

REVIEW ARTICLES

Workplace Interventions to Promote Sleep Health and an Alert, Healthy Workforce

Nancy S. Redeker, PhD, RN¹; Claire C. Caruso, PhD, RN²; Sarah D. Hashmi, MSc, MPH, MBBS³; Janet M. Mullington, PhD⁴; Michael Grandner, PhD, MTR⁵; Timothy I. Morgenthaler, MD, FAASM⁶

¹Yale School of Nursing, Orange, Connecticut; ²National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Cincinnati, Ohio; ³American Academy of Sleep Medicine, Darien, Illinois; ⁴Beth Israel Deaconess Medical Center, Boston, Massachusetts; ⁵University of Arizona College of Medicine, Tucson, Arizona; ⁶Center for Sleep Medicine, Mayo Clinic, Rochester, Minnesota

Study Objectives: The purpose of this review is to synthesize the published literature that addresses employer-initiated interventions to improve the sleep of workers and in turn improve health, productivity, absenteeism, and other outcomes that have been associated with sleep disorders or sleep deficiency.

Methods: We conducted a systematic search and a selective narrative review of publications in PubMed from 1966 to December 2017. We extracted study characteristics, including the workers' professions, workplace settings and shift work, and workplace interventions focused on worker sleep. Because of the high degree of heterogeneity in design and outcomes, we conducted a narrative review.

Results: We identified 219 publications. After restriction to publications with studies of workplace interventions that evaluated the outcomes of sleep duration or quality, we focused on 47 articles. An additional 13 articles were accepted in the peer-review process. Most studies employed non-randomized or controlled pretest and posttest designs and self-reported measures of sleep. The most common workplace interventions were educational programs stressing sleep hygiene or fatigue management. Other interventions included timed napping before or after work, urging increased daytime activity levels, modifying workplace environmental characteristics such as lighting, and screening, and referral for sleep disorders treatment. Overall, most reports indicated that employer efforts to encourage improved sleep hygiene and healthier habits result in improvements in sleep duration, sleep quality, and self-reported sleepiness complaints.

Conclusions: These studies suggest employer-sponsored efforts can improve sleep and sleep-related outcomes. The existing evidence, although weak, suggests efforts by employers to encourage better sleep habits and general fitness result in self-reported improvements in sleep-related outcomes, and may be associated with reduced absenteeism and better overall quality of life. Candidate workplace strategies to promote sleep health are provided.

Keywords: alertness strategies, education, fatigue management, naps, sleep, workplace

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INTRODUCTION

Sleep deficiency resulting from short sleep duration, poorly timed sleep, and/or poor sleep quality is common. The Institute of Medicine estimates that 50 to 70 million American adults have a chronic sleep disorder that hinders daily function and contributes to poor health.¹ Recent data from the Centers for Disease Control and Prevention indicate that many American adults get inadequate sleep: only 65.2% of adults indicate they sleep ≥ 7 hours.^{2,3} Sleep duration of less than 7 hours is associated with increased risks for cardiovascular disease, obesity, diabetes, hypertension, depression, and all-cause mortality.^{4–7}

The consequences of sleep deficiency also manifest in declines in cognitive function, including attention, reaction time, working and long-term memory, visuomotor performance, decision making skills, verbal function, response inhibition, and motivation.⁸ These cognitive and functional effects have a negative impact on quality of life and also lead to deterioration in performance at work. These outcomes have been most convincingly studied in health care workers,^{9,10} professional

drivers,¹¹ aircraft operators,^{10,12} and night shift workers.¹³ The effects of sleep deprivation can also have public health consequences. Approximately 20% of all serious motor vehicle accidents are thought to be associated with sleep deprivation.¹⁴ Up to 43% of commuter train accidents are thought to be due to fatigue.¹⁵

The financial impacts of sleep deprivation and sleep disorders may be categorized as direct (ie, costs of medical resource utilization, including the consumption of inpatient, outpatient, and pharmaceutical services within the health care delivery system) or indirect (ie, expenses incurred from absenteeism, reduced work productivity, and increased workplace errors and accidents). In a recent study of four companies, sleep-related reductions in productivity were estimated to cost \$54 million per year exclusive of the costs of absenteeism.¹⁶ In that study, those with insomnia complaints missed an extra five days of work annually compared to good sleepers.¹⁷ Data from a large state worker registry revealed that workers reporting more sleep disturbances were significantly more likely to be absent from work, have lower work performance ratings, and higher health care costs.¹⁸ Sleep-related occupational accidents have also led to

Table 1—Overview of included studies.

