Relationship of Sleep Deficiency to Perceived Pain and Functional Limitations in Hospital Patient Care Workers

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Objective: Health care workers are at high risk of developing musculoskeletal symptoms and pain. This study tested the hypothesis that sleep deficiency is associated with pain, functional limitations, and physical limitations that interfere with work. **Methods:** Hospital patient care workers completed a survey (79% response rate) including measures of health, sociodemographic, and workplace factors. Associations of sleep deficiency with pain, work interference due to this pain, and functional limitations were determined. **Results:** Of 1572 respondents (90% women; mean age, 41 years), 57% reported sleep deficiency, 73% pain in last 3 months, 33% work interference, and 18% functional limitation. Sleep deficiency was associated with higher rates of pain, work interference, and functional limitation controlling for socioeconomic, individual, and workplace characteristics. **Conclusions:** Sleep deficiency is significantly associated with pain, functional limitation, and workplace interference, suggesting modifiable outcomes for workplace health and safety interventions.

This study is part of the inaugural project for the Harvard School of Public Health Center for Work, Heath, and Well-being exploring how policies, programs, and practices of the health care unit impact the work and health of these workers. Health care workers are at a high risk of developing musculoskeletal symptoms, pain, injuries, and disorders. Health care is a rapidly growing industry[1] composed of an aging workforce,[2] such that the rates of these injuries and chronic conditions are expected to raise the level of disability in the workforce and force some employees out of the field. Estimates of the annual incidence of back injury and pain in the nursing workforce range between 30% and 75%, with a lifetime incidence between 35% and 80%.[3–13] Nursing aides suffer from back pain involving days away from work at rate of 28 per 10,000 full-time workers compared with the national average of 4, the highest of any occupation. Those suffering from any pain involving days away from work had a rate of 68 per 10,000 full-time workers compared with the national average of 13, a rate second only to that observed in police officers.[14] The physical demands of nursing work, including patient handling, are suspected as the major factor associated with the high rates of musculoskeletal symptoms and disorders of the lower back and other body parts.[15] Various interventions, including education programs, programs to reduce physical load such as conditioning and exercise programs, the use of mechanical lifts or other patient transfer equipment, and organizational changes such as prompt disability management, have been implemented to reduce risk for chronic musculoskeletal disorders.[16–18] In addition, occupational factors such as the psychosocial environment and organizational support are associated with pain, although not in all studies,[9] and are thought to interfere with pain resolution and return to full functionality.[19,20]

Less clear is the role of sleep in mediating the effects of work and workplace factors on pain. Habitual short sleep duration independently predicts the risk of a fall or other injury requiring an emergency department visit.[21] In health care workers, decreased sleep duration and extended shifts, as seen in shift work, have been related to workplace injuries (K. Hopcia, J. T. Dennerlein, D. M. Hashimoto, A.M. Stoddard, T. Orechia, G. Sorensen, unpublished data, 2009-2010). Mechanisms involved are thought to include the increased sleepiness associated with inadequate sleep.[22] Laboratory studies of sleep restriction have noted both an increase in spontaneous pain reports[23,24] and an increase in the response to a standard pain stimulus.[25,26] Insomnia is also associated with an increased incidence of pain.[27–29]

Sleep deficiency, a new term,[30] marks the presence of short sleep duration or sleep insufficiency,[31] such as by a sleep disorder, or both and reflects an unmet sleep need that further results in suboptimal health, performance, or well-being.[32,33] Short sleep duration, sleep insufficiency, or both have been linked to weight gain, obesity, Type 2 diabetes, elevated blood pressure, cardiovascular disease, and premature mortality.[34–39] Together, these health outcomes represent a large portion of morbidity and mortality both in the United States[40] and in the world.[41]

A number of studies have examined the role of sleep disturbance on work disability and worker physical and psychological health.[42,43] Conversely, both cross-sectional and longitudinal analyses of workplace stressors have been shown to contribute to sleep disturbances.[44]

The goal of this study was to test the hypotheses that sleep deficiency is associated with self-reported pain, work interference due to this pain, and functional limitations. Change in functional limitations may impact productivity or the ability to perform demanding health care work. It was hypothesized that, in a socioecological framework

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that includes individual, occupational, and workplace characteristics, sleep deficiency (short sleep duration, insomnia symptoms, sleep insufficiency, or all of the three) would be independently associated with outcomes of pain, work interference, and functional limitations while controlling for key covariate indicators of work organization and experiences. A sleep deficiency composite variable was defined, and the contributions of the components to the associations with the outcomes were described to establish sleep deficiency as a useful concept for future research.

METHODS

Study Design

This study focuses on cross-sectional survey data collected from patient care workers at two large academic hospitals in metropolitan Boston from October 2009 to January 2010. Research protocols approved by the applicable institutional review board were conducted in accordance with the Declaration of Helsinki.

