

# The Cost of Poor Sleep: Workplace Productivity Loss and Associated Costs

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**Objective:** To assess the impact of sleep disturbances on work performance/productivity. **Methods:** Employees ( $N = 4188$ ) at four US corporations were surveyed about sleep patterns and completed the Work Limitations Questionnaire. Respondents were classified into four categories: insomnia, insufficient sleep syndrome, at-risk, and good sleep. Employer costs related to productivity changes were estimated through the Work Limitations Questionnaire. Performance/productivity, safety, and treatment measures were compared using a one-way analysis of variance model. **Results:** Compared with at-risk and good-sleep groups, insomnia and insufficient sleep syndrome groups had significantly worse productivity, performance, and safety outcomes. The insomnia group had the highest rate of sleep medication use. The other groups were more likely to use nonmedication treatments. Fatigue-related productivity losses were estimated to cost \$1967/employee annually. **Conclusions:** Sleep disturbances contribute to decreased employee productivity at a high cost to employers.

Sleep disorders are among the most common presenting problems encountered by clinicians.<sup>1,2</sup> According to a 2005 National Institutes of Health consensus statement, 30% of adults in the United States (US) had disrupted sleep and 10% had symptoms of daytime functional impairment consistent with insomnia.<sup>3</sup> In the 2008 National Sleep Foundation (NSF) annual Sleep in America poll, 32% of respondents reported getting a good night's sleep only a few times per month or less.<sup>4</sup> Fifteen percent had symptoms of sleep apnea, and 11% had insomnia symptoms such as difficulty falling or staying asleep, awakening during the night, and awakening too early.<sup>4</sup> For some individuals, insomnia can be chronic, persisting for  $\geq 6$  months.<sup>5</sup>

Despite the high prevalence of sleep problems and related disorders (eg, restless leg syndrome [RLS]), their detection, diagnosis, and treatment are inadequate. In the United States, only about 20% of the estimated 20 million individuals with sleep apnea have been diagnosed and treated.<sup>4,6</sup> Similarly, only 1% of respondents to the 2008 NSF poll were receiving treatment for RLS, a proportion far lower than the actual percentage of adults who have this disorder, as indicated by surveys and polls (5% to 28%).<sup>2,4,7</sup> In addition, gaps in the diagnosis and treatment of insomnia are presumed to occur because the disorder is often regarded by physicians and individuals as a personal choice rather than a health problem.<sup>8</sup>

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Sleep disorders carry numerous personal and societal consequences.<sup>9</sup> Research has documented that poor sleep is related to depression, suicide, anxiety, and disability,<sup>7,10,11</sup> diabetes mellitus, obesity, and hypertension.<sup>7,12–15</sup> Compared with individuals who receive adequate sleep, those who report excessive daytime sleepiness due to disturbed sleep are more vulnerable to accidents and injuries both on and off the job.<sup>4</sup>

This article reports data from a study that focused on sleep disturbances and their relation to health, safety, and performance outcomes. Work schedules (regular vs irregular) can directly affect sleep and circadian rhythms, as evidenced by a growing body of literature that has examined the effects of factors including nocturnal work and rotating shifts on employee well-being.<sup>5,8,9</sup> Results from direct comparisons between employees working regular versus irregular schedules was hypothesized to show greater health-, safety-, and performance-related risks for employees in the irregularly scheduled group.

## METHODS

### Survey Methods

#### Survey Overview and Objectives

A web-based anonymous survey, sponsored by sanofi-aventis (Bridgewater, NJ), of employees at four US-based companies, was conducted by Alertness Solutions (Cupertino, CA) between November 2006 and March 2007. The survey instrument consisted of questions required for the classification of respondents into sleep-disturbed groups, based on the American Academy of Sleep Medicine and the *Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition Text Revision)* criteria for primary and secondary insomnia and insufficient sleep syndrome (ISS).<sup>16,17</sup> The validated Work Limitations Questionnaire (WLQ) was used to assess health-related limitations in ability to work as well as associated productivity losses and costs.<sup>18,19</sup>

#### Company and Employee Inclusion Criteria

The four US-based companies constituted a convenience sample chosen to represent different industries (health care, manufacturing, ground- and air-based transportation) and geographic locations. Each company had an opportunity to review the survey instrument before its administration. In addition, study procedures were approved by an independent institutional review board.

A subset of employees at each company was randomly selected to receive an e-mail from a coordinator at each company that described the survey and its purpose and requested their participation. An embedded link made the survey available for a 2-week period. At two of the companies, employers elected to provide the employees with a participation incentive (an opportunity to enter a random drawing for gift cards at popular retailers). To ensure participant anonymity, the survey did not obtain identifying information, such as names and addresses. Completed survey forms were returned as e-mails but without a personal address sent through a generic server that provided anonymity for the respondent. The returned survey data were then written to a log file.

