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Sleep disorders and work performance: findings from the 2008 National Sleep Foundation Sleep in America poll

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SUMMARY Chronic sleep deprivation is common among workers, and has been associated with negative work outcomes, including absenteeism and occupational accidents. The objective of the present study is to characterize reciprocal relationships between sleep and work. Specifically, we examined how sleep impacts work performance and how work affects sleep in individuals not at-risk for a sleep disorder; assessed work performance outcomes for individuals at-risk for sleep disorders, including insomnia, obstructive sleep apnea (OSA) and restless legs syndrome (RLS); and characterized work performance impairments in shift workers (SW) at-risk for shift work sleep disorders relative to SW and day workers. One-thousand Americans who work 30 h per week or more were asked questions about employment, work performance and sleep in the National Sleep Foundation's 2008 Sleep in America telephone poll. Long work hours were associated with shorter sleep times, and shorter sleep times were associated with more work impairments. Thirty-seven percent of respondents were classified as at-risk for any sleep disorder. These individuals had more negative work outcomes as compared with those not at-risk for a sleep disorder. Presenteeism was a significant problem for individuals with insomnia symptoms, OSA and RLS as compared with respondents not at-risk. These results suggest that long work hours may contribute to chronic sleep loss, which may in turn result in work impairment. Risk for sleep disorders substantially increases the likelihood of negative work outcomes, including occupational accidents, absenteeism and presenteeism.

KEYWORDS absenteeism, occupational accidents, presenteeism, sleep disorders, sleepiness, work

INTRODUCTION

Employed Americans spend much of their time working or sleeping (Basner *et al.*, 2007), but the relationships between sleep and work in the USA are understudied. Recent studies of Americans have shown direct relationships between work hours and total sleep time. The more time an individual spends working, the less time they spend sleeping, even on non-workdays (Basner *et al.*, 2007; Krueger and Friedman, 2009).

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Americans who report sleeping <6 h per night have longer work hours, and the odds of being a short sleeper have increased for full-time workers over the past 31 years (Knutson *et al.*, 2010). As workdays become longer and technology allows us to work from home at any time in the 24-h day, there is a real need to assess how work habits impact sleep and how sleep impacts work performance in the USA. Furthermore, considering that a large proportion of the American population is at-risk for experiencing a sleep disorder (Ancoli-Israel and Roth, 1999; Hiestand *et al.*, 2006; Ohayon, 2002; Phillips *et al.*, 2006), it is particularly important to quantify work-related outcomes for these individuals.

Sleep disorders that may impact professional outcomes include insomnia, obstructive sleep apnea (OSA) and shift work sleep disorder (SWSD). Reduced productivity (often termed presenteeism) and absenteeism are the most widely reported work performance impairments in individuals with insomnia (Daley *et al*., 2008; Erman *et al*., 2008; Godet-Cayre *et al*., 2006; Kleinman *et al*., 2009; Leger *et al*., 2002, 2006; Ozminkowski *et al*., 2007; Walsh *et al*., 2007). Occupational accidents were more common among French employees characterized as experiencing severe insomnia as compared with matched good sleepers (Leger *et al*., 2002). Individuals with OSA report more problems with concentration and learning, and higher rates of occupational accidents and injuries as compared with non-snoring controls (Lindberg *et al*., 2001; Spengler *et al*., 2004; Ulfberg *et al*., 1996). Recently, SWSD has emerged as an area of interest for occupational medicine. Literature on this disorder remains sparse, and the disorder itself has not been clearly defined. There are no published studies that have considered the effects of SWSD on work performance. However, there is emerging evidence to suggest increased morbidity in shift workers (SW) with sleep problems. When compared with SW without sleep complaints, SW with symptoms of insomnia or excessive sleepiness report a fourfold increase in ulcers, more than twice the rate of depression and more frequent sleepiness-related accidents (Drake *et al*., 2004).

We sought to address several gaps in the existing literature on work and sleep in the present study. First, most previous studies have relied on liberal definitions of sleep disorders, which may overestimate the impact of sleep disturbances on work performance. Studies using more strict criteria to define those at-risk for sleep disorders are needed to describe the specific contributions of likely sleep disorders to work problems for Americans. Moreover, most of the research on work correlates of individuals with sleep disorders has quantified outcomes using variables such as absenteeism and occupational accidents, which are low-incidence events and may not fully capture the nature or scope of work-related impairment for these individuals. Sleep disorders likely adversely affect day-to-day on-the-job performance, such as cognitive impairments, mood problems that impact relationships with co-workers and presenteeism (i.e. being physically present at a job but unable to perform to capacity because of physical or mental illness), yet these variables have received less attention in the literature. Finally, no research studies published to-date have examined work performance outcomes for individuals at-risk for restless legs syndrome (RLS) or SW at-risk for SWSD.

