

Occupational Injuries and Workplace Violence

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Abstract

Occupational injuries and workplace violence, a subset of occupational injuries, are defined and discussed in terms of their nature, scope and importance as public health problems. The public health approach to injury prevention is described, and distinctions and commonalities between occupational and non-occupational injuries are presented. Also described are sources of occupational injury data; causal and risk factors; prevention strategies (including the Haddon Matrix and hierarchy of controls), and strategies for transferring injury prevention research results to workplace practice. Workplace violence discussions also include its effects and special workplace violence circumstances (i.e., mass shootings and COVID-19 related workplace violence).

Key points

- Occupational injuries are a serious public health problem worldwide with profound impacts on workers' lives. Workplace violence is a subset of occupational injuries with unique risk factors and prevention strategies.

- The public health approach to preventing occupational injuries includes collection and analysis of data to guide and evaluate prevention efforts.
- Many injury causes that are common in the workplace are also common in other environments, such as transportation events, violence, falls and being struck by objects. While there are some common strategies for preventing occupational and non-occupational injuries, there are also strategies unique to occupational injuries, including prevention through design of workplaces, regulations, and employer-based policies and practices.
- Occupational injuries can be complex events with multiple contributors that require multi-faceted prevention strategies.
- Two prominent and complementary approaches for occupational injury prevention are the Haddon Matrix, which uses a systematic approach to identify points of intervention, and the hierarchy of controls, with an emphasis on controlling hazardous worker exposures through various levels of intervention.
- Occupational injury prevention is not the sole responsibility of a single person or group. Employers and their organizations, workers and their organizations, government agencies, standards setting bodies, and researchers each share in the responsibility for prevention.

Introduction

Occupational injuries are defined by Hagberg et al. (1997) as any damage to the body by energy transfer during work with a short duration between exposure and the health event (usually less than 48 h). Occupational injuries are distinct from occupational diseases in that they are caused (1) by acute workplace exposure to physical agents such as mechanical energy, electricity, and chemicals, or (2) from the sudden lack of essential agents such as oxygen or heat. Examples of events that can lead to worker injury include motor vehicle crashes, assaults, falls, being struck by tools or objects, being caught in parts of machinery, work in confined spaces, explosions, and fires (Castillo et al., 2017). Resultant injuries include fractures, lacerations, abrasions, burns, amputations, poisonings, and damage to internal organs.

The definition of work-relatedness varies among agencies, data sources, and countries. In addition to the common definition of “working for compensation,” other situations such as working in the informal economy, children working for a family business or farm, volunteering, performing domestic duties for pay or lodging, and commuting to and from work are inconsistently included in definitions of “working.” Variations in how occupational injuries are defined and recorded make global estimates and international comparisons difficult and inexact.

Yet there is no question that occupational injuries are a serious public health problem. Takala (2019) reports that 380,000 workers worldwide die each year from occupational injuries and that these numbers are growing. Deaths are just the tip of the iceberg. The countless nonfatal occupational injuries that occur are painful and too often are disabling, with profound effects on workers’ quality of life and the economic security of workers and their families. It has recently been estimated that the global cost of occupational injury deaths alone is around 3 trillion United States dollars (Takala, 2019).

Occupational vs. non-occupational injuries

Many injury causes that are common in the workplace are also common in other environments (Castillo et al., 2017). Transportation events, violence, falls, and being struck by objects are examples of injury causes that are common in multiple settings. Others are more common to the workplace, such as those caused by machinery, electrocutions, and explosions. Strategies for reducing and preventing injuries in multiple settings include changes to the environment (such as changes in roadway design), regulatory policy (such as specifying product safety parameters), and educational approaches. While broad injury prevention measures, such as those focused on improving roadway safety, reduce the risk of injury and death to the general public, they also help improve workplace safety.

Research on occupational injuries has relevance in other settings for several reasons. Common methods, risks, and prevention strategies overlap between work and non-work tasks and environments. In addition, work settings can serve as natural laboratories for testing and evaluating injury prevention strategies.

