Effects of Gastroesophageal Reflux Disease on Sleep and Outcomes

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BACKGROUND & AIMS: Nighttime symptoms of gastroesophageal reflux disease (GERD) are prevalent and have negative effects on sleep quality. We quantified the effects of GERD symptoms on sleep difficulties and their effects on outcomes.

METHODS: Data were obtained from a patient-reported survey conducted in 2006 among the general US population. Respondents who had experienced GERD symptoms at least twice during the past month were categorized as GERD patients and were subclassified into groups on the basis of nighttime symptoms and sleep difficulties. Outcomes included health care resource use in past 6 months, work productivity and activity impairment (WPAI), and health-related quality of life (HRQOL) based on results of the Short-Form Health Survey (SF-8). Regression analysis was used to adjust for demographics and clinical characteristics. RESULTS: Of 11,685 survey respondents with GERD, 88.9% experienced nighttime symptoms, 68.3% sleep difficulties, 49.1% difficulty initiating asleep (induction symptoms), and 58.3% difficulty maintaining sleep (maintenance symptoms). Respondents with nighttime GERD symptoms were more likely to experience sleep difficulties (odds ratio, 1.53) and difficulties with induction (odds ratio, 1.43) and maintenance (odds ratio, 1.56) of sleep (P < .001 for all). Sleep difficulties were associated with 0.9 additional provider visits, a 5.5% increase in overall work impairment, a 10.9% increase in activity impairment, and reductions of 3.1 and 3.6 points in SF-8 physical and mental summary scores, respectively. CONCLUSIONS: Nighttime GERD symptoms are associated with interruption of sleep induction and maintenance and result in considerable economic burden and reduction in HRQOL.

Gastroesophageal reflux disease (GERD) is “a condition that develops when the reflux of stomach contents causes troublesome symptoms and/or complications.” GERD is a commonly occurring condition in the United States, with approximately 10% of the general population experiencing symptoms daily, and more than 40% of the US population experiences GERD in general.2–4

The impact of GERD on economic and quality of life outcomes has been documented in the literature.5–6 However, recently there has been an increased focus on the impact of timing of GERD symptoms on these outcomes, with growing evidence that the clinical impact of nighttime GERD symptoms is greater than that of daytime GERD symptoms.7 Published literature estimates that approximately 75% of patients with heartburn experience nighttime GERD symptoms.8 A study by Farup et al9 noted that those with nighttime GERD symptoms report lower health-related quality of life (HRQOL) than those without nighttime symptoms.7 A study of employed adults demonstrated a similar relationship between nighttime GERD symptoms and lower HRQOL and also found that nighttime GERD symptoms were associated with greater work loss and functional limitations.9 Nighttime GERD symptoms have also been shown to have considerable impact on sleep, including difficulty inducing and maintaining sleep,9 poorer sleep quality10 and greater daytime sleepiness and fatigue.9,10

Whereas the impact of nighttime GERD symptoms on sleep and outcomes has been demonstrated, the impact of sleep difficulties on outcomes such as work productivity loss and activity impairment has not been quantified as thoroughly.8–10 A study by Dean et al11 has demonstrated that nighttime heartburn symptoms and resulting sleep difficulties impact work productivity. Some focus has been given to HRQOL, but the effects of sleep difficulties on HRQOL and healthcare resource use have not been vigorously studied among adults with GERD.

The aims of this study were 2-fold. The first was to determine the relationship between nighttime GERD symptoms and sleep difficulties, specifically differentiating the effects on induction and maintenance of sleep. The second was to assess the effects of these GERD-related sleep difficulties on health care resource use, lost work productivity and activity impairment (WPAI), and HRQOL.

Methods

Study Design

Data were obtained from the 2006 US National Health and Wellness Survey (NHWS) (Consumer Health Sciences, Princeton, NJ), an annual cross-sectional study of the disease status, health care attitudes, behaviors, and outcomes of the adult population aged 18+. NHWS data were collected through a self-administered, Internet-based questionnaire. The questionnaire was fielded to a stratified sample of a web-based consumer panel to reflect the gender, age, and racial composition of the total US adult population. NHWS study protocol and questionnaire were reviewed and approved by the Essex Institutional Review Board (Lebanon, NJ).