**TABLE 1.** Demographic and Sleep Characteristics by Sleep Group (N = 4,188)

Parameter	Insomnia (n = 403)	ISS (n = 247)	At-Risk (n = 1,660)	Good Sleep (n = 1,878)
Prevalence, %	9.6	5.9	39.6	44.8
Age, yr, mean (SD)	40.0 (10.3)	36.3 (11.0)	40.3 (11.1)	40.2 (11.4)
Male, %	38.7	54.7	50.4	59.0
BMI, mean (SD)	27.7 (5.9)	27.1 (5.1)	28.8 (6.4)	27.3 (5.3)
Sleep need, h/d, mean (SD)	7.8 (1.1)	8.0 (1.1)	7.7 (1.1)	7.5 (1.0)
Sleep total, h/d, mean (SD)	6.0 (1.2)*	5.9 (0.9)*	6.3 (1.1)*	6.7 (0.9)
Sleep latency, min, mean (SD)	32.0 (28.3)*	24.1 (20.7)*	26.8 (22.3)*	14.3 (11.7)
Awakenings/sleep period, mean (SD)	3.0 (2.1)*	2.3 (2.0)*	2.4 (2.1)*	1.5 (1.4)

\*Compared with results of the good-sleep group;  $P < 0.001$ , based on one-way ANOVA.

The survey instrument took ~20 minutes to complete, consisted of 55 questions presented in a variety of formats and was divided into two parts. The first part included questions on demographics and other general information, health status (medical and psychological conditions), sleep information, disturbed sleep treatment use and other strategies, the effects of disturbed sleep, and work scheduling. Questions were written for purposes of this survey to allow for the classification of respondents according to accepted minimum diagnostic criteria for “primary” and “secondary” insomnia and for ISS.<sup>16,17</sup> This process was not intended to provide a clinical diagnosis but rather to extend clinical diagnostic criteria to subjective survey data.

On the basis of the sleep data, employees were classified into the following four groups: insomnia (those who met the *Diagnostic and Statistical Manual of Mental Disorders [Fourth Edition Text Revision]* minimum criteria for primary insomnia and included secondary insomnia), ISS (those who met the criteria for ISS based on the American Academy of Sleep Medicine diagnostic classification system), at-risk (those who did not meet the criteria for primary insomnia and reported a medical, psychological, or sleep condition and at least one sleep complaint), and good sleep (those who did not meet the criteria for any of the other groups and reported no more than one sleep complaint) (Table 1).

The second portion consisted of the 25-item WLQ,<sup>18,19</sup> a validated instrument for measuring the degree to which health-related problems interfere with job performance and productivity. The WLQ includes four subscales that measure on-the-job time management, physical performance, mental performance, interpersonal functioning, and output.

An additional series of questions was developed and written for this project asking about work performance problems related to memory, concentration, decision-making, social functioning, communication, and attention while at work. Safety outcomes examined included unintentional sleeping while at work, injuring oneself at work due to tiredness or sleepiness, nodding off while driving, and poor driving/accidents due to tiredness or falling asleep while driving.

### Statistical Methods

The analysis included employees who completed all survey questions pertaining to the classification criteria for insomnia and ISS, all WLQ questions, and  $\geq 90\%$  of the other survey questions. Statistical comparisons of individual survey items, as well as WLQ subscale scores, were made among the four sleep groups using a one-way analysis of variance model for continuous data or  $\chi^2$  tests for proportional data. Microsoft Excel and JMP statistical software (2004, SAS Institute, Cary, NC) were used for data processing and analysis. For continuous measures, post hoc pairwise comparisons

were conducted using the Tukey–Kramer Honestly Significant Difference test. All statistical comparisons were two-sided and conducted at a significance level of 0.05.

Mean salary figures were provided by three of the participating companies. For the fourth company, mean salary data were determined for similar companies in the same industry, and an overall industry mean figure was applied to calculations for that company. Productivity costs were estimated using this wage data and a validated algorithm based on WLQ scores.

