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SCIENTIFIC INVESTIGATIONS

Incremental health care utilization and expenditures for sleep disorders in the United States

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Study Objectives: To determine the incremental increases in health care utilization and expenditures associated with sleep disorders.

Methods: Adults with a diagnosis of a sleep disorder (*International Classification of Diseases*, *10th Revision*, code G47.x) within the medical conditions file of the 2018 Medical Expenditure Panel Survey medical conditions file were identified. This dataset was then linked to the consolidated expenditures file and comparisons in health care utilization and expenditures were made between those with and without sleep disorders. Multivariate analyses, adjusted for demographics and comorbidities, were conducted for these comparisons.

Results: Overall, 5.6% ± 0.2% of the study population had been diagnosed with a sleep disorder, representing approximately 13.6 ± 0.6 million adults in the United States. Those with sleep disorders were more likely to be non-Hispanic, White, and female, with a higher proportion with public insurance and higher Charlson Comorbidity Scores. Adults with sleep disorders were found to have increased utilization of office visits (16.3 ± 0.8 vs 8.7 ± 0.3, $P < .001$), emergency room visits (0.52 ± 0.03 vs 0.37 ± 0.02, $P < .001$), and prescriptions (39.7 ± 1.2 vs 21.9 ± 0.4, $P < .001$) vs those without sleep disorders. The additional incremental health care expenses for those with sleep disorders were increased in all examined measures: total health care expense ($6,975 ± $800, $P < .001$), total office-based expenditures ($1,694 ± $277, $P < .001$), total prescription expenditures ($2,574 ± $364, $P < .001$), and total self-expenditures for prescriptions ($195 ± $32, $P < .001$).

Conclusion: Sleep disorders are associated with significantly higher rates of health care utilization and expenditures. By using the conservative prevalence estimate found in this study, the overall incremental health care costs of sleep disorders in the United States represents approximately $94.9 billion.

Keywords: sleep disorders, health care utilization, health care expenditures

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BRIEF SUMMARY

Current Knowledge/Study Rationale: The health care, economic, and/or societal burden of certain sleep disorders has previously been described. This study was performed to evaluate the direct health care costs and utilization attributable to sleep disorders overall in adults in the United States.

Study Impact: Sleep disorders are associated with significant incremental increases in health care utilization and expenditures. Improved recognition and treatment of sleep disorders may help reduce this effect on the health care system.

INTRODUCTION

The current *International Classification of Sleep Disorders* describes 83 distinct sleep disorders including obstructive sleep apnea (OSA), insomnia, and restless legs syndrome.[1] A substantial portion of the population has at least one of these sleep disorders, with wide-ranging degrees of short-term and long-term health, workplace, and quality of life implications. Many of these disorders have a robust literature, typically owing to significant sequelae and/or high prevalence rates, whereas others are in their relative infancy of our developing understanding.

One of the knowledge gaps in the sleep literature is an objective assessment of the health care utilization rates and overall financial burden of sleep disorders in the United States. Previous studies have examined the costs associated with specific sleep disorders (most notably OSA and insomnia), societal (indirect) costs of sleep disorders, and/or have performed analyses in other countries.[2–25] Regardless of the methodology, in each case, these studies have identified significant costs associated with 1 or more sleep disorders.

The objective of this study was to specifically determine the nationally representative, direct health care costs and utilization associated with sleep disorders overall in the United States, thereby providing a more global assessment of the impact of sleep disorders on the health care system. We determined the health care costs attributable to sleep disorders through an incremental cost approach: examining differences in health care expenditures in similar patients with and without sleep disorder diagnosis.[18,19,26–29]

METHODS

This study was reviewed by the Partners Healthcare committee on clinical investigations and determined to be exempt from review as it utilizes a publicly available, de-identified dataset. This methodology was previously applied to health care utilization and expenses

in chronic rhinosinusitis, allergic rhinitis, and acute otitis media by our group.[29–32] The 2018 Medical Expenditure Panel Survey (MEPS) served as the data source for this study. This household interview survey is administered by the Agency for Healthcare Research and Quality within the Department of Health and Human Services. The objective of the MEPS is to assess health care costs in the United States among a nationally representative sample. Within the 2018 MEPS, the medical conditions dataset was merged with the consolidated expenditures dataset. Up to 52 medical conditions were allowed per individual within the merged dataset.

Demographic data including age, sex, race, education level, region of residence, marital status, and medical insurance status were extracted from the database. The presence of a sleep disorder was determined by identifying patients in the medical conditions component dataset with an *International Classification of Disease, 10th Revision*, diagnosis code of G47.x. Those without code G47.x were considered to not have a sleep disorder.