In the present study, data from the 2008 National Sleep Foundation's (NSF) Sleep in America poll, a national survey of American workers, were used to quantify and characterize the reciprocal relationships between work and sleep. We hypothesized that those participants who reported working long hours would report shorter total sleep times, more daytime sleepiness and poorer work performance. With respect to the relationship between sleep and work, we predicted that individuals who reported poorer sleep quality or short sleep times would also report more negative work outcomes. We also hypothesized that participants classified as at-risk for any sleep disorder (insomnia, OSA, RLS) would report more negative work outcomes when compared with participants who were not classified as at-risk for any sleep disorder. Finally, we predicted that SW at-risk for SWSD would report more impairment in work performance relative to SW and day workers (DW).

MATERIALS AND METHODS

Data were obtained from the 2008 Sleep in America poll, a telephone-based annual survey conducted by the NSF. The 2008 survey focused on work and sleep. Telephone numbers were obtained from a purchased random sample, with quotas established by region based on USA population demographics. Interviews, which averaged 21 min long, were conducted over the telephone by WB&A Market Research between 25 September 2007 and 19 November 2007. Most interviews were conducted on weekdays between Eastern Standard Time 17:00 and 21:00 hours, Saturdays between 10:00 and 14:00 hours, and Sundays between 16:00 and 20:00 hours. Participants were 1000 residents of the continental USA aged 18 years or older, and working 30 h or more per week for pay. The response rate was 17%, which was calculated by dividing the number of completed interviews by the number of contacted households who refused participation or did not qualify. The response rate was lower than might be expected because only individuals who were employed 30 h or more per week qualified for the study.

Participants were asked questions regarding demographics, employment, sleep, daytime functioning and health. Institutional review board approval is not required to conduct or publish the results of a poll without any individual identifying information that is conducted by a non-profit independent organization.

Available sleep variables were used to classify participants as 'at-risk' for sleep disorders. The classification schemes were developed to be as consistent with International Classification of Sleep Disorders criteria (ICSD-2; American Academy of Sleep Medicine, 2005) as possible. Participants were considered to have insomnia symptoms if they reported difficulty with sleep onset, maintenance or early morning awakenings at least a few nights per week, and reported that daytime sleepiness interfered with their functioning at least a few days per week. The daytime sleepiness criterion served as a symptom of daytime functioning impairment related to insomnia. Risk for OSA was determined by positive scores on two or more of the following, based on the STOP questionnaire (Chung *et al*., 2008) : snoring at least a few nights per week, currently receiving treatment for hypertension, Epworth Sleepiness Scale (ESS) ≥10 or body mass index (BMI; calculated using self-reported height and weight) of 30 or greater. Participants were classified as experiencing symptoms of RLS if they reported unpleasant sensations in their legs at least a few nights per week that were worse in the evening. Participants were considered at-risk for SWSD if they were classified as SW

(defined as work start time between 18:00 and 06:00 hours) and experienced insomnia symptoms as defined above or reported excessive sleepiness (ESS ≥10).

Relationships between work and sleep variables were examined for the subset of healthy participants (those classified as not at-risk for any sleep disorder). To examine associations between work hours and sleep, chi-square tests of association and one-way ANOVAS (with Bonferroni correction for multiple comparisons) were performed between hours worked per week and sleep variables. We compared participants who reported working approximately full-time (those who worked 30–40 h per week), overtime (those who worked 41–59 h per week) and those who reported extended work hours (≥60 h). Relationships between total sleep time and work performance outcomes were assessed using one-way ANOVAS (with Bonferroni correction for multiple comparisons). To facilitate comparisons, participants were grouped by total sleep time on workdays (< 6 h; 6–8 h; > 8 h). Relationships between sleep quality (as measured by frequency of good nights of sleep per week) and work performance outcomes were assessed using *t*-tests between participants who reported a good night sleep at least a few nights per week (good sleep quality) and those who reported a good night sleep only a few times per month or less (poor sleep quality).

Logistic regressions (adjusted for the effects of age, gender and BMI) were used to predict the odds ratios [OR; with 95% confidence intervals (CI)] of various work outcomes for individuals at-risk for any sleep disorder, as well as those at-risk for insomnia, OSA and RLS. Logistic regression models using OSA as a predictor variable were not adjusted for BMI, as BMI was one of the criteria used to classify participants as at-risk for OSA. To facilitate logistic regression analyses, several variables were recoded from Likert-type scales to dichotomous variables. Variables assessing lost work time due to sleepiness (including absenteeism, arriving late to work or leaving early, and falling asleep at work) were recoded as positive for those participants who reported such occurrences more than 1 day in the past month. Negative work performance outcomes were grouped into domains, including cognitive (difficulty concentrating, difficulty with organization, mistakes), mood (becoming impatient with others at work, avoiding social interactions with co-workers, boredom) and presenteeism (decreased productivity, failure to finish assigned tasks). For the logistic regression analyses, these outcomes were recoded as positive for participants who reported such problems as occurring a few days per week or more.

RESULTS

Sample characteristics

Demographic and employment characteristics of the sample are summarized in Table 1. Participants ranged in age from 18 to 91 years. The mean age was 47 years (SD = 11). Comparison of sample demographic characteristics with the Bureau of Labor Statistics 2007 Current Population Survey data on employed persons aged 16 years and older shows that the poll sample closely matches the Current Population Survey national sample, although there were fewer Hispanic workers, more married individuals and more white collar workers in the poll sample.