Studies that elucidate risk factors and develop and evaluate effective intervention strategies in one setting can often be applied in others. Motor-vehicle related injuries are one example. Interventions that were developed to prevent injuries to the general public, such as seat belts and air bags, also prevent injuries and deaths among those who use vehicles as part of their job. In fact, interventions may be even more effective in this context because they may be more enforceable by employers. Prevention efforts initially developed specifically for truck drivers and other transportation workers, such as back-up sensors and collision warning systems, are now widely used in passenger motor vehicles and provide protection to the motoring public.

In some environments, the risks of occupational and non-occupational injuries are difficult to distinguish, such as on farms where families both live and work in the same hazardous environment, and in schools where students and teachers alike are exposed to the growing risk of intentional injuries. As a relatively controlled environment, the workplace can provide an ideal setting, a living laboratory for intervention evaluation studies. Similarly, workplaces offer an opportunity for widespread

implementation of prevention technologies and strategies. Following the Total Worker Health© approach (National Institute for Occupational Safety and Health (NIOSH), 2016), this would include employers providing injury prevention programs and training to keep workers injury free at *and* away from work.

Finally, injuries in all settings and among all populations can be complex events with multiple contributors that require the application, knowledge, skills, and efforts of many disciplines to understand and prevent them. These multi-factorial events require collaborative expertise in multiple disciplines to effectively identify risk factors and develop and implement prevention strategies. The disciplines of epidemiology, social and behavioral sciences, occupational medicine and nursing, safety sciences, ergonomics, industrial hygiene, criminology, law enforcement, architecture, and engineering all offer important expertise to occupational injury prevention.

The public health approach to prevention

Injuries are a public health issue. The public health approach to prevention is based primarily on the science of epidemiology: the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to control health problems (Porta, 2014). Public health pays special attention to people who are at increased risk for injury and poor health due to social determinants of health, such as economic resources, education and racial discrimination (Braveman et al., 2011). The public health approach to injury research and prevention includes the following steps:

- Identify and prioritize problems through injury surveillance
- Quantify and prioritize risk factors through analytic injury research
- Identify existing or develop new strategies to prevent or control occupational injuries
- Implement the most effective injury control measures through communication/dissemination/technology transfer, and then
- Evaluate and monitor the results of intervention efforts.

The public health approach begins with the collection of data. Through surveillance, injuries are identified and patterns of existing or emerging injury problems can be tracked. Surveillance data enable the monitoring of injury trends, establishment of prevention priorities, identification of areas where further research is needed, and the tracking of progress of injury prevention efforts.

After injury problems have been identified, analytic research may be used to identify causal mechanisms and risk factors that produce or contribute to injuries. The next step is to identify existing or new strategies to mitigate risk factors to prevent injuries. In some cases, prevention measures are available, but are not widely used, and research is needed to transfer knowledge into practice (Guerin et al., 2022). In other cases, prevention measures do not exist or are inadequate. Options may vary in effectiveness, cost, and feasibility. This component of the public health model may require the most multidisciplinary collaboration—among engineers, epidemiologists, social scientists, and others. Prevention measures can range from organizational and administrative controls including procedures and training, to engineering controls and regulations. Assessing the feasibility, efficacy, and cost effectiveness of promising prevention measures is a critical step in the process of identifying prevention options. Prevention strategies must then be communicated and transferred to those who can implement them in the workplace. Once implemented, prevention measures and programs should be evaluated to determine whether they are having the intended effect.

The public health approach to occupational injury prevention entails a multidisciplinary research approach on a continuum from data-driven problem identification to workplace implementation of prevention strategies. For some problems, the magnitude or risk is unknown, and surveillance is the necessary first step. For others, the causes are known, and intervention development or evaluation of existing interventions is needed. In other areas, effective interventions are known and efforts to transfer and implement are needed. The public health framework allows research activities to be structured sequentially from data-driven priorities to facilitating transfer and adoption of research findings into the workplace.