Workplace Contexts	Occupations	Types of Interventions	Sleep Outcomes in Literature
<ul style="list-style-type: none">• Shift work<ul style="list-style-type: none">◦ Rotating◦ Extended◦ Prolonged• Irregular work hours• Non-shift work office• Non-shift field work	<ul style="list-style-type: none">• Law enforcement• Security• Emergency response systems, including fire-fighters• Health care• Hospitality industry• Customer service call centers, including IT support centers• Manufacturing sector• Public transport• Truck drivers	<ul style="list-style-type: none">• Sleep hygiene education• Fatigue countermeasure programs• Self-management techniques• SAFER program• Strategic naps• Workplace weight loss and reduction of cardiovascular risk factors program• Relaxation techniques• Workplace flexibility and professional consults	<ul style="list-style-type: none">• Sleep quality• Error prevention• Reduction in daytime sleepiness• Behavioral changes• Drowsy driving prevention• Change in average sleep hours in a 24-hour period

SAFER = Sleep, Alertness, and Fatigue Education in Residency.

ecological costs. The fatigue and performance effects of sleep loss and circadian misalignment associated with shift work reportedly contributed to the explosion at the Union Carbide plant in Bhopal, the Three Mile Island and Chernobyl nuclear meltdowns, and the grounding of the Exxon Valdez supertanker.¹ The National Academy of Medicine, formerly the Institute of Medicine, concluded that “hundreds of billions of dollars are spent and/or lost annually because of poor or limited sleep.”¹ Improving sleep and reducing the impact of sleep disorders and sleep deprivation could greatly enhance quality of life, work productivity, and national and global economic performance.¹⁶

Despite compelling evidence of the negative impact of sleep deficiency and specific sleep disorders on worker health and safety, there have been few systematic efforts to address this problem in workplace settings. Although there is a broad literature on worker productivity, absenteeism, and other non-sleep outcomes, there are very few, if any, systematic reviews that focus on workplace interventions that specifically addressed sleep health. This paper reviews the literature on employer-initiated sleep interventions in workplace settings, identifies gaps in the literature, and provides strategic workplace policy considerations to reduce sleep deprivation and improve the safety and productivity of workers.

METHODOLOGY

Literature Retrieval

We conducted a comprehensive search of the PubMed database to identify publications that addressed interventions in the workplace that influence or improve sleep. Results were limited to studies involving humans and published in English. Reviews, newsletters, comments, editorials, and case reports were excluded. The search terms were: sleep AND workplace AND (education OR fatigue management OR naps OR alertness strategies). We retrieved literature published from 1966 to December 2017, which yielded 219 papers. We reviewed all titles and abstracts to identify those that met the following criteria for review in full text: (1) addressed a population consisting of any group of employees, (2) tested an intervention that focused on specific employee behavior, changes in workplace policies or procedures, or manipulation of the environment to

improve sleep quality, duration, or to reduce sleepiness, and (3) compared these outcomes against either an historic or contemporary comparator group. We identified 47 relevant papers. In addition, during review of the bibliography and including papers added by experts on the task force, we identified 13 additional papers, for a total of 60 accepted papers.

Extraction and Analysis of the Literature

Although we had hoped to perform a meta-analysis, the heterogeneity of study designs, populations, and outcomes did not lend the literature to this kind of analysis. Therefore, a narrative review was conducted. We recorded the types of workplaces, occupations of the workers, types of interventions, and sleep-related outcomes from the retrieved articles, all of which may be seen in the supplemental material. The types of workplace contexts, occupations, interventions, and outcomes included in our retrieved literature are summarized in **Table 1**. Based on these characteristics, we identified three major categories of sleep interventions: educational interventions (ie, education about sleep, sleep behaviors and/or sleep-related cognitions or relaxation); interventions focused on health promotion behaviors that might improve sleep (eg, activity/exercise); and interventions focused on workplace environmental modifications to promote sleep.