Abbreviations used in this paper: BMI, body mass index; GERD, gastroesophageal reflux disease; HRQOL, health-related quality of life; NHWS, National Health and Wellness Survey; SF-8, Medical Outcomes Study Short-Form Health Survey; WPAI, work productivity and activity impairment.
Study Measures

Presence of gastroesophageal reflux disease: Respondents were asked, “Which of the following conditions did you experience in the past twelve months?” Those who selected either GERD or heartburn from a prompted list were asked further questions about these conditions including “How frequently did you experience GERD or reflux problems during the past month?” and “How often did you experience heartburn problems during the past month?” Respondents who experienced GERD and/or heartburn 2 or more times during the past month were classified as adults with GERD. Respondents who did not experience GERD or heartburn during the past 12 months were classified as adults without GERD. Respondents who experienced GERD and/or heartburn fewer than 2 times during the past month were excluded from the analyses.

Time of gastroesophageal reflux disease symptoms. Respondents who met the above criteria for experiencing GERD were further categorized as experiencing nighttime symptoms (with or without daytime symptoms) or experiencing daytime only symptoms (without nighttime symptoms). These categories were based on responses to the questions, “At what point in the day does your GERD or reflux problem occur?” and “At what point in the day does your heartburn occur?” The response set for each question included “During the day only,” “At night only,” and “Both day and night.”

Demographics and clinical characteristics. Demographics included age, gender, race, marital status, and education. Clinical characteristics included physical comorbidity, psychiatric comorbidity, body mass index (BMI), currently smoke cigarettes, prescription GERD treatment, and over-the-counter GERD treatment. Physical comorbidity was assessed as a count of physical conditions that included angina, arrhythmia, arthritis, asthma, atrial fibrillation, chronic obstructive pulmonary disease, congestive heart failure, deep vein thrombosis, diabetes, epilepsy, high blood pressure, high cholesterol, inflammatory bowel disease, irritable bowel syndrome, migraine, nasal allergies, osteoporosis, overactive bladder, peripheral arterial disease, peripheral vascular disease, psoriasis, and thyroid condition. Psychiatric comorbidity was assessed as the presence of any of the following psychiatric conditions: anxiety, bipolar disorder, depression, generalized anxiety disorder, obsessive compulsive disorder, panic disorder, phobias, post-traumatic stress disorder, or social anxiety disorder.

Sleep difficulties. Sleep difficulties were defined independently of GERD symptoms, because previous research has shown that most disruption of sleep in this population occurs without the presence of GERD symptoms. Respondents who experienced insomnia or sleep difficulty during the past 12 months were further asked to report on the frequency with which they experienced sleep difficulties. Response options included once or twice a year, every other month, once a month, a few times each month, once a week, 2-3 times per week, 4 or more times per week. Those who reported experiencing sleep difficulties at least once a month were categorized as experiencing sleep difficulties. Respondents who did not experience sleep difficulties during the past 12 months were classified as not experiencing sleep difficulties. Respondents who experienced sleep difficulties less than once per month were excluded from the analyses.

Respondents who met the above criteria for experiencing sleep difficulties were further categorized as experiencing induction symptoms and/or experiencing maintenance symptoms, on the basis of responses to the question, “Thinking of the sleeplessness or difficulty sleeping that you experience, which of the following sleep problems or symptoms do you regularly experience?” The response set included difficulty falling asleep (induction); difficulty staying asleep, waking during the night and not being able to get back to sleep (maintenance); waking several times during the night (maintenance); waking up too early (such as before the alarm clock) (maintenance).

Health care resource use. Health care resource use was assessed for a 6-month period. The metrics included number of emergency department visits, number of days hospitalized, and number of visits to medical providers.