Data sources

There are a variety of occupational injury data sources. Some governments have agencies that document occupational injuries on the basis of reports from employers, employer surveys, or insurance programs created specifically to compensate workers with occupational injuries and illnesses. There is considerable variability among these available governmental data sources in terms of the types of workers encompassed, work-relatedness definitions, and severity of injuries that are included. In some governmental sources, only selected economic activities are included, leaving out major high-risk sectors such as agriculture or groups such as the self-employed and gig workers. Some sources require that a worker be absent from work for a minimum period of time before the injury is recorded or reported. Motor vehicle injuries to workers who drive as part of their job, injuries while commuting, and workplace violence are differentially covered. The informal work sector is excluded from most government data sources, and underreporting is common among specific groups and overall. It is important that users of occupational injury data understand the limitations of the surveillance system and the types of workers and injuries that are encompassed in, or excluded from, the data. It is generally recognized that government data sources under-represent the true incidence of occupational injuries. The International Labour Organization compiles occupational injury statistics from numerous governments and provides information about methods used in each country. The variation in coverage is important to recognize and consider.

Additional data are available from government and research agencies that are not focused on occupational injuries but include occupational injuries. When these data sources include a means to specifically identify injuries associated with work (for example, answers to questions such as “injury at work?” or indication of payment for healthcare by workers’ compensation systems), these data can be used to study and report on the incidence and patterns of occupational injuries. These non-occupational data sources are important for assessing the burden of injuries in the workplace compared with other settings, describing occupational injuries that may not be captured by official government statistics, and providing detailed data that might not otherwise be available in occupational injury data sources. Examples of non-occupational data sources that may include data on occupational injuries are death certificates and registries, data from hospitals and other health care settings, health surveys of the general population, data on transportation-related events, and data on violence and crime collected by law enforcement agencies.

Employers, trade/labor unions, and research organizations are other sources of data on occupational injuries. Some employers keep detailed records on occupational injuries that can be useful for monitoring occupational injuries in specific work settings and guiding workplace-specific injury prevention efforts. Trade/labor unions and research organizations use a variety of methods to estimate, characterize, and track occupational injuries, including survey methodology.

Rapid advances in technology and analytic methods and increased digitalization are introducing new sources of data on occupational injuries. This includes analytic methods to identify and characterize occupational injuries using digital news sources and social media, and the ability to characterize physical impacts on workers through wearable sensors.

Causes and risk factors

Although the immediate cause of injury is exposure to energy or deprivation from essential agents, injury events arise from a complex interaction of factors associated with the vector or vehicle that is the immediate source of injury, the injured person or host, and the social and physical environment. In occupational settings, these factors include physical hazards in the workplace or setting, hazards and safety features of machinery and tools, the development and implementation of safe work practices, the organization of work, the design of workplaces, the safety culture of the employer, availability and use of personal protective equipment (PPE), demographic characteristics of workers, experience and knowledge of workers, worker psychosocial characteristics and associated distraction or impairment, and economic and social factors.

Fig. 1 illustrates how occupational injury events can have multiple contributory factors.

