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SCIENTIFIC INVESTIGATIONS

The association between sleep disorders, employment, and income among adults in the United States

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Study Objectives: To examine the association between sleep disorders, employment status, and income among US adults aged 18–64 years.

Methods: The 2018–2019 Medical Expenditure Panel Survey medical conditions file was queried for adults aged 18–64 years with a diagnosis of a sleep disorder (*International Classification of Diseases*, *10th Revision,* code G47.x) and linked to the household dataset. Comparisons in rates of wage, supplemental, and social security income as well as mean wage income were made between those with and without sleep disorders. Multivariate analyses, adjusting for demographics and comorbidities, were conducted.

Results: A sleep disorder was diagnosed in 4.4% ± 0.2% of the study population (approximately 8.8 ± 0.4 million adults aged 18–64 years in the United States; mean age 46.9 years, 55.8% female). Adults with sleep disorders were less likely to have wage income from employment (adjusted odds ratio 0.5, 95% confidence interval 0.4–0.6, $P < .001$) and more likely to have Supplemental Security (1.8, 1.4–2.4, $P < .001$) and Social Security income (2.0, 1.6–2.4, $P < .001$) compared with those without sleep disorders. Among wage-earning adults, those with sleep disorders had $2,496 less mean annual wage income compared with those without a sleep disorder ($20,445 vs $22,941, $P = .007$), adjusting for demographics and comorbidities.

Conclusions: There are significantly higher indirect costs associated with sleep disorders. This study specifically demonstrates lower employment rates, lower wages, and higher welfare income utilization among those with sleep disorders despite using a very conservative estimate of sleep disorder prevalence.

Keywords: sleep disorders, indirect costs, income, employment

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BRIEF SUMMARY

Current Knowledge/Study Rationale: Sleep disorders result in significantly higher direct and indirect costs. This study was performed to assess the indirect cost of productivity—namely, income and employment status discrepancies associated with sleep disorders in adults in the United States.

Study Impact: Sleep disorders are associated with significantly lower mean wage income and employment as well as increased rates of Supplemental and Social Security income. The potential impact of improved recognition and treatment of sleep disorders on employment rates and income deserves further investigation.

INTRODUCTION

Sleep disorders are exceptionally common and many are associated with significant quality-of-life and health consequences.[1–6] There is a growing body of literature highlighting the tremendous financial implications of sleep disorders.[7–32] From each of these diverse study designs, it is fairly clear that sleep disorders have a substantial financial footprint in terms of both direct health care costs and (indirect) societal costs.

Given that many sleep disorders negatively impact sleep quality, decreased school and workplace performance/productivity as well as increased absenteeism have been demonstrated.[33–40] A recent comprehensive estimate of total costs of sleep disorders in Australia found that roughly one-third of this cost was attributable to productivity losses.[8] What is less clear is if and to what degree does this decreased performance translate to a measurable decrease in wage income and employment amongst those with sleep disorders. The objective of this study was to determine the association between sleep disorders, employment status, and income source in the United States.

METHODS

The combined 2018–2019 Medical Expenditure Panel Survey (MEPS) was the data source for this study.[7] This study was exempt from review as it utilizes a publicly available, deidentified dataset. We previously utilized a portion of this dataset to evaluate the direct medical costs of sleep disorders.[7] Administered by the Agency for Healthcare Research and Quality, the MEPS is a set of large-scale surveys of families and individuals and their medical providers and employers across the United States conducted annually since 1996. As a household-based survey, it provides nationally representative data measuring how Americans use and pay for medical care. It has been described as the most complete source of data on the cost and

use of health care in the United States. Information on medical expenditures, conditions and events are surveyed at the household level by interview five times over a 2-year period.[41]

