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Approaches to managing work-related fatigue to meet the needs of American workers and employers

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Abstract

On September 13–14, 2019, the National Institute for Occupational Safety and Health (NIOSH) hosted a national forum entitled “Working hours, sleep and fatigue: Meeting the needs of American workers and employers.” The purpose of this inaugural meeting was to discuss current evidence about the broad-based risks and effective countermeasures related to working hours, sleep, and fatigue, with further considerations to tailor solutions for specific industries and worker populations. We aimed to identify the knowledge gaps and needs in this area and future directions for research. We also sought to identify similarities across industries with the goal of sharing lessons learned and successful mitigation strategies across sectors. Participants included an international representation of academics, scientists, government representatives, policymakers, industry leaders, occupational health and safety professionals, and labor representatives. A total of eight manuscripts were developed following stakeholder comments and forum discussions. Six focused on sector-specific approaches (i.e., Agriculture, Forestry & Fishing; Healthcare & Social Assistance; Mining; Oil and Gas Extraction; Public Safety; Transportation, Warehousing & Utilities) to identify unique factors for fatigue-risk and effective countermeasures. Two additional manuscripts addressed topic areas that cut across all industries (disproportionate risks, and economic evaluation). Findings from the Forum highlight that the identification of common risk factors across sectors allows for transfer of information, such as evidence for effective mitigation strategies, from sectors where fatigue risk has been more widely studied to those sectors where it has been less so. Further considerations should be made to improve knowledge

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AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

ETHICS STATEMENT

The work was performed at the National Institute for Occupational Safety and Health. Human subjects' institutional review and approval were not required because the work did not involve human subjects.

DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily reflect the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

translation activities by incorporating different languages and modes of dissemination such that information is accessible for all workers. Additionally, while economic evaluation can be an important decision-making tool for organizational- and policy-level activities, multi-disciplinary approaches combining epidemiology and economics are needed to provide a more balanced approach to economic evaluation with considerations for societal impacts. Although fatigue risk management must be tailored to fit industries, organizations, and individuals, knowledge gained in this forum can be leveraged, modified, and adapted to address these variabilities. Our hope is to continue sharing lessons learned to encourage future innovative, multi-disciplinary, cross-industry collaborations that will meet the needs of workers and employers to mitigate the risks and losses related to workplace fatigue.

Keywords

nonstandard work hours; occupational fatigue; sleep

1 | INTRODUCTION

Occupational fatigue in the United States has been estimated to cost employers at present over \$218 billion annually due to lost-time work productivity attributed to health-related work absenteeism and presenteeism.¹ Fatigue can slow down reaction times, reduce attention or concentration, limit short-term memory, and impair judgment. It can increase the propensity for risky behavior, with consequences for fatigue-related incidents causing work injuries and adverse health outcomes.^{2–5} Effects of work-related fatigue can have a significant impact not only on worker health and safety but also on the safety of other coworkers and the general public.⁶ For example, human fatigue has been cited as a contributing factor in high-profile disasters such as the nuclear meltdown at Three Mile Island and the grounding of the Exxon Valdez oil tanker.^{7,8} The National Highway Traffic Safety Administration estimates that in 2017 drowsy driving was a factor in 91,000 police-reported motor vehicle crashes, which resulted in approximately 50,000 injuries and 800 fatalities. However, this is almost certainly an underestimation of the impact of drowsy driving, as not all crashes are recorded or reported to the police, and fatigue can be a difficult causal factor to identify. Fatigue can affect mood and psychological well-being and can also result in negative consequences for the family.^{9,10} The impact of fatigue can extend from workers to their partners, by limiting personal resources and time to attend to household responsibilities and social recovery.¹¹ Parental fatigue may have adverse effects on parental adaptability and childhood development.¹²

Work-related fatigue is often associated with nonstandard work schedules such as night shifts and extended hours, and their sequela, impaired sleep. However, fatigue is a complex multifaceted construct which can be attributed to a variety of other factors.¹³ Other work-related sources of fatigue include physically or mentally demanding tasks, monotony, exposure to extreme heat or cold, or prolonged exposure to stressful situations.¹⁴ At the individual level, factors such as age, health, lifestyle choices, and household responsibilities can also contribute to greater fatigue risk.¹³