Study Sample

A human resources database at each hospital was used to identify eligible employees. The sampling frame for the Patient Care Worker Survey included all current benefits-eligible workers employed in Patient Care Services who had direct patient care responsibilities during the period of May 30, 2009, to August 22, 2009. Eligible employees worked on a unit defined primarily as a patient care unit. Staff assigned to the "float" unit were eligible, but those assigned to environmental services and physical medicine units (physical therapy, occupational therapy, speech therapy, etc) were excluded. Workers on extended absence for more than 12 weeks, *per diem* staff, traveling/contract nurses, administrative workers, and those working for less than 20 hours per week on average or with jobs not exclusively related to a specific unit were ineligible. From 7019 eligible workers (3474 from one hospital, 3545 from the other), a random sample of 2000 workers was selected. Detailed shift information was extracted from a payroll database to create a night shift variable (see later).

Data Collection

Eligible employees and directors were sent an introductory e-mail and a personalized link to the Web-based survey. A second e-mail was sent 2 weeks later to anyone who had not completed the survey. A paper survey was sent, with a stamped return envelope, to the homes of those who did not complete the on-line survey, followed by one more e-mail and mailed survey at 2-week intervals for a total of up to 5 contacts. A $20 gift card was given to participants. A total of 1572 workers initiated the survey on-line, and 1399 (89%) completed at least 50% of the items, the eligibility requirement for this analysis; 173 workers completed a paper version. The total number of completed surveys was 1572 (79% response rate).

Measures

Outcomes

Pain was measured using an adaptation of the Nordic question for musculoskeletal systems[45]: "During the past 3 months, have you had pain or aching in any of the areas shown on the diagram?" Using a diagram as a reference, respondents were asked to identify areas in which they experienced pain: lower back, shoulder, wrist or forearm, knee, neck, ankle or feet, or none of the above.

Work interference due to pain was reported in the modified Nordic question for musculoskeletal systems: "In general how much did this pain interfere with your normal work?" Responses were rated on a five-point scale from 1 (not at all) to 5 (extremely). Work interference was defined as a response of 3 (moderately) or greater.

Functional limitation was assessed by a series of questions asking the participant about their ability to do a list of activities in the last week. For each activity, they rated their ability on a five-point scale from 1 (no difficulty) to 5 (unable to do without help). The activities included heavy household chores; carry a shopping bag or brief case; recreational activities in which there is impact in the arm, shoulder, or hand; standing for an hour or more; reaching for an object on a high shelf; putting on shoes or socks; getting in or out of a car; stooping or bending toward the floor; kneeling or squatting; and using any handheld tool or equipment. The scores were summed, resulting in a scale that ranged from 10 (no difficulty on any item) to 50 (unable to do any of the 10 items without help). Functional limitation was defined to be a score of 14 or more, the 83rd percentile.[46]

Covariates

All covariates were determined *a priori*. Respondents answered questions regarding their sleep habits during the preceding 4 weeks. *Sleep duration* was assessed by asking how many hours respondents slept each night. *Sleep insufficiency* was assessed by asking how often they got enough sleep to feel rested upon waking, with five response categories from "never" to "always," similar to the previously used term *sleep adequacy*.[30,47] *Insomnia symptoms* were assessed by asking how often they woke in the middle of the night or early, with four response categories from "not at all in the last 4 weeks" to "3 or more times a week." In an exploratory analysis, *sleep deficiency* was defined as the presence of *short sleep duration* (<6 hours per day) or *sleep insufficiency* (never feeling rested on waking) or *insomnia symptoms* three or more times a week.

For sociodemographic factors, participants reported their occupation, race/ethnicity, education, gender, age, height, and weight. Body mass index (BMI) was computed as weight (kg) per meter squared (m^2) of height.

Psychological distress was measured using the K-6 Nonspecific Distress Scale,[48] a six-item scale that asks how often the respondent has felt the following ways in the last 30 days: "so sad nothing could cheer you up," "nervous," "restless or fidgety," "hopeless," "that everything was an effort," and "worthless." Responses were rated on a five-point scale from 0 (none of the time) to 4 (all of the time). Responses to the six items were summed, resulting in a scale that ranged from 0 to 24.

Unit category. Participants worked in 128 patient care units. The patient care units were grouped into 12 categories reflecting similar workloads based on the type of unit, acuity, staffing, physical location, and number of beds. The categories were emergency department, operating room, adult medical/surgical, adult intensive care unit, step-down, pediatric medical/surgical, pediatric/neonatal intensive care, psychiatry, obstetrics/postpartum, float pool, ambulatory units, and orthopedics.

Hours worked was assessed by self-report about a typical week (<20, 20 to 29, 30 to 34, 35 to 39, 40 to 44, 45 to 50, and >50 hours).

Job title was categorized as staff nurse (assistant nurse manager, clinical nurse specialist, staff nurse), patient care associate, or other (operations coordinator and other).