The *International Classification of Diseases*, *10th Revision* (ICD-10), diagnosis code of G47.x within the medical conditions component dataset was used to distinguish those with and without a sleep disorder in this cross-sectional study design. ICD-10 codes falling under G47.x include diagnoses of insomnia, hypersomnia, circadian rhythm sleep disorders, sleep apnea, narcolepsy and cataplexy, parasomnia, sleep-related movement disorders, and other/unspecified sleep disorders. The ICD-10 diagnoses codes were extracted from the linked MEPS household component medical conditions data file. The MEPS sample weight was used for statistical calculations in accordance with the weighted sample design of the MEPS. The medical conditions data file was merged with the consolidated household dataset within the 2018 and the 2019 MEPS based on the patient ID linkage variable contained within both data files. Data regarding individuals reporting income and their wage data were obtained from the consolidated household dataset component. The merged dataset was restricted to those aged 18–64 years and as many as 52 medical conditions were allowed per individual. Demographic information was compiled for those patients with and without sleep disorders. Comorbid medical conditions were calculated using the D'Hoore et al adaptation of the Charlson Comorbidity Index (CCI) for each subject.[42,43] Three categories for income were analyzed: wage income, Social Security income, and Supplemental Security income; wage income was considered as a proxy for employment-related income and therefore employment status.

Analyses for the association of decreased income and the presence or absence of a sleep disorder were conducted in two stages. First, we analyzed the association between the presence of a sleep disorder and having or not having wage income. The presence or absence of any income in each of the three income categories was tabulated and the proportions compared with a logistic regression model adjusting for age, sex, race, ethnicity, education, insurance, region, marital status, and CCI score. Adjusted odds ratios with 95% confidence intervals were computed for the likelihood of income in the three categories with the presence of a sleep disorder.

Second, selecting only adults with positive wage income (ie, adults with employment income), we then compared difference in wage income between adult patients with and without a sleep disorder by using general multivariate linear model adjusting for age, sex, race, ethnicity, education, insurance, region, marital status, and CCI score.[44] Wage income was logarithmically transformed to fulfill normal distribution criteria for the multivariate regression. Because the sample design of the MEPS survey includes stratification, clustering, multiple stages of selection, and disproportionate sampling, we utilized appropriate complex survey design statistical methods to determine nationally representative means and standard errors. Statistical significance was set at $P = .05$. As the MEPS is a structured survey with survey weights, data are reported as mean or proportion ± standard error of the estimate or 95% confidence interval as appropriate.

RESULTS

The study population (raw n = 33,680 individuals within the MEPS dataset, representing a population of 201 million adults) was 47.3% male and an average of 41.5 ± 13.6 years old (range 18–64 years). Overall, 4.4% ± 0.2% were found to have a sleep disorder, and when this sample estimate is applied to the 2020 US Census for age 18–64 years, a projected 8.8 ± 0.4 million individuals in the United States have at least one sleep disorder. Differences in patient characteristics between those with and without sleep disorders are depicted in **Table 1**. Differences in comorbidities within the CCI are shown in **Table S1** in the supplemental material.

Table 2 demonstrates that those with sleep disorders were less likely to have wage income (adjusted odds ratio, 0.5 [0.4–0.6]) and more likely to receive Supplemental and Social Security income (adjusted odds ratios, 1.8 [1.4–2.4] and 2.0 [1.6–2.4], respectively). Restricting the analysis to those adults with reported wage income and controlled for age, sex, comorbidities, ethnicity, insurance, and educational status, those with sleep disorders earned $20,445 as compared to $22,941 for those without a sleep disorder, for an annual wage decrease of $2,496 with a sleep disorder ($P = .007$; **Table 3**). As seen in **Table 3**, the income value of Social Security and Supplemental income was no different in the presence or absence of a sleep disorder.

DISCUSSION

We previously reported on the significant increase in health care utilization and costs attributable to sleep disorders using the MEPS database.[7] In his commentary, Wickwire notes that the study fell short of examining the broader economic implications of sleep disorders by not including indirect costs attributable to sleep disorders.[45] We therefore sought to utilize the MEPS database to examine what is likely to be the major, measurable contributor to such indirect costs of sleep disorders: productivity in the form of employment and wage income.