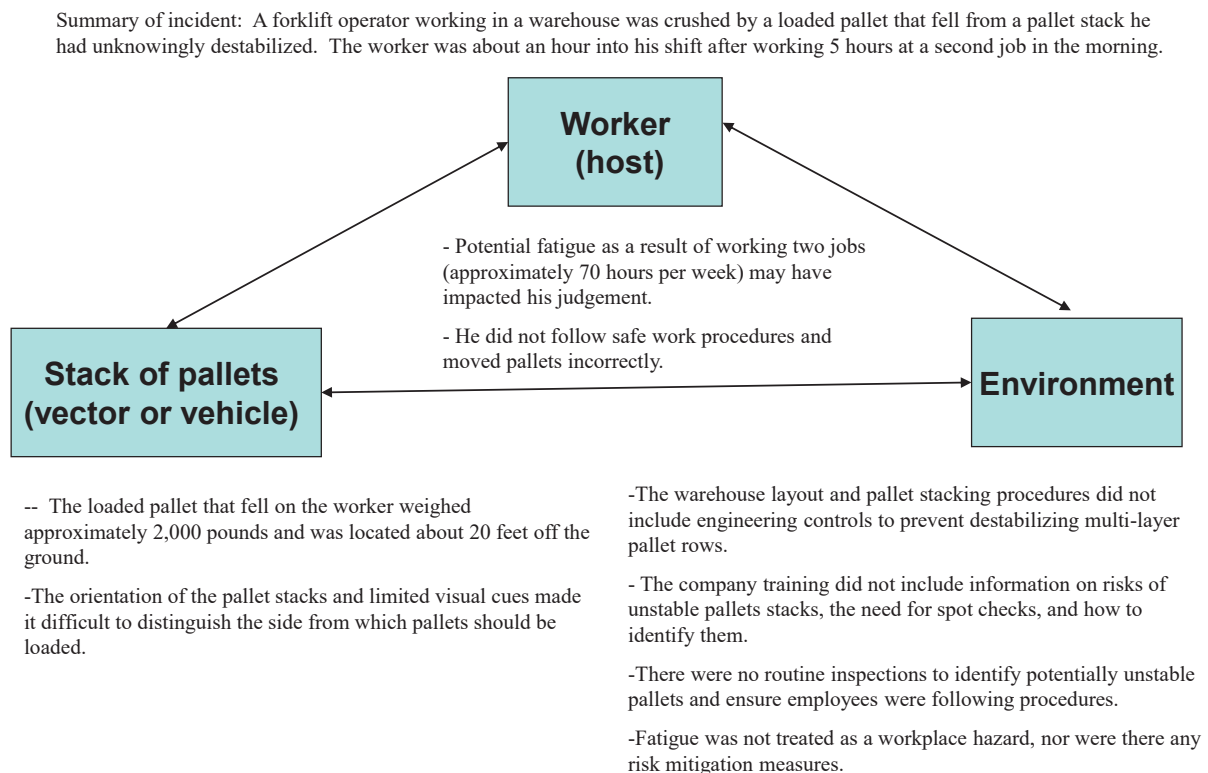


Fig. 1 Example of multifactorial causes of an occupational injury. Incident circumstances were derived from a worker fatality investigated by the Oregon State Fatality Assessment and Control Evaluation (FACE) Program (2020). Forklift operator crushed by full pallet of soft drink cans—Oregon. Portland, OR. Report# 2020OR010.

Table 1 Haddon's Matrix—tool to identify injury prevention strategies.

	<i>Person (host)</i>	<i>Vector or vehicle</i>	<i>Physical environment</i>	<i>Socio economic environment</i>
Pre-event	Is host pre-disposed or overexposed to risk?	Is vector hazardous?	Is environment hazardous? Does it have hazard reduction features?	Does environment encourage or discourage risk-taking and hazard?
Event	Is host able to tolerate force or energy transfer?	Does vector provide protection?	Does environment contribute to injury during event?	Does environment contribute to injury during event?
Post-event	How severe is the trauma or harm?	Does vector contribute to the trauma?	Does environment add to the trauma after the event?	Does environment contribute to recovery?

Adapted from Haddon W (1968) The changing approach to the epidemiology, prevention, and amelioration of trauma: The transition to approaches etiologically rather than descriptively based. *American Journal of Public Health* 58: 1431–1438.

Prevention strategies

Two prominent and complementary approaches for occupational injury prevention are the Haddon Matrix, which uses a systematic approach to identify points of intervention, and the hierarchy of controls, with an emphasis on controlling hazardous worker exposures through various levels of intervention to reduce or remove hazards.

