NATIONAL OCCUPATIONAL RESEARCH AGENDA (NORA)

NATIONAL OCCUPATIONAL RESEARCH AGENDA FOR HEALTHY WORK DESIGN AND WELL-BEING

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Developed by the NORA Healthy Work Design and Well-Being (HWD) Cross-Sector Council

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INTRODUCTION

What is the National Occupational Research Agenda?

The National Occupational Research Agenda (NORA) is a partnership program to stimulate innovative research and workplace interventions. In combination with other initiatives, the products of this program are expected to reduce the occurrence of injuries and illnesses at work. Unveiled in 1996, NORA has become a research framework for the Nation and National Institute for Occupational Safety and Health (NIOSH). Diverse parties collaborate to identify the most critical issues in workplace safety and health and develop research objectives for addressing those needs.

NORA enters is third decade in 2016 with an enhanced structure. The ten sectors formed for the second decade continue to prioritize occupational safety and health research by major areas of the U.S. economy. In addition, there are seven cross-sectors organized according the major health and safety issues affecting the U.S. working population. While NIOSH is serving as the steward to move this effort forward, it is truly a national effort. NORA is carried out through multi-stakeholder councils, which are developing and implementing research agendas for the occupational safety and health community over the decade (2016-2026). Councils address objectives through information exchange, partnership building, and enhanced dissemination and implementation of evidence-based solutions.

NORA groups health and safety issues into seven cross-sectors. The Healthy Work Design and Well-Being (HWD) Cross-Sector focuses on protecting and advancing worker safety, health, and well-being by improving the design of work, management practices, and the physical and psychosocial work environment. HWD's holistic perspective focuses on how work affects overall safety, health and well-being, including physical, psychological, social, and economic aspects.

What are NORA Councils?

Participation in NORA Councils is broad, including stakeholders from universities, large and small businesses, professional societies, government agencies, and worker organizations. Councils are co-chaired by one NIOSH representative and another member from outside NIOSH.

Statement of Purpose

NORA councils are a national venue for individuals and organizations with common interests in occupational safety and health topics to come together. Councils will start the third decade by identifying broad occupational safety and health research objectives for the nation. These research objectives will build from advances in knowledge in the last decade, address emerging issues, and be based on council member and public input. Councils will spend the remainder of the decade working together to address the agenda through information exchange, collaboration, and enhanced dissemination and implementation of solutions that work.

Although NIOSH is the steward of NORA, it is just one of many partners that make NORA possible. Councils are not an opportunity to give consensus advice to NIOSH, but instead a way to maximize resources towards improved occupational safety and health nationwide. Councils are platforms that help build close partnerships among members and broader collaborations between councils and other organizations. The resulting information sharing and leveraging efforts promote widespread adoption of improved workplace practices based on research results.

Councils are diverse and dynamic, and are open to anyone with an interest in occupational safety and health. Members benefit by hearing about cutting-edge research findings, learning about evidence-based ways to improve safety and health efforts in their organization, and forming new partnerships. In turn, members share their knowledge and experiences with others and reciprocate partnerships.

NORA Healthy Work Design and Well-Being (HWD) Council

The NORA HWD Cross-Sector Council was formed in early 2017. The council aims to provide national leadership in the area of HWD through gathering and synthesizing scientific information, creating knowledge, providing recommendations, and delivering products to those who are developing and implementing workplace prevention efforts. The Council intends for the National Occupational Research Agenda for HWD to succinctly summarize research objectives that will address important gaps and needs, and advance knowledge and practice. The members of the NORA HWD Cross-Sector Council are:

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L. Casey Chosewood, MD, MPH, NIOSH, Co-Chair

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What does the National Occupational Research Agenda for HWD represent?

The National Occupational Research Agenda for HWD is intended to identify the knowledge and actions most urgently needed to identify occupational risk factors to prevent avoidable adverse health outcomes among

workers. This Agenda provides a vehicle for stakeholders to describe the most relevant issues, research gaps, and safety and health needs for the cross-sector. It is meant to be broader than any one agency or organization. It identifies the priorities for the entire country and all of its research and development entities, whether government, higher education, or industry. Because the Agenda is intended to guide national occupational health and safety efforts for HWD, it cannot at the same time be an *inventory* of all issues worthy of attention. The omission of a topic does not mean that topic was viewed as unimportant. Those who developed this Agenda did, however, believe that the number of topics should be small enough so that resources could be focused on a manageable set of objectives, thereby increasing the likelihood of real impact in the workplace.

NIOSH used the draft Agendas created by the sector and cross-sector NORA councils as an input into the development of a [NIOSH Strategic Plan](). Programs used the [burden, need and impact method]() to write research goals that articulate and operationalize the components of the NORA sector and cross-sector Agendas that NIOSH will take up. NORA Agendas and the NIOSH Strategic Plan are separate but linked.

Who are the target audiences?

The National Occupational Research Agenda for HWD was developed to provide information about the most relevant HWD research gaps and needs and is targeted to researchers, health and safety professionals, practitioners, and human resources professionals in industry, labor, academia, and government. The objectives are meant to assist in setting priorities around occupational health and safety research and produce information that can help inform workplace practices.

How was the research agenda developed?

This Agenda was developed through a series of conference calls and email communications. A draft list of relevant topics was drawn up, then refined and grouped into seven broad objectives by the HWD Council. Working subgroups were formed for each of the seven objectives. A variety of information sources were used, including articles from the scientific literature, and HWD Council member expertise and experience. HWD Council members went through three iterations of review and discussion and redrafting the objectives in the development of the Agenda. Although there is some overlap in the risk factors and outcomes across the objectives, each has a unique primary focus.

THE OBJECTIVES

The Healthy Work Design and Well-Being (HWD) Cross-Sector focuses on protecting and advancing worker safety, health, and well-being by improving the design of work, management practices, and the physical and psychosocial work environment. HWD's holistic perspective focuses on how work affects overall safety, health and well-being, including physical, psychological, social, and economic aspects. The following seven research objectives address the most critical HWD issues identified by the HWD Council.