## RESULTS

### Participants and Sleep Information

Among the 26,175 workers invited to participate, 4188 (16% response rate) completed the survey. The sample consisted of respondents located in 45 of the 48 contiguous states. On average, employees had been with their present employer  $7.3 \pm 7.8$  years. At the time of the survey, 31% held managerial positions, 22% held technical positions, 18% held administrative positions, and 29% held “other” positions. Most (65%) were married and were in generally good health; 16.5% said they had a general medical condition whereas 7.5% stated that they had a psychological condition. Approximately two thirds (66.8%) were overweight or obese (ie, had a body mass index of  $\geq 25$  kg/m<sup>2</sup>). Among the participants diagnosed with a sleep disorder by a physician ( $n = 395$  [9.4%] of 4188), sleep-disordered breathing was the most common disorder (57.1%), followed by insomnia (27.6%) and RLS (14.4%).

Respondents reported working a mean of  $9.3 \pm 1.5$  hr/d and, given the variety of modern work schedules, additional analyses were conducted that compared individuals with regular ( $n = 2080$ ) versus those with irregular ( $n = 2180$ ) schedules. Irregular schedules were defined as work periods that included rotating shifts, weekends, nights, changing start and end times, and work outside traditional daytime hours (7 AM to 6 PM). Individuals who worked irregular schedules worked more hours daily (9.8 vs 8.8) and weekly (47.4 vs 43.9) than those with regular schedules, and 65% reported working some overtime.

Respondents stated that they needed an average sleep time of  $7.6 \pm 1.0$  hr/d to feel rested, but length of sleep averaged  $6.4 \pm 1.0$  hr/d. Table 1 indicates the demographic and sleep characteristics of the respondents by sleep group. Respondents in the insomnia, ISS, and at-risk groups reported significantly shorter total sleep times, longer sleep latencies, and more awakenings than the good-sleep respondents (all  $P < 0.001$ ).

Individuals who worked irregular schedules reported more impaired sleep than those on regular schedules. They reported less

total sleep (6.3 vs 6.5;  $P < 0.001$ ), more awakenings (2.2 vs 2.0;  $P < 0.001$ ), and worse sleep quality ratings (5.7 vs 6.0;  $P < 0.001$ ). In addition, more workers with irregular schedules were classified as insomnia or ISS (17.3% vs 13.8%;  $P < 0.01$ ), and fewer were in the good-sleep category (40.5% vs 49.2%;  $P < 0.001$ ).

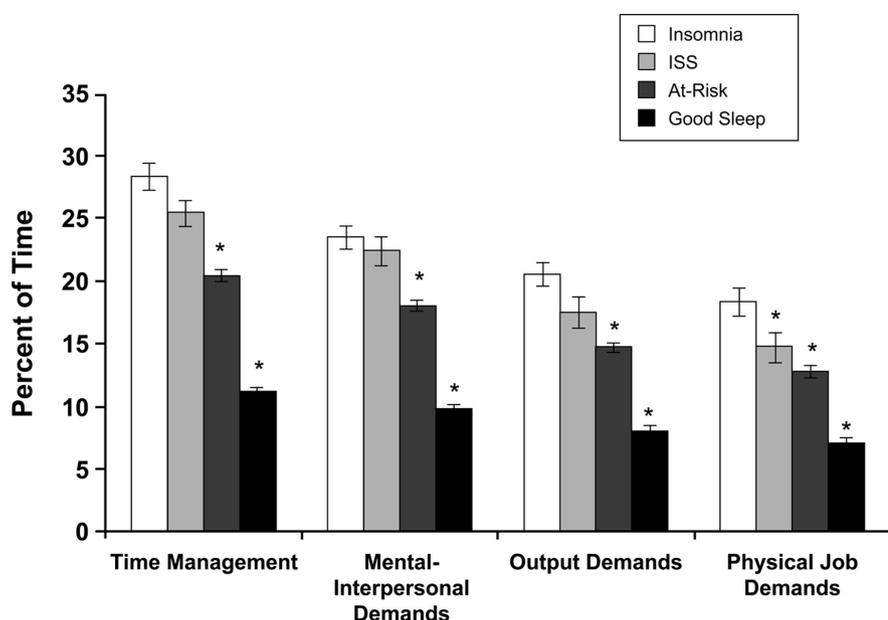
### On-the-Job Productivity

Figure 1 illustrates the mean WLQ subscale scores for each sleep group. Compared with individuals in the at-risk and good-sleep groups, respondents in the insomnia and ISS groups had significantly greater decrements in their ability to perform work tasks. Significant differences occurred on each of the four scales with time management having the highest (poorest) scores. Mean productivity loss (Fig. 2) was significantly higher for the insomnia group (6.1%) than for the at-risk (4.6%) and good-sleep (2.5%)