Haddon Matrix

Haddon (1968) introduced the concept that injury causation was a chain of multifactorial events, each of which provides opportunities for intervention. Haddon developed a widely used matrix in the injury prevention field that facilitates an examination of different points of intervention related to the human or host, vector or vehicle, and the physical and social environment across the time sequence of an injury event—pre-event, event, and post-event. The Haddon Matrix is shown in Table 1. Haddon also proposed 10 basic strategies for injury prevention that have similarities to the hierarchy of controls, such as eliminating the hazard or preventing transmission of hazardous energy capable of causing injury.

Hierarchy of controls

The hierarchy of controls (NIOSH, 2023a) is a prioritized set of prevention strategies presented in order of most effective to least effective as outlined in Fig. 2.

The hierarchy of controls includes passive controls, which do not require worker actions for effective prevention, and active controls, which require workers to take action for effective prevention. The following is a summary of the hierarchy of controls in order of priority.

1. Elimination—physically removing the hazard, such as locating serviceable pumps outside of confined spaces so that entry is not required for maintenance or repair
2. Substitution—replacing the hazard, such as using a material that is less hazardous
3. Engineering controls—isolating workers from hazards through safeguards, such as barrier fencing

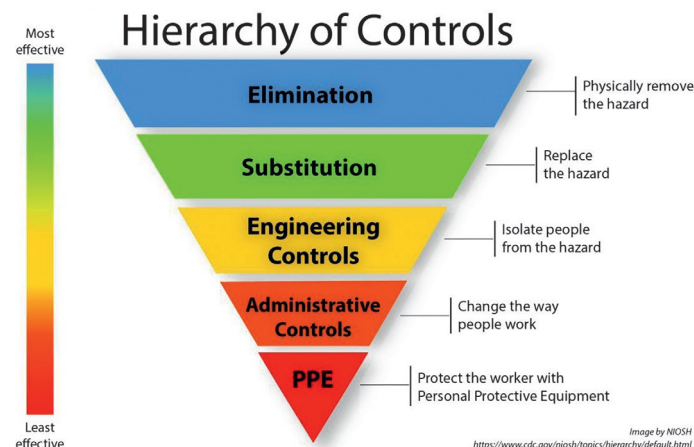


Fig. 2 Hierarchy of controls. Reprinted from National Institute for Occupational Safety and Health (2023a) (website which is in the public domain).

4. Administrative controls—developing safe work procedures and providing worker training
5. Personal protective equipment (PPE)—using PPE, such as protective eyewear, to reduce hazards from flying particles.

Passive controls

The first three controls from the hierarchy (elimination, substitution, and engineering controls) are often referred to as passive controls, as injury prevention is provided with little to no actions from workers. For example, completely enclosing moving or rotating components of machinery is a passive engineering control which can protect workers from struck-by or caught-in type injuries through physical separation from hazards.

Active controls

The bottom two controls from the hierarchy, administrative and PPE, are often referred to as active controls, as they require worker actions to be effective. For example, seat belt policies require workers to fasten their seat belts whenever they are required to drive or ride in a vehicle. Likewise, workers must consistently and correctly wear PPE, such as protective helmets and fall restraint devices, for these controls to be effective in protecting workers. The following provides more detail on two common active controls, training and personal protective equipment.

Training: Training is a common example of an administrative control. Training provides workers with knowledge and safe work procedures to help reduce exposure to hazards and mitigate injuries, as long as the training is followed. Training programs should be based on an assessment of training needs specific for the tasks the worker will be performing. Unique characteristics of the specific workforce should be considered when developing or implementing safety training programs, e.g., language, literacy, cognition, cultural issues. Worker training should be periodically reviewed and updated as new processes, systems, or changes are implemented in the workplace. In addition, the effectiveness of the training should be routinely assessed, and feedback provided to workers on their knowledge and skills.