Objective 1: Identify and examine the impact of changes in worker demographics on worker safety, health, and well-being

Background

The demographics of the U.S. population are changing, and this is altering the characteristics of the workforce in significant ways. Changes in the distribution of workers in terms of age, gender, sexual orientation, race, ethnicity, country of origin, and language interact with work design, management practices, and physical and psychosocial work environments in ways that may adversely and disproportionately affect worker safety, health, and well-being.

Some of the demographic groups described below often face elevated safety and health risks because they are more likely to have physically demanding, labor-intensive jobs. Workers with certain demographic characteristics are often more concentrated in work arrangements that are temporary in nature (Ray, Kenigsberg, & Pana-Cryan, 2017) and where exposure to physical and psychosocial risks is more pronounced (Howard, 2017; Benavides et al., 2006). (See Objective 2 for more information on work arrangements.) In addition, many of these jobs do not provide employee benefits such as health insurance paid leave and retirement, thereby affecting overall worker well-being. In March of 2017, while 93% of managers had paid sick leave benefits, only 46% of service workers and 47% of construction, extraction, farming, fishing, and forestry workers had paid sick leave benefits. Less than half (48%) of private industry establishments offered retirement benefits, and a little over a half (58%) of these establishments offered healthcare benefits to their workers. (BLS, 2018a; BLS, 2018b).

Age

Older workers
The Bureau of Labor Statistics (BLS) projects that by 2024 approximately 25% of the American workforce (about 41 million workers) will be aged 55 or older, with workers aged 65 or older expected to be the fastest growing segment (Toossi & Torpey, 2017). While older workers are often psychologically healthier, report more positive psychosocial work environments (Sauter, Keel, & Hanseman, 2009), and have fewer occupational injuries overall than younger workers, the rate of fatalities due to occupational injuries suffered by workers aged 65 and older is nearly three times that of the overall workforce (BLS, 2017). In addition, older workers suffer from more chronic health conditions that can affect their ability to stay safe and healthy at work. Maintaining productivity in an aging workforce has important economic implications. The Congressional Budget Office has projected that by 2030 aggregate expenditures on federal programs that include social security, Medicare, and Medicaid will likely be 16% of the total output of the economy (CBO, 2001). These challenges demonstrate a need to develop and implement age-friendly work design, management practices, and physical and psychosocial work environments to create workplaces that are safe for all workers as they age (Silverstein, 2008).

Younger workers
In 2016, there were about 19 million workers aged 16 to 24, representing about 13% of the total workforce. In 2016, over 380 workers under the age of 24 died from occupational injuries (BLS, 2017). In 2014, the rate of occupational injuries treated in emergency departments for workers aged 15–19 was 2.18 times greater than the

rate for workers aged 25 and older. The rate for workers aged 20–24 was 1.76 times greater than for workers aged 25 and older (NIOSH, 2017). Injuries to young workers are often the result of working in high-risk jobs, lack of work experience and safety training, and fear of speaking up about the workplace hazards that they and newly hired workers face.

Gender, Gender Identity, and Sexual Orientation

Women accounted for about one-third of the total labor force in 1950. By 2000, women comprised over 46 percent of the workforce or approximately 66 million workers. By 2015, this number had increased to almost 74 million, and in 2016, 48% of the US workforce were women. The number of women in the labor force is expected to increase to around 77 million by 2024 (Toossi & Morisi, 2017). The increase in the proportion of female workers may improve personal and family earnings and access to employee benefits, which can in turn affect the well-being of all family members. But we have limited understanding of how these changes will impact work-life integration and family life for both women and men. (See Objective 7 for more information on the work and non-work interface and access to employee benefits.)

In 2015, 7% of U.S. workers considered themselves as gay or transgender (BLS, 2015). Other recent estimates indicate that between 2.2% and 4.1% of the adult population in the U.S. identify as gay or transgender and this number is increasing (Gates, 2014; Gallup, 2017). Based upon these estimates, this would represent up to 10 million working age people. Even though it is illegal under Equal Employment Opportunity Commission enforcement of Title VII of the Civil Rights Act, discrimination and differential treatment, harassment, disparagement, and denials of benefits and promotions based on their sexual minority status are routinely reported by gay and transgender workers (EEOC, 2018). We have limited understanding of the safety, health and well-being impacts upon sexual minorities who face these types of maltreatment while at work.

Race and ethnicity

The American workforce continues to become more diverse. In 1996, White non-Hispanic workers comprised about 75% of the workforce. In 2016, White non-Hispanic workers comprised 63% of the workforce, and are predicted to be about 58% of the workforce by 2026 (BLS, 2017). By 2026, Hispanics, non-Hispanic Blacks, and non-Hispanic Asians are expected to constitute about 21%, 13%, and 7% of the workforce, respectively (BLS, 2017).

Country of origin and language

In 2016, there were 27 million foreign-born workers in the U.S., comprising about 17% of the total labor force (BLS, 2017).   Foreign-born workers face language and literacy challenges that create barriers to receiving safety and health training, increase the likelihood of workplace discrimination, and lead to lack of familiarity with programs that protect workers (Byler, 2013). In addition, foreign-born workers may experience fear of speaking up and of exercising their right to a safe and healthy workplace. These disparities have resulted in high rates of injuries, illnesses, and fatalities among foreign-born workers (Byler, 2013).

Research gaps

- Enable better sharing of data among state and national agencies to improve the understanding about the nature, source, and consequences of injuries and illnesses among older and younger workers.

- Gather and disseminate best practices for age-friendly workplace policies, including job redesign interventions, flexible scheduling models, and anti-discrimination policies.

- Conduct intervention research on strategies to promote awareness among young workers about occupational safety and health and development of necessary skills to actively address occupational hazards, including youth leadership training programs, community awareness campaigns, and school based and job training programs.