Standard demographic information including age and sex distribution was compiled for those patients reporting and not reporting sleep disorders. The additional demographic information extracted and compared included race, ethnicity, level of education, insurance status, region, and marital status (**Table 1**). Additionally, the D'Hoore et al[33] adaptation of the Charlson Comorbidity Score (CCS) was calculated based on comorbid

Table 1—Univariate demographic comparisons among adults with and without sleep disorders.

Characteristic	Without SD		With SD		*P* Value
	Value	SE	Value	SE	
Age (mean years)	46.3	0.2	56.8	0.6	< .001
Sex (%)					< .001
Male	48.9	0.3	42.4	1.4	
Female	51.1	0.3	57.6	1.4	
Race (%)					< .001
Hispanic	17.2	0.9	6.9	0.8	
Non-Hispanic White	61.0	1.0	79.2	1.2	
Non-Hispanic Black	12.2	0.6	8.4	0.9	
Other or multiple race	9.6	0.5	5.5	0.7	
Education (%)					.065
No degree	11.7	0.4	9.6	0.1	
High school diploma	44.9	0.6	44.5	1.9	
Bachelor's degree	21.0	0.5	20.0	1.3	
Master's/doctorate/other	22.4	0.5	25.9	1.7	
Marital status (%)					.866
Presently married	52.1	0.5	52.4	1.9	
Presently unmarried	47.9	0.5	47.6	1.9	
Insurance (%)					< .001
Private	70.6	0.7	64.0	1.8	
Public	21.2	0.6	35.2	1.7	
Uninsured	8.3	0.4	0.8	0.3	
Region (%)					.046
Northeast	17.4	0.9	17.3	1.6	
Midwest	20.6	0.7	23.9	2.1	
South	38.0	1.0	39.1	2.2	
West	24.1	1.1	19.7	1.5	
Charlson Comorbidity Score					< .001
0	78.5	0.4	50.8	1.7	
1	8.9	0.2	18.4	1.2	
2	8.6	0.2	16.0	1.1	
3 or more	4.1	0.2	14.8	1.1	

SD = sleep disorder, SE = standard error of the national estimate.

medical conditions for each patient.[34] This index adjusts for comorbidities, including myocardial infarction, congestive heart failure, peripheral vascular disease, dementia, cerebral vascular disease, chronic pulmonary disease, peptic ulcer disease, and liver disease among others. It allows individuals to be compared with "like" individuals with similar comorbidities.

Data are reported as mean or proportion ± standard error of the estimate. Because the sample design of the MEPS survey includes stratification, clustering, multiple stages of selection, and weighted sampling, appropriate weighted survey design statistical methods were utilized to determine nationally representative means and standard errors. Differences in health care consumption measures between those with and without sleep disorders were compared with a general linear model, adjusting for age, sex, race, ethnicity, education, insurance, region, marital status, and CCS with statistical significance set at $P = .05$.

Two broad types of measures of health care consumption were determined from utilization and expenditure variables within the MEPS. First, national estimates of office visits, emergency facility visits, and total number of prescription fills were determined and compared between individuals with and without sleep disorders. Second, differences in estimated health care expenditures were determined between those with and without sleep disorders with respect to annual total health care expenditures, office-based health care expenditures, prescription expenditures, and patients' self-expenditures for prescription medications in 2018 US dollars. Where necessary, expenditure data were reset to the 99th percentile for severe outliers.

RESULTS

The study population (raw n = 22,186 individuals within the MEPS dataset, representing an adult population of 242.5 million,) was 46.9% male and an average of 48.0 ± 17.7 years old (range 18–84 years). Overall, 5.6% ± 0.2% were found to have a sleep disorder, and when this sample estimate is applied to the 2010 US Census for age > 18 years, a projected 13.6 ± 0.6 million individuals in the United States have at least 1 sleep disorder. As seen in **Table 1**, patients with sleep disorders were more often of non-Hispanic ethnicity, White race, and of female sex with a higher proportion with a public insurance plan and with a significantly higher CCS.

Table 2 presents the difference in health care utilization in terms of numbers of office visits, emergency room visits and prescriptions filled between those with and without sleep disorders. **Table 3** displays differential health care expenditures between those with and without sleep disorders. The data within **Table 2** and **Table 3** are adjusted for demographics and comorbidities using the CCS. By using the prevalence of sleep disorders found in this study and total incremental health care expense, the direct health care costs of sleep disorders in the United States represents approximately $94.9 billion annually.