Work productivity loss and activity impairment. Work productivity loss and activity impairment were assessed by using the general health version of the Work Productivity and Activity Impairment (WPAI) questionnaire. The WPAI is appropriate for use across occupations and disease areas, such as GERD and sleep difficulties, and has been used more extensively than any other metric of work productivity loss. The WPAI lost work productivity metrics include absenteeism (work time missed as a result of health problems), presenteeism (impairment at work), and overall work productivity loss (combination of absenteeism and presenteeism) and were assessed only for respondents who worked full-time. An additional metric of activity impairment caused by health was assessed for all respondents. All 4 WPAI metrics are expressed as impairment percentages, with higher values indicating a greater proportion of impairment.

Health-related quality of life. HRQOL was assessed for the past 4 weeks by using the Medical Outcomes Study Short-Form Health Survey (SF-8), a validated metric based on the SF-36. The 8 individual items of the SF-8 directly correspond to the SF-36 subscales (physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and mental health). The SF-8 provides physical and mental component summary scores. For both summary measures, the normative score for the US population is 50 (standard deviation of 10), with higher scores indicating better physical or mental HRQOL.

Statistical Analysis

Descriptive analyses were conducted to assess the association of GERD and time of symptoms with demographics, clinical characteristics, and sleep difficulties. Additional descriptive analyses were conducted to assess the association of sleep difficulties with demographics, clinical characteristics, health care resource use, work productivity loss and activity impairment, and HRQOL. Chi-square was used to test for significant difference in categorical variables, and analysis of variance was used to test for significant differences in continuous variables.

Separate logistic regression models were developed to determine the independent effects of GERD and time of symptoms on sleep difficulties. The specific dependent variables included...
sleep difficulties, induction symptoms, and maintenance symptoms. Separate linear regression models were developed to determine the independent effects of sleep difficulties on health care resource use, work productivity loss and activity impairment, and HRQOL. Demographics, physical comorbidity, psychiatric comorbidity, BMI, and smoking were included as potential confounders in all models. GERD treatments (using prescription medications and using over-the-counter products) were also included as potential confounders in the models of the effects of time of symptoms on sleep difficulties and the models of the effects of sleep difficulties on health care use, work productivity loss and activity impairment, and HRQOL. Because of the web-based format of the questionnaire, questions could not be skipped, and the only missing data were related to sensitive items that included a decline to answer questions. Because respondent weight included a decline to answer option, mean substitution was used in regression models for missing BMI values.

Results

Sample Characteristics

Of the 62,833 respondents to the 2006 NSHWS, 11,685 (18.6%) respondents were classified as experiencing GERD, and 29,634 (47.2%) were not as experiencing GERD. Respondents with GERD significantly differed from respondents without GERD demographically and in their comorbid conditions. Respondents with GERD were significantly more likely to be female, white, married or living with a partner, and not have a college degree than respondents without GERD (P < .001 for all). Respondents with GERD also had a greater number of physical comorbid conditions (3.1 vs 1.8, P < .001) and greater average BMI (30.1 vs 28.2, P = .024), and a higher proportion of them reported having a psychiatric comorbidity (52.1% vs 27.9%, P < .001) and currently smoking (29.2% vs 22.9%, P < .001). Among respondents with GERD, 34% reported using a prescription medication, and 56.4% reported using an over-the-counter product to treat their GERD (Table 1).

Of respondents with GERD, 10,383 (88.9%) experienced nighttime GERD symptoms (with or without daytime symptoms), and 1302 (11.1%) experienced daytime only symptoms. Respondents with nighttime symptoms significantly differed from those with daytime only symptoms in their demographics and clinical characteristics. Specifically, respondents with nighttime GERD symptoms were more likely to experience a psychiatric comorbidity (53.1% vs 44.2%, P < .001), and were more likely to currently smoke (30.0% vs 23.0%, P < .001). Respondents with nighttime GERD symptoms also were more likely to use both prescription (35.2% vs 24.8%, P < .001) and over-the-counter (56.9% vs 52.1%, P = .001) treatments for GERD than those with daytime only symptoms (Table 2).