- Conduct research on workplace risk factors related to gender, gender identity, and sexual orientation such as discrimination, sexual harassment, pay inequality, work-life conflict, job design, and exposures to reproductive hazards.

- Improve data collection systems, and determine the extent of underreporting of injuries and illnesses by foreign-born and other vulnerable workers and their employers.

- Collect and disseminate best practices for addressing the occupational safety and health of foreign-born workers, including policies that promote worker involvement in identifying and addressing hazards without fear of retaliation and education and training efforts that reflect the specific language and literacy needs of diverse workers.

Objective 2: Improve the Safety, Health, and Well-Being of Workers with Non-Standard Work Arrangements

Background

Non-standard work arrangements have accounted for much of the employment growth in the U.S. during the past two decades. According to definitions and data used in a recent study by Katz and Krueger (2016), in 2015, nearly one in five workers had a non-standard work arrangement; this is nearly double the percentage of workers in non-standard work arrangements in 1995. One commonality shared by many workers in non-standard work arrangements is that there is no expectation of permanence (Howard, 2017). Many non-standard work arrangements are characterized by temporariness, instability, unpredictability of work hours, limited schedule control, and lack of legal protections and employer sponsored benefits for workers (Bushnell et al., 2017). All of these factors can influence worker safety, health, and well-being.

Although there has been a rise in the prevalence of non-standard work arrangements, these types of work arrangements are understudied, and their determinants and safety, health, and well-being consequences are poorly understood. Current occupational safety and health surveillance systems do not adequately capture information about non-standard work arrangements and associated adverse health outcomes. In addition, traditional workplace-based interventions to improve safety, health, and well-being are likely to be inadequate for addressing any harmful characteristics of non-standard work. Likewise, traditional intervention dissemination models may be inadequate for improving the safety, health, and well-being of workers in certain non-standard work arrangements.

Categories of non-standard work arrangements

Although there is currently no consistent definition for non-standard work arrangements among surveys that aim to collect these data, workers in these arrangements can be grouped into several categories: (1) contingent workers, hired for a specific project or other short-term need; (2) subcontracted workers, where working conditions are controlled by an entity other than the workers' employer (for example, temporary agency workers); (3) independent contractors, who are self-employed and work at a location controlled by a business with which they have a contractual relationship; (4)"gig" workers, who perform work intermediated by a digital on-line platform; (5) part-time workers, many of whom are in low-wage hourly jobs, have unpredictable work hours and schedules, and would prefer to work full-time; and (6) workers assigned to schedules other than the traditional 8:00 am to 5:00 pm, Monday through Friday routine (Howard, 2017; Swanberg, Watson, & Eastman, 2014). Non-standard work arrangements may be associated with increased chronic opioid use. Pensa et al., (2018) found that being paid hourly was a predictor for increased chronic opioid prescribing.

Temporary and precarious employment

Compared with standard work arrangements, several non-standard arrangements involve temporary jobs and insecurity of employment and income, which have been linked to low levels of health and well-being (Virtanen, et al., 2005). Insufficient household income and non-standard or irregular hours are associated with poor mental health (De Moortel, Vandenheede, & Vanroelen, 2014). Similarly to newly hired workers, temporary workers frequently lack safety and other job training, and experience higher injury rates than permanently employed workers (Foley, 2017). (See Objective 1, younger workers.) A recent study that used data from years between 2002 and 2014 demonstrated that work arrangement was an important predictor of job stress. Compared with non-stressed workers, stressed workers across all work arrangements reported more days of poor physical and mental health and more days with activity limitations (Ray et al., 2017). (See Objectives 4 and 6 for more information on the adverse effects of job stress.)

Research gaps

- Improve occupational health surveillance systems data collection on non-standard work arrangements and associated adverse health outcomes .

- Develop surveillance methods that measure the prevalence and characteristics of non-standard work and identify workers and workplaces with non-standard arrangements.

- Describe the characteristics of non-standard work that are detrimental to worker health.

- Identify the broader socioeconomic factors that have led to a rise in the number of jobs with non-standard work arrangements.

- Identify and evaluate interventions that improve the safety, health, and well-being of workers employed in non-standard work arrangements.

- Disseminate effective interventions that improve the safety, health, and well-being of workers employed in non-standard work arrangements.

- Understand specific risk factors, such as job insecurity, associated with precarious work and non-standard work arrangements.

Objective 3: Address the Safety and Health Implications of Advancing Technology

Background

Computers have become a central component of many jobs, and there are rapidly expanding applications of robotics and sophisticated information and communication technologies affecting most industries and occupations. Continuing developments in artificial intelligence and machine learning are driving much of this expansion. Recently, an expert panel concluded that "advances in information technology are far from over, and some of the biggest improvements in areas like artificial intelligence are likely still to come" (National Academies of Sciences, Engineering, and Medicine, 2017). The full impact of changes in technology follows from both the development of new technologies and the diffusion and maturation of existing technologies. For most of the topics discussed below, there has been only scattered direct research. There is a clear need to develop surveillance methods, prioritize research, and create and disseminate strategies for safeguarding workers during a time of rapid technological dynamism.

New technological demands on workers

New technologies have the potential to make jobs safer and easier to perform but can also produce the opposite effect: jobs can become more complex and workers can be confronted with new and unanticipated hazards. Technology can also result in the creation of entirely new jobs and the elimination of other jobs. A recent study indicated that as many as 45% of the activities people are paid to perform could be automated by taking advantage of currently available technologies (Chui, Manyika, & Miremadi, 2016). The introduction of new technologies may require changes in business processes, job definitions, and worker adaptation. Workers must learn how to use the new technology and how best to incorporate it into their workflow. The term "technostress" has been coined to refer to the demands placed on workers by the incorporation of new technologies into the workplace (Tarafdar et al., 2015).