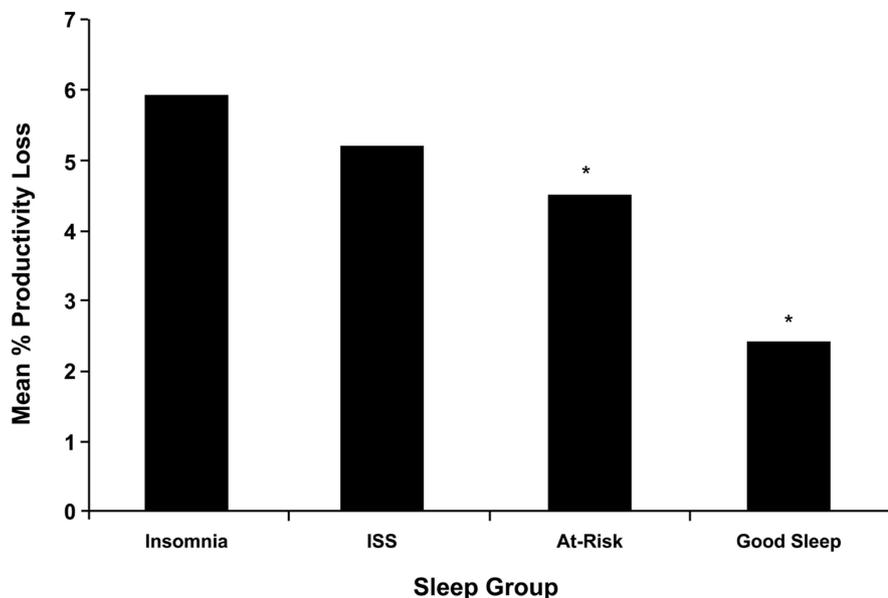
groups (all  $P < 0.05$ ). The ISS group had an intermediate level of productivity loss (5.5%).

### On-the-Job Performance

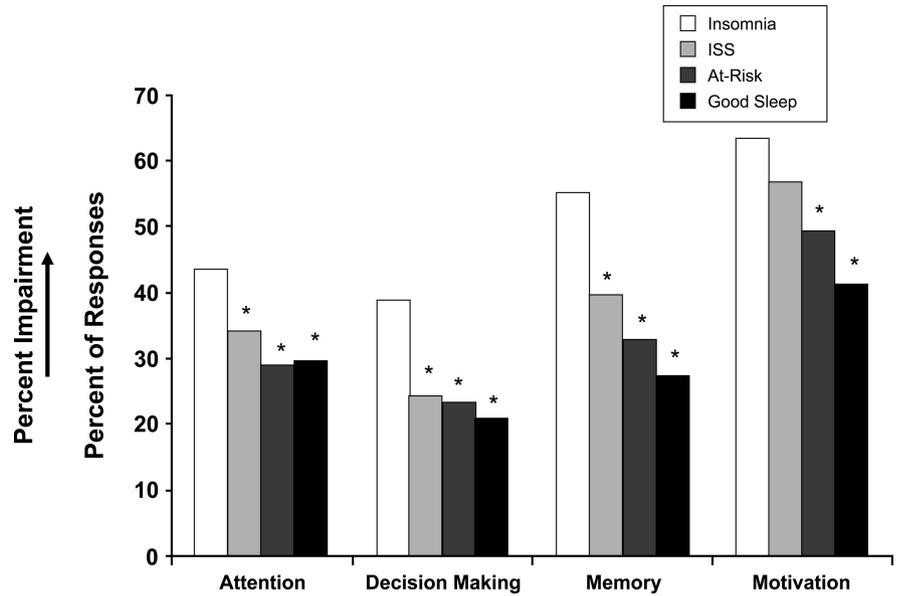
Highly negative effects of sleepiness or fatigue at work were seen in a broad range of responses to the individual survey questions. Figure 3 shows that, compared with individuals in the ISS, at-risk, and good-sleep groups, individuals in the insomnia group reported significantly greater negative effects of fatigue on attention, decision-making, memory, and motivation at work. Similar negative effects were seen in the insomnia group for survey items assessing the ability to concentrate, social functioning, and communication (all  $P < 0.01$  vs the at-risk group and  $P < 0.001$  vs the good-sleep group).