Of respondents with GERD, 7985 (68.3%) experienced sleep difficulties, and 3703 (31.7%) did not experience sleep difficulties. Of respondents with GERD, demographics, comorbidity, and treatment profiles significantly differed for those with versus those without sleep difficulties. Respondents with GERD who experienced sleep difficulties were significantly more likely to be female, younger, nonwhite, and not a college graduate (P < .001 for all). They had a greater number of physical comorbid conditions (3.5 vs 2.2, P < .001), had greater BMI (30.6 vs 29.2, P < .001), were more than twice as likely to experience psychiatric comorbidity (64.4% vs 25.5%, P < .001), and were more likely to currently smoke (34.3% vs 23.4%, P < .001). Those with sleep difficulties were also more likely to use prescription medications but less likely to use over-the-counter products than those without sleep difficulties (Table 3).

Table 1. Characteristics of Respondents With and Without GERD

<table>
<thead>
<tr>
<th></th>
<th>With GERD (n = 11,685)</th>
<th>Without GERD (n = 29,634)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (y) (SD)</td>
<td>47.65 (15.02)</td>
<td>47.93 (16.58)</td>
<td>.113</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>6290 (53.8)</td>
<td>14,917 (50.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Nonwhite, n (%)</td>
<td>2215 (19.0)</td>
<td>7265 (24.5)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Married or living with partner, n (%)</td>
<td>7642 (65.4)</td>
<td>18,257 (61.6)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>College graduate, n (%)</td>
<td>3829 (32.8)</td>
<td>11,792 (39.8)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Clinical characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of physical comorbidities, mean (SD)</td>
<td>3.07 (2.29)</td>
<td>1.79 (1.75)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Have psychiatric comorbidity, n (%)</td>
<td>6087 (52.1)</td>
<td>8278 (27.9)</td>
<td>&lt;.001</td>
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<tr>
<td>BMI, mean (SD)</td>
<td>30.13 (7.45)</td>
<td>28.24 (6.93)</td>
<td>.024</td>
</tr>
<tr>
<td>Currently smoke, n (%)</td>
<td>4526 (29.2)</td>
<td>9532 (22.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Use prescription medication for GERD, n (%)</td>
<td>3981 (34.1)</td>
<td>6590 (56.4)</td>
<td></td>
</tr>
<tr>
<td>Use over-the-counter product for GERD, n (%)</td>
<td>6590 (56.4)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>Sleep difficulties</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience sleep difficulties, n (%)</td>
<td>7985 (68.3)</td>
<td>11,242 (37.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Experience induction symptoms with or without maintenance symptoms, n (%)</td>
<td>5733 (49.1)</td>
<td>7542 (25.5)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Experience maintenance symptoms with or without induction symptoms, n (%)</td>
<td>6816 (58.3)</td>
<td>9172 (31.0)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Experience both induction and maintenance symptoms, n (%)</td>
<td>4896 (41.9)</td>
<td>6066 (20.5)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

SD, standard deviation.

*P* values are computed by using *χ*² analysis for categorical variables and analysis of variance for continuous variables.
Table 2. Characteristics of GERD Respondents With and Without Nighttime Symptomsa