New technologies may force workers to use multiple streams of information from different devices and sources, leading to increased mental workload. Existing systems and components may be updated or otherwise modified with little warning and inadequate training or technical support. In some cases, technologies can make work tasks monotonous or less engaging through oversimplification. Tasks that once involved specific actions and direct involvement in production processes may now mostly involve passive monitoring of computer screens or gauges. Technology can also be used to monitor employee performance, which may be stressful for workers. Thus far, technology has been viewed as primarily impacting low-skill jobs and less educated workers. Future impacts, however, are likely to be much broader as increasingly advanced technologies are introduced into skilled professions such as medicine, banking, and law. For highly skilled workers, technology is more likely to complement their jobs than eliminate them. Still, the incorporation of these changes is likely to be disruptive and stressful at least in the short term.

Human-machine interaction

Workers have long interacted with technology of one kind or another. Currently, however, these interactions are changing in fundamental ways. Early robotic systems performed basic tasks with high mechanical precision, whereas many of today's robots are programmable and utilize various types of sensors. Some can learn a new task from observation of humans. Progress is also being made in computer perception of speech, vision, and sound (National Academies of Sciences, Engineering, and Medicine, 2017). In the future, workers will interact with and communicate with robots in a variety of different ways. Workers will supervise and support robots at the same time that they are interacting with other people (Hancock, 2009; Rus, 2015) and robots will also communicate and interact with each other.

Virtual work, re-defining the "workplace"

Technology can clearly impact how people work; it can also impact where they work, when they work, and even how much they work. Today, workers in many jobs can telecommute or work remotely, and interact with colleagues in multiple locations around the world. The wide availability of information and communication technologies have blurred the separation between work life and home life. A 2015 Pew Research Center report (Purcell & Rainie, 2015) indicated that 35% of employed adults who use the internet at work reported that the internet, email, and cell phones have increased the amount of time they spend working. In essence, workers can be continuously connected to their work. Technological change can also alter the fundamental contract between employer and employee. Non-standard work arrangements such as independent contracting and working for temporary employment agencies have been expanding for some time (Katz & Krueger, 2016). Information and communication technologies have helped fuel this trend by making it easier for employers and potential workers to connect, communicate, and complete a variety of tasks remotely. This has led to the creation of new companies that make use of technology-mediated on-demand or "gig" employment (U.S. Census Bureau, 2015). While these non-standard work arrangements have led to increased employment insecurity for some, they have provided

others with increased flexibility and expanded employment opportunities. (See Objective 2 for more information on non-standard work arrangements and Objective 7 for more information on workplace flexibility policies and practices.)

Research gaps

- Develop a taxonomy of types of work-related technological changes and the types and extent of worker interaction with them.

- Conduct surveillance on the use of different types of technology by industry and occupation over time and the relationship with worker safety, health, and productivity outcomes.

- Conduct systematic, multidisciplinary research on the impact on workers of different types of technology, including through changes in job design, work schedules, training, demands, and safety.

- Conduct research on how to best design technology, including research on how humans interact with technology, to enhance worker safety, health, and productivity.

- Develop best practices for supporting worker safety and health in the introduction of new work-related technologies.

Objective 4: Reduce Work Organization-Related Chronic Health Conditions among Workers

Background

Although more than a century's worth of research documents the link between work organization, job design, and acute and chronic worker health outcomes, research on these linkages has intensified in recent years (Sauter & Hurrell, 2017; Vinchur & Koppes, 2011). Management and human resources policies, leadership and management practices, organizational climate and culture, and economic conditions can have profound implications for the health of workers. Many chronic health conditions have been shown to be associated with working conditions. Given the enormous health and economic burden of chronic health conditions for both individuals and society as a whole, there is a need to understand the links between job design, working conditions, work organization, and these chronic health conditions.

Obesity

Obesity is a complex and costly condition which affected approximately 36% of adults in the U.S. during 2011–2014. (Ogden et al., 2015). Being overweight or obese is linked to an increased risk of developing a variety of serious health problems, including hypertension, type 2 diabetes, metabolic syndrome, stroke, coronary heart disease, sleep apnea, osteoarthritis, and some cancers (National Center for Chronic Disease Prevention and Health Promotion, 2016). Obesity and its associated health problems have had a significant economic impact on both health care costs and work-related productivity (Cawley & Meyerhoefer, 2012). Using 2006 and 2008 data, annual costs attributable to obesity among full-time employees in the U.S. have been estimated to exceed 70 billion dollars (Finkelstein et al., 2010). Overweight and obesity also have important implications in the work environment and lead to a number of significant negative impacts on workers as well as employers. Overweight and obese workers, on average, earn lower salaries, are viewed more negatively than others of normal weight, both by supervisors and coworkers, and can be victims of discrimination in the workplace (Judge & Cable, 2011). When obesity is present, companies incur costs linked to absenteeism and both workers and employers have higher medical expenditures (Finkelstein, Fiebelkorn & Wang, 2005). Additionally, workers with obesity

experience lower productivity at work due to health problems and associated "presenteeism" (Ricci & Chee, 2005) and higher rates of obesity-related disability (Sturm, Ringel, & Andreyeva, 2004).

Cardiovascular disease

Cardiovascular disease (CVD), including heart and cerebrovascular disease, is the leading cause of death in the U.S. (Heron, 2016). CVD is prevalent among the working population; 53% of those with CVD are less than 60 years of age, according to pre-2000 data (Cooper et al., 2000; Leigh & Miller, 1998). CVD is a leading cause of death and permanent disability among workers, resulting in an average loss of seven years of life expectancy (American Heart Association, 2000). While many workplace prevention efforts for CVD have primarily focused upon altering individual health behaviors (e.g., smoking, physical activity, and nutritional practices), a growing body of research has identified the need to focus on the association between CVD and work organization factors, including psychosocial risks common in many workplaces (Theorell et al., 2016). The Sixth International Conference on Work Environment and Cardiovascular Disease adopted a statement in 2013 estimating that "10%-20% of all causes of CVD deaths among working age populations…. are work-related" (International Commission on Occupational Health, 2013, page 4).