DISCUSSION

To our knowledge, this is the first study examining the increased health care utilization and increased health care expenditures attributable to sleep disorders overall in the United States. This analysis found a dramatically significant increase in health care utilization rates and expenses associated with the diagnosis of a sleep disorder in all measures examined, but in particular the frequency and cost associated with office visits and prescription medications. When taken together, the overall direct health care cost of sleep disorders nationally was estimated to be quite high, approximating $94.9 billion.

While this figure of $94.9 billion may initially seem quite high, it almost certainly represents an underestimate. First, this calculation was made based on an overall prevalence of sleep disorders of 5.6%. While this figure is remarkably similar to that found in a recent cross-sectional analysis of the 2010 National Health and Nutrition Examination Survey by the authors,[35] most studies cite prevalence estimates of sleep disorders overall between 30–40%, amounting to over 50 million Americans.[9,36] Consider, for example, that prevalence rates of OSA, insomnia, and short sleep duration alone are estimated at 17–34%, 10–20%, and 37.1%, respectively.[37–40] The low prevalence rate in this study is also reflective of the use of *International Classification of Disease*, *10th Revision*, code G47.x to identify patients with sleep disorders. Although this does encompass many of the common sleep disorders such as OSA, narcolepsy, and restless legs syndrome, many common diagnoses are not within the G47 subheading, including insufficient sleep syndrome, primary snoring, obesity hypoventilation syndrome, Cheyne-Stokes breathing, and most of the subclassified insomnias. Finally, there is presumed to be a significant underdiagnosis of sleep disorders in the United States resulting from a lack of awareness and/or availability of subspecialists.[41] According to one recent large database study examining expected health care encounters for sleep disorders, this indeed translated to fewer than expected outpatient visits.[42] Although it is conducted at the household level, inclusion in the MEPS database requires a formal diagnosis of a sleep disorder and appropriate coding entry.

Another consequence of the likely underdiagnosis of sleep disorders is that the control group is contaminated by undiagnosed sleep disorders that are contributing to increased cost without being attributed to the sleep disorder by virtue of our methodology. It is unlikely that a major sleep disorder requiring multiple visits and medications would not be diagnosed, and most, but not all, of the comorbidities associated with untreated sleep disorders (such as congestive heart failure in undiagnosed central sleep apnea) were controlled for using the CCS as discussed above. However, consider Wickwire et al's[22] analysis of Medicare beneficiaries, which found a nearly 10-fold higher discrepancy between overall health care costs in patients with insomnia vs controls than seen in our study. Most of the $63,607 difference (compared to our $6,975) was driven by inpatient care ($60,900), which was unlikely to be for a diagnosis of insomnia but may be related to the long-term health consequences to poor sleep and possibly hypnotic therapy (eg, falls). Such costs may not be directly tied to a sleep disorder *International Classification of Disease*, *10th Revision*, code or controlled for in the CCS but clearly do have significant implications. The higher health care costs seen in this study and others when compared to ours likely reflects the broader age distribution and inclusion of all sleep disorders including less costly ones. Taken together, the figures cited

Table 2—Incremental direct health care utilization associated with sleep disorders in the United States in 2018.

Expenditure or Utilization Measure	Without SD		With SD		Difference		*P* Value
	Mean	SE	Mean	SE	Mean	SE	
Number of office visits	8.7	0.3	16.3	0.8	7.6	0.8	< .001
Number of emergency facility visits	0.37	0.02	0.52	0.03	0.16	0.03	< .001
Number of prescription fills	21.9	0.4	39.7	1.2	17.8	1.1	< .001

SD = sleep disorder, SE = standard error of the national estimate.

in this study are likely to be significant underestimates of the true financial impact of sleep disorders in US adults.

Beyond the overall financial burden, we found that patients with sleep disorders attended nearly 8 more office visits and had 18 additional medication prescriptions per year when compared to similar patients without sleep disorders. Aside from the increased costs associated with these differences (**Table 3**), it can be assumed that this increased health care utilization requires time off from work, school, or other social obligations. This further contributes to the well-established high rates of absenteeism and decreased productivity associated with the symptomatic sequelae of the sleep disorders themselves.[9,11,20]

To be sure, certain sleep disorders (eg, confusional arousals, catathrenia) are less likely to have significant health care expenses associated with them. One limitation of this study is the inability to decipher which sleep disorders contribute most to this burden. This is a limitation of the MEPS dataset that restricts diagnosis code searches to 3 characters, in this case G47.x. This is required to maintain the individual respondent's confidentiality within the dataset. As previously described, analyses have been done for several major sleep disorders such as OSA, and the objective of this study was to assess the health care burden of sleep disorders overall.