Although the general concept of work-related fatigue seems at first straightforward, it lacks a standard definition making it difficult to accurately identify, quantify and manage.^{5,15} The terms “fatigue” and “sleepiness” are related and often used interchangeably in the general vernacular; however, prior literature underscores the difference between these constructs.^{5,16} Whereas sleepiness is recognized as the tendency, or the desire, to fall asleep, fatigue is a broader concept related to the lack of energy to complete a specific task.^{4,5} Fatigue may be reduced by sedentary activity or by rest without sleeping, but sleepiness may be worsened by the same measures.¹⁷ Recognizing the difference is critical when identifying risk factors and corresponding effective intervention strategies. Managing fatigue can be further complicated by how it is categorized. Fatigue can be conceptualized as acute or chronic, which relates to frequency of exposure and potential carry-over effects, resulting in differential effects on health and wellbeing.^{3,18} Fatigue has also been described as central or peripheral, referring to its effects on the central nervous system and cognition, versus those on the peripheral nervous system or on neuromuscular outcomes.^{19,20} Others have defined central fatigue as having a psychological etiology, whereas peripheral fatigue arises from physical factors.¹⁹ Awareness of various determinants of fatigue can help identify its primary sources in different work settings, and aid in the development of effective mitigation strategies.

Despite the extensive literature surrounding occupational fatigue risks and consequences, and the considerable variation in fatigue risk factors and subcategories of fatigue, most intervention strategies have largely concentrated on working hour limitations or other work scheduling practices, and provision of sleep hygiene education and training.²¹ Most fatigue mitigation strategies are designed for workers with regular or predictable work schedules and do not account for the complexities of work-related fatigue and variability across workplaces, job tasks, and individual-level factors. Except for a few industries, most strategies are written in broad language for the general workforce population. However, these approaches may not be applicable in some industries which face unique environments or job tasks. For example, some industries involve remote locations (e.g., mining) or prolonged periods of intense activity (e.g., utility workers during storm events) where a regular work/sleep routine may not be feasible. In addition, fatigue-related risks may also vary widely across industries, and therefore, mitigation strategies will also differ.

2 | NIOSH WORKING HOURS, SLEEP, AND FATIGUE FORUM

On September 13–14, 2019, the National Institute for Occupational Safety and Health (NIOSH) hosted a 2-day national forum entitled “Working hours, sleep and fatigue: Meeting the needs of American workers and employers.” The forum was planned and chaired by the Working Hours and Fatigue Working Group within the NIOSH Healthy Work Design and Well-Being Cross-Sector Program.²² The purpose of this inaugural meeting was to discuss current evidence about the broad-based risks and effective countermeasures related to working hours, sleep, and fatigue, with further considerations to tailor solutions for specific industries and worker populations. We aimed to identify the knowledge gaps and needs in this area and future directions for research. We also sought to identify similarities across industries with the goal of sharing lessons learned and successful mitigation strategies across sectors. Over 90 international participants attended, including academics, scientists,

government representatives, policymakers, industry leaders, occupational health and safety professionals, and labor representatives.

Using the industry sector classification system defined in the National Occupational Research Agenda (NORA),²³ we invited NIOSH leaders from each sector group to participate in the forum. Six sector teams (Agriculture, Forestry & Fishing; Healthcare & Social Assistance; Mining; Oil and Gas Extraction; Public Safety; Transportation, Warehousing & Utilities) identified work-related fatigue as a priority area for discussion. Two study teams were formed to examine two additional priority topics. One team was dedicated to workers with disproportionate risks for occupational injuries and illness, where fatigue may also be a critical contributing factor. Another team was developed to examine economic benefits and costs related to nonstandard schedules. These eight working groups developed peer-reviewed extended abstracts which were published on the NIOSH website 6 months before the forum.²⁴ Two invitations for stakeholder comments on the content were solicited through NIOSH NORA sector councils, industry/labor networks, and NIOSH media networks. All comments received were considered and abstracts were revised accordingly.

During the forum, breakout sessions were held to present the extended abstracts for each sector and topic area. Discussions focused on the current state of evidence, gaps and needs in knowledge, and future directions for research and countermeasures of fatigue risk. The 8 extended abstracts were then developed into scientific manuscripts following feedback during the forum and were subsequently peer-reviewed internally and externally to NIOSH. This special issue of the American Journal of Industrial Medicine represents the culmination of the collective efforts of scientists, policymakers, OSH professionals, and industry and labor representatives, following the NIOSH tripartite approach of collaboration among government, industry, and labor.