<table>
<thead>
<tr>
<th>Respondents with GERD</th>
<th>With nighttime symptoms (n = 10,383)</th>
<th>Without nighttime (daytime only) symptoms (n = 1,302)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (y) (SD)</td>
<td>47.43 (14.82)</td>
<td>49.37 (16.43)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>5586 (53.8)</td>
<td>704 (54.1)</td>
<td>.853</td>
</tr>
<tr>
<td>Nonwhite, n (%)</td>
<td>1695 (19.0)</td>
<td>246 (18.9)</td>
<td>.952</td>
</tr>
<tr>
<td>Married or living with partner, n (%)</td>
<td>6795 (65.4)</td>
<td>847 (65.1)</td>
<td>.780</td>
</tr>
<tr>
<td>College graduate, n (%)</td>
<td>3318 (32.0)</td>
<td>511 (39.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Clinical characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of physical comorbidities, mean (SD)</td>
<td>3.10 (2.30)</td>
<td>2.80 (2.13)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Have psychiatric comorbidity, n (%)</td>
<td>5512 (53.1)</td>
<td>575 (44.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>30.27 (7.52)</td>
<td>29.01 (6.81)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Currently smoke, n (%)</td>
<td>4115 (30.0)</td>
<td>411 (23.0)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Use prescription medication for GERD, n (%)</td>
<td>3650 (35.2)</td>
<td>321 (21.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Use over-the-counter product for GERD, n (%)</td>
<td>5912 (56.9)</td>
<td>678 (52.1)</td>
<td>.001</td>
</tr>
<tr>
<td>Sleep difficulties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience sleep difficulties, n (%)</td>
<td>7240 (69.7)</td>
<td>742 (57.0)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Experience induction symptoms with or without maintenance symptoms, n (%)</td>
<td>5236 (50.4)</td>
<td>497 (38.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Experience maintenance symptoms with or without induction symptoms, n (%)</td>
<td>6218 (59.9)</td>
<td>598 (45.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Experience both induction and maintenance symptoms, n (%)</td>
<td>4503 (43.4)</td>
<td>393 (30.2)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

SD, standard deviation.

aP values are computed by using χ² analysis for categorical variables and analysis of variance for continuous variables.

Effects of the Presence of Gastroesophageal Reflux Disease and Time of Gastroesophageal Reflux Disease Symptoms on Sleep Difficulties

Results of the descriptive analyses showed that respondents with GERD were significantly more likely to report experiencing sleep difficulties (68.3% vs 37.9%), including induction symptoms with or without maintenance symptoms (49.1% vs 25.5%), maintenance symptoms with or without induction symptoms (58.3% vs 31.0%), and both induction and maintenance symptoms (41.9% vs 20.5%), than respondents without GERD (P < .001 for all) (Table 1). Adjusting for differences in demographics and comorbid conditions, respondents with GERD were more than twice as likely (odds ratio, 2.09) to experience sleep difficulties, 1.75 times as likely to experience induction symptoms, and 1.89 times as likely to experience maintenance symptoms as respondents without GERD (P < .001 for all). The presence of GERD had a greater effect on maintaining sleep than initiating sleep (Figure 1).

Among respondents with GERD, those with nighttime symptoms were significantly more likely to report sleep difficulties (69.7% vs 57.0%), including both induction symptoms with or without maintenance symptoms (50.4% vs 38.2%), maintenance symptoms with or without induction symptoms (59.9% vs 45.9%), both induction and maintenance symptoms (43.4% vs 30.2%), than respondents with daytime only symptoms (P < .001 for all) (Table 2). Adjusting for demographics and clinical characteristics, respondents with nighttime GERD symptoms were 1.53 times as likely to experience sleep difficulties, 1.43 times as likely to experience induction symptoms, and 1.56 times as likely to experience maintenance symptoms compared with those with daytime only GERD symptoms (P < .001 for all) (Figure 1).

Effects of Sleep Difficulties on Health Care Resource Use, Work Productivity, and Health-Related Quality of Life

Before adjusting for potential confounders, respondents with GERD who experienced sleep difficulties had significantly greater health care resource use including more emergency department visits, days hospitalized, and visits to traditional medical providers than those without sleep difficulties (Table 4). Adjusting for demographics and clinical characteristics, there were no differences in number of emergency department visits and days hospitalized by sleep difficulties. However, respondents with GERD who experienced sleep difficulties did have more visits to traditional medical providers than those without sleep difficulties (Table 5).

Among respondents who were employed full-time, those with GERD who experienced sleep difficulties reported a substantial magnitude of work impairment as a result of presenteeism (30%) as well as overall work productivity loss (24%). In descriptive analyses, absenteeism, presenteeism, and overall work impairment were double the magnitude for those without sleep difficulties as for those with sleep difficulties (Table 4). Adjusting for differences in demographics and clinical characteristics, those with sleep difficulties continued to experience greater presenteeism (8.8%) and greater overall work impairment (5.5%) than those without sleep difficulties. Among all respondents with GERD after adjusting for potential confounders, those with sleep difficulties also had significantly greater activity impairment (10.9%) than those without sleep difficulties (Table 5).

