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Comparative Levels of Excessive Daytime Sleepiness in Common Medical Disorders

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Abstract

Introduction—Sleep restriction and sleep disorders are common causes of excessive daytime sleepiness (EDS). Medical disorders (MD) can also cause EDS, but previous studies have used non-standardized measures, selected samples, or have examined EDS in singular disorders. This study describes the relative degree of EDS associated with medical disorders to provide comparative data across a range of common medical conditions in a large unselected community-based sample.

Methods—Responses of 2612 individuals (aged 18-65) were assessed after excluding those with suspected sleep disordered breathing, narcolepsy, and shift workers. Participants across a range of medical disorders were evaluated using the Epworth Sleepiness Scale (ESS) and patient reports of nocturnal sleep.

Results—Sixty-seven percent of the sample reported a MD. The prevalence of EDS (ESS ≥ 10) was 31.4% in individuals with MD and increased as a function of number of MD (0 MD = 29.4%, 1 MD = 28.4%, 2 MD = 31.0%, 3 MD = 35.3%, 4 MD = 38.4%). Disorders which were independent predictors of EDS were ulcers OR = 2.21 (95% CI = 1.35 - 3.61), migraines OR = 1.36 (95% CI = 1.08 - 1.72), and depression OR = 1.46 (95% CI = 1.16 - 1.83) after controlling for other conditions, age, gender, time in bed, caffeine, smoking and alcohol use. Participants with ulcers had the highest prevalence of sleepiness, 50.0%, as well as the highest level of problems falling asleep (40.8%) and awakenings during the night (62.5%).

Conclusions—Individuals with ulcers, migraines, and depression have independent and clinically significant levels of EDS relative to other common MD.

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Introduction

Excessive daytime sleepiness (EDS) is defined by the inability to stay awake and alert during the major waking episodes of the day. [1] The prevalence of EDS in the general population is between 11-25%. [2-5] Excessive daytime sleepiness is an important clinical and public health concern and can lead to significant decreases in quality of life [6], an increased risk of occupational and vehicular accidents [6,7], as well as interference with tasks of daily living. [8] Profound impairment of cognitive and psychomotor performance and mood disturbance is also associated with the presence of EDS, further emphasizing its clinical significance. [9] Insufficient sleep due to poor sleep hygiene, sleep fragmentation, and circadian rhythm disturbance are common causes of excessive sleepiness. Although a variety of sleep disorders are well known causes of EDS, there is evidence that specific medical disorders (MD) play an important role as well. [10]

The Epworth Sleepiness Scale (ESS) is a validated clinical tool for the evaluation of EDS. [11] Several studies in selected populations have used the ESS to characterize EDS in separate disorders, such as neurological diseases [12,13], headache [14], depression [15], and [16] Parkinson's disease (PD). PD patients had a statistically higher ESS mean compared to controls, and there was positive correlation between ESS and disease severity. [16] In epilepsy patients, ESS was not significantly different compared with controls [17]. In patients with migraines, EDS was found at a prevalence of 37% (ESS $\geq$ 10), with a mean ESS of 8.4, in a study of 200 consecutive patients. [14] In a cross-sectional study, 57.2% from a sample of 70 patients with depression had an ESS $\geq$ 10. [14,18] In a study of sleep disorder patients, mean ESS was similar in those with or without mental disorders (12.8 vs. 12.2, $p=0.48$). But comorbidities associated with EDS were not controlled for, and ESS is known to be higher in clinic-based samples. [15] Despite separate studies of ESS measured sleepiness in specific conditions, there are limited data available comparing the relative degree of EDS across multiple medical conditions in a large community-based sample.

Several studies have investigated the relationship between EDS and general MD using a non-standardized sleepiness assessment (i.e., one question). Foley et al. used the 2003 National Foundation's annual *Sleep in America* survey to look at the association between common sleep disturbances, including daytime sleepiness, and 10 chronic MD (obesity, pain, arthritis, osteoporosis, depression, memory problems, heart disease, stroke, diabetes, and lung disease). [8] Daytime sleepiness was associated with stroke OR = 2.20 (95% CI, 1.16-4.34), depression OR = 2.19 (95% CI, 1.36-3.55) diabetes OR = 1.98 (95% CI, 1.24-3.14), lung disease OR = 1.81 (95% CI, 1.10-2.99), and body pain 1.73 (95% CI, 1.13-2.66). However, the study had a low response rate of only 23% and used an unvalidated yes-no item for the assessment of sleepiness in a limited sample of older individuals. Furthermore, the risk associated with MD was not adjusted for confounding variables and each disorder was examined separately, preventing conclusions regarding the independent contribution of specific disorders.