Depression and anxiety

In 2016, there were an estimated 44.7 million adults aged 18 or older in the U.S. (about 18% of the adult population) with any mental illness (AMI) within the past year (National Institute of Mental Health, 2016). AMI can vary in impact, ranging from no impairment to mild, moderate, or severe impairment. Moreover, nearly one in four of those with AMI (approximately 10.4 million Americans) have a serious mental illness, which results in significant functional impairment. Depression, anxiety, and other mental health conditions are costly in both human and economic terms. In 2015, more than 16 million Americans (or nearly 7% of all adult Americans) had a major depressive episode within the past year (National Institute of Mental Health, 2015). In 2003, depression was estimated to be responsible for $36.6 billion to $51.5 billion in lost productivity in American workplaces (Stewart, Ricci, Chee, et al., 2003). It is also widely believed that mental health conditions interact with many other chronic health conditions, such as CVD, obesity, and respiratory disease, increasing the severity, costs, and risk for disability from these chronic health conditions (Huffman et al., 2013; Wells et al., 1989). Fast-paced work, high job demands, job insecurity, and low wages in many work settings may increase risks for poor mental health outcomes. (See Objective 6.) Depression symptoms are also strongly related to a number of productivity outcomes such as impaired work performance and work absences (National Institute for Occupational Safety and Health, 1999). A 2012 analysis found that depression topped the list of risk factors linked to increased employee and employer health-care spending (Goetzel et al., 2012).

Cancer

In 2018, the International Agency for Research on Cancer estimated that there were 18.1 million new cancer cases and 9.5 million cancer deaths around the globe (International Agency for Research on Cancer, 2018. In the U.S., cancer remains a leading cause of death. Many factors play a role in the development of cancer including personal characteristics, family history, diet and personal habits, exposures to cancer-causing agents in the environment, and a variety of exposures related to work. The link between cancer and work exposures is well-documented. Up to 14% of cancer deaths in men may be related to work (Purdue et al., 2015). Up to 20% of lung cancer deaths and 7% of bladder cancer deaths were attributed to occupational exposures in Great Britain in 2004-2005 (Rushton et al., 2012). Research on work organization and job design factors and cancer is expanding. Examples include findings related to circadian disruption and shift work, job stress, long hours of work, missed health screenings and lack of or limitations in healthcare benefits related to work arrangement or employment status (Costa, House, & Stevens, 2010; Straif et al., 2007). (See Objectives 2, 5, and 6.)

Substance misuse and the opioid overdose crisis

Substance misuse among the working population is a serious and growing problem. The recent acuity and severity of a crisis related to opioid misuse and overdose deaths from opioids have brought renewed attention to this issue. Overdose deaths from prescription and non-medical opioid use doubled from 2010 to 2016, with more than 43000 deaths in 2016 (CDC 2016). Of the 70,237 drug overdose deaths in 2017, nearly 68% (47,600) involved an opioid (Scholl et al., 2017). The rate of overdose deaths continues to increase. In response, the President declared the opioid epidemic to be a public health emergency in October 2017 (The White House, 2017). The Bureau of Labor Statistics (BLS) reported that overdose deaths at work from non-medical use of drugs or alcohol increased by at least 38% annually between 2013 and 2016. The 217 workplace overdose deaths reported in 2016 accounted for 4.2% of occupational injury deaths that year, compared to 1.8% in 2013 (BLS 2017). This large increase in overdose deaths in the workplace (from all drugs) parallels a surge in overall overdose deaths from opioids reported by CDC (2017).

Opioids are often initially prescribed to manage pain arising from a work injury. Risky workplace conditions that lead to injury, such as slip, trip, and fall hazards or heavy physical workloads, can be associated with prescription opioid use (Kowalski-McGraw et al., 2017). Other factors, such as job insecurity, job loss, and high demand/low control jobs may also be associated with prescription opioid use (Kowalski-McGraw et al., 2017). Some people who are prescribed opioids may misuse them and/or develop dependence. A recent study of Massachusetts workers showed rates of opioid overdose deaths were significantly higher among workers employed in industries and occupations known to have high rates of work-related injuries and illnesses. Additionally, rates were significantly higher among workers in occupations with lower availability of paid sick leave and lower job security, suggesting that the need to return to work soon after an injury may contribute to high rates of opioid-related overdose death (MDPH, 2018). Additional insights into the connection between opioid misuse and employment factors such as employment benefits, working conditions, work design, and work organization are needed to more effectively respond to this challenge.

Research gaps
- Expand research to understand the work organization-related etiology of chronic health conditions, including obesity and metabolic disorders, CVD, mental health disorders, substance use disorders, and cancer.

- Expand research to examine the contribution of new forms of work arrangements and design of work (as further detailed in Objectives 2 and 6) to chronic disease risk in the workforce.

- Improve the understanding and awareness of how to design work to decrease risk factors related to chronic health conditions.

- Conduct research and analyses to better monetize the costs and other burdens of unhealthy work design related to disease incidence and prevalence, healthcare costs, and organizational factors such as absenteeism, presenteeism, productivity loss, turnover, and reputational risk, helping to make a stronger business case for interventions to improve the design of work.

- Incentivize employers to improve the design of work and implement healthier work organization principles shown to decrease risks for chronic disease and improve the workplace management of them.

- Test strategies to increase awareness among management, human resources professionals, employee benefit managers, and occupational health communities of the influence of work design on chronic disease outcomes among workers.

- Improve methods of translation and implementation of research on work design and health effects to encourage better uptake by organizations.