Among respondents with GERD, HRQOL measured by both SF-8 summary scores was significantly poorer for respondents with sleep difficulties than those without (Table 4). Adjusting for demographics and clinical characteristics, GERD respondents
with sleep difficulties had SF-8 physical summary scores that were 3.10 points lower and mental summary scores that were 3.52 points lower than respondents without sleep difficulties (Table 5).

### Table 3. Characteristics of GERD Respondents With and Without Sleep Difficulties

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>With sleep difficulties (n = 7982)</th>
<th>Without sleep difficulties (n = 3703)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (y) (SD)</td>
<td>46.51 (14.25)</td>
<td>50.10 (16.28)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>4552 (57.0)</td>
<td>1738 (46.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Nonwhite, n (%)</td>
<td>1597 (20.0)</td>
<td>618 (16.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Married or living with partner, n (%)</td>
<td>5129 (64.3)</td>
<td>2513 (67.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>College graduate, n (%)</td>
<td>2457 (30.8)</td>
<td>1372 (37.1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Clinical characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of physical comorbidities, mean (SD)</td>
<td>3.45 (2.39)</td>
<td>2.24 (1.78)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Have psychiatric comorbidity, n (%)</td>
<td>5141 (64.4)</td>
<td>946 (25.5)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>30.59 (7.97)</td>
<td>29.25 (6.50)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Currently smoke, n (%)</td>
<td>2736 (34.3)</td>
<td>865 (23.4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Use prescription medication for GERD, n (%)</td>
<td>2833 (35.5)</td>
<td>1148 (31.0)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Use over-the-counter product for GERD, n (%)</td>
<td>4425 (55.4)</td>
<td>2165 (58.5)</td>
<td>.002</td>
</tr>
</tbody>
</table>

**SD**, standard deviation.

*P* values are computed by using χ² analysis for categorical variables and analysis of variance for continuous variables.

Discussion

Recent literature indicates that a substantial proportion of adults with GERD experience nighttime symptoms and that these nighttime GERD symptoms negatively affect sleep.9

**Table 4. Unadjusted Effects of Sleep Difficulties Among Respondents With GERD on Health Care Resource Use, Work Productivity, and HRQOL**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>With sleep difficulties (Mean (SD))</th>
<th>Without sleep difficulties (Mean (SD))</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare resource use</td>
<td>n = 7982</td>
<td>n = 3703</td>
<td>.001</td>
</tr>
<tr>
<td>No. of emergency department visits</td>
<td>0.47 (1.94)</td>
<td>0.19 (0.74)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>No. of days hospitalized</td>
<td>0.74 (3.45)</td>
<td>0.37 (3.16)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>No. of traditional medical provider visits</td>
<td>7.12 (10.05)</td>
<td>4.33 (5.40)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WPAI</td>
<td>n = 2875</td>
<td>n = 1497</td>
<td>.001</td>
</tr>
<tr>
<td>% Work time missed (absenteeism)³</td>
<td>7.18 (17.49)</td>
<td>3.93 (14.63)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>% Impairment while working (presenteeism)³</td>
<td>29.72 (26.30)</td>
<td>14.05 (20.91)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>% Overall work impairment⁴</td>
<td>23.58 (29.63)</td>
<td>12.29 (22.90)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Activity impairment³</td>
<td>n = 7982</td>
<td>n = 3703</td>
<td>.001</td>
</tr>
<tr>
<td>HRQOL (SF-8)</td>
<td>44.56 (30.58)</td>
<td>23.12 (26.96)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Physical summary score</td>
<td>42.18 (10.65)</td>
<td>47.65 (9.04)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Mental summary score</td>
<td>42.21 (11.00)</td>
<td>50.78 (8.47)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**SD**, standard deviation.

*P* values are computed by using analysis of variance.