Clearly, EDS has been found to be prevalent in MD. In the majority of studies, however, data were gathered from samples of convenience, some with small numbers of patients, in the absence of control groups, using a non-standardized measure of EDS and in some cases without controlling for potential confounding variables. The few epidemiological studies on sleepiness and MD targeted elderly populations. [8,19,20] To date, there are no epidemiological studies that evaluated and compared EDS across specific conditions in the adult population (18 to 65 years old). The objective of our study was to characterize EDS associated with MD in a large randomly drawn adult population-based sample (18 to 65 years old), using the ESS as a standardized measure of EDS. Another goal was to provide information regarding the presence of sleep disturbances and their association with clinically significant EDS in a number of common MD encountered in the general population.

Methods

The subjects for this study were a subset (see below) of those that participated in a larger epidemiologic study assessing the relationship between daytime sleepiness and automotive accidents. The subjects were drawn from the general population of the tri-county Detroit area. The institutional review board approved all procedures, and informed consent was obtained verbally from all participants before commencing with the phone survey. Individuals were paid \$25 for study participation.

Data collection

Random digital dialing techniques were used to identify potential subjects. The calling address had to be a residence and the respondent an adult aged 18 to 65. A random probability selection procedure was used to determine the sex of the target adult. If 2 or 3 adults within the target sex were present in a household, a random probability selection procedure (oldest/second, oldest/youngest) was used to determine the target respondent. If 4 or more adults with the target sex were present in the household, the last birthday method was used to determine the target respondent. Participants completed a 20-minute telephone interview which included questions related to sleep habits, excessive sleepiness, medical and psychiatric history and disability. Individuals who could not answer the questionnaire due to sensory or mental impairment were excluded from the sample.

Out of a total 4682 participants, 3283 individuals were interviewed. The response rate, calculated by the number of interviews that were conducted relative to the number of eligible participants, was 70.1%. After exclusion (see below), 2612 individuals were included in the study. One individual was excluded because he was outside of the age range criteria. Individuals with suspected sleep disordered breathing ($n = 218$), narcolepsy ($n = 3$), and night and rotating shift workers ($n = 536$) were excluded. The total excluded was 670 subjects, who could be in more than 1 of these categories. Individuals with suspected sleep disordered breathing were defined by the presence of self-reported "loud" snoring and a $BMI \geq 34$. Narcolepsy was self-reported as diagnosed by a physician. Night and rotating shift workers were determined based on self-reported current work schedules (previous 2 weeks).

Medical disorders assessment

Participants were asked about specific and current MD which were diagnosed by their doctor. The list of MD included cardiac disease, hypertension, diabetes, chronic bronchitis or emphysema, asthma, thyroid disease, cancer, gastro-duodenal ulcers, colitis, arthritis, migraine, stroke, epilepsy or seizures, other neurological diseases, menstrual and gynecological disorders, other disorders (e.g., acid reflux, psoriasis, kidney stones, etc.), and major depression. As many patients with depression are often undiagnosed, depression was assessed using the Diagnostic Interview Schedule. [21] We further divided our sample into subjects who do not have the disorder and those who do not currently have the respective disorder.