Objective 5: Decrease the Burden of Shift Work, Long Hours of Work, and Sleep Deficiency

Background

Sleep deficiency is a broad term that includes inadequate sleep duration, poor sleep quality, untreated sleep disorders, and mistimed sleep that is not synchronized with circadian rhythms. Sleep deficiency can be caused by both work and personal factors and contributes to a variety of safety and health risks both on and off the job. In 2004, almost 15% of full-time workers were employed in evening, night, rotating, split, or employer-arranged irregular shifts (McMenamin, 2007). According to American Time Use Survey analyses during 2003–2011 and National Health Interview Survey analyses during 1997-2011, an additional 10% of Americans work multiple jobs, reported to impact sleep duration and quality and increase the risk of and incidence of injury (Marucci-Wellman, Lombardi, & Willetts, 2016; Marucci-Wellman, Willetts, Lin, Brennan, & Verma, 2014). In some instances, long work hours and night work cannot be eliminated because society needs critical services around-the-clock for occupations such as police and fire protection, health care, transportation, and public utilities. A recent study estimated that insufficient sleep cost the overall U.S. economy upwards of $411 billion (2.28% of its GDP) in 2015, due to a variety of negative impacts (Hafner et al., 2016).

Research is needed to develop effective administrative controls for managers and individual strategies for workers to use in their personal life. Research is also needed on many types of interventions to reduce risks, including education programs, testing various work scheduling patterns, manipulating light exposure, pharmacological agents, diet regimens, work organization strategies and efforts to change workplace culture, workplace interventions including policies, fatigue risk management systems, mathematical models to predict risks, and studies of the impact of broader public policy measures such as the impact of State laws that ban mandatory overtime in nurses.

Work factors

Work factors associated with poor sleep quality and duration include shift work, long work hours, and job stress. Shift work and long work hours also negatively affect personal relationships and responsibilities due to tired workers' poor moods and reduced quality time to spend with their families. Several studies show shift work and long work hours increases the risk for work-life conflict (Albertsen et al., 2008; Carlson & Perrewe 1999). (See Objective 7 on work-life conflict.) Additional research demonstrates the adverse impacts of workplace stressors, such as work-life conflict and unsupportive supervisors, on sleep quality, duration, and fatigue (Crain et al., 2014). Certain employee groups, such as nurses, experience excessive physical and psychological stress, and increased work pace. Because physiologic recovery from stress is delayed past the cessation of stressful events, sleep may become more difficult to initiate and maintain among these workers. Over time, this may lead to maladaptive fatigue, characterized by problems with supervisors, peers, increased emotional demand and mental load (Winwood & Lushington, 2006).

Personal factors

Personal factors that lead to fatigue on the job include sleep disorders and not allowing enough time for sleep for a variety of personal and other reasons. For example, care-giving responsibilities, long commutes, and working at more than one job can cut down on the time available for sleep. An estimated 18 million American adults had obstructive sleep apnea in 2006 (Institute of Medicine, 2006) and an estimated 30 million had insomnia in 2017

(National Sleep Foundation, 2017). A recent literature review, representing more than 12,000 participants in 10 studies published from 2000 to 2015, indicated that workers with obstructive sleep apnea experienced just over twice as many occupational injuries and other adverse events as workers without obstructive sleep apnea (Garbarino et al., 2016). In truck drivers, sleep restriction, sleep apnea, and daytime sleepiness were all significantly associated with motor vehicle crashes and near misses.

Sleep deficiency endangers safety and health

Workers with sleep deficiency can show reduced ability to perform work and other tasks. Studies report that performance when awake 17 or more hours is similar to performance when intoxicated with alcohol (Dawson & Reid, 1997; Williamson & Feyer, 2000). Workers with sleep deficiency can show a general slowing of cognitive functioning and degradation in attention, vigilance, processing speed, and alertness (Kilgore, 2010). They can also show impairment in memory consolidation (Havekes & Abel, 2017). In addition, a person who experiences sleep deprivation may not see or recognize a hazard quickly enough to avoid it, or may recognize the hazard, but respond too slowly to counteract it (Rakitin et al., 2012). Cognitive responses due to sleep deficiency degrade in a dose-response manner (Goel et al., 2014), but do not recover in a dose-response manner. That is, multiple nights of recovery sleep may be required to recover from sleep-related cognitive impairments (Banks et al., 2010).

The safety of the public is a concern when workers do not get enough good quality sleep. Rosekind (2015) reported that up to 20% of the fatal vehicle crashes investigated by the National Transportation Safety Board were due to drowsy driving. Investigators of several well-known industrial disasters reported worker fatigue to be one of the causal factors. These disasters include the 2005 BP Texas City explosion, the Buffalo jet crash, and the Exxon Valdez oil spill (Baker Panel, 2007; National Transportation Safety Board, 2004; National Transportation Safety Board, 2009).

In addition to the safety risks, sleep deficiency, shift work, and long work hours are associated with a broad range of health risks. These include premature death, obesity, adverse reproductive outcomes, infections, and a wide range of chronic illnesses including cardiovascular, gastrointestinal, and musculoskeletal disorders, diabetes mellitus, cancer, Alzheimer's disease, and disturbances to mood and cognition (Bubu et al., 2017; Durmer & Dinges, 2005: Irwin, 2015; Luyster et al., 2012; NIOSH, 2015).

Research gaps

- Develop surveillance methods that measure the prevalence and characteristics of shift work, long work hour schedules, and other factors that lead to fatigue in the workplace.

- Identify and test interventions that reduce the adverse safety and health consequences of shift work, long work hour schedules, and other factors that lead to fatigue in the workplace.

- Develop and test interventions for workers on shift work and long work hour schedules in occupations involving public safety (e.g., health care, law enforcement, transportation, utilities) where the consequences of errors due to fatigue can be especially great to the public.

- Develop implementation and dissemination strategies for effective interventions that reduce the adverse health and safety consequences of shift work, long work hour schedules, and other factors that lead to fatigue in the workplace.