3 | TOWARD MORE TARGETED APPROACHES TO WORK-RELATED FATIGUE

The NIOSH Working Hours, Sleep and Fatigue Forum resulted in a total of eight manuscripts, with six focused on sector-specific approaches to identify unique factors for fatigue risk and effective countermeasures. Studies in work-related fatigue risk most often involve the transportation, healthcare, and public safety sectors. Sieber et al. summarize extensive literature concentrating on the transportation industry but find that little has been published about utility workers.²⁵ While the transportation and utility sectors share similarities in terms of nonstandard schedules such as long and irregular shifts, there are substantially more resources and regulations (e.g., hours of service) existing for some groups of transportation workers (including aviation, rail, and commercial trucking) than for utility workers. Stress and work pressures are also identified as significant fatigue factors, suggesting that fatigue management strategies should also consider addressing these salient issues. Caruso et al. report that nonstandard work schedules and inadequate sleep were prevalent among almost half of all healthcare and social assistance workers.²⁶ Work schedule design and workplace culture are identified as priority areas for improvement,

with additional considerations for fatigue-mitigation strategies such as promoting education for workers and employers, reducing fatigued driving, studying individual differences, and developing holistic fatigue risk management systems. Allison et al. report that nonstandard schedules are also highly prevalent in public safety occupations such as firefighting (including wildland), emergency medical services, corrections, and law enforcement.²⁷ However, unlike most other sectors, these occupations are subject to periods of inactivity, interspersed with unpredictable peaks of physical activity and psychological strain during emergency situations which may involve exposure to traumatic incidents. These emergency situations can last over several consecutive shifts and may not allow opportunities for sufficient recovery. While there is substantial scientific work examining working hours, sleep, and fatigue in this sector, there is a paucity of research on fatigue-mitigation strategies, highlighting the need for more work in this area.

While limited information can be found on work-related fatigue and mitigation strategies among the Oil and Gas Extraction, Mining, and Agriculture, Forestry and Fishing sectors, several areas are identified for future exploration. Work in these sectors can involve long commutes to remote locations, unpredictable and prolonged working periods during peak harvest or annual maintenance and inspections, physically demanding labor, extreme temperatures, and living away from home in communal housing or camps. As such, traditional approaches to sleep and fatigue management such as work hour restrictions or promoting sufficient sleep in quiet, dark environments may not always be feasible.

A scoping review of Oil and Gas Extraction literature from Hagan-Haynes and colleagues finds that most studies have been cross-sectional etiologic studies conducted in offshore operations.²⁸ A limited number of intervention studies focus on motor vehicle crash prevention, lighting strategies, and use of melatonin. Opportunities for further work include research on interactions between occupational and nonoccupational risk factors, identifying and evaluating other interventions such as fatigue detection technologies, and implementation of fatigue risk management systems. Bauerle and the Mining sector team explore the human factors of mineworker fatigue which include long work hours, ergonomic problems, exposure to hazardous substances, monotonous and disengaging work tasks, dim lighting in underground environments, and long commutes to remote locations.²⁹ Despite the variety of potential sources of fatigue, countermeasures have been limited to shift scheduling practices. Holistic fatigue risk management systems were also suggested to address the variety of fatigue-related factors in mining operations. Elliot and coauthors identify hazardous and physically demanding working conditions in Agriculture, Forestry and Fishing, which include long working hours, often over several consecutive days or weeks particularly during peak seasons, with little opportunities for rest or recovery (reference). However, there is limited evidence of fatigue-mitigation strategies currently in practice.

In addition to our sector-specific approach, two topic areas (populations at disproportionate risks, and economic evaluation) which cut across all industries were explored. Cunningham et al. find that in addition to nonstandard shifts, lack of access to fatigue management resources and socioeconomic barriers may increase the risk for fatigue-related health and safety concerns among young or new, female or minority workers, those with low levels of

education or socioeconomic status, or those employed in small businesses.³⁰ Recognition of these challenges may identify additional intervention strategies such as improving access to resources and refining knowledge translation activities by incorporating different languages and modes of dissemination. In their scoping review, Wong and colleagues explore how economic benefits and costs associated with nonstandard schedules are described in the current literature.³¹ As economic evaluation can be an important decision-making tool for implementation of organizational- and policy-level activities, providing examples of prior evaluations can serve as a resource. However, findings from the scoping review also suggest that multi-disciplinary approaches combining epidemiology and economics are needed to provide a more balanced approach to economic evaluation with considerations for societal impacts.

4 | CONCLUSION

The findings and discussions from the NIOSH Work Hours, Sleep and Fatigue Forum highlight the substantial research and knowledge base of these problems in some sectors and areas for further exploration in other sectors. However, identification of common fatigue risk factors across sectors allows for transfer of information, such as evidence for effective mitigation strategies, from sectors where fatigue risk has been more widely studied to those sectors where it has been less so. Although fatigue risk management programs must be tailored to fit particular industries, organizations, and individuals, the knowledge gained in this forum can be leveraged, modified, and adapted to address these variabilities. Our hope is to continue sharing lessons learned to encourage future innovative, multi-disciplinary, cross-industry collaborations that will meet the needs of workers and employers to mitigate the risks and losses related to workplace fatigue.

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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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