Sleep habits assessment

Participants reported their habitual weekday and weekend total sleep time (TST) and time in bed (TIB) per 24 hours in the last 2 weeks prior to the study. TST was determined with 2 questions about how long they slept on weekdays and on weekends. TIB was determined by asking individuals their bedtime and wake time for both weekdays and weekends. The TST was calculated as a weighted average of weekdays and weekends ($[\text{week-day TST} \times 5 + \text{week-end TST} \times 2] / 7$). TIB was calculated in a similar manner. Sleep efficiency was calculated by the formula $TST/TIB \times 100$. Sleep efficiency (SE) was considered 100% if calculated SE%

was >100%. This occurred as the result of the overestimation of TST or underestimation of the TIB of some participants. Problems with falling asleep and frequent awakenings were determined by responses to the following questions regarding the past 2 weeks: “Did you have difficulty falling asleep?” and “Did you wake up more than 3 times during the night?” Participants responded with “often,” “sometimes,” “rarely” or “never.” Problems falling asleep or frequent awakenings were operationalized as individuals who reported “often” to the respective question. Alcohol intake was reported as number of drinks per week, as calculated by multiplication of the number of drinks per occasion and number of days used per week in the past 12 months. Caffeine intake per day was calculated as the addition of the average number of cups of coffee and other caffeinated beverages per day in the past 2 weeks. Smoking was assessed as the reported number of cigarettes smoked per day.

Excessive daytime sleepiness (EDS) assessment

Excessive daytime sleepiness was assessed using the Epworth Sleepiness Scale (ESS). [22] The ESS is a well validated tool [22,23] used for quantification of sleepiness. [11,22] Unlike other scales, which measure sleepiness at a single point in time, the ESS is designed to evaluate the general level of sleepiness. The ESS is an eight-item, self-administered questionnaire that is designed to provide a measure of subject’s propensity to fall asleep in a variety of situations. Similar to previous studies [5], we used a score of 10 or greater on the ESS to measure excessive sleepiness.

Statistical analysis

The statistical analyses were done using SPSS 14.0 and SAS 9.1. First, multiple regression was used to determine if number of disorders was a predictor of sleepiness while co-varying for age, gender, TIB, caffeine, tobacco, and alcohol consumption. Second, multiple regression was performed to identify specific disorders associated with sleepiness along with all covariates that were significant in the overall analysis. To understand the risk for clinical levels of sleepiness we performed a multiple logistic regression analysis to determine the relative risk for excessive sleepiness (ESS score of ≥ 10) associated with each specific condition, again using covariates from the initial analyses. In order to investigate the relationship between sleep disturbance and EDS in disorders where excessive sleepiness was present, we determined the prevalence of insomnia symptoms (i.e., difficulty falling asleep and frequent awakenings) in those with and without the respective conditions and tested differences from those without MD using Chi-Square analyses. A final analysis (multiple logistic regression) was performed to determine if differences in sleep identified in each disorder could account for the associated EDS.

Results

Demographic characteristics of the study sample in relation to census data for the United States are shown in Table 1. In general, the demographics were comparable. The mean age of the sample was 42.61 ± 12.53 . The United States Census data include individuals 15-17 years old, which accounts for the proportional difference in age categories. The study sample included somewhat fewer Caucasians and more African Americans and more subjects earning greater than \$75,000 than national averages.

The prevalence of each medical condition in our sample is presented in Tables 1 and 2 and is consistent with 2005 data from the CDC. [24] Prevalence of diseases in our sample was slightly lower, as the CDC data include all individuals with any current or previous history of the disorder. Although ulcers seem to be underrepresented, the percent of subjects with any history of ulcers in our sample was 9.3%, consistent with the CDC (8.3%). Within our sample population, 67% suffered from one or more current MD. Eight percent of individuals suffered

from 4 or more MDs. One-third of the subjects reported no MD (Table 3). Arthritis (24%), hypertension (18%), depression (16%), migraine (16%), and asthma (9%) were the most frequently reported conditions. The most frequent neurological disorders encountered were radiculopathies (n = 15), peripheral neuropathies (n = 10), and spinal injuries (n = 5). The most frequent gynecological conditions encountered were hysterectomies, dysmenorrhea, irregular and heavy menstrual periods, endometriosis and fibroid uterine tumors.

Figure 1 shows the relationship between the number of MD and the level of sleepiness. The mean ESS in subjects with MD was significantly higher compared with mean ESS in subjects without MD ($p < 0.001$ for linear trend). The prevalence of clinically significant EDS ($ESS \geq 10$) increased directly with the number of MD (Figure 2).