Table 1 Participant characteristics

	NSF poll sample %	*CPS %*
Male	55	58
Race		
Caucasian	84	82
African–American	8	11
Hispanic	5	14
Marital status		
Married/partnered	73	58
Single	13	25
Divorced/widowed	14	16
Occupational classification		
White collar	55	45
Gray collar	23	32
Blue collar	22	23
Shift worker	7	
Annual household income		
Income < 15–35 K	16	
Income 35–50 K	15	
Income 50–75 K	24	
Income > 75 K	36	

CPS, 2007 Bureau of Labor Statistics Current Population Survey for employed Americans aged 16 years and older; NSF, National Sleep Foundation.

For the total sample, participants reported sleeping, on average, 6.7 h on workdays and 7.4 h on non-workdays, and described a total sleep need of between 7 and 8 h per night to be at their best during the next day. Approximately half of the participants (49%) reported that they experienced non-refreshing sleep a few nights per week or more, with nearly as many (42%) reporting frequent awakenings at night a few nights per week or more, and 26% reporting difficulty falling asleep a few nights per week or more. With respect to daytime sleepiness, approximately 18% of the sample scored ≥10 on the ESS, 29% reported extreme sleepiness or falling asleep at work in the past month, and 20% reported that their intimate relationships are affected by sleepiness. Nearly half the sample (48%) reported snoring a few nights per week or more.

Associations between work hours, sleep and work performance in participants not at-risk for any sleep disorder

Work hours and sleep

Basic sleep characteristics for participants not at-risk for any sleep disorder are shown in Table 2, for the subsample and by work hours category. Participants who reported working extended hours (≥60 h) reported significantly less sleep on workdays and non-workdays as compared with those who reported working full-time or overtime schedules. Significantly more participants (30%) who worked extended hours reported that their work schedule did not allow them to get enough sleep [versus 4 and 14% of full-time and overtime workers,

Table 2 Sleep characteristics by hours worked per week for participants not at-risk for any sleep disorder

	30–40 h week^{-1} *n* = 364	*41–59 h week*$^{-1}$ *n* = 189	*≥60 h week*$^{-1}$ *n* = 80	*Total not at-risk* *n* = 633
	Mean (SD) or n (%)	*Mean (SD) or n* (%)	*Mean (SD) or n* (%)	*Mean (SD) or n* (%)
TST				
TST workdays, h	6.8 (1.1)	6.9 (0.9)	6.4 (0.9)†	6.8 (1.1)
TST non-workdays, h	7.5 (1.3)	7.6 (1.2)	7.1 (1.2)‡	7.5 (1.3)
Sleep quality				
Difficulty falling asleep*	71 (20)	38 (20)	15 (19)	124 (20)
Frequent awakenings*	124 (34)	70 (37)	25 (31)	219 (35)
Unrefreshing sleep*	136 (38)	89 (48)	32 (40)	257 (41)
Daytime sleepiness				
Sleepiness interferes with daily activities*	13 (4)	5 (3)	1 (1)	19 (3)
ESS ≥10	36 (10)	23 (12)	10 (13)	69 (11)

*Occurring a few days per week or more.
†Versus 30–40 h week^{-1} and 41–59 h week^{-1}, $F_{1,600} = 8.52$, $P = 0.002$.
‡Versus 30–40 h week^{-1} and 41–59 h week^{-1}, $F_{1,601} = 4.15$, $P = 0.045$.
ESS, Epworth Sleepiness Scale; TST, total sleep time.

respectively; χ^2 (2) = 49.11, $P \leq 0.001$]. However, there were no other differences in sleep characteristics or daytime sleepiness between the groups.

Sleep and work performance

Participants who reported sleeping <6 h per night on workdays were more likely to report that their work schedule did not allow them to get enough sleep ($F_{2,629} = 9.81$, $P = 0.001$) as compared with participants who reported sleeping between 6 and 8 h or >8 h. Participants who reported sleeping <6 h per night on workdays reported more avoidance of social interactions with co-workers ($F_{1,597} = 7.95$, $P = 0.020$). No other negative work performance outcomes were observed between participants who reported sleeping <6 h and those who reported sleeping 6–8 h or >8 h. Participants who reported poor sleep quality were more likely to report problems at work, including poor concentration ($t_{257} = 5.69$, $P < 0.001$), difficulty with organization ($t_{228} = 4.04$, $P < 0.001$) and impatience ($t_{267} = 3.92$, $P < 0.001$).

Associations between risk for sleep disorders and work performance

Overall, 37% of the sample was characterized as at-risk for any sleep disorder. Ninety-six participants (9.6%) were classified as at-risk for more than one sleep disorder. Mean values for negative work outcomes by sleep disorder category are shown in Table 3. Logistic regression analyses were used to compare dichotomous negative work outcomes for those participants classified as at-risk for any sleep disorder (i.e. insomnia, OSA or RLS) and for each individual sleep disorder, relative to those classified as not at-risk for any sleep disorder.