FINDINGS

Educational Interventions

Educational interventions for sleep aim to disseminate information about personal behaviors (eg, use of caffeine, exercise), environmental factors (eg, bedroom characteristics, bedtime schedule), or sleep disorders that may promote or interfere with sleep. We identified 17 publications that tested the influence of educational interventions on workers’ sleep or sleep-related outcomes.^{19–38} The types of workers varied widely and included flight crews, health care professionals, police, firefighters, teachers, and white-collar workers. Studies were conducted in several countries, in different kinds of industries and work settings. The interventions varied widely in content, delivery method, and level of interactivity with participants. Sample sizes also varied widely but were generally small and underpowered to determine statistically significant effects.

Studies used both experimental and quasi-experimental designs with generally short periods of follow-up. The majority employed self-reported measures of sleep and sleep-related outcomes. Seven publications reported studies of day workers^{21,27,31–35,39} and ten included shift workers.^{20,23,25,26,28,30,36–38,40} We summarize the approaches to educational interventions separately in select studies on day and shift workers below.

Day Workers

Two studies examined the use of a sleep-hygiene educational session in Japanese information system workers. The first study, in predominantly male Japanese information system engineers, employed a 1-hour sleep hygiene lecture that included personal strategies for controlling behavioral and environmental factors, compared to a control group with no intervention.³² The workers receiving the sleep hygiene lecture reported improved afternoon sleepiness and a non-statistically significant trend in improvement in self-reported sleep quality, compared to a control group,³² but there was no difference in sleep duration. The second study, a randomized controlled trial (RCT), tested the effects of two types of delivery of sleep hygiene information.³⁴ All participants received a 30-minute lecture on the importance of sleep and healthy sleep habits, followed by opportunity for questions and answers; one group also received an individualized 30-minute training session with relaxation techniques, stimulus control, or sleep restriction selected by the participant.³⁴ Both groups reported improved sleep quality, but the improvements were greater in the participants receiving the individualized treatment.

Suzuki et al. conducted a RCT using a 2-week interactive internet-based program with Japanese day workers who were interested in improving their sleep.³⁵ The program provided general information about sleep and behaviors that improve or interfere with sleep, and included daily monitoring of sleep, performing three sleep-related behaviors that the participant selected, feedback by email, weekly advice, and a report on the participant's sleep quality. At a 3-week follow-up, participants reported improvements in sleep quality and sleep behaviors. There was also a non-statistically significant trend suggesting that the intervention improved sleep onset latency.³⁵

Two studies specifically addressed insomnia symptoms in workers. A randomized control trial to test the effects of individualized sleep hygiene, relaxation, stimulus control, and sleep restriction (standard components of cognitive behavioral therapy for insomnia) was conducted among Japanese workers at an electrical manufacturing company. Participants had consistent daytime work schedules, but 37% worked more than 45 hours a week. The intervention significantly improved self-reported sleep quality and reduced the number of participants who had poor sleep quality by 20% in the intervention, compared to the control group.³³ In a second study, mindfulness training improved sleep duration, insomnia symptoms, and daytime sleepiness in predominantly women elementary and secondary school teachers in Canada and the United States.³¹

Shift Workers

Shift work is any work schedule outside of the period of 7:00 AM to 6:00 PM.⁴¹ Shift work schedules vary widely and can include

fixed work times, rotating shifts, split shifts, or irregular work times. Shift workers often experience significant sleep deficiency due to short sleep as well as a mismatch of the time available for sleep and the worker's circadian rhythms. Therefore, workers may need sleep interventions that address these circadian rhythm challenges and the sometimes-limited time available for sleep. Lerman et al. discusses a comprehensive set of practice guidelines for managers to reduce risks from shift work, long work hours, and other causes of worker fatigue. They discuss specific content for education programs for shift workers.