Two measures of social support on the job were included. *Coworker support* was assessed using two items ("If needed, I can get support and help with my work from my co-workers" and "The people I work with are helpful in getting the job done,"), with five response categories from 1 (never) to 5 (always). The responses were summed, resulting in a scale that ranged from 2 to 10.[49] *Supervisor support* was measured using three items ("If needed, I can get support and help with my work from my immediate supervisor," "My supervisor is helpful in getting the job done," and "My work achievements are appreciated by my immediate supervisor"), with response categories rated on the same five-point scale. The responses were summed, resulting in a scale that ranged from 3 to 15.[49]

Job demands were determined using an abbreviated version of the Job Content Questionnaire (JCQ),[49] with a focus on the psychological job demand subscales (five items) with equally weighted responses summed and scaled (range, 12 to 48).

Nightwork shifts were quantified from administrative payroll data during the period October 2008 to August 2009, compiled as the average number of hours between 10 PM and 6 AM for those months worked, excluding shifts of less than 4 hours and categorized as 0 to 6, 6 to 72, and more than 72 hours per month.

Analysis

Associations between sleep variables and pain, work interference, and functional limitations, controlling for other worker and work characteristics, were examined using simple and multiple logistic regression analysis (SAS 9.2, SAS Institute, Inc, Cary, NC). Odds ratios (ORs) are reported with 95% confidence intervals (CIs).

RESULTS

Of the 1572 respondents, 90% were women, with a mean age of 41.4 years (SD, 11.7 years) and a mean BMI of 26.3 kg/m^2 (SD, 5.3 kg/m^2).

Table 1 presents the bivariate associations of the participant characteristics with each of the sleep variables. *Short sleep duration* was reported by 22.5% of total respondents, *sleep insufficiency* by 27.2%, and *insomnia symptoms* by 40.1%. Figure 1 depicts the frequencies of the sleep variables, numbers missing, and their overlap with one another. *Pain* was reported by 73.4%, *functional limitation* by 17.6%, and *work interference* by 32.8% of the entire sample.

Multivariable Associations of Sleep Variables to Outcomes

In multivariable models, *short sleep duration* was significantly associated with increased *pain* (OR, 0.88; 95% CI, 0.79 to 0.98; $P = 0.020$) and *work interference* (OR, 0.86; 95% CI, 0.78 to 0.96; $P = 0.005$), but not *functional limitation* (OR, 0.90; 95% CI, 0.79 to 1.03; $P = 0.115$). These effects remained despite controlling for covariates that remained significant in multivariable models (*gender*, *age*, *BMI*, *psychological distress*, *occupation*, *job demands*, *coworker support*, and *supervisor support*) and other nonsignificant covariates (*race*, *unit category*, *hours worked*, and *nightwork*). See Table 2 for details.

Sleep insufficiency was significantly associated with increased *pain* ("sometimes" vs "never/rarely": OR, 0.89; 95% CI, 0.62 to 1.27; "often/always" vs "never/rarely": OR, 0.57; 95% CI, 0.39 to 082; $P = 0.003$), *work interference* ("sometimes" vs "never/rarely": OR, 0.66; 95% CI, 0.49 to 0.89; "often/always" vs "never/rarely": OR, 0.48; 95% CI, 0.34 to 0.67; $P < 0.0001$), and *functional limitation* ("sometimes" vs "never/rarely": OR, 0.83; 95% CI, 0.57 to 1.21; "often/always" vs "never/rarely": OR, 0.56; 95% CI, 0.36 to 087; $P = 0.033$). These effects remained despite controlling for covariates that remained significant in multivariable models (*age*, *BMI*, *psychological distress*, *occupation*, *job demands*, *coworker support*, and *supervisor support*) and other nonsignificant covariates (*race*, *gender*, *unit category*, *hours worked*, and *nightwork*). See Table 3 for details.

The presence of *insomnia symptoms* was significantly associated with increased *pain* (OR, 1.45; 95% CI, 1.09 to 1.93; $P = 0.010$), *work interference* (OR, 1.64; 95% CI, 1.27 to 2.12; $P < 0.001$), and *functional limitation* (OR, 1.85; 95% CI, 1.33 to 2.57; $P < 0.001$). These effects remained despite controlling for covariates that remained significant in multivariable models (*gender*, *age*, *BMI*, *psychological distress*, *occupation*, *job demands*, *coworker support*, and *supervisor support*) and other nonsignificant covariates (*race*, *unit category*, *hours worked*, and *nightwork*). See Table 4 for details.

DISCUSSION

This study assesses sleep- and work-related outcomes of bodily pain, work interference from this pain, and functional limitations of tasks of daily living. Strong and significant associations of sleep deficiency with pain, functional limitation, and workplace interference persisted despite controlling for the effects of sociodemographic, psychological, and workplace factors. Obtaining short sleep duration, reporting insomnia symptoms, having sleep insufficiency, or any combination of the three may thus be related to workplace exposures or may represent additional health-related sequelae of workplace exposures, ramifying the consequences of prior workplace exposures. Alternatively, bodily pain, work interference from this pain, and functional limitations of daily living tasks may increase the likelihood of sleep deficiency.

