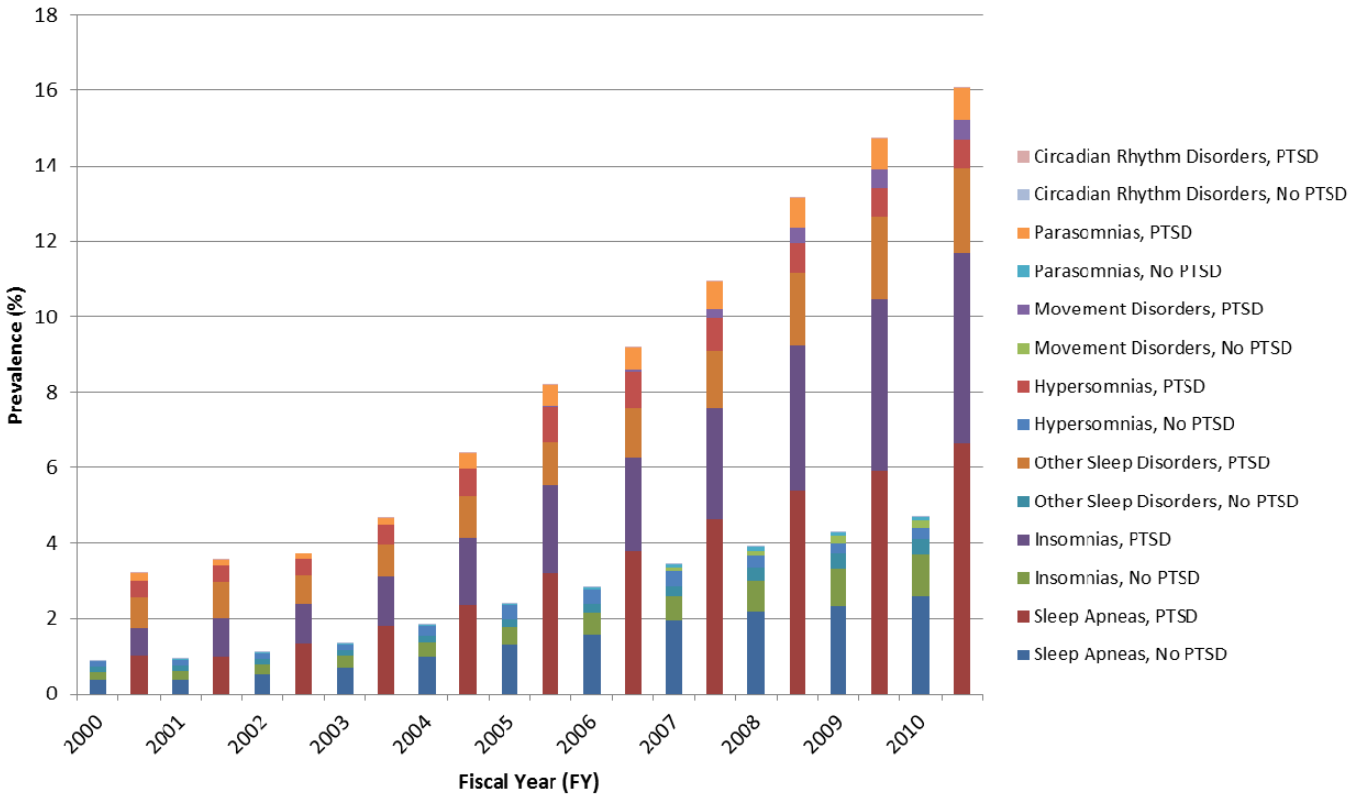

Figure 6—Age-adjusted prevalence of sleep disorders by POSTTRAUMATIC STRESS DISORDER (PTSD) status among United States veterans seeking care through the Veterans Health Administration (FY2000–2010, n = 9,786,778).

disorders. By 2010, there was a greater than 7-fold relative difference in total sleep disorder prevalence among veterans with or without combat experience.

Sleep disorder prevalence also was examined across BMI categories (Figures S5a–S5g in the supplemental material). As expected, obese veterans (BMI ≥ 30 kg/m^2) experienced the largest increase (5.6%) in sleep apnea prevalence over time (1.4% in FY2000, 7.0% in FY2010, Figure S5a). For insomnia, veterans who were underweight or had normal BMI were the fastest growing group, with a 1.8% absolute increase in insomnia prevalence over time (0.3% in FY2000, 2.1% in FY2010, Figure S5b).