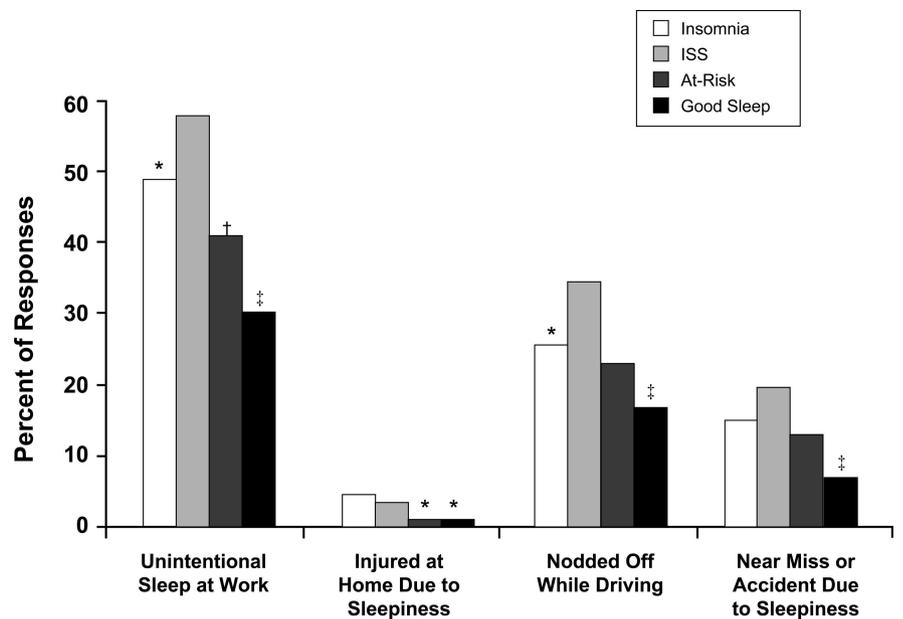
**FIGURE 1.** Percent work time with performance limited, by work dimension and sleep group. \*Versus insomnia group;  $P < 0.05$ .



**FIGURE 2.** Overall average productivity loss, by sleep group. \*Versus insomnia group;  $P < 0.05$ .



**FIGURE 3.** Negative job performance while sleepy or tired, by sleep group. \*Versus insomnia group;  $P < 0.01$ .



**FIGURE 4.** Safety outcomes, by sleep group. \*Versus ISS group;  $P < 0.05$ . †Versus insomnia and ISS groups;  $P < 0.01$ . ‡Versus insomnia and ISS groups;  $P < 0.001$ .

**Safety Outcomes**

Safety was reported to be impaired in the sleep-disturbed groups across the full range of outcomes evaluated. Figure 4 illustrates that, compared with the at-risk and good-sleep groups, the insomnia and ISS groups had significantly more reports of unintentional sleep at work, injury at home due to being sleepy or tired, nodding off while driving, and having a near miss or automobile accident due to sleepiness or tiredness. Interestingly, the ISS group had significantly more reports of unintentional sleep at work and nodding off while driving than the insomnia group.

**Effects of Irregular Work Schedules**

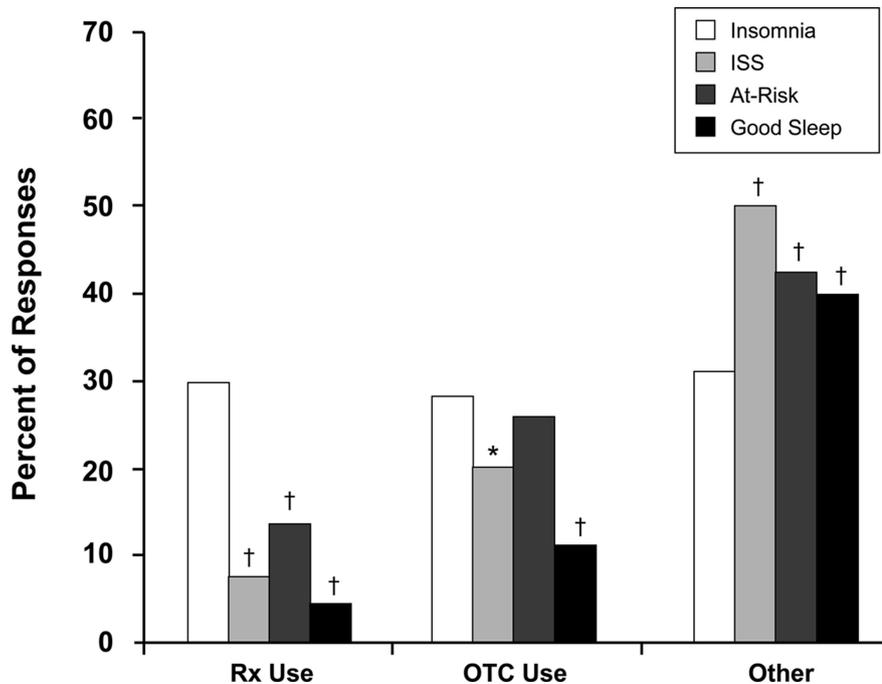
Workers on irregular schedules reported significantly greater decrements ( $P < 0.001$ ) in their on-the-job productivity for all WLQ measures compared with regular-schedule workers,

with time management showing the poorest score. Productivity loss also was greater for individuals on irregular schedules (4.2% vs 3.5%;  $P < 0.001$ ).