An innovative aspect of this analysis is the use of the sleep deficiency construct. Prior work in sleep typically focused on the presence or absence of a specific sleep disorder. This novel construct for sleep deficiency[30] posits that sleep may become "deficient" for a variety of or even a constellation of reasons. Components of sleep deficiency each demonstrated association with all three outcomes of bodily pain, work interference from that pain, and functional limitations (see Tables 2-4), with the exception that sleep duration was not significantly associated with funtional limitation ($P = 0.115$), but the contributions of psychosocial factors significantly associated with each outcome varied slightly by outcome. As with other organic deficiencies, the exact source of deficiency may be less important for outcomes than the presence of the deficiency, though the components are critical for identifying modifiable sources. The strength of the sleep deficiency construct is in defining an important factor for positive change, irrespective of the source. The validity of this emerging construct is strengthened by its significant association with three conceptually related but distinct outcomes.[23,24,50] Restricting time in bed to 4 hours per night over 12 days in a laboratory setting has been shown to increase self-reported levels of pain and of the inflammatory markers interleukin-6 and C-reactive protein.[23] Sleep-deprived healthy subjects report significantly more pain than when rested.[24] Sleep sufficiency also matters for bodily pain; insomnia symptoms are associated with increased levels of pain[27–29] and, conversely, pain, especially untreated, can lead to disrupted sleep.[33,51] Restoration of sleep sufficiency is associated with the resolution of pain.[52] Sleep deficiency may be related to the concept of chronic "exhaustion" developed from the vitality scale of the 36-item Medical Outcomes Study Short Form (SF-36), which is related to psychosocial factors at work, controlling for pain and other sociodemographic factors.[53]

Sleep, pain, and pain-related disability are important health indicators for health care workers. The health care sector ranks second in the largest share of work-related injuries behind manufacturing.[54] By far, nursing personnel bear the largest burden of injury in health care, and back injuries constitute the greatest source of their disability.[55] Current trends in hospitalized patient characteristics and in the health care work force are only likely to increase these risks to workers' health in coming years, given the aging nursing workforce[56] and increased work demands.[57]

Work organizational factors included psychosocial job demands,[58,59] which were significantly related to sleep deficiency in bivariate analyses yet independently and significantly related to all three outcomes in this study. In contrast, perceived coworker support was related only to the outcome of functional limitation on tasks of daily living and supervisor social support was related only to work interference. A particular strength of the current analysis was the night shift variable gleaned from administrative payroll records; a precise measure of actual night hours worked over the past year compared with self-reported night shift status typically used. In contrast to work organization and social factors, night shift was not significant in the current analyses. Although the public health literature has focused on identifying specific risk factors,

TABLE 1. Frequency (%) or Mean (SD) of Respondent Characteristics by the Presence or Absence of Deficiency Within Each of the Three Sleep Variables, Duration, Quality, and Insomnia Symptoms, with *P* value for Test of No Association With the Sleep Variables*