Personal protective equipment: PPE consists of devices worn by workers to protect them from exposures to a hazard by reducing the effect of the exposure. PPE does not completely eliminate hazards but reduces the potential for worker injury. Although PPE is essential for worker protection in many workplaces, PPE is considered the least effective approach based on the hierarchy of controls and is required when hazardous exposures cannot be controlled through the more effective strategies of elimination, substitution, and engineering controls. When PPE is required, the fit of the equipment to the worker is essential to ensure the highest levels of protection afforded by the equipment are maintained. This is especially important in providing proper fitting PPE for today's diverse workforce, including minority and female workers. Fig. 3 depicts a worker using a hard hat to protect against falling objects, eyewear to protect against flying objects, and hearing protection to minimize hazardous noise exposure.

Prevention in practice

Whenever possible, implementing passive controls at the top of the hierarchy of controls results in the most effective approaches for reducing worker exposures to hazards and mitigating the risk of illness or injury. However, since passive controls cannot always be implemented into existing work systems and processes, the best time to adopt these approaches is often during the design or development stage of a work process or system, or when a work process or system is being changed or new equipment is being purchased.

Also, it is not always possible to implement the most effective control strategies throughout a workplace. Typically, worker injury prevention efforts require implementation of the entire hierarchy of control structure to achieve maximum worker protection.



Fig. 3 Example of worker using personal protective equipment: Hard hat, eye and hearing protection. Permission to print from Getty images [Photo by ©Hybrid Images/Getty Images].

Table 2 Injury hazards and control strategies by category.

<i>Injury hazard</i>	<i>Passive controls Elimination/substitution/engineering controls</i>	<i>Administrative controls</i>	<i>Personal protective equipment</i>
Motor vehicle crashes	Ensure all vehicles are equipped with air bags and advanced safety features, such as forward collision avoidance systems with automatic braking and traction stability control	Implement a mandatory seat belt policy; purchase vehicles with blind-spot monitoring and lane-departure warning systems	Provide helmets and eye protection for workers whose jobs require operating motorcycles or bicycles
Assaults	Install bullet-resistant barriers or enclosures in retail settings	Train workers in nonviolent response when confronted with volatile situations	Provide body armor for public safety workers
Falls from elevation	Install grids or screens over skylight fixtures that meet OSHA standards for protection from falls through skylights	Train workers to set up extension ladders at the optimal inclination angle of 75 degree using the NIOSH ladder safety smart phone app ^a	Provide personal fall-arrest systems during work at elevations
Falls to same level	Redirect downspouts away from walkways with high pedestrian traffic	Implement a policy encouraging workers to clean up or report floor spills promptly	Provide or require workers to wear shoes with slip-resistant soles
Caught in	Ensure that controls on skid-steer loaders are interlocked and require operators to be properly positioned with seat belts fastened before the vehicle can be started and the bucket raised	Develop standard procedures for safely clearing material jams on machinery and equipment	Ensure long hair is tied back or covered when working around machinery with rotating or moving components
Struck by	Install fencing or other physical barriers around robots or other moving equipment, with access through interlocked gates	Minimize forklift traffic during shift changes to reduce exposure to moving forklifts during times when large numbers of worker pass through an area during a short time period	Provide protective hard hats, eyewear, and shoes
Contact with electrical energy	Install ground fault circuit interrupters in damp or wet locations	Develop and implement a hazardous energy control policy for all maintenance and repair activities	Provide electricians with properly rated dielectric gloves when procedures require work on energized components, such as troubleshooting an electrical panel
Overexertion	Use mechanical lifting devices, such as ceiling mounted cranes, to lift heavy and bulky items	Use job rotation schedules with different physical demands to reduce the frequency of lifting and repetitive motion tasks	Provide workers with nonslip safety gloves during manual materials handling tasks
Confined spaces	Where possible, locate serviceable components, such as pumps, agitators, and gauges outside of confined spaces so that entry is not required for maintenance, repair, or monitoring	Ensure workers test any confined space for flammable, toxic, or oxygen-deficient atmospheres prior to entry; identify and post warning signs outside of all confined spaces	Provide self-contained breathing apparatus or other appropriate air-supplied respirators if entry is required into spaces with flammable, toxic or oxygen-deficient atmospheres

Note: OSHA, Occupational Safety and Health Administration; NIOSH, National Institute for Occupational Safety and Health.