The mean ESS and the prevalence of EDS ($ESS \geq 10$) for each disorder are presented in Table 3. The multiple regression analysis predicting ESS score from each separate medical condition, while controlling for age, gender, TIB, caffeine, smoking, and alcohol intake was significant, $\beta = 10.07$, $t(2589) = 5.46$, $p < .001$. Ulcers, migraines, and depression were significant independent predictors of sleepiness ($p < .05$ for all). Colitis was a significant predictor of reduced sleepiness ($p < .01$).

A multiple logistic regression analysis was performed predicting EDS from the medical disorders identified as significant above to determine if these disorders were risk factors for clinical levels of sleepiness ($ESS \geq 10$). Significant independent predictors of EDS were ulcers, Odds Ratio (OR) = 2.23 (95% CI = 1.38 – 3.62), migraines OR = 1.34 (95% CI = 1.07 – 1.68), and depression OR = 1.38 (95% CI = 1.10 – 1.72). Adjusted Odds Ratios remained significant after controlling for age, gender, TIB, caffeine, smoking, and alcohol: ulcers OR = 2.21 (95% CI = 1.35 – 3.61), migraines OR = 1.36 (95% CI = 1.08 – 1.72), and depression OR = 1.46 (95% CI = 1.16 – 1.83), see Table 4.

Data for reported sleep parameters in each condition are presented in Table 3. In ulcers, migraine and depression groups there was a significantly higher reported frequency of sleep disturbances ($p < .05$ for problems falling asleep, multiple awakenings, and reduced TST) compared to those without medical conditions. Sleep disturbances were found more frequently in ulcer patients than in any other disorder. Total sleep time was significantly reduced in ulcers ($p < .001$) and migraines ($p < .001$), but not depression ($p = .11$). A final analysis was performed to determine if the sleep disturbances identified (e.g., increased awakenings, problems falling asleep, and reduced TST) in each disorder could account for the associated EDS. To test this possibility, a logistic multiple regression was performed predicting the presence of EDS (i.e., $ESS \geq 10$) from all disorders with the additional covariates of multiple awakenings, problems falling asleep, and TST. Results of this analysis indicated that while awakenings ($p < .01$) and TST ($p < .01$) were significant independent predictors of EDS, importantly, the previously identified disorders (ulcers, migraines, and depression) all continued to remain significant predictors of EDS.

Discussion

The objective of this study was to determine the relative degree of sleepiness in common medical disorders. Ulcers, migraines and depression were found to be strong independent predictors of sleepiness, even after controlling for age, gender, caffeine, alcohol, smoking, and time in bed. Sleep disturbances including difficulty falling asleep and frequent awakenings were also elevated in ulcers, migraines and depression. Significant sleep disturbance was also present in individuals with colitis, a medical condition with a decreased risk for sleepiness in the present study. But the disorder which consistently displayed the greatest degree of sleepiness and sleep disturbances was presence of ulcer. [25] Importantly, the risk for clinically

significant levels of sleepiness (ESS score ≥ 10) was also associated with these three conditions even after controlling for the degree of sleep disturbance present in each condition.

The prevalence of EDS in our study sample (24%) was similar to other epidemiological studies. [5,19] In contrast to our study of a younger adult population, previous epidemiological studies analyzed MD and sleepiness in elderly samples.[8,19,20,26] Also, previous studies focused either on general health, [19] or only on limited pre-specified MD.[8,19,27] Similar to studies in older samples [8,19], we found a significant association between depression and EDS. However, in contrast to the Foley et al. study [8], we did not find an association between stroke, diabetes, or lung disease and EDS. This could be explained by the age difference of the population studied, the use of a single item to assess EDS in the Foley et al. study. The present study extends the association previously found between poor general health and EDS [8,19, 28] [27] by demonstrating a significant relationship between the number of MD and increasing EDS and insomnia symptoms as well as the prevalence of EDS in a large representative sample of adults. This finding has significant clinical implications. For example, an important question is what level of a given medical sign or symptom should appropriately induce general practitioners or other clinicians to perform a sleep evaluation. Currently, an ESS ≥ 10 is considered clinically significant and often triggers further evaluation. Given the current strong association of ESS and the number of medical conditions, further sleep-wake evaluation should be considered in patients with multiple comorbidities.