	Sleep Duration			Sleep Sufficiency			Insomnia Symptoms		
	<6 hr/night (N = 354)	≥6 hr/night (N = 1,115)	*P*	Never/Rarely (N = 428)	Sometimes/ Often/Always (N = 1,075)	*P*	≥3×/wk (N = 631)	<3×/wk (N = 872)	*P*
Any pain									
No	73 (20.6%)	312 (28.0%)	**0.006**	87 (20.3%)	306 (28.5%)	**0.001**	130 (20.6%)	268 (30.7%)	**<0.0001**
Yes	281 (79.4%)	803 (72.0%)		341 (79.7%)	769 (71.5%)		501 (79.4%)	604 (69.3%)	
Work interference									
No	206 (58.7%)	781 (70.3%)	**<0.0001**	238 (55.9%)	769 (71.9%)	**<0.0001**	380 (60.2%)	632 (73.1%)	**<0.0001**
Yes	145 (41.3%)	330 (29.7%)		188 (44.1%)	301 (28.1%)		251 (39.8%)	233 (26.9%)	
Functional limitation									
No	271 (76.6%)	945 (84.8%)	**<0.001**	334 (78.0%)	904 (84.1%)	**0.005**	482 (76.4%)	762 (87.4%)	**<0.0001**
Yes	83 (23.4%)	170 (15.2%)		94 (22.0%)	171 (15.9%)		149 (23.6%)	110 (12.6%)	
Race									
Hispanic	13 (3.7%)	49 (4.5%)	**0.001**	20 (4.8%)	43 (4.1%)	0.912	18 (2.9%)	45 (5.3%)	**0.001**
White	261 (74.4%)	905 (82.3%)		330 (78.8%)	845 (79.7%)		528 (84.6%)	650 (75.9%)	
Black	50 (14.2%)	92 (8.4%)		45 (10.7%)	108 (10.2%)		48 (7.7%)	103 (12.0%)	
Mixed race/other	27 (7.7%)	54 (4.9%)		24 (5.7%)	64 (6.0%)		30 (4.8%)	58 (6.8%)	
Gender									
Male	29 (8.2%)	108 (9.8%)	0.393	41 (9.8%)	99 (9.3%)	0.770	60 (9.6%)	81 (9.4%)	0.916
Female	323 (91.8%)	998 (90.2%)		379 (90.2%)	969 (90.7%)		567 (90.4%)	780 (90.6%)	
Age, yr	42.3 (11.45)	40.9 (11.77)	0.056	39.6 (10.88)	42.0 (11.93)	**<0.001**	42.9 (11.56)	40.1 (11.60)	**<0.0001**
BMI, kg/m^2	27.3 (5.84)	26.0 (5.04)	**<0.001**	26.4 (5.45)	26.3 (5.22)	0.765	26.5 (5.37)	26.1 (5.22)	0.154
Psychological distress	3.2 (3.68)	2.3 (3.21)	**<0.001**	3.7 (4.11)	2.1 (2.83)	**<0.0001**	3.1 (3.69)	2.2 (3.02)	**<0.0001**
Unit category									
ED	25 (7.1%)	56 (5.0%)	0.485	26 (6.1%)	59 (5.5%)	0.822	32 (5.1%)	51 (5.8%)	**0.017**
OR	37 (10.5%)	109 (9.8%)		44 (10.3%)	107 (10.0%)		66 (10.5%)	84 (9.6%)	
Adult Med/Surg	122 (34.5%)	378 (33.9%)		142 (33.2%)	373 (34.7%)		201 (31.9%)	315 (36.1%)	
Adult ICU	48 (13.6%)	136 (12.2%)		52 (12.1%)	138 (12.8%)		87 (13.8%)	101 (11.6%)	
Step-down	18 (5.1%)	59 (5.3%)		25 (5.8%)	55 (5.1%)		27 (4.3%)	54 (6.2%)	
Ped Med/Surg	4 (1.1%)	16 (1.4%)		7 (1.6%)	13 (1.2%)		6 (1.0%)	14 (1.6%)	
Ped ICU/NICU	17 (4.8%)	45 (4.0%)		21 (4.9%)	40 (3.7%)		33 (5.2%)	30 (3.4%)	
Psychiatry	0 (0.0%)	19 (1.7%)		3 (0.7%)	17 (1.6%)		7 (1.1%)	13 (1.5%)	
OB-Postpartum	28 (7.9%)	98 (8.8%)		39 (9.1%)	86 (8.0%)		55 (8.7%)	71 (8.1%)	
Float pool	12 (3.4%)	50 (4.5%)		16 (3.7%)	48 (4.5%)		30 (4.8%)	34 (3.9%)	
Amb only/Consult/Educ	35 (9.9%)	120 (10.8%)		46 (10.7%)	109 (10.1%)		79 (12.5%)	76 (8.7%)	
Orthopedics	8 (2.3%)	29 (2.6%)		7 (1.6%)	30 (2.8%)		8 (1.3%)	29 (3.3%)	
Hours worked									
<30	60 (17.0%)	277 (24.9%)	**0.004**	95 (22.4%)	241 (22.5%)	0.178	137 (21.8%)	200 (23.0%)	0.229
30–34	41 (11.6%)	138 (12.4%)		60 (14.1%)	120 (11.2%)		84 (13.4%)	97 (11.2%)	
35–39	98 (27.8%)	324 (29.2%)		117 (27.5%)	315 (29.4%)		185 (29.4%)	247 (28.5%)	
40–44	137 (38.8%)	328 (29.5%)		128 (30.1%)	355 (33.1%)		190 (30.2%)	293 (33.8%)	
>44	17 (4.8%)	44 (4.0%)		25 (5.9%)	41 (3.8%)		33 (5.2%)	31 (3.6%)	
Occupation									
Staff nurse	238 (67.4%)	812 (73.2%)	0.074	291 (68.5%)	768 (71.6%)	0.375	447 (71.1%)	612 (70.5%)	**0.024**
Patient care associate	31 (8.8%)	68 (6.1%)		32 (7.5%)	82 (7.6%)		35 (5.6%)	79 (9.1%)	
Other	84 (23.8%)	230 (20.7%)		102 (24.0%)	222 (20.7%)		147 (23.4%)	177 (20.4%)	
Nightwork									
0–6 hr/mo	188 (53.1%)	651 (58.4%)	0.167	228 (53.3%)	629 (58.5%)	0.175	379 (60.1%)	479 (54.9%)	0.085
6–72 hr/mo	99 (28.0%)	291 (26.1%)		121 (28.3%)	274 (25.5%)		160 (25.4%)	234 (26.8%)	
>72 hr/mo	67 (18.9%)	173 (15.5%)		79 (18.5%)	172 (16.0%)		92 (14.6%)	159 (18.2%)	
Coworker support	7.8 (1.51)	8.1 (1.45)	**0.008**	7.8 (1.59)	8.1 (1.45)	**0.007**	8.0 (1.45)	8.0 (1.52)	0.552
Supervisor support	10.5 (2.96)	10.7 (2.96)	0.228	10.0 (3.17)	10.9 (2.88)	**<0.0001**	10.6 (2.93)	10.7 (3.02)	0.444
Job demands	36.4 (5.12)	35.8 (5.13)	0.080	36.8 (5.24)	35.6 (5.14)	**<0.0001**	36.3 (5.29)	35.6 (5.08)	**0.006**

ED indicates emergency department; OR, operating room; Med/Surg, medical/surgical; ICU, intensive care unit; Ped Med/Surg, pediatric medical/surgical; Ped ICU/NICU, pediatric/neonatal intensive care unit; OB-Postpartum, obstetrics/postpartum; Amb only/Consult/Educ, ambulatory units/consultation/education.