Sleep disorder prevalence stratified by sex is presented over the study period in Figure S6 in the supplemental material. Male veterans consistently had a higher prevalence of sleep apnea across the study period. Female veterans either had the same or higher insomnia prevalence until FY2008. Thereafter, their rates were exceeded by those among male veterans. Trends in sleep disorder prevalence by race and ethnicity are presented in Figures S7a–S7g in the supplemental material. The largest absolute increase in sleep apnea prevalence over the study period (3.1%) was observed among Hispanic or Mexican-American veterans (0.5% in FY2000 to 3.6% in FY2010, Figure S7a). This group also had the highest prevalence of sleep apnea among those studied. Veterans of unknown race/ethnicity had the largest absolute increase (1.5%) in insomnia prevalence over time (0.3% in FY2000 to 1.8 % in FY2010, Figure S7b). The northeast and southern US regions dominated increases observed in sleep disorder prevalence (Figures S8a–S8g in the supplemental material). Specifically, the northeast region experienced the greatest absolute increases in sleep apnea, circadian rhythm disorders, parasomnias, and other sleep disorders; whereas the southern region experienced increases in insomnias, hypersomnias, and movement disorders.

DISCUSSION

In 2000, there were ~26.4 million veterans comprising ~12.7% of the US population.[64] Results from this study indicate a notable rise in sleep disorder diagnoses, especially for sleep apnea and insomnia, among US veterans who sought care through the VHA from FY2000 through FY2010. The largest increases were noted among veterans grouped according to certain demographic or clinical characteristics, particularly those with PTSD, other mental health disorders, or combat experience. The increasing trends observed in this study are similar to results from the National Ambulatory Medical Care Survey,[19] where a 442% relative increase in office visits for sleep apnea was reported among adults within a similar time period (1999–2010).[19] Those investigators acknowledged uncertainty as to whether this represented a true increase in prevalence or if it was due to heightened awareness, or a combination of factors.

In 2004, veterans requiring the use of breathing assistance equipment, such as continuous positive airway pressure devices, were granted a service-connected disability benefit for sleep apnea,[65] which likely led to more veterans discussing sleep complaints with their provider. However, increases in sleep disorders in the present study were still observed prior to 2004; for example, sleep apnea prevalence nearly doubled between FY2000 and FY2003. Thus, the changes in sleep disorder prevalence may not have been attributable solely to this administrative change. Of note, rates for other sleep disorders not covered by the new disability rating also increased during the same period.

Potential administrative bias was evaluated in this study by examining trends in the utilization of clinical procedures (CPT codes) for a sleep disorder diagnosis. The increases in prevalence observed for sleep apnea or other sleep disorders did not match the magnitude or frequency of diagnostic procedures for sleep that were recorded during the same period (Figure 3). Some veterans may have sought medical care outside of the VHA system.[66] A previous investigation found that ~28% of veterans reported dual-use primary care (VA and non-VA).[67] It is unknown whether such patients may have preferentially sought care for sleep disorders at non-VHA facilities, but the possibility cannot be excluded.

Other study uncertainties include a lack of information on the relative proportions or influx of certified sleep physicians entering the VHA system during the study period, or the extent to which updates in diagnostic criteria may have influenced national trends in sleep disorder diagnoses among VHA providers. The Accreditation Council on Graduate Medical Education initiated a national sleep medicine training and certification program in 2004–2005,[68] which coincides with the increase in movement disorder diagnoses that were virtually absent within the VHA medical record in prior years. This suggests that providers may not have been trained to recognize these sleep disorders, and that veterans may have been underdiagnosed for these conditions prior to the initiation of this program. A recent inventory of VHA sleep medicine programs indicated that demand for sleep services is high and that there is considerable variability in the types of services offered; 28% had more advanced facilities, whereas 17% did not offer any formal sleep services.[69]

Only a few studies have examined the prevalence of diagnosed sleep disorders in a national sample, and several of those studies focused on veterans.[59,60,70] Prior investigations examined prevalence over a shorter time frame (i.e., across one or two fiscal years) and/or evaluated a single type of sleep disorder.[59,60,70] In the current study, sleep apnea prevalence ranged from 0.4% to 3.0%. A large cohort study examining the relationship between sleep apnea and psychiatric comorbidities reported a sleep apnea prevalence of 2.9% in a two-year period (FY1998–2001),[70] which exceeds the current study's prevalence of 0.4% in FY2001. Another investigation of sleep apnea among veterans ≥ 65 years old (FY2003–2005) utilized criteria similar to the present study (sleep apnea cases were defined as individuals with two outpatient diagnoses ≥ 7 days apart, or one inpatient diagnosis) and reported a sleep apnea prevalence of 4.4%.[60] In the current study, a sleep apnea prevalence of 3.6% was obtained when the population was restricted to veterans ≥ 65 years old in FY2005, which is reasonably consistent with previous studies.[60,70]