This study demonstrates significant differences in overall wage income as well as income source in those with and without sleep disorders. Individuals with a sleep disorder were significantly less likely to have wage income (ie, employed, odds ratio 0.5 [0.4–0.6], $P < .001$) and that income was on average $2,496 per year lower than those without a sleep disorder. Given that the mean annual income for those without sleep disorders was $22,941, this is a fairly substantial difference, especially when considered over the course of a lifetime of earnings. When one considers that the prevalence of moderate-to-severe obstructive sleep apnea alone may be close to 40%,[46] the presumed dramatic underestimate of sleep disorder prevalence seen here (4.4%) results in a significant number of undiagnosed, and therefore untreated, sleep disorders, within the non-sleep-disorder group. The G47.x ICD-10 code also does not capture all sleep disorders. The result of these two methodological limitations is that the discrepancies in income reported here are likely to be far greater.

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

Characteristic	Without SD		With SD		*P*
	Value	SE	Value	SE	
Age (mean years)	40.2	0.1	46.9	0.6	<.001
Sex, %					.003
Male	49.3	0.3	44.2	1.6	
Female	50.7	0.3	55.8	1.6	
Race, %					<.001
Hispanic, %	19.1	0.9	7.7	0.9	
Non-Hispanic White	58.2	1.0	76.4	1.4	
Non-Hispanic Black	12.7	0.6	9.9	1.0	
Other or multiple race	10.1	0.5	6.1	0.8	
Education, %					.071
No degree	11.9	0.4	10.3	1.0	
High school diploma	44.3	0.6	43.4	1.6	
Bachelor's degree	21.5	0.5	20.5	1.6	
Master/doctorate/other	22.2	0.5	25.8	1.4	
Marital status, %					.327
Presently married	50.2	0.5	52.1	1.8	
Presently unmarried	49.8	0.5	47.9	1.8	
Insurance, %					<.001
Private	74.8	0.7	68.9	1.8	
Public	15.3	0.5	29.7	1.7	
Uninsured	9.9	0.4	1.5	0.5	
Region, %					.373
Northeast	17.4	1.3	16.1	1.8	
Midwest	20.6	1.0	23.0	2.0	
South	37.8	1.5	38.5	2.4	
West	24.2	1.3	22.5	1.7	
Charlson Comorbidity Index					<.001
0	84.3	0.3	58.7	1.7	
1	7.6	0.2	18.0	1.2	
2	5.9	0.2	13.2	1.1	
3 or more	2.2	0.1	10.1	1.0	

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

Table 2—Source of income associated with sleep disorders in the United States in 2018.

Characteristic	Without SD		With SD		Adjusted OR (95% CI)*	*P*
	%	95% CI	%	95% CI		
Had wage income	83.3	82.5–84.0	65.2	62.1–68.3	0.5 (0.4–0.6)	<.001
Had SuS income	2.2	1.9–2.4	9.2	7.7–11.0	1.8 (1.4–2.4)	<.001
Had SoS income	4.2	3.9–4.6	17.0	14.8–19.4	2.0 (1.6–2.4)	<.001

*Adjusted for age, sex, race/ethnicity, highest educational degree, insurance coverage, region, and Charlson Comorbidity Index. CI = confidence interval, OR = odds ratio, SD = sleep disorder, SoS = Social Security income, SuS = Supplemental Security income.

Table 3—Income value associated with sleep disorders in United States in 2018.

	Without SD	With SD	Difference	*P*
Wage income	22,941	20,445	2,496	.007
SuS income	8,161	8,446	−286	.520
SoS income	10,583	11,177	−595	.111

Adjusted for age, sex, race/ethnicity, highest educational degree, insurance coverage, region, and Charlson Comorbidity Index. SD = sleep disorder, SoS = Social Security income, SuS = Supplemental Security income.

This study also demonstrated dramatically higher rates, but not amounts, of social welfare sources of income in those with sleep disorders. By way of review, Social Security income is intended for those who are over 62 years old, disabled, or blind and previously logged work credits to qualify for this federal benefit. Supplemental Social income is a distinct program from social security in that it is funded through general (non-Social-Security) taxes and provides benefits to "aged, disabled or blind individuals with little or no income" and is intended to cover basic need expenses.