Relative to participants classified as not at-risk for any sleep disorder, participants at-risk for any sleep disorder were more likely to report impairment in all domains examined, including cognitive: difficulty with concentration (OR = 3.32, CI = 2.08–5.29, $P < 0.001$) and problems with organization (OR = 2.76, CI = 1.56–4.9, $P = 0.001$); mood: impatience with others (OR = 1.57, CI = 1.12–2.21, $P = 0.009$), avoiding interactions with co-workers (OR = 2.24, CI = 1.3–3.85, $P = 0.004$) and boredom (OR = 1.57, CI = 1.09–2.26, $P = 0.016$); presenteeism: decreased productivity (OR = 3.26, CI = 1.83–5.81, $P < 0.001$); and missed work time due to sleepiness, including absenteeism (OR = 3.54, CI = 1.35–9.28, $P = 0.010$) and falling asleep at work (OR = 1.65, CI = 1.22–2.25, $P = 0.001$).

Relative to participants not at-risk for any sleep disorder, participants with insomnia symptoms had increased odds for reporting a variety of negative work outcomes. They reported difficulty with cognitive tasks at work, including problems with concentration (OR = 5.19, CI = 2.96–9.12, $P < 0.001$) and organization (OR = 3.44, CI = 1.69–7.00, $P = 0.001$). They were also more likely to report experiencing mood-related problems at work, including impatience (OR = 2.25, CI = 1.42–3.58, $P = 0.001$), avoiding interactions with co-workers (OR = 3.51, CI = 1.79–6.89, $P < 0.001$) and boredom (OR = 2.16, CI = 1.27–3.52, $P = 0.002$). Presenteeism was also observed in individuals at-risk for insomnia symptoms, with increased odds for reporting decreased productivity (OR = 5.49, CI = 2.75–10.95, $P < 0.001$). Furthermore, participants with insomnia symptoms were at significantly increased odds for reporting missed work time due to sleepiness, including absenteeism (OR = 6.76, CI = 2.37–19.28, $P < 0.001$), leaving work early (OR = 2.69, CI = 1.22–5.95, $P = 0.014$) and falling asleep at work (OR = 4.17, CI = 2.68–6.49, $P < 0.001$). Moreover, they also had a higher OR for experiencing an occupational accident in the past year (OR = 2.28, CI = 1.11–4.74, $P = 0.026$).

Those participants classified as at-risk for OSA, relative to participants not at-risk for a sleep disorder, were at increased odds for difficulty with cognitive tasks at work, including

Table 3 Negative work outcomes by sleep disorder

	Any sleep disorder $n = 367$		*Insomnia* $n = 109$		*OSA* $n = 247$		*RLS* $n = 108$		*Not at-risk* $n = 633$
	Mean (SD)	*t*-test	*Mean (SD)*	*t*-test	*Mean (SD)*	*t*-test	*Mean (SD)*	*t*-test	*Mean (SD)*
Cognitive									
Difficulty with concentration†	2.3 (1.2)	−4.2***	2.6 (1.4)	−5.2***	2.2 (1.1)	−2.8**	2.4 (1.3)	−3.5***	1.9 (0.9)
Problems with organization†	1.8 (1)	−2.9**	2.0 (1.2)	−3.0**	1.8 (1.0)	−2.4*	1.8 (1.1)	−2.0*	1.6 (0.9)
Mistakes†	1.7 (0.9)	−2.4*	1.8 (0.9)	−2.4*	1.6 (0.8)	−1.3	1.7 (0.9)	−1.9	1.6 (0.7)
Mood									
Impatience†	2.6 (1.3)	−2.4*	3.0 (1.4)	−4.4***	2.5 (1.3)	−0.8	2.7 (1.4)	−2.2*	2.4 (1.2)
Avoids interactions†	1.8 (1.2)	−3.3***	2.2 (1.5)	−4.2***	1.7 (1.1)	−2.2*	1.7 (1.1)	−1.2	1.5 (0.9)
Boredom†	2.3 (1.4)	−2.1*	2.6 (1.5)	−3.5***	2.3 (1.3)	−1.5	2.2 (1.3)	−0.6	2.1 (1.3)
Presenteeism									
Decreased productivity†	2 (1.1)	−4.2***	2.3 (1.2)	−4.7***	1.9 (1.1)	−3.1**	2.0 (1.1)	−2.5*	1.7 (0.8)
Failure to finish assigned tasks†	1.5 (0.8)	−2.1*	1.6 (1.0)	−2.7**	1.5 (0.8)	−1.9	1.5 (1.0)	−1.5	1.4 (0.7)
Missed work time									
Late to work‡	1.3 (0.8)	−0.9	1.5 (1.0)	−2.1*	1.2 (0.7)	−0.1	1.4 (1.1)	−1.6	1.2 (0.8)
Absenteeism‡	1.1 (0.3)	−2.5**	1.1 (0.5)	−2.5*	1.1 (0.3)	−2.2*	1.0 (0.3)	−1.0	1.0 (0.1)
Leaving early‡	1.1 (0.5)	−1.5	1.2 (0.7)	−2.2*	1.1 (0.5)	−1.2	1.1 (0.5)	−1.1	1.1 (0.3)
Falling asleep at work‡	2.0 (1.5)	−5.1***	2.7 (1.8)	−6.9***	1.9 (1.4)	−4.2***	2.0 (1.5)	−3.5***	1.5 (1.0)