^aNIOSH Ladder Safety Mobile Application. Available at: <http://www.cdc.gov/niosh/topics/falls/mobileapp.html>.

Reproduced from Castillo D, Pizatella TJ, and Stout NA (2017) Injuries and occupational safety. In: Levy BS, Wegman DH, Baron SL, and Sokas R (eds.) *Occupational and Environmental Health*, 7th edn. Oxford, NY: Oxford University Press.

In many work environments, a combination of the control strategies of elimination, substitution, engineering controls, administrative controls, and PPE will be required for a complete and effective injury prevention program. See Table 2 for examples of control strategies for various injury hazards based on passive controls (elimination, substitution, engineering) and active controls (administrative and PPE).

Prevention through design

Prevention through Design (PtD) is a proactive approach that focuses on adopting injury prevention strategies when designing work equipment, tools, systems and processes (NIOSH, 2023b). The goal of PtD is to design out or minimize hazards and risks at the time a new process or system is being developed or changed, or when new equipment is being purchased. This is an opportune time to identify systems and equipment that meet PtD principles and follow hierarchy of control strategies at the top of the pyramid (Fig. 2) which are most effective.

To provide additional information regarding PtD principles, a consensus standard has been developed that provides guidelines for addressing occupational hazards and risks in design and redesign processes ([American National Standards Institute \(ANSI\)/American Society of Safety Professionals \(ASSP\), 2021](#)). One key PtD concept is to consider a full lifecycle in design and redesign processes. This can include construction, manufacture, use, maintenance, and disposal or reuse. Guidance is also provided in the ANSI/ASSP standard for systematically considering and documenting risk assessment during the PtD process. The PtD process is most effective when ensuring multiple perspectives are represented, e.g., management, safety professionals, engineers, workers, researchers.

Increase in technology and automation for prevention

It is important to consider technology and automation advances when developing occupational injury prevention strategies. Automation includes the introduction of robots to the workplace. Some robotic installations may eliminate certain hazardous exposures to the worker and fall in the “Elimination” portion of the hierarchy of controls. However, risk assessments and associated mitigation measures are important to ensure that humans coming into contact with robots for training, maintenance, and collaborative operations are protected from unintentional robot contact and movement ([Occupational Safety and Health Administration \(OSHA\), 2021](#)).

Technological advances provide new opportunities for workplace injury prevention. Some have termed this new phase in the workplace as Industry 4.0 ([Bloom et al., 2018](#)). It can involve the Internet of Things (IoT) or, more specifically for the workplace, the Industrial Internet of Things (IIoT). In general, an IIoT system would have three main layers: perception (also called embedded or edge); network (also called gateway); and application (also called cloud). The perception layer includes sensor input. The network layer aids with communication of perception layer information, while the application layer is where analysis of information can occur. As an example, physiological sensors to gather heart rate and body temperature data can be combined with environmental sensors collecting ambient temperature and humidity data to monitor worker health and safety. As another example, IIoT could use equipment performance data for predictive maintenance which may be more efficient and have lower risk than “reactive” or regular maintenance schedules.

Roles and responsibilities

Occupational injury prevention is not the sole responsibility of a single person or group ([Castillo et al., 2017](#)). Employers and their organizations, workers and their organizations, government agencies, standards setting bodies, and researchers each share in the responsibility for prevention.