Two studies were identified which examined the effects of sleep hygiene training in shift workers. Holbrook et al. tested the efficacy of a 1-hour sleep hygiene program in a group of predominantly male United States law enforcement officers who worked irregular rotating work hours.²⁰ Immediately after the training, officers' knowledge about sleep hygiene improved. However, at one-month follow-up the officers remained dissatisfied with their sleep and reported that the work hours and lack of control over their sleep times made it difficult to apply the healthy sleep practices provided in the program.²⁰ In a second study, 37 Taiwanese female workers, among whom 12 were shift workers, participated in a 5-week sleep hygiene training program. The training included suggestions for shift workers: adjusting sleep schedules, timed exposure to light, using naps before night shift, and reducing noise.³⁰ After the 5-week program participants reported significant improvements in sleep quality.³⁰

Several studies were identified which examined the effects of "fatigue management" programs with heterogeneous components in a variety of worker populations. Rosekind et al. tested a 3.5-hour fatigue training program in United States male flight crew members who made frequent transcontinental flights. The program included alertness strategies, shift scheduling, and information about healthy sleep and various sleep disorders. The intervention significantly improved actigraphy-recorded sleep duration by one hour, knowledge about sleep, and reaction time.³⁶

Scott et al.^{37,38} tested a 1-hour fatigue management program in nurses. It provided information about fatigue, sleep circadian rhythms, effects of poor sleep and strategies for improving sleep quality and duration, minimizing fatigue and promoting alertness, and the use of naps and caffeine.^{37,38} At 4-week and 3-month follow-up, there were significant improvements in sleep duration, sleep quality, alertness, and error prevention. However, the nurses continued to experience poor sleep quality, sleepiness and guilt about leaving the hospital unit to take a nap or a rest break.

A single study reports the effects of the Sleep, Alertness, and Fatigue Education in Residency (SAFER) program, a 60 to 90-minute lunchtime lecture about sleep loss and recovery sleep with the goal of increasing residents' sleep and reducing sleep deprivation.²⁸ The investigators provided SAFER to 58 United States first year medical residents during their 1-month general medicine inpatient rotation between 2003 and 2005. The residents worked 80 hours a week and were only off from work every fourth night. The program did not improve actigraphy-recorded sleep duration that remained well below

recommended sleep durations. The authors concluded that the demanding nature of the residents' work and work hours were significant barriers to obtaining adequate sleep.

We identified two studies of the effects of a training and sleep disorders screening intervention for United States firefighters who worked 24-hour shifts followed by 48 hours off.^{26,40} The 30-minute training program included screening questionnaires and follow-up for sleep disorders, and education about sleep, sleep hygiene, and sleep-related health hazards. In the first study, firefighters working in stations that received the intervention had on average 46% fewer disability days and were 24% less likely to file an injury report.^{26,40} In the second study, investigators compared three methods of delivering the training program in a sample of over 6,000 firefighters from eight fire departments. The methodologies were either expert-led, train-the-trainer or online.⁴⁰ All methods of delivery led to positive behavior changes, with the class that was led by an expert showing the largest gains in knowledge scores, participation rates, and obtaining sleep disorder evaluations.

Taken together, studies of educational interventions conducted in day workers suggest that they lead to at least modest improvements in self-reported sleep quality and quantity, and less sleepiness during the work period. However, there was considerable variability in the criteria for study participation, intervention components and delivery methods. Interventions that used interactive methods to assist workers to problem-solve their sleep concerns seem to be more effective than those focused solely on providing education. The interventions focused on shift workers seemed to be somewhat less effective due to the difficult work hours.

Naps

Naps, both specifically timed or taken ad lib, have been studied as a way to combat effects of sleep deprivation. Twelve studies looked at the effectiveness of napping as a countermeasure to sleepiness and fatigue in safety-sensitive industries.^{42–53} In controlled laboratory settings, the benefits of napping have been shown to depend on several factors, including duration, timing and amount of deep sleep contained in the nap.^{51–53}

Two studies examined the napping intervention in employees working night shifts.^{45,48} The first was a 2-week study of aircraft maintenance engineers working in a forward rotating 12-hour shift pattern, taking a single 20-minute nap during the first night shift. After two weeks, the engineers significantly improved speed of response on a vigilance task measured at the end of the shift compared with the control condition.⁴⁵ In the second study, napping was offered to six nursing units in two hospitals. Nurses found naps to be helpful and reported being less drowsy while driving home after their shift.⁴⁸