For all *t*-tests, the comparison group is the 'not at-risk' sample.
†Items are scored on a Likert-type scale: 1 = never, 2 = rarely, 3 = a few days per month, 4 = a few days per week, 5 = every day or almost every day.
‡Items are scored on a Likert-type scale: 1 = never, 2 = 1 day, 3 = 2–3 days, 4 = 4–5 days, 5 = 6–10 days, 6 = >10 days.
OSA, obstructive sleep apnea; RLS, restless legs syndrome.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

problems with concentration (OR = 2.22, CI = 1.23–4.01, $P = 0.008$) and organization (OR = 2.78, CI = 1.30–5.91, $P = 0.008$). They were also more likely to report decreased productivity (OR = 3.12, CI = 1.57–6.18, $P = 0.001$). With respect to missed work time, they were at increased odds for absenteeism due to sleepiness (OR = 6.06, CI = 1.93–19.04, $P = 0.002$) and falling asleep at work (OR = 1.62, CI = 1.11–2.34, $P = 0.012$).

Relative to participants not at-risk for any sleep disorder, participants with RLS symptoms also had increased OR for difficulty with cognitive tasks at work, including problems with concentration (OR = 4.69, CI = 2.54–8.68, $P < 0.001$) and organization (OR = 4.32, CI = 1.90–9.83, $P < 0.001$); additionally, they were more likely to report experiencing impatience with co-workers (OR = 1.96, CI = 1.19–3.22, $P = 0.008$). Participants at-risk for RLS also evidenced presenteeism: they were more likely to report decreased productivity (OR = 3.99, CI = 1.85–8.62, $P < 0.001$) and failure to finish assigned tasks (OR = 4.06, CI = 1.57–10.50, $P = 0.004$). Finally, they also had increased odds of falling asleep at work (OR = 1.88, CI = 1.18–3.00, $P = 0.007$).

The effects of shift work

Of the participants classified as SW, 21% reported symptoms consistent with SWSD (1.5% of all participants). Table 4 shows mean values for negative work outcomes for SW, DW and SWSD. Logistic regressions were calculated comparing SW with DW, SWSD with DW, and SWSD with SW.

Relative to DW, SW were at increased odds for falling asleep at work (OR = 1.75, CI = 1.02–2.99, $P = 0.041$) and experiencing an occupational accident in the past year (OR = 2.77, CI = 1.27–6.02, $P = 0.01$). Relative to DW, SWSD were found to have increased odds for several negative work outcomes, including mood-related impairment, such as impatience (OR = 3.86, CI = 1.27–11.77, $P = 0.018$), avoiding interactions with co-workers (OR = 6.01, CI = 1.79–20.24, $P = 0.004$) and boredom (OR = 3.71, CI = 1.21–11.65, $P = 0.022$), as well as falling asleep at work (OR = 5.62, CI = 1.69–18.61, $P = 0.005$). They were also at an increased risk to report experiencing an occupational accident in the past year (OR = 4.36, CI = 1.15–16.48, $P = 0.03$). Relative to SW, SWSD were found to have increased odds for impatience at work (OR = 3.86, CI = 1.27–11.77, $P = 0.018$) and avoiding interactions with co-workers (OR = 6.01, CI = 1.79–20.24, $P = 0.004$).

DISCUSSION

The results from this NSF poll of American workers found that employed Americans get less sleep than they need to function well at work. When they do sleep, nearly half of the

Table 4 Negative work outcomes for SW and DW

	SW		*SWSD*		*DW*
	Mean (SD)	*t*-test	*Mean (SD)*	*t*-test	*Mean (SD)*
Cognitive					
Difficulty with concentration†	1.9 (1)	1.2	2.4 (1.4)	−1.1	2.1 (1)
Problems with organization†	1.5 (0.8)	1.9	1.6 (0.9)	0.1	1.7 (0.9)
Mistakes†	1.7 (0.9)	−0.06	2.1 (1.2)	−2.3	1.6 (0.8)
Mood					
Impatience†	2.7 (1.4)	−1.2	3.7 (1.3)	−3.7**	2.48 (1.2)
Avoids interactions†	1.7 (1.2)	−0.9	2.5 (1.5)	−2.2*	1.6 (1)
Boredom†	2.4 (1.4)	−1.2	2.9 (1.4)	−1.9	2.16 (1.3)
Presenteeism					
Decreased productivity†	1.8 (1)	0.2	2.3 (1.2)	−1.8	1.8 (0.9)
Failure to finish assigned tasks†	1.4 (0.8)	0.5	1.8 (1.1)	−1.9	1.4 (0.8)
Missed work time					
Late to work‡	1.1 (0.4)	2.9**	1.3 (0.6)	−0.2	1.3 (0.8)
Absenteeism‡	1 (0.1)	0.5	1.1 (0.3)	−0.8	1 (0.2)
Leaving work early‡	1.1 (0.4)	0.1	1.2 (0.8)	−0.7	1.1 (0.4)
Falling asleep at work‡	2.1 (1.6)	−2.2*	3.1 (1.8)	−3.0**	1.6 (1.2)