Ulcers

The prevalence of ulcers in our sample was comparable to the prevalence found in the U.S. population. No other study has analyzed the relationship between ulcers and EDS in a similar population. Published studies in night workers who reported excessive sleepiness have shown that shift-work is associated with a two-fold risk of ulcers.[29,30] Our study extends those findings showing that even in non-shift-workers, there is a strong relationship between ulcers and EDS. This association remained after excluding shift workers and controlling for potential confounds including age, gender, caffeine, alcohol, and smoking. It is possible that previous shift-workers were present in our sample which may have accounted for some of this relationship. Individuals with ulcers in our study also had a high prevalence of sleep disturbance and medical and psychiatric comorbid disorders (≥ 4) (52.8%). However, ulcers were significantly related to EDS independently of the number of comorbid disorders as well as the degree of sleep disturbance. Further studies using objective measures of sleep are warranted.

Our study confirms previous findings of increased sleep disturbances (problems falling asleep and multiple awakenings) in individuals with ulcers and suggests that 50% of ulcer patients meet criteria for elevated sleepiness. Nakazawa found a higher frequency of increased sleep latency problems and frequent awakenings in peptic ulcer patients compared to controls. [31] He also found that individuals with peptic ulcers went to bed and awakened later compared to individuals without ulcers, a finding which would be consistent with a phase delay syndrome which could produce excessive sleepiness in some patients, although this was not specifically assessed in the present study. As previously hypothesized, sleep disturbances might predispose one to ulcers through gastrointestinal function aberrations secondary to autonomic nervous system changes. [30,32] Additional research, including prospective case-control studies, with larger samples of patients with peptic ulcer diagnosed endoscopically, will clarify the present findings in relation to specific disease processes (e.g., helicobacter pylori, pain, endocrine and other stress measures). It will be important to differentiate between gastric, pre-pyloric and duodenal ulcers, as it is thought that the latter is more likely to cause sleep disturbances.

Migraine

The prevalence of EDS and the mean ESS of participants with migraine found in our study are similar to those previously reported in the literature. [14] Similar to previous studies, we found that migraine participants had significantly more symptoms of insomnia, including problems falling asleep, multiple awakenings, decreased sleep time and decreased sleep efficiency [33], and this sleep disturbance is a risk factor for triggering migraine episodes. [37] While significant sleep disturbance was present in individuals with migraine after controlling for the presence of awakenings, problems falling asleep, and TST, migraines remained a significant predictor of clinical levels of sleepiness. This suggests that EDS could be an intrinsic symptom of migraine, rather than entirely secondary to the accompanying sleep disturbance.

Depression

EDS has been associated with depression in a number of studies. [8,18-20,34,35] We found that 37.4% of individuals with depression had EDS, significantly more than individuals without the disorder. However, a previous study found a higher prevalence of 57.1%, although its methods of data collection and use of a convenience sample make the data less compelling. [18] Using a representative population-based sample, our study is designed to calculate an accurate prevalence. Our finding is consistent with another epidemiological study that found that one-third of individuals with minor depression and one-half of individuals with major depression have EDS. Although we did not differentiate the severity of depression, the prevalence of EDS associated with depression in our study was intermediate between the prevalence found in major and minor depression in that study. [3] In contrast, Tsuno et al. showed that depressive symptoms, but not current major depression, were associated with EDS in the elderly. [26] Using objective measures of EDS, previous studies have found a normal [36] or not significantly decreased MSLT sleep latency [37] in mood disorders. However, the failure to find significantly reduced MSLT could be related to the heterogeneity of subjects in those studies that included individuals with different mood disorders: bipolar disorder, major depression, dysthymia, mania, seasonal affective disorder. Alternatively, the discrepancy could also be related to differences in the use of objective versus subjective measures in those studies. For example, it may be that the fatigue characteristic of depression may confound subjective measures of sleepiness due to the overlap of these constructs, while objective measures of sleepiness may be relatively free from such ambiguity.