Individuals on irregular work schedules reported more safety-related issues, including acting in an unsafe manner (24.1% vs 13.6%;  $P < 0.001$ ), being hurt more at home due to being tired or sleepy (7.6% vs 3.9%;  $P < 0.001$ ), and more reports of falling asleep at work (40.2% vs 35.8%;  $P < 0.01$ ). Those with irregular schedules also reported more driving safety issues, including nodding off while driving (25.3% vs 16.8%;  $P < 0.001$ ) and near misses or accidents due to being tired (13.5% vs 8.1%;  $P < 0.001$ ).

**Treatment Use**

Among survey respondents as a whole, 72% reported the use of a treatment for sleep disturbances. A small portion of the sample as a whole reported having seen a physician about sleep distur-



**FIGURE 5.** Treatment of sleep disturbances, by sleep group. \*Versus insomnia group;  $P < 0.05$ . †Versus insomnia group;  $P < 0.01$ . Rx denotes prescription.

bances. As shown in Fig. 5, larger proportions of the insomnia group stated that they used over-the-counter (OTC) and/or prescription sleep medications compared with the ISS, at-risk, and good-sleep groups. Among individuals in the insomnia group, 11.7% reported the use of both an OTC and a prescription sleep medication; this is at least twice the rate of such treatment use reported by any of the other sleep groups (range, 0.6% to 5.8%) (data not shown). Conversely, other approaches used by individuals to help improve their sleep, including herbal remedies, lifestyle changes, alcohol, and relaxation techniques, were reported by significantly larger proportions of individuals in the ISS, at-risk, and good-sleep groups compared with the insomnia group (Fig. 5).

**Economic Cost of Poor Sleep**

Based on the salary figures provided by each participating company, the mean estimated annual cost per employee (expressed in 2007 \$US) of sleep-disturbance-related at-work productivity loss was greatest for the insomnia group at \$3156/employee (range among the four companies, \$2531 to \$3980). For the ISS group, the mean figure was \$2796/employee (range, \$2410 to \$3556), and for the at-risk group, it was \$2319/employee (range, \$1790 to \$2996). The good-sleep group had the lowest mean figure, \$1293/employee (range, \$1148 to \$1593). Estimated annual costs related to productivity losses per sleep group are summarized in Table 2. As shown in Table 2, extending these productivity loss/cost calculations to the total employee population at all four companies, it was estimated that work productivity loss due to insomnia, insufficient sleep, and sleep disturbances would reach a cost of \$54 million annually.

**DISCUSSION**

Although occupational medicine has demonstrated the importance and benefits of addressing a variety of health issues in the workplace (eg, cardiovascular disease, smoking, alcohol use, diabetes mellitus, back problems), insomnia and sleep disturbances are rarely the focus of public health and workplace safety initiatives.<sup>20,21</sup> Nevertheless, the competitive global economy and local issues, such as long commutes, have increased the number of people working nonstandard shifts.<sup>22</sup> This changing nature of work

**TABLE 2.** Estimated Annual Costs\* of Productivity Loss Due to Disturbed Sleep, by Sleep Group

Parameter	Insomnia	ISS	At-Risk	Good Sleep
Surveyed respondents, <i>n</i>	403	247	1,660	1,878
Mean cost per employee, \$	3,156	2,796	2,319	1,293
Estimated annual cost for sleep group as a whole, \$	1.3 M	0.7 M	3.8 M	2.4 M
Estimated annual cost for entire employee population, \$	8.9 M	4.3 M	24.3 M	16.5 M
Total estimated annual costs, \$54.0 M				

\*Costs are expressed in 2007 \$US.

and increased emphasis on productivity creates a challenge for maintaining normal sleep.<sup>8,23</sup> In addition to regular/irregular work schedules, there are a host of issues extending beyond traditional perspectives that can detrimentally affect circadian physiology, including time zone changes, extended and/or consecutive work periods, reduced time/insufficient recovery between shifts, on-call or reserve status, and day-to-night/night-to-day transitions.<sup>24</sup> Although nonbiological factors (eg, workload) can negatively influence employees, the most significant effects will occur through acute and cumulative sleep loss, disturbed sleep, and circadian clock disruption.<sup>8,23,24,25</sup> Although difficulties in initiating and maintaining normal sleep contribute to insomnia, which can result in decreased performance and safety issues, night work through a window of circadian low can also produce similar effects.<sup>8,24,25</sup> These work and schedule-related issues are likely to affect >80 million Americans<sup>26</sup> and are likely to exacerbate the prevalence of sleep problems. Minimal information is available to quantify the effects of sleep disruption and insomnia on individuals' work performance, safety, and productivity.<sup>27</sup> Potential indirect economic costs of outcomes related to lost

productivity due to insomnia and sleep disturbances also have not been well quantified.<sup>28</sup>