For all *t*-test comparisons, the comparison group are DW.
†Items are scored on a Likert-type scale: 1 = never, 2 = rarely, 3 = a few days per month, 4 = a few days per week, 5 = every day or almost every day.
‡Items are scored on a Likert-type scale: 1 = never, 2 = 1 day, 3 = 2–3 days, 4 = 4–5 days, 5 = 6–10 days, 6 = >10 days.
DW, day workers (n = 916); SW, shift workers (n = 67); SWSD, shift work sleep disorder (n = 14).
*$P < 0.05$; **$P < 0.01$.

participants describe poor sleep quality. Not surprisingly, a striking number of participants (29%) report extreme sleepiness or falling asleep at work in the past month, and 20% report that this sleepiness negatively affects their relationships. Long work hours are a likely contributor to the sleep problems observed in our sample. One-third of participants reported working 50 h per week or more, and 13% reported working in excess of 60 h per week.

Among those participants not classified as at-risk for a sleep disorder, working extended hours had negative effects on sleep, and short total sleep times and poor sleep quality were associated with more work impairment. Participants who reported working extended hours were much more likely to report that their work schedule interfered with their ability to sleep as much as they needed. Our hypothesis that long work hours would be associated with shorter total sleep times was supported; individuals who reported extended work hours slept more than 30 min less on average on both workdays and non-workdays, which is consistent with previous studies (Basner *et al*., 2007; Knutson *et al*., 2010; Krueger and Friedman, 2009). Participants who worked long hours did not report more daytime sleepiness or more impairment at work. This was an unexpected finding, particularly considering that these individuals slept fewer hours on both workdays and non-workdays, suggesting that they are not making up for lost sleep on non-workdays. There are a few possible explanations for this. Naturally short sleepers may self-select jobs that involve long work hours. Alternatively, they may not be cognizant of their impairments or level of sleepiness because of the effects of chronic sleep restriction (Van Dongen *et al*., 2003).

We predicted that individuals who had poor sleep quality and short total sleep times would also report more negative work outcomes. Independent of sleep duration, poor sleep quality was associated with impairments at work, including difficulty with concentration and organization, and impatience with co-workers. Participants who reported shorter total sleep times were more likely to report avoiding social interaction with colleagues at work. These findings illustrate the importance of examining sleep quality in addition to sleep duration.

Risk for sleep disorders, which are another potential contributor to chronic sleep loss, was present in more than one-third (37%) of the sample. Consistent with previous population-based studies of sleep disorders, including past NSF polls, 11% of the current sample was classified as experiencing insomnia symptoms (Ancoli-Israel *et al*., 2003; Ohayon, 2002), 11% were classified as experiencing symptoms of RLS (Phillips *et al*., 2006) and 25% were classified as at-risk for OSA (Hiestand *et al*., 2006). As we hypothesized, participants classified as at-risk for any sleep disorder reported more work-related impairments, including significant problems related to cognitive and mood-related performance at work, presenteeism and absenteeism.

Of all of the sleep disorders in this study, experiencing symptoms consistent with insomnia was associated with the most negative outcomes at work, including impairment in both cognitive and mood-related work domains, as well as presenteeism. These findings are a logical extension of previous work that has shown far-reaching negative impacts of insomnia on multiple quality of life domains (Kyle *et al*., 2010). The increased risk for mood-related work problems is consistent with research showing higher rates of depression and anxiety

in individuals with insomnia (Breslau *et al*., 1996; Buysse *et al*., 1994; Neckelmann *et al*., 2007; Taylor *et al*., 2005). In addition, absenteeism and falling asleep at work were much more likely for these participants compared with respondents not at-risk for any sleep disorder. Of particular concern, participants with insomnia symptoms had a twofold increase in risk for occupational accidents. These results are largely congruent with findings from other studies that have examined relationships between insomnia and self-reported work productivity and efficiency (Daley *et al*., 2008; Erman *et al*., 2008; Leger *et al*., 2002, 2006; Linton and Bryngelsson, 2000; Walsh *et al*., 2007). It is clear from these data that individuals with insomnia experience a wide variety of work problems, including both low-incidence outcomes such as absenteeism and occupational accidents, as well as more subtle negative outcomes consistent with presenteeism. Two recent studies suggest that these work deficits can be substantially improved for these individuals with treatment of the chronic insomnia (Erman *et al*., 2008; Walsh *et al*., 2007).

Similar to findings from previous research on OSA and work performance (Lindberg *et al*., 2001; Spengler *et al*., 2004; Ulfberg *et al*., 1996, 2000), we found that individuals at-risk for OSA were more likely to report presenteeism, absenteeism, falling asleep at work and problems related to cognitive functioning at work. However, in contrast to Lindberg *et al*. (2001) and Spengler *et al*. (2004), individuals at-risk for OSA in the present study did not have increased odds of reporting that they have experienced an occupational accident in the past year. Methodological differences (e.g. how risk for OSA was defined, self-report versus objective data on accidents) likely contributed to this discrepancy.