Health Promotion Interventions

Health-promoting behaviors are activities undertaken for the purposes of reducing or preventing disease and improving health and wellbeing. Behaviors such as exercise or increased physical activity can improve sleep health as a secondary outcome and may be an effective tool for workers. We identified ten studies that examined the benefits of health promotion

interventions on sleep.^{22,24,25,27,54–59} Two studies evaluated the effects of encouraging increased physical activity on sleep. Bouchard et al. converted seated workstations into treadmill workstations in the office of nurses and dieticians who ordinarily sat at desks for much of the day. Twenty-two participants were encouraged to use the treadmill workstations for a minimum of 2 hours each day to reduce sedentary time, with a secondary goal of improving sleep quality. After 3 months, time spent in low-intensity activities decreased by 20% and most participants (58%) reported improvements in sleep quality.⁵⁴ In a larger study of 490 healthy workers, Hori et al. found that a 4-week walking intervention, accompanied by weekly email reminders, improved sleep quality, sleep onset latency, and sleep duration.⁵⁶

Workplace programs that target body weight and diet report improved sleep. One wellness program focused on body weight, diet, nutrition, physical activity, stress management, and sleep habits.²² After 1 year, participants reported a slight increase in the number of restful nights of sleep per week from 3.7 to 4 nights. A 12-week workplace weight-loss program reported less sleepless nights 26 days after the program.²⁷ Sleep information was not included in this program.

Another study evaluated the effect of alternative medicine including ear acupressure, acupuncture, and a proprietary form of massage based upon Chinese medicine principles.⁵⁵ The self-selected sample included mostly health care workers at a military hospital. After allowing ad libitum use of the different modalities for one year, participants reported strong agreement on a 5-point Likert scale questionnaire with experiencing improved mood and sleep, as well as job satisfaction. These effects increased with the number of clinic visits.⁵⁵

These studies suggest that health-promoting behaviors provided during the workday, such as physical activity and relaxation approaches may improve sleep and sleep-related outcomes. However, there is a need to examine additional sleep-related outcomes such as worker performance and to address limitations such as sleep not being objectively measured.

Workplace Environment Modifications

Three studies highlighted the effectiveness of environmental modifications on sleep.^{60–62} In a study of light supplementation/modification in a group of shift-working nurses, circadian rhythms, as assessed by core body temperature and salivary melatonin, improved.⁶⁰ The study employed supplemental bright light during the first 6 hours of their shift, then participants wore darkening goggles at the end of their shift to limit light exposure prior to daytime sleep after work.⁶⁰ A subsequent study, conducted by Baek and Min, demonstrated that that bright short-spectrum light applied immediately after noon reduced self-reported drowsiness, EEG alpha activity, and increased task performance during the early to mid-afternoon period.⁶¹ The effects on nocturnal sleep were not examined.⁶¹

There have been few other studies that directly examined the impact of modifying physical environmental factors on sleep parameters, although the existing literature suggests possible directions. For example, access to windows and daylight exposure is correlated with improved sleep and daytime function.⁶³ Some studies have shown that the physical environment affects

the value of naps taken in the workplace⁶⁴ and that proper ventilation may influence performance and sleep.⁶⁵

DISCUSSION

We reviewed the literature concerning interventions that might be initiated by employers to improve the sleep of their workers. The interventions we identified included educational programs for day and shift workers, health promotion programs such as those promoting physical activity, strategic naps, and environmental modifications in the workplace—all of which demonstrated some promising findings. However, our review confirms that there is a pressing need for additional research on the effectiveness of workplace interventions to improve sleep.

Challenges and gaps in the literature are related to two overarching limitations that must be addressed prior to more widespread implementation of sleep interventions in the workplace. These limitations are (1) the heterogeneity in populations, settings, intervention components, and outcomes; and (2) the scientific rigor of the studies. These limitations make it difficult to compare and synthesize study results and limit the generalizability of the findings. We discuss both of these limitations below and make recommendations for intervention and public health and policy approaches.