Consistent with previous studies, we found that problems with falling asleep and frequent awakenings were associated with depression. [8,20] However, we found problems falling asleep related to EDS only in individuals with depression. Our finding suggests that individuals with depression and with difficulty falling asleep may be at greater risk for EDS. Two studies have shown no relationship between sleep latency and daytime sleepiness in depressed patients, using both objective [38] and subjective measures. [25] But differences in sample size, age, and depression measures used might explain these discrepancies. The use of objective measures of sleep and sleepiness in large representative samples of depressed patients are needed in order to clarify these findings.

Neurological and respiratory disorders

There is significant literature on the association between EDS and neurological disorders, specifically neurodegenerative (i.e., Parkinson) [16,39-41] and neuromuscular disorders. [42, 43] In our study, this association was not found, likely because the majority of participants with neurological disorders in our sample had radiculopathies, peripheral neuropathies, spinal injuries, and disorders not associated with EDS in previous studies. Our study also did not find an association between epilepsy and EDS, consistent with other studies. [17,44]

An important strength of the present study is the response rate of 70.1%, [11,45,46] and the sample size. The population-based data allowed us to calculate prevalence rates; specifically, we looked at the overall prevalence of EDS with increasing MD, as well as for specific disorders and their combinations. The demographics and prevalence of disease of our sample and the U.S. were comparable [24,47], allowing extrapolation to the population. The assessment of EDS was based on a validated tool used in both epidemiological and clinical evaluations. The diagnosis of depression was made with the Diagnostic Interview Schedule, a well-validated measure. [21] Previous epidemiological studies of sleep and MD were done using samples of older persons. Moreover, the majority of data come from non-population based studies, some with small number of patients, absence of control groups, and non-standardized measures of EDS and sleep disturbances. Our study results are strengthened by overcoming these deficiencies. While previous epidemiological studies targeted only the elderly population, our study shows that even in the adult population (aged 18-65 years old) there is a strong association between EDS and sleep disturbances and specifies those disorders with an independent association with clinical levels of sleepiness.

Despite these strengths, there are limitations related to the design of the present study. First, there is no objective verification of the self-reported diagnoses. For example, the methodology did not allow us to verify the presence and location of ulcers using radiographic examination. Also, we could not verify if the participants interviewed might have confused certain diseases, such as peptic ulcers with GERD, or esophageal ulcers, or migraine and other types of headaches. However, the present methodology is commonly used in epidemiological research and carries important strengths as noted. Also, prevalence rates were generally consistent with CDC reported rates. The age range used (18-65) does not allow generalizability to those greater than 65 and younger than 18 years old. Another limitation of the study was that severity of the illness or specific medication use and dose was not determined. Thus, there is the possibility that common medical treatments for the disorders studied contributed to increased rates of EDS and/or sleep disturbance. Future studies will need to assess specific aspects of disease severity as well as type and dosage and frequency of medication use. Lack of specific standardized assessment of additional sleep disorders such as restless legs syndrome was also a limitation. Due to the epidemiologic nature of the study, we could not objectively assess sleep parameters, diagnose sleep disorders using a polysomnogram (PSG), or measure the level of sleepiness using a Multiple Sleep Latency Test (MSLT). Thus, screening measures used to exclude sleep disordered breathing likely resulted in underreporting. Nevertheless, the ESS, our major outcome variable, is a standardized measure of sleepiness used in both epidemiological and clinical studies. Finally, while we are aware that sedative medications, pain, and stress might have influenced the results, the data collection method did not allow us to reliably control for these variables. Thus, while we found a relationship between medical disorders and EDS, we cannot make causal attributions since our study design was cross-sectional.

In summary, these results confirm and give more precision to the relationship between MD and sleepiness. Clearly, in managing patients suffering from these disorders, evaluating daytime sleepiness is important. Finally, while there is an abundance of data on the causes and consequences of EDS, research is needed to determine the specificity of these factors in different MD and the causal paths in various disorders.

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Figure 1.
Mean ESS score as a function of number of medical conditions $\pm$ standard error.

Figure 2.

Relationship between prevalence of excessive sleepiness and the number of current medical conditions. Overall chi-square; $P < .05$.