*Significant *P* values are bolded. Variables significant across all three sleep variables are also bolded and include any pain, work interference, functional limitation, and psychological distress.

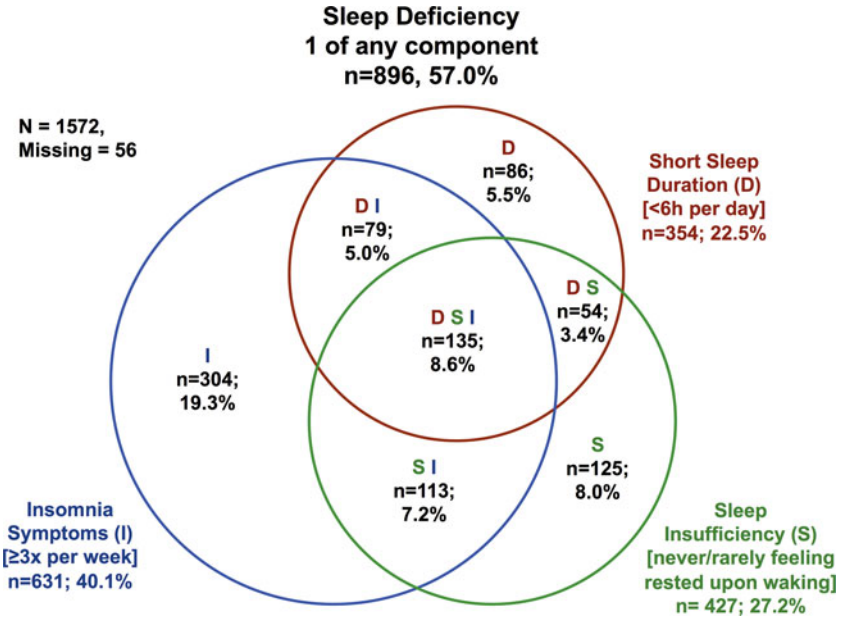

FIGURE 1. Frequencies of sleep deficiencies. Subjects (n = 1516 without missingness) with short sleep duration (<6 hours per day, red circle; D), sleep insufficiency (never/rarely feeling rested on waking; green; S), and/or insomnia symptoms (≥3 times a week, blue; I) are depicted.

TABLE 2. Multivariable Association of Sleep Duration and Other Respondent Characteristics With Pain, Work Interference, and Functional Limitations: Odds Ratios, 95% Confidence Intervals, and *P* Values*

	Sleep Duration Models					
	Any Pain		Work Interference		Functional Limitation	
Effect	**Odds Ratio (95% CI)**	***P***	**Odds Ratio (95% CI)**	***P***	**Odds Ratio (95% CI)**	***P***
Hours sleep	0.88 (0.79–0.98)	**0.020**	0.86 (0.78–0.96)	**0.005**	0.90 (0.79–1.03)	0.115
Race (vs Hispanic)	. . .	0.083	. . .	0.438	. . .	0.893
White	0.94 (0.44–2.01)	. . .	0.60 (0.30–1.20)	. . .	1.30 (0.46–3.71)	. . .
Black	0.49 (0.21–1.14)	. . .	0.52 (0.23–1.18)	. . .	1.35 (0.42–4.29)	. . .
Mixed race/other	0.82 (0.32–2.09)	. . .	0.66 (0.27–1.58)	. . .	1.63 (0.46–5.70)	. . .
Gender (female vs male)	1.48 (0.94–2.31)	0.089	1.77 (1.09–2.89)	**0.022**	0.99 (0.56–1.75)	0.974
Age, yr	1.00 (0.99–1.02)	0.689	1.02 (1.00–1.03)	**0.016**	1.05 (1.03–1.07)	**<0.0001**
Body mass index, kg/m^2	1.03 (1.00–1.06)	**0.045**	1.03 (1.01–1.06)	**0.009**	1.08 (1.04–1.11)	**<0.0001**
Psychological distress	1.06 (1.01–1.12)	**0.012**	1.10 (1.06–1.14)	**<0.0001**	1.13 (1.08–1.18)	**<0.0001**
Occupation (vs staff nurse)	. . .	**0.002**	. . .	0.057	. . .	1.000
Patient care associate	0.75 (0.40–1.4)	. . .	1.46 (0.78–2.75)	. . .	1.00 (0.43–2.34)	. . .
Other	0.51 (0.35–0.74)	. . .	0.71 (0.48–1.04)	. . .	0.99 (0.63–1.57)	. . .
Nightwork (vs 0–6 hr/mo)	. . .	0.611	. . .	0.327	. . .	0.669
6–72 hr/mo	1.16 (0.80–1.68)	. . .	1.29 (0.92–1.81)	. . .	1.16 (0.74–1.81)	. . .
>72 hr/mo	0.94 (0.63–1.43)	. . .	1.05 (0.71–1.55)	. . .	0.91 (0.55–1.51)	. . .
Job demands	1.05 (1.02–1.08)	**<0.001**	1.06 (1.03–1.09)	**<0.0001**	1.04 (1.01–1.08)	**0.017**
Coworker support	1.02 (0.91–1.14)	0.692	0.96 (0.87–1.06)	0.447	0.86 (0.76–0.98)	**0.024**
Supervisor support	0.96 (0.91–1.01)	0.134	0.95 (0.91–1.00)	**0.043**	0.97 (0.91–1.03)	0.329