This survey examined sleep and sleep disturbances in >4000 employees from several work populations in four US companies. About one in 10 (9.6%) met the criteria for insomnia, whereas one in 16 (5.9%) met the criteria for ISS. The findings demonstrate that, in general, these sleep disturbances were associated with lower at-work productivity, impaired work performance, and poorer safety outcomes, based on various WLQ-derived measures, compared with scores seen for respondents in the at-risk and good-sleep groups. Although the large majority of respondents (72%) reported that they used strategies and treatments to ameliorate sleep disturbances, respondents in the insomnia group more frequently used OTC or prescription sleep medications. Fatigue-related decrements in at-work productivity were linked to significant estimated annual costs to employers, ranging from a high of \$3156/employee in the insomnia group to a low of \$1293/employee in the good-sleep group.

### Sleep and Job Performance

The current findings suggest that disturbed sleep is related to poor at-work functioning. Insomnia and ISS respondents in the present survey reported impairments in job performance and reduced productivity marked by decreased attention, memory, social and interpersonal functioning, and communication. Similar performance deficits resulting from disturbed or inadequate sleep have been firmly established by other researchers.<sup>29–31</sup> One study of sleep habits and sleep disturbances among industrial workers in Israel found that more pre-sleep and post-sleep complaints, mid-sleep disturbances, work accidents, employment dissatisfaction, and increased prevalence of asthma, hypertension, headaches, arthritis, and ulcers were noted.<sup>29–31</sup> The present findings also agree with those of a recent investigation of individuals with obstructive sleep apnea. Mulgrew et al<sup>31</sup> found that severe obstructive sleep apnea in blue-collar workers was associated with impaired time management and mental/interpersonal interactions, based on the WLQ. Moreover, subjective sleepiness, based on the Epworth Sleepiness Scale, was strongly associated with limitations in job performance according to three of the four WLQ subscales (work output, mental/interpersonal interactions, and time management).<sup>31</sup> The decrements in performance and productivity linked to sleep disturbances in the present survey and in prior research have important implications for both job safety and employer costs.

### Sleep and Safety

The current investigation raises further concerns about decreased work safety due to sleepiness or tiredness in individuals with a sleep disturbance. Average total sleep time among the insomnia group in the present sample was 6.0 hr/d, less than the average adult daily sleep need of 8 hours, which is required physiologically to maintain alertness.<sup>32</sup> Respondents who reported sleep disturbances were more likely to report unintentional sleep at work and injury to themselves or others while at work. This is not unexpected, as other researchers have found that sleep loss slowed reaction times on a psychomotor vigilance test, divided attention, reduced memory recall, and decreased self-rated qualities of performance.<sup>33</sup> Problems with safety related to inadequate sleep have also been described in health care settings, in which a strong positive relationship between level of physician fatigue and rate of patient treatment error has been observed consistently.<sup>30,34</sup>

The findings are also consistent with those of other reports highlighting a strong link between inadequate sleep and driving accidents.<sup>35,36</sup> According to the National Transportation Safety Board, sleepiness is the third leading cause of accidents in the United States.<sup>37,38</sup> The data suggest that individuals in the insomnia and ISS groups were significantly more likely than individuals in

the good-sleep group to report nodding off while driving and to have a near miss or accident due to sleepiness. Other studies have also shown that individuals with insomnia incur significantly greater direct and indirect health care costs than do individuals without insomnia.<sup>39</sup>

### Treatment Use

The use of hypnotic drugs, medications, and behavioral techniques has long been shown to be a reliable way to aid sleep. The large majority (72%) of respondents to the present survey indicated that they used at least one treatment for their sleep disturbances. However, many reported using “treatments” that do not improve sleep and may worsen it, such as alcohol. Alcohol tends to be a common choice among those with a sleep disturbance,<sup>40</sup> rather than herbal remedies or relaxation techniques.<sup>41</sup> Unfortunately, this may be ineffective as it tends to produce interrupted sleep.<sup>40,42</sup> Such use of alcohol is also risky as it is subject to the development of tolerance and dependence. Few respondents (<13%) reported having seen a physician for disturbed sleep; this included only ~30% of individuals in the insomnia group. Among individuals in this group, 30% reported the use of prescription sleep medications and 30% reported the use of relaxation techniques. This approach tends to be effective if used properly and is associated with high ratings for patient satisfaction compared with other treatment types.<sup>43</sup>