Objective 6: Improve the Safety, Health, and Well-being of Workers through Healthier Work Design and Better Organizational Practices

Background

Work design has implications for the safety, health, well-being, and functioning of individuals, families, groups, organizations, and communities. Workplaces are settings to target not only work-related risks, such as unsafe working conditions, high job demands, and low job control, but also to promote workplace conditions and programs that provide support for workers' health and well-being, such as smoking cessation or promotion of healthy physical activity (Sorensen et al., 2010). Worker well-being characterizes quality of life with respect to an individual's health and work-related environmental, organizational, and psychosocial factors. Worker well-being includes the concept of work that allows individuals to reach their full potential along with the recognition that positive work design has an impact on worker functioning and satisfaction both within the organization and in the community and society (Schulte & Vainio, 2010). Organizational practices that focus on prevention of safety and health hazards and promotion of well-being typically involve multi-level approaches that include commitment and involvement from management as well as worker input on identification of strategies most effective in reducing unreasonable work demands (e.g., workload, work pace), workplace physical hazards, precarious work, and hazards associated with non-standard work schedules. (See Objective 2 on non-standard work arrangements and Objective 5 on work schedules). Organizational factors that can differentiate successful from unsuccessful employer efforts to reduce occupational injury and illness and promote worker well-being include aligning programs with the organization's mission and values; coordinating multi-level or cross-organization efforts; tailoring initiatives to meet the unique needs of the organization and its workers; garnering support from senior leaders; designing effective two-way communications; and promoting ongoing evaluation and a philosophy of continuous improvement (Fitz-enz, 1993; Goetzel et al., 2007; Grawitch et al., 2009).

Hazard control and job design

Safety and health initiatives that focus on eliminating workplace safety and health hazards first and then changing workplace systems to improve the physical and mental health of workers are the preferred approach. A wide variety of workplace practices can help workers improve their physical and mental health, reduce health risks, minimize chronic illness and disability, and reduce stress. These include efforts to identify and eliminate workplace safety and health hazards, ensure that workspaces and tools are ergonomically designed to avoid injury, and ensure that workload and work pace are reasonable. These efforts also include primary-level interventions that change the design of both physical workspaces and work processes. Although sustained efforts have been made to control workplace safety and health hazards, more than half of Americans still report exposure to potentially hazardous working conditions (RAND, 2017).

Psychosocial workplace conditions

There is a need for additional strategies and interventions to improve psychosocial workplace conditions. For example, in 2017, most American workers reported having to work at high speeds or under tight deadlines, or having too little time to do their job, and almost one in five American workers reported experiencing a hostile or threatening work environment (RAND, 2017). Job insecurity is another critical psychosocial stressor within many sectors of the workforce that is deserving of more attention (Sinclair et al., 2010). While job stress is related to adverse safety, health, and well-being outcomes and some interventions have been identified that address contributors to job stress (Hurrell & Sauter, 2013; Sauter & Murphy, 2006), more research is needed.

Organizational culture and psychosocial climate

Kelloway's (2015) commentary on Grawitch, Ballard, & Erb (2015) points out that "a psychologically healthy workplace is far more than a mere list of programs and initiatives. Instead, it is a description of an organizational

culture—a culture that provides the foundation for the psychological health and wellbeing of employees" (p. 263). The culture should facilitate the development and utilization of workplace practices intended to improve worker well-being. Psychological factors such as respect, trust, feeling valued, and management and organizational support also play key roles in worker well-being. In the American Psychological Association's (APA) 2016 survey, workers who felt valued were more likely to say they regularly participated in their employer's health and well-being programs, training activities, and involvement efforts and were less likely to report chronic job stress (APA, 2016). Access to a health and well-being program at work can have health and productivity benefits. NIOSH analyses of 2014 Quality of WorkLife survey data indicate that workers who had a stress management program at their workplace had 1.5 fewer days of poor mental health per month than workers who did not have stress management programs at their workplace (NIOSH, 2017).

Employee involvement and autonomy

Increasing employee involvement in decision making and providing sufficient autonomy and control can increase job satisfaction, employee morale, and commitment to the organization as well as increase productivity, reduce turnover and absenteeism, and enhance the quality of products and services (Freeman & Rogers, 1999; Lawler, 1991; Vandenberg, Richardson, & Eastman, 1999). Increased worker control, particularly in high demand work conditions, has been associated with reduced risk of cardiovascular disease, improved mental health (Mikkelsen & Saksvik, 1999), and with a significantly reduced risk of mortality (Mule & Cockburn, 2017). Bourbonnais et al. (2006) have demonstrated the positive effects of worker participation in reducing adverse workplace psychosocial factors and improving worker mental health. Despite strong evidence of the value of worker involvement and autonomy, according to a 2017 survey of the U.S. workforce, only 58% of working Americans reported that their employer provided sufficient opportunities to be involved in decision making, and even fewer (53%) said they regularly participated in activities involving decision making, solving problems, or setting goals (APA, 2017). Another national study by RAND (2017) found that one in three Americans reported no control over their work schedules. Thus, increasing control over how and when workers do their work, and increasing opportunities for workers to be involved in workplace decision making activities are important to address.

Career development

Opportunities for advancement and career development, and promotion policies and practices that are fair and equitable, are important contributors to employee well-being. The opportunity to gain new skills and experiences can increase employee motivation and job satisfaction and help workers more effectively manage job stress (Pfeffer, 1994; Browne, 2000). These practices include self-set goals and feedback, as well as the ways performance is measured and how related data are used. In APA's 2017 survey, lack of opportunity for growth or advancement was second only to low salaries as a source of job stress; only 60% of the U.S. workforce reported being satisfied with the development opportunities offered by their employer, and less than half (49%) said their employer provided sufficient opportunity for internal advancement (APA, 2017). As job satisfaction has been shown to influence worker mental and physical health, career development and advancement opportunity influences on job satisfaction are important from a worker health standpoint as well (Ferragher et al., 2005).

Research gaps

- Explore effective strategies for comprehensive systems-based interventions (i.e., collective sets of organization and work practices and how they relate to and interact with each other in real-world settings) and evaluation of those interventions.