Addressing the Heterogeneity in Populations, Settings, and Interventions

The wide variability noted in the reviewed studies suggests that sleep interventions in the workplace will not be effective using a single approach. There was wide variability in the characteristics of the worker population (eg, age, sex, geographic location, societal and cultural factors) that may influence the efficacy of specific sleep interventions, as well as the targeted sleep characteristics (eg, duration, timing, quality). For example, several studies reported use of sleep hygiene, which is one part of multi-component cognitive behavioral therapy for insomnia. Sleep hygiene is minimally efficacious as a solo therapy for insomnia⁶⁶ and may not be efficacious for shift workers or those who work prolonged shifts. These workers may instead benefit from naps before the work shift or judicious use of light or other circadian stimuli to regularize circadian rhythms. Few studies considered the influence of worker characteristics or differential characteristics of sleep on the efficacy of interventions. Most used only bivariate or simple regression analyses without attention to potentially confounding variables, mediators, or moderators of treatment effects.

Characteristics of the work and the workplace may also influence the feasibility and effectiveness of sleep interventions. For example, work-related stress associated with heavy workloads or emotionally demanding activities may contribute to both short sleep duration and insomnia. Time available for sleep and health-promoting activities are also important considerations for future research. Taking naps during work breaks may improve worker performance, but they may also affect staffing levels and the availability of important services. These are especially concerning in settings where the work requires rapid response to emergency situations, such as acute

care hospitals or law enforcement. Future studies should address these concerns within and across workplace settings.

Taken together the wide heterogeneity in populations, settings, and interventions, suggests the need to identify the most efficacious intervention for specific workers in specific workplaces.

Addressing the Scientific Rigor of Study Designs

The studies reviewed employed a variety of research designs, including RCTs and quasi-experimental designs, with inconsistent control conditions. Sample sizes were generally small and therefore underpowered to detect significant effects. Few studies used objective sleep measurement methods, and many relied on global measures of sleep quality, such as the Pittsburgh Sleep Quality Index. Objective measures, such as actigraphy or biomarkers would improve reliability of results. Study design was also an issue. While conducting RCTs is challenging in complex workplace settings, this area of science may benefit from the use of pragmatic clinical trials, adaptive designs, or other methods that may be more feasible than standard RCTs in these settings.⁶⁷ There is also a pressing need for implementation science that better addresses practical concerns related to the reach, adoption, implementation, and maintenance of these interventions in workplace settings.

Recommendations Regarding Intervention Approaches

The reviewed literature indicates use of a variety of interventions that have usually included didactic/educational components delivered by face-to-face methods. Some studies also included interactive components and coaching that promote problem-solving. Given that education alone is not likely to create sustained change, more interactive approaches are needed that are based on behavioral change theories. These approaches may include addressing social cognitive processes (eg, self-efficacy), and facilitating social support, as well as providing resources such as time, personnel, and educational materials to support these behaviors.

Although our review supports the use of education that emphasizes the importance of sleep behavior, encouraging health-promoting behaviors and relaxation strategies may also be useful. The benefits of these interventions may also include improvements in broader health outcomes. Incorporating sleep content in broader health promotion efforts for day workers, such as those focusing on diet and physical activity may be practical and cost effective.

Workplace napping has been recommended but not extensively studied in the workplace, and there are several considerations that require further clarification. Nap duration appears to be an important factor in self-reported alertness or task completion, with shorter naps of 10–20 minutes often providing improvement. A short 15-minute post-lunch nap promoted subsequent alertness, performance and nocturnal sleep in factory workers.⁴⁴ In contrast, naps of 50 minutes are more likely to result in entry into slow wave sleep; arousals from slow wave sleep result in greater sleep inertia and impair performance immediately upon awakening.^{68,69} Although naps of 30 minutes or less have been recommended to minimize sleep inertia, a recent systematic review concluded that 15 minutes

Table 2—Suggested strategies to promote healthy sleep in the workplace.