Insomnia prevalence in the current study ranged from 0.4% to 1.5%. Another recent study of insomnia prevalence reported that 3.4% of veterans had insomnia in FY2010,[59] which is more than double the prevalence found in the current study in the

same year (1.5%), but is consistent with the prevalence of self-reported, physician-diagnosed insomnia that was recently described in a nationally representative sample of the non-institutionalized US population (1.2%).[46] Inconsistencies in sleep disorder prevalence reported among different studies may be due to differences in case definitions (e.g., some studies used a single occurrence of sleep disorder, which could overestimate case frequencies), or a tendency for physicians to consider sleep impairment as a comorbid symptom rather than a diagnosable disorder. The current study may have underestimated the true prevalence of sleep disorders among veterans since the use of ICD-9 codes only captures those who are diagnosed and misses those who may have a clinically important but undiagnosed sleep disorder.[43,44] Differences in population demographics, comorbidities, or the time period studied also may contribute to differences in sleep disorder prevalence among published studies.

An increase in the prevalence of comorbid diseases may have contributed to the increasing trend of sleep disorder diagnoses observed in this study. Veterans with cardiovascular disease, cancer, or mental health disorders (particularly PTSD) experienced higher rates of sleep disorder diagnoses relative to those without such conditions, a phenomenon that has been observed in other populations.[71–73] Veterans tend to have more mental disorders compared to the general population,[9,26,50,74–77] and the co-occurrence of sleep disorders among those with PTSD or other psychiatric disorders has been previously described.[39,51–55,78] The current study used two occurrences of a PTSD diagnosis to identify veterans with PTSD, which has a positive predictive value (PPV) of 82%, whereas a single occurrence had a PPV of 75%.[79] A 12-month prevalence study of DSM-IV disorders indicated that 3.5% of Americans had PTSD,[80] which is similar to what was observed in the present study during the same time period (FY2001–2003, 3.3–3.5%). PTSD prevalence in this study also was within the range previously reported among veterans (2–17%).[81] PTSD rates among veterans increased three-fold over the 11-year period, an absolute increase of almost 7%. It was the greatest change among the mental health disorders evaluated, resulting in a PTSD prevalence of 10% by FY2010. The US' multiple-front war effort that occurred during this period likely contributed to this striking trend.[82]

Sleep disturbances are a significant component of PTSD; some studies report that sleep disturbances can predict the development of PTSD or depression.[24] However, there is no clear consensus on the cause-effect relationship between sleep disorders and psychiatric outcomes, and these relationships may be bi-directional, depending on individual context. For example, one study found that insomnia preceded a current anxiety disorder in less than 20% of cases, that anxiety appeared prior to insomnia in 44% of cases, and that these disorders co-occurred in approximately 40% of cases.[55] In a community-based study of adolescents with comorbid disorders, prior insomnia was not associated with onset of anxiety disorders, but nearly 75% had anxiety prior to their insomnia diagnosis. Another investigation also found that generalized anxiety disorder and/or depression predicted increases in sleep problems over time.[53] This suggests that mental health disorders including PTSD may be driving secular trends in sleep disorder prevalence among veterans, although the cross-sectional nature of the current study precludes an ability to infer causality. Some studies indicate that sleep problems can persist even after amelioration of PTSD or TBI symptoms, and that sleep improvement can facilitate better responses to PTSD therapy.[24] Others reported that successful treatment of sleep apnea led to clinically meaningful improvements in PTSD symptoms.[83–85] This highlights the importance of integrated strategies to ameliorate the long-term combined impacts of mental and sleep-related disorders among VHA patients.

An aging population has been frequently cited as a factor that could be driving an increase in sleep disorder prevalence, particularly sleep apnea. Age-standardization in the present study eliminated potential biases that may have been introduced due to a shift in the age distribution among veteran patients during the study period. Examination of changes within specific age groups over time did not provide strong evidence for aging as an explanation for the observed trends (Tables S1 and S2 in the supplemental material), and age-adjusted sleep disorder prevalence did not differ notably from crude rates (data not shown).