*Significant *P* values and variables significant across all three outcomes are bolded.

intervention research indicates that approaches addressing multiple factors are often the most effective, providing credence to the organizational and psychosocial environmental factors.[30,60]

Limitations

This analysis has several important limitations, primarily that the cross-sectional approach does not allow for inferences on causal directions for the effects of workplace factors on sleep deficiency and pain/limitations, the effects of sleep deficiency on pain/limitations, or the effects of pain/limitations on sleep deficiency. Longitudinal and intervention studies will be needed to fully understand the causal mechanisms involved. Also, self-report was relied upon for sleep and other measures in this occupational cohort. Future studies using the sleep deficiency construct would benefit if components of sleep deficiency were measured (eg, actigraphy or polysomnography). Sleep-disordered breathing was not included in the construct, but given its importance for health, should be included in future studies.

TABLE 3. Multivariable Association of Sleep Sufficiency and Other Respondent Characteristics With Pain, Work Interference, and Functional Limitations: Odds Ratios, 95% Confidence Intervals, and *P* Values*

	Sleep Sufficiency Models					
	Any Pain		Work Interference		Functional Limitation	
Effect	**Odds Ratio (95% CI)**	***P***	**Odds Ratio (95% CI)**	***P***	**Odds Ratio (95% CI)**	***P***
Sleep sufficiency (vs never/rarely)	. . .	**0.003**	. . .	**<0.0001**	. . .	**0.033**
Sometimes	0.89 (0.62–1.27)	. . .	0.66 (0.49–0.89)	. . .	0.83 (0.57–1.21)	. . .
Often/always	0.57 (0.39–0.82)	. . .	0.48 (0.34–0.67)	. . .	0.56 (0.36–0.87)	. . .
Race (vs Hispanic)	. . .	0.099	. . .	0.591	. . .	0.683
White	1.08 (0.52–2.26)	. . .	0.63 (0.32–1.25)	. . .	1.34 (0.48–3.79)	. . .
Black	0.58 (0.25–1.31)	. . .	0.60 (0.27–1.34)	. . .	1.79 (0.58–5.52)	. . .
Mixed race/other	0.98 (0.40–2.42)	. . .	0.67 (0.28–1.59)	. . .	1.66 (0.48–5.77)	. . .
Gender (female vs male)	1.47 (0.95–2.28)	0.087	1.60 (1.00–2.56)	0.050	0.92 (0.53–1.59)	0.765
Age, yr	1.01 (0.99–1.02)	0.273	1.02 (1.01–1.03)	**0.002**	1.05 (1.04–1.07)	**<0.0001**
Body mass index, kg/m^2	1.02 (1.00–1.05)	0.098	1.03 (1.00–1.05)	**0.025**	1.07 (1.04–1.10)	**<0.0001**
Psychological distress	1.06 (1.01–1.11)	**0.030**	1.09 (1.05–1.13)	**<0.0001**	1.12 (1.07–1.17)	**<0.0001**
Occupation (vs staff nurse)	. . .	**0.003**	. . .	0.121	. . .	0.977
Patient care associate	0.82 (0.45–1.51)	. . .	1.29 (0.70–2.37)	. . .	1.06 (0.48–2.34)	. . .
Other	0.51 (0.35–0.75)	. . .	0.73 (0.50–1.06)	. . .	0.97 (0.62–1.53)	. . .
Nightwork (vs 0–6 hr/mo)	. . .	0.541	. . .	0.355	. . .	0.710
6–72 hr/mo	1.14 (0.78–1.64)	. . .	1.27 (0.91–1.78)	. . .	1.15 (0.74–1.79)	. . .
>72 hr/mo	0.89 (0.59–1.34)	. . .	1.04 (0.71–1.53)	. . .	0.92 (0.56–1.52)	. . .
Job demands	1.05 (1.02–1.08)	**<0.001**	1.06 (1.03–1.09)	**<0.0001**	1.04 (1.01–1.08)	**0.014**
Coworker support	1.02 (0.91–1.14)	0.789	0.96 (0.87–1.07)	0.480	0.85 (0.75–0.96)	**0.010**
Supervisor support	0.96 (0.91–1.02)	0.163	0.95 (0.91–1.00)	**0.044**	0.98 (0.92–1.04)	0.417

*Significant *P* values and variables significant across all three outcomes are bolded.