The increased utilization of Social Security and Supplemental Security income is most likely explained by qualification through permanent disability and/or early withdrawal from the workplace (ie, retirement). This lends further support to the decreased rates of employment defined by the aforementioned reduced rates of wage income seen in those with sleep disorders. It is also consistent with prior reports specific to obstructive sleep apnea and insomnia that show lower rates of employment and higher rates of disability.[20,33] Although blindness is not controlled for in the CCI and certain ophthalmologic conditions are indeed associated with obstructive sleep apnea (eg, nonarteritic ischemic optic neuropathy[47]), the relative infrequency of blindness is unlikely to have a major impact on these findings. Regardless, it is quite clear that patients with sleep disorders are significantly more dependent upon these federal sources of welfare support.

There are typically four reasons for decreased productivity and therefore decreased income: absenteeism (absence from work due to illness), presenteeism (decreased productivity within the workplace), reduced employment through early retirement or termination, and early mortality.[8] Early mortality would not be assessed in this study. Absenteeism would be captured here predominantly in hourly wage employees; decreases in overall ordinary income would result from fewer hours worked. Presenteeism is likely represented by wage decreases from lack of promotions and production bonuses in both hourly and salaried professions. As mentioned, we may see the results of early retirement due to disability in the significant increases in Social and Supplemental Security income sources among those with sleep disorders.

Such a reduction in wage income and employment is only a part of the indirect costs associated with sleep disorders. Other societal burdens such as informal care costs of sleep disorders (ie, family member taking a patient to an appointment), motor vehicle and workplace accidents, deadweight losses (eg, lost taxable income), and well-being (eg, lost quality of life years) are not captured in this study. It has been estimated that collectively these represent an even larger cost than lost productivity associated with sleep disorders but are more challenging to measure.[8]

A similar study methodology has been applied to hearing loss and rheumatoid arthritis, finding differences in mean annual income of $7,791 and $8,957, respectively.[44,48] While these figures are higher than seen here for sleep disorders, the rate of undiagnosed/untreated patients within the control group is likely to be far higher in sleep disorders. Furthermore, while some sleep disorders have significant quality-of-life implications, others are relatively benign and less likely to affect workplace performance.

There are a number of limitations to this study design. First, we relied on the presence of a sleep disorder diagnosis code to assign a sampled individual to the sleep disorder cohort. Thus, there may be individuals in the non-sleep-disorder comparison cohort that were not identified. Furthermore, due to privacy reasons the MEPS is limited to three-digit diagnosis codes so we are unable to comment on the distribution of specific sleep diagnoses or the treatment status. Second, we were able to control for many comorbidities using the CCI, but not all. It is therefore possible that the findings of this study are influenced by comorbidities that associate with sleep disorders (eg, depression or anxiety and insomnia) that are not captured in the CCI but may have significant implications on workplace participation and performance. Additionally, we controlled for CCI score rather than specific comorbidities, which is a limitation of this large dataset investigation but is the standard set in previous studies of similar methodology. **Table S1** does show some significant differences in certain comorbidities within the CCI in those with and without sleep disorders. However, controlling for individual disorders in our analysis is not possible due to sample sizes for the individual disorders. Finally, due to the cross-sectional design of this study, it is not known if the sleep disorder is driving the lower income, or vice versa, for instance, if longer work hours or worrying over low income contributes to or causes the sleep disorder itself. Further research is needed to elucidate this relationship between income and the presence of sleep disorders.

As discussed, it can be assumed that undiagnosed sleep disorders are untreated and therefore reduce the effect size seen here. Although the influence of treating certain sleep disorders on reducing direct health care costs and accidents as well as improving well-being (quality of life) has been reported, to our knowledge there is no study examining the impact of treating sleep disorders and the implications on income and employment

status.[49] While it stands to reason that treating sleep disorders should have a positive effect on these outcome measures, this represents another area of future research need.

In conclusion, a diagnosis of a sleep disorder was associated with a significant decrease in having wage income (ie, employment) and a $2,496 decrease in annual wage income. There were also far higher rates of federal welfare sources of income, implying higher rates of unemployment due to significant disability.

ABBREVIATIONS

CCI, Charlson Comorbidity Index
ICD-10, *International Classification of Diseases, 10th Revision*
MEPS, Medical Expenditure Panel Survey

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DISCLOSURE STATEMENT

Both authors have reviewed and approved the manuscript. The authors report no conflicts of interest.