This is the first study to examine work outcomes for individuals at-risk for RLS. Participants who reported symptoms consistent with RLS reported significant problems in the work domains of cognitive impairment, presenteeism and falling asleep at work. However, in contrast to respondents with insomnia symptoms, participants with RLS symptoms were not more likely to be at-risk for occupational accidents and absenteeism, and had less impairment at work related to mood problems.

The effects of shift work are understudied. In this investigation, a significant proportion of SW reported symptoms consistent with SWSD (21%). Consistent with findings from Drake *et al*. (2004), the most negative work outcomes were observed for those SW who reported symptoms of insomnia or excessive daytime sleepiness (i.e. at-risk for SWSD). Significant sleepiness at work or falling asleep at work was more common for these participants, and they were four–six times more likely to experience mood-related work impairment, including impatience with others, avoidance of social interactions and boredom. Their risk of occupational accidents is further cause for alarm, as SW at-risk for SWSD were four times more likely to report experiencing such accidents. Comparisons in our sample between SW and DW showed that SW were at a nearly threefold risk for occupational accidents and more likely to fall asleep at work.

There are several limitations to this study. The cross-sectional study design is a methodological concern, as it does not permit conclusions about causality or the direction of associations. Use of multiple statistical analyses may have increased the risk for type I error, and the results should be interpreted accordingly. Although we defined risk for sleep disorders based on ICSD-2 criteria, it is likely that some participants with sleep disorders may have been misclassified both as having a sleep disorder and within the sleep disorders category. Our ability to classify participants into diagnostic categories was limited by the questions asked during the poll. While a more precise method of diagnosis is desirable, it is also impractical for a large-scale study. The assessment of work performance consisted of single-item questions for each domain. While face-valid, these questions have not been formally validated. Replication of these findings with a validated measure of work performance is important. The racial composition and occupational classification (i.e. white, blue, gray collar) of the sample were consistent with those reported by the Bureau of Labor Statistics for workers in the USA who are employed full-time. Nevertheless, our sample was heavily Caucasian, older (average age was late 40s) and more than one-third reported an annual household income $> \$75\,000$. This may limit the generalizability of the findings to other racial groups, younger individuals and those of lower socioeconomic status. Finally, we relied entirely on self-report for our measures, which may result in social desirability bias.

The field of research on sleep and work is ripe for further exploration. Use of methodologies beyond cross-sectional designs are important to more fully appreciate the nature of the complex relationships between sleep, sleep disorders and work performance. Employing objective measures of work performance and sleep (e.g. wrist actigraphy, polysomnography) and using prospective methods (e.g. daily sleep diaries) are critical to our understanding of how sleep affects performance at work and how work hours impact sleep. Research using more definitive diagnostic methods for sleep disorders and examination of changes in work performance after treatment for sleep disorders is also crucial. Finally, to know whether relationships between sleep and work are different across diverse populations, future research should include participants from traditionally understudied groups (e.g. non-Caucasian races/ethnicity, individuals with lower socioeconomic status, younger adults). In summary, this national poll of American workers showed that longer work hours are associated with shorter sleep times. We studied individuals at-risk for four major sleep disorders, including insomnia, OSA, RLS and SWSD. Using work outcomes that included low-frequency, high-impact variables (e.g. absenteeism, occupational accidents), as well as more subtle, daily outcome variables (e.g. presenteeism, cognitive and mood-related problems) allowed us to more completely describe work impairments. The results of this study support the need for increased public awareness of the impact of untreated sleep disorders on work performance, as well as the associations between long work hours and problems due to sleepiness.

Employers may benefit from screening for sleep disorders in their employee assistance programs, by offering work-based educational programs that increase awareness of the detriments associated with long work hours and sleep problems, and dedicating more resources to treatments for sleep disorders in their employees. Reduced absenteeism, increased productivity and fewer occupational accidents are just a few of the potential benefits employers may realize from such programs. In turn, their employees may experience improved quality of life at work. Increasing resources for education, diagnosis and treatment of sleep disorders would profit employers, their employees and our society at large.

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CONFLICTS OF INTEREST

None of the authors have any conflicts of interest to disclose.

REFERENCES

American Academy of Sleep Medicine. *The International Classification of Sleep Disorders: Diagnostic and Coding Manual*, 2nd edn. American Academy of Sleep Medicine, Westchester, IL, 2005.

Ancoli-Israel, S. and Roth, T. Characteristics of insomnia in the united states: results of the 1991 National Sleep Foundation survey. I. *Sleep*, 1999, 22(Suppl. 2): S347–S353.

Ancoli-Israel, S., Cole, R., Alessi, C., Chambers, M., Moorcroft, W. and Pollak, C. P. The role of actigraphy in the study of sleep and circadian rhythms. *Sleep*, 2003, 26: 342–392.

Basner, M., Fomberstein, K. M., Razavi, F. M. *et al*. American time use survey: sleep time and its relationship to waking activities. *Sleep*, 2007, 30: 1085–1095.

Breslau, N., Roth, T., Rosenthal, L. and Andreski, P. Sleep disturbance and psychiatric disorders: a longitudinal epidemiological study of young adults. *Biol. Psychiatry*, 1996, 39: 411–418.