Strategies for Accredited Sleep Centers	<ol style="list-style-type: none">1. Develop expertise about the health and safety risks that are associated with shift work and long work hours and the strategies that reduce those risks. Be a resource for the evaluation and treatment for the workers and consultation for employers.2. Develop and disseminate sleep education programs that can be provided onsite at workplaces. Publicize to local workplaces and provide programs on request.
Workplace Strategies for Employers	<p>On hours worked:</p> <ol style="list-style-type: none">1. Set limits on the number of hours worked per 24 hours and per 7-day period. This should include restrictions on how much and when overtime can be worked.2. Establish a minimum of 10 to 11 consecutive hours off from work per 24-hour period for workers to obtain at least 7 hours of sleep.3. Implement flexible scheduling options. <p>Environmental support:</p> <ol style="list-style-type: none">1. Provide a sleep education program for all employees.2. Promote the use of short naps during work breaks.3. Establish fatigue risk management systems.¹⁹4. Incorporate fatigue-related factors into incident investigations. Establish an anonymous, no-blame reporting system for incidents and near misses.5. Establish a system to facilitate workers with sleep problems seeing a health care provider or an accredited sleep disorders center.6. Protect the time for sleep for evening and night shift employees by not requiring attendance at meetings or attention to work functions during time off.7. Modify environmental factors, such as lighting, to promote worker well-being and alertness.8. Incentivize the use of public transportation, especially after long or late shifts and for workers with longer commutes. Educate drivers on the dangers of drowsy driving.9. Where possible, encourage teleworking to facilitate more time for sleep.

may be optimal.⁵³ However, the investigators concluded that there is insufficient evidence to recommend napping during the night shift, expressing concerns that sleep inertia may also be influenced by other sleep and circadian rhythm processes, including sleep debt.⁵³ The research identifying the best duration and timing for naps requires more clarification.

The concerns over sleep inertia highlight one level of complex trade-offs. While a nap might combat effects of sleep debt, sleep inertia may inadvertently jeopardize safety, particularly if those who nap must be immediately alert and functional upon awakening to safely and effectively perform their work roles. The nature of work may influence feasibility of napping while on the job. For example, emergency medical personnel may be unable to sleep on a busy shift.

Additionally, studies of worker age⁷⁰ and of long-term effects of replacement napping are lacking.⁷¹ Finally, in the work setting, developing specific recommendations about naps is challenging^{72,73} due to the enormous variation in the possible timing, duration and frequency of naps and the potential for sleep inertia after napping.⁴⁸ Napping in the context of teams creates another level of complexity, as the impact on team function of one or more team members napping at different times has not been addressed. Nonetheless, strategic napping may be appropriate for certain workers in specific situations.

Strategic Public Health Policy Considerations

A large body of epidemiological evidence demonstrates the critical importance of sleep to health. Extant findings also suggest the potential of workplace interventions to improve sleep and sleep-related outcomes including public safety and worker productivity, although the strength of the evidence is

less robust. However, it is unlikely that individually-focused interventions will be effective without significant support from policy at the workplace and governmental levels. Therefore, there is a pressing need for the development, evaluation, and implementation of policies to improve sleep worker health.

The duration and scheduling of work hours and time off from work are an important focus, since these can be key obstacles to workers having enough time to get the 7 or more hours of sleep recommended for adults.⁷⁴ Information on policies and workplace strategies to promote sleep health are available in Module 5 of NIOSH et al.⁷⁵ and Caruso.⁷⁶ In **Table 2**, we suggest potential strategies to promote sleep in the occupational health setting.

Limitations and Conclusions

This review has several limitations. Specific search terms were used to identify relevant reports, however, it is possible that relevant papers were missed. We only included English language publications, so there is risk of language bias. We did not apply a formal evidence quality assessment once we determined that we would not be performing a meta-analysis. Although fairly broad search terms were used, there are many outcomes of sleep interventions, which our search may have failed to identify.

This review did not include the effect of shift work and long work hours on sleep, which are other workplace factors that strongly impact sleep. Work hours can restrict the time available for sleep and can prevent the worker from sleeping at times that are appropriately aligned with their circadian rhythms. As a result, shift work and long work hours are often associated with short sleep duration and sleep disturbances.^{77–79} This topic

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has been examined in many studies and can be a focus for a future review of the literature.

Short and irregularly timed sleep, as well as insomnia symptoms adversely impact worker health, quality of life, productivity, and safety. Workplace efforts to improve sleep have high potential to address this important public health problem. Critical for addressing this problem are systematic ways to integrate sleep health into workplace settings and develop policies at the level of the workplace and society including state and federal governments that take into consideration the costs and benefits to workers, their families, communities, and employers.

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Address correspondence to: Nancy S. Redeker, PhD, RN, Beatrice Renfield Term Professor of Nursing, Director, Biobehavioral Laboratory, Yale School of Nursing, 400 West Campus Drive West Haven, CT 06516; Email: research@aasm.org

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