One unexpected finding was that sleep apnea prevalence did not display a monotonic increase with age (Table S2), which has been cited previously as a strong predictor of this disorder.[86] Instead, the prevalence of sleep apnea was highest among veterans 40–69 years old (Table S2). Discrepancies with other reports may be due to differences in the criteria used to diagnose sleep apnea, the types of sleep apnea included in the analyses (i.e., obstructive, central, and mixed), not accounting for therapy or other comorbid conditions, or a combination of these factors. A previous study using either clinical or laboratory-based criteria found that sleep apnea prevalence peaked among middle-aged men.[87] Older veterans may be less likely to seek medical care for sleep disruption symptoms since they are more likely to be retired and the consequences of sleep disruption may be less likely to interfere with daily activities. Although veteran patients ≥ 80 years old exhibited the largest increase among age groups over time (Table S1), they consistently had among the lowest rates of sleep disorder diagnoses in this population (Table S2). Another explanation may be related to provider practices.[59] As veterans return from deployment in recent conflicts, PTSD, or other comorbid diagnoses can arise, which may make it more likely that providers diagnose these veterans with sleep disorders relative to older veterans or those not deployed.[59]

The obesity epidemic has been cited as another factor influencing elevated sleep disorder prevalence, and veterans have experienced increases in obesity over time that could account, in part, for increases in sleep apnea prevalence observed in the current study.[33,61] Previous investigations also have reported an increased incidence of insomnia among obese individuals.[88] However, the prevalence of insomnia, the second-most common sleep disorder, rose fastest among veteran patients in the normal BMI category, which suggests that other factors, such as comorbid disease, may have had a predominant role in the trends observed in the present study.

The strengths of this study included its large sample size, use of validated methods for characterizing sleep outcomes

and important covariates, and a medical care system that ensured equal access to care. Furthermore, prevalence estimates were age-adjusted to account for changes in age distribution, and CPT codes for sleep procedures were examined to evaluate potential reporting bias over time. This study consisted of serial cross-sectional data, and was therefore subject to limitations typically associated with this type of study design, including a lack of appropriate temporal sequencing between sleep disorder diagnoses and their predictors or modifiers. Furthermore, this investigation used only data from veterans who sought care through the VHA system, resulting in an over-representation of older men with multiple comorbidities and limiting the generalizability of the results among patients outside the VHA.[89] Sleep disorder prevalence may have been overestimated due to the distribution of age or comorbid disease in this population. However, prevalence values were age-adjusted and stricter criteria were used for case definitions (two diagnostic codes ≥ 30 days apart) to reduce potential misclassification. This may have resulted in more conservative estimates of sleep disorder prevalence relative to some other studies.

In summary, results from this study suggest that prevalence of sleep disorder diagnoses increased among US veterans between FY2000 and FY2010, which may have important implications for the health and longevity of this population. The trajectory of sleep disorder diagnoses over the study period suggests that upward trends may continue beyond FY2010. Sleep disturbances are linked with increased morbidity and mortality. For example, recent meta-analyses reported 10% to 12% increases in mortality risk among those with short sleep duration,[20,21] and clinically significant, untreated sleep apnea has been associated with an increased risk of cardiovascular disease and all-cause mortality.[90] The cross-sectional nature of the current study precludes resolution of the complex interrelationships between factors such as comorbid chronic disease, obesity, and sleep disorder diagnoses. Thus, further examination of these issues using other study designs is warranted. Early identification and adequate treatment of the expanding population of veterans with diagnosed sleep disorders may lead to lower health care utilization and improved quality of life for those patients.

ABBREVIATIONS

BMI, body mass index
COPD, chronic obstructive pulmonary disease
CPT, current procedural technology
CVD, cardiovascular disease
HIV, human immunodeficiency virus
HST, home sleep test
ICD-9, International Classification of Diseases, Ninth Revision
PPV, positive predictive value
PTSD, posttraumatic stress disorder
TBI, traumatic brain injury
US, United States
VA, Veterans Affairs
VHA, Veterans Health Administration
VINCI, Veterans Administration Informatics and Computing Infrastructure
VISN, Veterans Integrated Service Networks

SUPPLEMENTAL MATERIAL

Supplemental tables and figures identified in the text can be viewed by accessing this journal's online content. Differences in the characteristics of veterans seeking care through the VHA from FY2000 to FY2010 are presented in Table S1. Age-specific sleep disorder prevalence is presented in Table S2. Data presented in Figures 4–6 appears in tabular format in the supplemental material (Tables S3–S5). Tabular data for results presented in other figures, or results for temporal trends in sleep disorder diagnoses statifed by other co-morbid diseases (asthma, chronic obstructive pulmonary disease, diabetes, fibromyalgia, gastrointestinal (GI) disease, human immunodeficiency virus (HIV) infection, renal disease, stroke), can be requested by contacting the corresponding author.

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