### Economic Impact

In the present investigation, decreases in productivity related to tiredness or sleepiness ranged from a high of 6.1% in the insomnia group to a low of 2.5% in the good-sleep group. Estimated costs per employee linked to productivity decreases were also highest for individuals in the insomnia group (\$3156), in contrast to a low of \$1293 in the good-sleep group. Extending the >15% of respondents classified in the insomnia and ISS groups to the total workforce for all four participating companies would result in an estimated 4000 workers affected by insomnia or insufficient sleep. The estimated cost of lost productivity associated with these individuals is \$13.2 million annually. Inclusion of the at-risk group increases the number of affected employees to >14,000, with estimated lost productivity costs of \$37.5 million. For the entire respondent group, work productivity lost due to insomnia, insufficient sleep, and sleep disturbances would reach costs of \$54 million annually. Other researchers have shown that higher costs to employers related to sleep disturbance may occur due to increased absenteeism.<sup>44</sup> In their study of health care employees, Godet-Cayré et al found that employees with insomnia were absent from work an average of 11.5 d/yr, compared with only 7 d/yr for good sleepers. Extra costs related to increased absenteeism among employees with insomnia were estimated at €1472/yr (approximately \$US 1984/yr), and employers bore most of this cost. These estimated costs of lost workplace productivity provide a strong rationale for improving the detection and treatment of insomnia and sleep disturbances and present the opportunity to reduce associated productivity deficits.<sup>45,46</sup>

### Remedies

There are a number of steps employers and employees can take to address workplace sleepiness related to sleep disturbances. Some evidence shows that workplace flexibility (allowing more flexible work start and end times) may contribute to positive lifestyle behaviors, and may play an important role in effective worksite health promotion programs.<sup>47</sup> Another possible step is to address the complex and often contentious issues related to work schedule policies and practices.<sup>26</sup> Researchers have also shown that allowing for “unwinding” time between work and home improves sleep patterns; negative work-to-home transition interference has

the potential to decrease the risk of poor sleep quality. Adequate rest between work periods and workdays may help to increase unwinding and, in turn, sleep quality.<sup>48</sup> Employers can also play a role in educating workers about the importance of sleep and how to effectively and safely manage sleep loss/fatigue through a variety of proven strategies, including naps, better managed work demands, regular exercise, duty hour considerations, and instructing them on the basics of good sleep habits.<sup>49–53</sup>

### Study Limitations

A number of the present findings are derived from responses to the WLQ, a validated and well-characterized measure of job productivity. The findings, however, should be viewed in light of a number of study limitations. First, no systematic criteria were used to select participating companies; geographic location within the 48 contiguous states was key. Whether the sample was representative of the general US population is not known. The high proportion of employees who reported nonstandard working hours (50.3%) was much higher in the current survey sample than in a recent report based on the NSF 2008 poll that indicated about 7% of the American workforce works nonstandard hours (ie, shift work).<sup>4</sup> Moreover, the survey did not obtain data regarding ethnicity. However, it should be noted that survey responses were obtained from employees located in 45 of the 48 contiguous states and represented a broad range of skills—including managerial, technical, administrative, and “other”—and income levels.

A second limitation of the study was that different methods were used to encourage employee participation; at two companies no incentives were offered, whereas at the other two companies employees who completed the survey had the opportunity to enter a drawing for gift cards. The potential impact of this difference was not examined. The low level of incentive offered may account for the low response rate obtained (16%). A third limitation was that all survey outcome measures were based entirely on self-reporting, and the extent to which responses were reliable and valid is not known.

Although survey-based measures of sleep may lack robust reliability and validity and have larger error margins compared with alternate approaches to measuring sleep (including polysomnography), it should be noted that these “gold standard” laboratory recordings would be expensive, extremely time consuming for participants, geographically difficult to obtain a large, distributed participant population, and not provide any data on the work-related aspects that would still require a subjective survey component.

### CONCLUSIONS

Insomnia and disturbed sleep were prevalent in the surveyed workforces and were associated with decreased job performance and productivity. Individuals meeting the criteria for insomnia reported the greatest losses and impairments. The associated annual economic costs due to lost productivity for the entire work population at the participating companies were estimated to be \$54 million (~\$1967/employee). Our findings highlight the potential for the improved detection and treatment of sleep disturbances to significantly improve workplace safety and productivity and reduce the associated economic costs.

### ACKNOWLEDGMENTS

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