Table1
Demographic characteristics in the study sample

Characteristic	Study sample n=2,612	United States Census Data n=175,975,440*
Gender, %		
Male	49.6	49.1
Female	50.4	50.9
Age, yr		
18 to 24	8.9	15.4
25 to 34	20.5	22.6
35 to 44	25	25.7
45 to 54	25.9	21.4
55 to 65	19.7	14.8
Race, %		
Caucasian	71.4	75.1
African American	22.2	12.3
Asian/Pacific Islander	2.2	3.7
Native American	0.8	0.9
Other	2.6	7.9
Household income, \$ (in thousands)**		
<10	6.17	9.5
10 to <15	3.62	6.3
15 to <25	10.34	12.8
25 to <35	10.88	12.8
35 to <50	13.64	16.5
50 to <75	22.4	19.5
>75	32.91	22.5
Disorders %		CDC 2005 N=182,727 ***
Arthritis	24	25.7
Hypertension	18	16.7
Migraines	16	17.9
Asthma	9	7.1
Diabetes	5	8.9
Heart Disease	5	8
Emphysema	4	1
Ulcers	3	8.3
Cancer	1	4.6
Stroke	1	1.1

Remaining variables had less than 1% missing data

* U.S. Bureau of the Census, Census 2000 US, percentages calculated based on total individuals 18-65 years old 215 responders (8.2%) refused to provide income information.

*** Centers for Disease Control, 2005; n=total number of population with ages 18-64 years old. Individuals were asked if they ever been told by a doctor other health professional that they had the respective disease [24]

Table 2
Demographic Characteristics of the Study Sample

	% (N)	Age± SD	Gender (Male %)
Overall	100 (2612)	42.61±12.53	49.6
Arthritis	24 (608)	50.17±10.61	42.4
Hypertension	18 (439)	51.32±10.12	48.1
Migraines	16 (394)	39.69±11.21	33.5
Depression	16 (412)	42.92±11.97	36.4
Asthma	9 (232)	41.14±12.78	37.1
Thyroid	6 (144)	47.83±10.94	18.1
Heart Disease	5 (123)	51.98±10.33	56.1
Diabetes	5 (130)	53.54±9.46	50.8
Gynecological disorders	5 (125)	38.19±9.82	0
Emphysema	4 (112)	47.15±11.73	46.4
Ulcers	3 (72)	41.55±12.31	44.4
Neurological disorder	3 (65)	47.95±8.85	44.4
Colitis	1 (37)	43.69±10.95	43.2
Stroke	1 (36)	53.36±10.96	41.7
Epilepsy	1 (30)	45.26±11.47	50
Cancer	1 (26)	52.26±6.82	65.4
Other disorders	20 (576)	44.86±11.84	45.3

The number of subjects with medical conditions exceeds the total sample size because subjects could have more than one medical condition

Table 3

Epworth Sleepiness Scale, prevalence of EDS, time in bed, total sleep time and sleep efficiency $\pm$ standard deviation in subjects who report a current medical condition