³Among respondents who are employed full-time.

**Figure 1. Adjusted effects of GERD and nighttime symptoms on sleep difficulties.**
and nighttime symptoms had greater negative effects on main-

50.4%. respectively). In addition, both the presence of GERD 
experienced sleep difficulties. Maintenance symptoms were 
among GERD respondents with nighttime symptoms, 70% 
experiencing sleep difficulties within the GERD population. 

However, to date, there has been very little focus in the litera-
ture on specific types of sleep difficulties, specifically the effects 
of GERD and the time of GERD symptoms on initiating sleep 
(induction symptoms) versus maintaining sleep (maintenance 
symptoms).

In this study, nighttime symptoms and sleep difficulties were 
both highly prevalent among respondents with GERD (88.9% 
and 68.3%, respectively). However, types of sleep difficulties 
were experienced at different rates, with a higher proportion of 
respondents with GERD experiencing maintenance symptoms 
(58.3%) than induction symptoms (49.1%). Although the pres-
ence of GERD was associated with more than twice thelike-
lihood of experiencing sleep difficulties, the presence of nighttime 
symptoms themselves was associated with greater likelihood of 
experiencing sleep difficulties within the GERD population. 
Among GERD respondents with nighttime symptoms, 70% 
experienced sleep difficulties. Maintenance symptoms were 
more commonly reported than induction symptoms (59.9% and 
50.4%, respectively). In addition, both the presence of GERD 
and nighttime symptoms had greater negative effects on main-
taining sleep than initiating sleep. These results are consistent 
with those of Dubois et al18 in their study of employed GERD 
patients. Of those with nighttime symptoms, 74.8% reported 
symptoms causing waking in the night, and 68.5% reported 
trouble getting to sleep as a result of symptoms, and among 
those without nighttime symptoms, the rates were 36.5% and 
31.0%, respectively.

The current study showed that among adults with GERD, 
sleep difficulties were associated with greater use of health care 
resources and loss of work productivity and increased impair-
ment of daily activities. This is consistent with a previous study 
by Dean et al11 that demonstrated that nighttime heartburn 
symptoms and their resulting sleep difficulties negatively af-
ected work productivity. Although sleep difficulties did not 
affect missing work, they had a significant association with 
reduced productivity while working, which negatively affected 
overall work productivity. Overall, adults with GERD who 
experienced sleep difficulties had 5.5% greater work productivity 
loss than those without sleep difficulties. This will equate to a 
loss of 2.2 hours of work during a 40-hour work week. Assuming 
a 50-week work-year, sleep difficulties can be associated 
with an additional 110 hours or 2.75 weeks of lost productivity 
per year per sufferer compared with those without sleep diffi-
culties. Thus, the increased use of health care resource use 
and loss of work productivity among GERD sufferers with sleep 
difficulties contribute to increased economic burden of GERD.

Among adults with GERD, nighttime symptoms signifi-
cantly affected sleep difficulties, and sleep difficulties were neg-
atively associated with HRQOL. These results are consistent 
with a previous study that found that those with nighttime 
GERD symptoms reported lower HRQOL than those without 
nighttime symptoms.7 Among respondents with GERD who 
experienced sleep difficulties, mean SF-8 physical and mental 
summary scores were substantially poorer than the general 
population with its norm of 50. After adjusting for differences 
in demographics and clinical characteristics, the differences in 
SF-8 physical and mental summary scores between those with 
and without sleep difficulties were greater than 3 points each. A 
recent study has shown that a 3-point change in the SF-36, and 
by extension the SF-8, is a clinically meaningful difference.17 
Therefore, the negative effects of sleep difficulties on HRQOL 
were not only statistically significant but had meaningful clin-
ical implications.

Sleep difficulties were defined broadly as being experienced 
at least once per month. It is likely that greater frequency of 
sleep difficulties might have greater effects on outcomes. There-
fore, sleep symptoms might be associated with greater health 
care resource use and work productivity loss as well as poorer 
HRQOL than we have demonstrated with this broad definition. 
These greater effects would translate to greater economic bur-
den associated with GERD.