By way of comparison, analogous studies have been performed examining the incremental expenditures and health care utilization for other common chronic conditions that are often comorbid with sleep disorders. The analyses in these studies found the overall incremental expenditures to be $55.0 billion for hypertension (2001 MEPS dataset),[28] $37.2 billion for adults and children with asthma (2004),[26] $9.2 billion for migraine headaches (2013),[43] and $5.8 billion for heart failure (2011).[44] Although our analysis groups together many different disorders, $94.9 billion remains a staggering figure when one compares the prevalence rate of 5.6% for sleep disorders to 17.7% for hypertension and 7.2% for asthma.

This analysis controlled for many, but not all, medical conditions that frequently coexist with certain sleep disorders using the CCS. Consistent with previous reports, patients with sleep disorders have higher rates of medical comorbidities as measured by the CCS. Our recent study, for example, found strong associations between sleep disorders overall and coronary artery disease, stroke, emphysema, and all-cause mortality.[35] Notably, we found that individuals with sleep disorders demonstrated a much higher frequency of multiple comorbidities, with almost 15% of those with sleep disorders having 3 or more such comorbid conditions. Although we adjusted for this elevated CCS in this analysis to highlight the incremental costs, there remains the potential for the downstream effects of the interplay between sleep disorders and other chronic conditions, particularly if the underlying sleep disorder is not diagnosed and treated.

The finding that those with sleep disorders were more likely to have public insurance and be of non-Hispanic White ethnicity despite similar levels of education and marital status is not explained by our database analysis but certainly deserves further investigation.

Hillman and coauthors[9,10] found indirect costs related to sleep disorders (workplace related incidents, absenteeism/lost productivity, motor vehicle accidents) to be the major contributor to the overall economic costs associated with sleep disorders. They estimated that only 2% of the overall costs of sleep disorders were direct medical costs in Australia, an economy and society similar to the United States. If this analysis holds true in the United States, the overall economic burden on sleep disorders (ie, direct and indirect costs) may be in excess of 1 trillion dollars.

Table 3—Incremental direct health care costs associated with sleep disorders in the United States in 2018.

Expenditure or Utilization Measure	Without SD		With SD		Difference		*P* Value
	Mean	SE	Mean	SE	Mean	SE	
Total health care expense ($)	11,063	393	18,038	908	6,975	800	< .001
Total office-based expenditures ($)	2,268	114	3,962	310	1,694	277	< .001
Total prescription expenditures ($)	3,433	140	6,007	390	2,574	364	< .001
Total self-expenditures for prescription ($)	331	21	526	36	195	32	< .001

SD = sleep disorder, SE = standard error of the national estimate.

Fortunately, there is evidence that treating certain sleep disorders has a positive impact on direct and indirect costs as well as health care utilization. In a cost-effectiveness model, Sassani et al[17] found that treating all drivers with OSA with positive airway pressure therapy would be an effective means to reduce accidents, prevent deaths, and reduce cost. Potts et al[45] found considerable cost savings and reduced hospitalizations when comparing health care claims before and after an educational campaign on sleep-disordered breathing and initiation of positive airway pressure. A Canadian study demonstrated that in the 5 years following initiation of positive airway pressure for OSA, trends of increased office visits and costs were reversed.[7] Kauta et al[46] found decreased readmission rates in cardiac patients with implementation of treatment for OSA. Public education on the importance of sleep duration seems to be slowing the rates of short sleep duration in the United States.[47,48] Finally, Wickwire et al[49] recently published a systematic review OSA treatments and found improvements in quality adjusted life years and health care use.

In conclusion, a diagnosis of a sleep disorder was associated with approximately 8 additional office visits, 18 additional prescriptions, and an incremental increase in health care expenditures of almost $7,000 per individual per year. Even with a conservative prevalence instrument based on diagnosed individuals, the costs and health care utilization rates associated with sleep disorders are staggering. However, when extrapolating experiences learned from specific sleep disorders to the broader field, there is promise that increased recognition and treatment has the potential to reduce these high costs and health care utilization rates associated with sleep disorders.

ABBREVIATIONS

CCS, Charlson Comorbidity Score
MEPS, Medical Expenditure Panel Survey
OSA, obstructive sleep apnea

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DISCLOSURE STATEMENT

All authors have seen and approved this manuscript. The authors report no conflicts of interest.