MD	N [^]	Mean ESS	ESS ≥ 10 %	TIB (hrs)	TST (hrs)	SE%	Difficulty Falling Asleep (%) [¶]	Frequent Awakenings
No Medical Conditions	867	7.31 $\pm$ 4.18	29.4	7.53 $\pm$ 1.10	6.92 $\pm$ 1.09	90.92 $\pm$ 10.45	9.3	19.7
Ulcers	72	9.57 $\pm$ 5.37*	50*	7.45 $\pm$ 1.57	6.22 $\pm$ 1.32*	83.09 $\pm$ 12.95*	40.8*	62.5*
Gynecological disorders	125	8.75 $\pm$ 4.54*	36	7.75 $\pm$ 1.29*	6.73 $\pm$ 1.53	85.80 $\pm$ 15.18*	25.6*	40*
Neurological disorders	65	8.73 $\pm$ 5.26	39.7*	7.61 $\pm$ 1.58	6.59 $\pm$ 1.63	84.85 $\pm$ 14.93*	47.9*	46*
Migraines	394	8.62 $\pm$ 4.72*	37.1*	7.60 $\pm$ 1.30	6.58 $\pm$ 1.34*	85.92 $\pm$ 13.43*	29.4*	39.3*
Depression	412	8.56 $\pm$ 4.64*	37.4*	7.65 $\pm$ 1.37	6.79 $\pm$ 1.46	87.51 $\pm$ 14.92*	33.2*	41.4*
Emphysema	112	8.5 $\pm$ 5.02	35.7	7.46 $\pm$ 1.50	6.39 $\pm$ 1.57*	84.88 $\pm$ 16.46*	32.1*	47.3*
Heart Disease	123	8.4 $\pm$ 4.75	37.4*	8.01 $\pm$ 1.53*	6.96 $\pm$ 1.61	86.18 $\pm$ 15.81*	26*	47.2*
Asthma	232	8.27 $\pm$ 4.69*	32.8	7.74 $\pm$ 1.47	6.73 $\pm$ 1.48	86.73 $\pm$ 14.60*	26.7*	37.7*
Other	576	8.08 $\pm$ 4.47*	32.1	7.66 $\pm$ 1.31	6.84 $\pm$ 1.31	88.11 $\pm$ 12.33*	25.7*	36.9*
Stroke	36	8.03 $\pm$ 5.36	33.4	7.60 $\pm$ 2.19	6.13 $\pm$ 1.46*	81.09 $\pm$ 14.92*	33.3*	41.7*
Arthritis	608	7.83 $\pm$ 4.59	30.9	7.64 $\pm$ 1.35	6.64 $\pm$ 1.35*	86.39 $\pm$ 13.53*	25*	42.5*
Diabetes	130	7.71 $\pm$ 4.42	30.8	7.84 $\pm$ 1.60	6.78 $\pm$ 1.43	85.55 $\pm$ 15.29*	23.3*	38.8*
Hypertension	439	7.55 $\pm$ 4.59	30.8	7.68 $\pm$ 1.42	6.72 $\pm$ 1.33	86.82 $\pm$ 13.16*	23.1*	39.3*
Epilepsy	30	7.46 $\pm$ 4.5	39.4*	7.91 $\pm$ 1.68	6.96 $\pm$ 1.92	86.37 $\pm$ 13.95	27.6*	43.3*
Thyroid	144	7.4 $\pm$ 4.79	23.6	7.73 $\pm$ 1.24	7.09 $\pm$ 1.37	89.59 $\pm$ 10.59	22.4*	39.6*
Cancer	26	7.15 $\pm$ 4.48	19.2	7.43 $\pm$ 1.50	7.08 $\pm$ 1.58	92.54 $\pm$ 8.83	23.1	57.7*
Colitis	37	6.65 $\pm$ 4.39	21.6	7.48 $\pm$ 1.09	6.39 $\pm$ 1.29	84.42 $\pm$ 12.87*	37.8*	48.8*
Any medical Condition	1745	7.91 $\pm$ 4.54*	31.3	7.61 $\pm$ 1.33	6.79 $\pm$ 1.32	88.28 $\pm$ 12.63*	21.4*	34.1*

Abbreviations: difficulty falling asleep DFA, AWK= ≥ 3 awakenings

Abbreviations: TIB=time in bed, TST=total sleep time, SE%=sleep efficiency%, EDS=excessive daytime sleepiness, ESS=Epworth Sleepiness Scale, MD=medical disorder.

¶ percent of participants that responded “often” to the questions “you had difficulty falling asleep for >60 minutes” and “you wake up more than 3 times during the night?”; Any medical disorder refers to those in the table above.

* P<.05 vs no medical condition (t-test or Chi-Square with bonferoni correction)
^ A subject can be in more than 1 disorder category

Table 4
The Odds Ratios and Adjusted Odds Ratios for EDS in Ulcers, Migraines, and Depression
(significant multivariate predictors)

Disorder	RR	95% CI	Adjusted RR	95% CI
Ulcers	2.23*	1.38-3.62	2.21*	1.35-3.61
Migraines	1.34*	1.07-1.68	1.36*	1.08-1.72
Depression	1.38*	1.10-1.72	1.46*	1.16-1.83

* P<0.05. The adjusted RR was calculated, controlling for age, gender, TIB, caffeine, smoking, alcohol.