This study had several limitations with respect to the NHWS 
study design. Potential respondents were recruited through a 
web-based panel, which might have resulted in a sample that 
was not representative of the total US population. It was pos-
sible that certain segments of the US population were excluded 
from the study, such as those from lower socioeconomic 
groups, those residing in rural areas, or those who choose not 
to use the Internet.18 However, according to data from the US 
Census Bureau, 70% of adults had Internet access in 2006.19 
Data collection was based on self-administered question-
naires that were completed at a single moment in time. The 
self-reported responses were not verified against clinician diag-
noses or chart reviews. There is also the potential for recall bias. 
Because of the cross-sectional nature of this study, it is not 
possible to infer causation of sleep difficulties on health care 
resource use, work productivity, and HRQOL. Also, specific 
metrics such as overall work productivity might have varied if 
they had been measured at a different point in time.

Table 5. Summary of Adjusteda Effects of Experiencing 
Sleep Difficulties (1) Versus No Sleep Difficulties 
(0) Among Respondents With GERD on Health 
Care Resource Use, Work Productivity, and HRQOL 
(n = 11,685) 

<table>
<thead>
<tr>
<th>Health care resource use</th>
<th>Regression coefficient (B)</th>
<th>P value</th>
<th>95% Confidence interval Low</th>
<th>95% Confidence interval High</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of emergency department visits</td>
<td>0.016</td>
<td>.661</td>
<td>-0.054</td>
<td>0.085</td>
</tr>
<tr>
<td>No. of days hospitalized</td>
<td>0.088</td>
<td>.228</td>
<td>-0.055</td>
<td>0.230</td>
</tr>
<tr>
<td>No. of traditional medical provider visits</td>
<td>0.895</td>
<td>&lt;.001</td>
<td>0.536</td>
<td>1.254</td>
</tr>
</tbody>
</table>

WPAL 

% Work time missed (absenteeism)b: 0.854 .131 −0.255 1.963 

% Impairment while working (presenteeism)b: 8.782 <.001 7.209 10.355 

% Overall work impairmentb: 5.454 <.001 3.646 7.263 

% Activity impairment: 10.944 <.001 9.810 12.077 

HRQOL (SF-8): 

Physical summary score: −3.098 <.001 −3.478 −2.718 

Mental summary score: −3.522 <.001 −3.894 −3.150 

Notes: 

a Linear regression models adjust for gender, age, race, marital sta-
tus, education, number of physical comorbid conditions, experiencing 
a psychiatric condition, BMI, use of prescription medication for GERD, 
and use of over-the-counter product for GERD. 
b Among respondents who are employed full-time. Sample size of 
full-time employed is 4372.
Sleep difficulties are highly prevalent among adults with GERD, especially those who experience nighttime symptoms. These sleep difficulties result in substantial costs to the health care system by increasing provider visits. There are a greater loss of productivity to the employer and poorer HRQOL to the patient. Appropriate management of GERD must include treatment of nighttime symptoms that affect both difficulty initiating and maintaining sleep.

**Supplementary data**

Note: to access the supplementary material accompanying this article, visit the online version of *Clinical Gastroenterology and Hepatology* at www.cghjournal.org.

**References**


**Reprint requests**

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**Conflicts of interest**

The authors disclose the following: Reema Mody is an employee of Takeda Pharmaceuticals North America, Inc, Deerfield, IL. (At the time of study conduct and analysis she was an employee of TAP Pharmaceutical Products Inc, Lake Forest, IL, now a part of Takeda Pharmaceuticals North America, Inc.). Susan C. Bolge is an employee of Consumer Health Sciences, Princeton, NJ. Hema Kannan is an employee of Consumer Health Sciences, Princeton, NJ. Ronnie Fass serves as a consultant to Takeda, AstraZeneca, GSK, P&G, Adelex, Pfizer, Vecta, Eisai, and Salix. He has research funding from Takeda, Wyeth, AstraZeneca, and Sucampo.

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