- Develop interventions to improve the impact of management systems, leadership styles, and supervisor and co-worker support approaches on employee and organizational outcomes.

- Identify best-practice methods for assessing worker well-being in individual workplaces and identifying

deficits that need to be addressed. Special attention should focus on understanding how these best practice methods may vary by worker or organization characteristics such as age, gender, ethnicity, occupational group, and industry sector.

- Develop effective evidence-based design, implementation and dissemination strategies for best practice assessment, interventions, and program evaluation, critical to the translation of research to practice. Emphasize evidence-based methods that are cost effective and realistic for small- and medium-size organizations without dedicated staff or access to internal experts.

- Evaluate labor-management relationships and involvement in establishing overall work policies and practices and the related implications for worker safety, health, and well-being.

- Collect and analyze data on differences in worker and organizational needs, preferences, practices, and outcomes by industry, region, size, structure, and job type.

- Identify characteristics of the built environment (e.g., ergonomics, workspace design) that, in combination with psychosocial work environment characteristics, promote worker safety, health, and well-being.

- Develop and evaluate organizational and managerial strategies to respond to misuse of opioids and illicit drugs by employees. These strategies could include:

  - Identifying and correcting demanding work organization factors that increase the risk for substance misuse by workers;

  - Identifying ways to assist workers with substance misuse while protecting worker privacy;

  - Identifying ways of supporting workers with substance misuse through return to work assistance and continued employment while protecting worker and public safety;

  - Facilitating effective treatment through anti-stigma interventions and improved treatment access.

Objective 7: Promote a sustainable work and non-work interface

Background
The boundaries between people's work and non-work lives continue to blur, with 42% of U.S. workers in 2014 reporting that they take care of personal or family needs during work and about a quarter indicating that they regularly bring work home, work during vacations, and allow work to interrupt time with family and friends (APA, 2015). A U.S. nationally representative study found that, in 2015, about one-half of workers indicated doing some work in their free time to meet the demands of their jobs and 31% of workers reported that it was somewhat or very difficult to adjust their work schedule to accommodate a personal matter (RAND, 2017). For many workers, such blurring of the boundaries between work and non-work demands leads to work-life conflict, which is now viewed as an occupational hazard (Hammer & Sauter, 2013).

Work-life conflict
Research has demonstrated that work-life conflict , or the conflicting demands of work and non-work responsibilities, is associated with adverse outcomes for workers, their families, and their employers (Amstad, Meier, Fasel, Elfering, & Semmer, 2011; Hammer & Sauter, 2013). Work-life conflict is related to adverse workplace safety outcomes (Cullen & Hammer, 2007; Smith & DeJoy, 2012; Turner et al., 2014). Workers who experience work-life conflict also report low career, job, family, and life satisfaction, poor sleep quality, poor health behaviors, and physical and mental health problems. In addition, work-family conflict affects employers

through high levels of employee absenteeism, burnout, and turnover, as well as poor job performance, low commitment, and poor organizational citizenship behaviors.

Managing work and non-work interface

Despite the research demonstrating the adverse worker health and safety effects of work-life conflict, few workers have access to benefits and services that can help them better manage work and non-work responsibilities. Such access does have health and safety benefits for both the workers and their families. For example, parental access to paid sick leave is associated with significantly higher odds of children receiving annual medical checkups and vaccinations, and significantly lower odds of children receiving delayed medical care or being taken to the emergency room (Asfaw et al., 2017). Low-income women, in particular, cannot take time off to care for their children or themselves (Clemens-Cope et al, 2008; Shepherd-Banigan & Bell, 2014).

Other employer-provided services and benefits are similarly limited for workers. In 2016, only 13% of private sector organizations provided access to paid family leave (BLS, 2016). In 2017, only 4% of employers subsidized childcare and 17% of employers offered referral to childcare services (SHRM, 2017). Also in 2017, 13% of employers offered referral to elder care services, 62% offered some type of teleworking, and 51% offered some type of flexible schedules (SHRM, 2017). Interest in workplace flexibility and managing the work and non-work interface is not based on family obligations exclusively. The non-work domain includes many activities, including leisure, educational, spiritual, and community (Keeney et al., 2013), and workers without families also desire access to work-life initiatives (Ryan & Kossek, 2008).

While reducing work-life conflict and the related negative consequences is critical, successful management of the work and non-work interface requires more than simply mitigating negative experiences. Organizational strategies that can be implemented to improve the work and non-work interface include increasing supervisor support for managing work and family demands, increasing worker control over where, when, and how they work, and decreasing the excessive demands of work, especially among lower-income workers including workers in low hourly wage jobs (Kelly et al., 2008). Training supervisors on family supportive behaviors has been shown to have positive impacts on worker job satisfaction and physical health (Hammer et al., 2011), as well as workplace productivity (Odle-Dusseau et al. 2016). (See objective 6 on organizational practices.) Work can also be a source of personal enrichment and enjoyment, with opportunities for meaningful work and personal development.

Research gaps

- Define well-being as it relates to successful management of the work and non-work interface. Raise awareness of how workplace experiences across the occupational spectrum can spill over to affect the well-being of families and communities.

- Conduct research on contextual factors and their implications for the work and non-work interface. Examples of organizational contextual factors include job type, industry, organizational culture, leadership, management skills, and available technology. Examples of individual contextual factors include demographic considerations, such as age, gender, race and ethnicity, language ability, education, income, marital status, and family make-up.

- Investigate the safety and health effects of work-life conflict of workers in jobs without much stability or security and workers in low-paying hourly jobs with limited flexibility to deal with family demands or emergencies and continual financial stress.

- Examine safety and health implications associated with commuting, work travel, and work-life conflict.

- Design and implement work-life interventions, including policies, programs, and practices, that reduce work-life conflict and support worker and family safety, health, and well-being.

- Translate science on known work-life risks to increase awareness of those risks and use it to inform practice-based research.

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