TABLE 4. Multivariable Association of Insomnia Symptoms and Other Respondent Characteristics With Pain, Work Interference and Functional Limitations: Odds Ratios, 95% Confidence Intervals, and *P* Values*

	Insomnia Symptoms Models					
	Any Pain		Work Interference		Functional Limitation	
Effect	**Odds Ratio (95% CI)**	***P***	**Odds Ratio (95% CI)**	***P***	**Odds Ratio (95% CI)**	***P***
Insomnia (yes vs no)	1.45 (1.09–1.93)	**0.010**	1.64 (1.27–2.12)	**<0.001**	1.85 (1.33–2.57)	**<0.001**
Race (vs Hispanic)	. . .	0.168	. . .	0.512	. . .	0.627
White	1.06 (0.51–2.20)	. . .	0.60 (0.30–1.18)	. . .	1.26 (0.45–3.57)	. . .
Black	0.60 (0.26–1.36)	. . .	0.60 (0.27–1.34)	. . .	1.75 (0.57–5.42)	. . .
Mixed race/other	0.96 (0.39–2.36)	. . .	0.66 (0.28–1.56)	. . .	1.66 (0.48–5.75)	. . .
Gender (female vs male)	1.48 (0.96–2.30)	0.079	1.60 (1.00–2.56)	**0.050**	0.92 (0.53–1.59)	0.764
Age, yr	1.00 (0.99–1.02)	0.661	1.02 (1.00–1.03)	**0.026**	1.05 (1.03–1.06)	**<0.0001**
Body mass index, kg/m^2	1.03 (1.00–1.05)	0.076	1.03 (1.01–1.06)	**0.017**	1.07 (1.04–1.11)	**<0.0001**
Psychological distress	1.06 (1.01–1.11)	**0.013**	1.10 (1.06–1.14)	**<0.0001**	1.12 (1.07–1.17)	**<0.0001**
Occupation	. . .	**0.004**	. . .	0.166	. . .	0.991
Patient care associate	0.80 (0.44–1.47)	. . .	1.23 (0.67–2.27)	. . .	1.04 (0.47–2.29)	. . .
Other	. . .	. . .	. . .	. . .	. . .	. . .
Nightwork (vs 0–6 hr/mo)	. . .	0.561	. . .	0.300	. . .	0.748
6–72 hr/mo	1.19 (0.82–1.71)	. . .	1.31 (0.93–1.83)	. . .	1.18 (0.75–1.85)	. . .
>72 hr/mo	0.96 (0.64–1.44)	. . .	1.11 (0.76–1.63)	. . .	1.01 (0.61–1.65)	. . .
Job demands	1.06 (1.03–1.09)	**<0.001**	1.06 (1.03–1.09)	**<0.0001**	1.04 (1.01–1.08)	**0.014**
Coworker support	1.01 (0.90–1.13)	0.911	0.95 (0.86–1.06)	0.365	0.84 (0.74–0.95)	**0.006**
Supervisor support	0.96 (0.90–1.01)	0.1115	0.95 (0.90–0.99)	**0.028**	0.97 (0.91–1.03)	0.311

*Significant *P* values and variables significant across all three outcomes are bolded.

Although important to retain in the model, there was not a significant relationship of hours worked or nightwork for either sleep deficiency or any components of sleep deficiency (see Supplemental Tables S1, available at http://links.lww.com/JOM/A82, and S2, available at http://links.lww.com/JOM/A83). The associations of sleep deficiency with each of the pain, work interference, and functional limitation outcomes thus seem to be independent of the expected confounders work hours and night shift.

CONCLUSION

A reductionist approach to sleep[61] might characterize that separate "disorders" account for sleep-related health and other problems and focus clinical and other health care–related efforts on ameliorating specific individual-level sleep maladies with targeted treatments. In population-level studies, however, it can be useful to identify first whether sleep overall is deficient in a cohort and then identify specific sources of disruption, for example, to a workforce, that may impact workers in a heterogeneous manner despite potentially common root causes such as the workplace factors of low supervisor and coworker support. The role of the social environment may not be immediately apparent because an understanding of causal relationships does not extend to a full understanding of what constitutes an effective intervention. Ultimately, both population- and individual-level interventions will be needed to reduce the public health burden of sleep deficiency by treating sleep disorders and improving conditions in the workplace. The current study suggests that comprehensive workplace interventions may usefully include sleep deficiency to address sleep duration–extending behaviors, sleep disorder mitigation, and other sleep promotion activities. At a minimum, future workplace interventions could include components on sleep deficiency in the assessment of modifiable outcomes closely related and potentially causally linked to musculoskeletal disorders, pain, and functional limitations that may increase the risk of disability.[62]

Multilevel interventions may be an effective way of supporting changes among individual workers within the context of the work environment. For example, policies that provide increased flexibility on shift length and timing may contribute to a supportive work environment that acknowledges the pivotal role of sleep in worker health outcomes. In tandem, educational programs to inform workers of the important associations between sleep, musculoskeletal disorders, and pain may motivate workers to consider improved sleep hygiene practices.

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