Buysse, D. J., Reynolds, C. F. III and Kupfer, D. J. *et al*. Clinical diagnoses in 216 insomnia patients using the International Classification of Sleep Disorders (ICSD), DSM-IV and ICD-10 categories: a report from the APA/NIMH DSM-IV field trial. *Sleep*, 1994, 17: 630–637.

Chung, F., Yegneswaran, B., Liao, P. *et al*. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. *Anesthesiology*, 2008, 108: 812–821.

Daley, M., Morin, C. M., Leblanc, M., Gregoire, J. P., Savard, J. and Baillargeon, L. Insomnia and its relationship to health-care utilization, work absenteeism, productivity and accidents. *Sleep Med.*, 2008, 10: 427–438.

Drake, C. L., Roehrs, T., Richardson, G., Walsh, J. K. and Roth, T. Shift work sleep disorder: prevalence and consequences beyond that of symptomatic day workers. *Sleep*, 2004, 27: 1453–1462.

Erman, M., Guiraud, A., Joish, V. and Lerner, D. Zolpidem extended-release 12.5 mg associated with improvements in work performance in a 6-month randomized, placebo-controlled trial. *Sleep*, 2008, 31: 1371–1378.

Godet-Cayre, V., Pelletier-Fleury, N., Le Vaillant, M., Dinet, J., Massuel, M. A. and Leger, D. Insomnia and absenteeism at work: who pays the cost? *Sleep*, 2006, 29: 179–184.

Hiestand, D. M., Britz, P., Goldman, M. and Phillips, B. Prevalence of symptoms and risk of sleep apnea in the US population: results from the National Sleep Foundation Sleep in America 2005 poll. *Chest*, 2006, 130: 780–786.

Kleinman, N., Brook, R., Doan, J., Melkonian, A. and Baran, R. Health benefit costs and absenteeism due to insomnia from the employer's perspective: a retrospective, case-control, database study. *J. Clin. Psychiatry*, 2009, 70: 1098–1104.

Knutson, K., Van Cauter, E., Rathouz, P., DeLeire, T. and Lauderdale, D. Trends in the prevalence of short sleepers in the USA: 1975–2006. *Sleep*, 2010, 33: 37–45.

Krueger, P. and Friedman, E. Sleep duration in the United States: a cross-sectional population-based study. *Am. J. Epidemiol.*, 2009, 169: 1052–1063.

Kyle, S., Morgan, K. and Espie, C. Insomnia and health-related quality of life. *Sleep Med. Rev.*, 2010, 14: 69–82.

Leger, D., Guilleminault, C., Bader, G., Levy, E. and Paillard, M. Medical and socio-professional impact of insomnia. *Sleep*, 2002, 25: 625–629.

Leger, D., Massuel, M. A., Metlaine, A. and SISYPHE Study Group. Professional correlates of insomnia. *Sleep*, 2006, 29: 171–178.

Lindberg, E., Carter, N., Gislason, T. and Janson, C. Role of snoring and daytime sleepiness in occupational accidents. *Am. J. Respir. Crit. Care Med.*, 2001, 164: 2031–2035.

Linton, S. J. and Bryngelsson, I. L. Insomnia and its relationship to work and health in a working-age population. *J. Occup. Rehabil.*, 2000, 10: 169–183.

Neckelmann, D., Mykletun, A. and Dahl, A. A. Chronic insomnia as a risk factor for developing anxiety and depression. *Sleep*, 2007, 30: 873–880.

Ohayon, M. M. Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Med. Rev.*, 2002, 6: 97–111.

Ozminkowski, R. J., Wang, S. and Walsh, J. K. The direct and indirect costs of untreated insomnia in adults in the United States. *Sleep*, 2007, 30: 263–273.

Phillips, B., Hening, W., Britz, P. and Mannino, D. Prevalence and correlates of restless legs syndrome: results from the 2005 National Sleep Foundation poll. *Chest*, 2006, 129: 76–80.

Spengler, S. E., Browning, S. R. and Reed, D. B. Sleep deprivation and injuries in part-time Kentucky farmers: impact of self reported sleep habits and sleep problems on injury risk. *AAOHN J.*, 2004, 52: 373–382.

Taylor, D. J., Lichstein, K. L., Durrence, H. H., Reidel, B. W. and Bush, A. J. Epidemiology of insomnia, depression, and anxiety. *Sleep*, 2005, 28: 1457–1464.

Ulfberg, J., Carter, N., Talbäck, M. and Edling, C. Excessive daytime sleepiness at work and subjective work performance in the general population and among heavy snorers and patients with obstructive sleep apnea. *Chest*, 1996, 110: 659–663.

Ulfberg, J., Carter, N. and Edling, C. Sleep-disordered breathing and occupational accidents. *Scand. J. Work Environ. Health*, 2000, 26: 237–242.

Van Dongen, H. P. A., Maislin, G., Mullington, J. and Dinges, D. The cumulative cost of additional wakefulness: dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. *Sleep*, 2003, 26: 117–126.

Walsh, J., Krystal, A., Amato, D. *et al*. Nightly treatment of primary insomnia with eszopiclone for six months: effect on sleep, quality of life, and work limitations. *Sleep*, 2007, 30: 959–968.