Employers

Employers are responsible for developing a comprehensive safety program and effectively implementing that program at the workplace. An effective safety program will strive to identify hazards through job safety analysis or other methods of systems safety analysis, and eliminate or control identified hazards through the various approaches previously described. An effective safety program includes management commitment; written policies and procedures that are monitored and enforced; consultation with workers and their representatives; worker training; and proper maintenance of vehicles, equipment, and machinery. As part of a comprehensive safety program, employers should require systematic reporting and tracking of occupational injuries by workers and supervisors, and assess this information for corrective action to prevent similar occurrences. Trade associations (i.e., organizations that provide support to and advocate for groups of like businesses) can provide occupational safety guidance and resources to their employer members.

Workers

Workers play a vital role in workplace safety. Workers share the responsibility for complying with safe work practices and policies, maintaining a safe work area, and using appropriate PPE. Workers should also participate in company-sponsored training. They should report unsafe conditions for corrective action. As the experts in their jobs, workers should be involved in systems safety analysis and development of safe solutions. In many countries, there are requirements for workers and their representatives, either through safety committee or trade/labor unions, to be represented in decision-making around workplace health and safety issues. Trade/labor unions have played key roles in identifying the need for and advocating worker safety protections.

Government agencies

Many developed nations have government agencies with mandated responsibilities for occupational safety and health. These responsibilities typically include development and enforcement of standards and regulations that specify conditions for safe work. Government regulation of worker safety can be contentious; governments frequently try to strike a balance of providing necessary worker safety protections without unnecessarily burdening employers. Some governments have agencies with responsibilities that

include collecting and reporting occupational injury data and conducting occupational injury research. The United Nations (UN) has two specialized agencies that address occupational safety across countries, the International Labour Organization (ILO) and the World Health Organization (WHO). The ILO was established in 1919 and became part of the UN in 1946. The ILO formulates international labor standards, including standards that address worker safety. The WHO established in 1948 promotes health and well-being, including research and programs addressing worker safety.

Standards setting bodies

In addition to government agencies mandating standards for worker safety, there are numerous other standards setting bodies whose efforts improve worker safety. These standards setting bodies promulgate standards that cover a multitude of hazards addressing the work environment, work practices, equipment, PPE, and worker training. For example, numerous specifications, codes, and guidelines address safety concerns for machinery, equipment, tools, and materials. These standards are frequently developed using a consensus approach involving various stakeholders with opportunities for public input. Setting standards or procedures to promote safety through a consensus process can be contentious, as the standards frequently involve the use of scarce resources to promote enhanced safety in the workplace. While not regulated or enforced, voluntary standards can be effective prevention strategies, as market competition and labor or societal pressures often result in widespread adoption and compliance. The International Organization for Standardization (ISO) is an independent, global network of nongovernmental organizations with a membership of 167 standards bodies in 2023.

Researchers

Researchers make contributions to workplace safety through all steps of the public health approach. Researchers help identify the incidence, patterns, and trends in occupational injuries, including important research to identify injuries not captured in official government statistics. Researchers uncover health inequities between worker groups, such as increased rates of injury among racial and ethnic minorities, and increasingly focus on these underserved worker populations and the root causes of these inequities (Flynn et al., 2022). Research is the key agent for identifying and quantifying risk factors for occupational injury across workplaces, including rigorously demanding research to assess the role of work organization and culture. Researchers develop occupational injury prevention strategies and tools, including engineering controls, and evaluate their effectiveness. Finally, researchers conduct implementation science to improve the adoption, implementation, and sustainability of evidence-based interventions (Guerin et al., 2022).

Research to practice

Many different entities have the ability to, and responsibility for, transferring workplace injury prevention research to practice in the workplace. NIOSH, the United States government agency responsible for research to improve worker safety and health, developed the Research to Practice (R2P) Program to help ensure that research results are transferred to or towards workplace application (NIOSH, 2023c). Every research effort, from surveillance and basic laboratory research to field and evaluation studies, should have at least one identified and appropriate recipient of the study results who will carry out the next step in moving the new knowledge or technology towards workplace implementation. It is imperative that researchers identify and involve the appropriate recipients from the conceptual phase of the study, both to ensure the relevance and applicability of the research, as well as to make certain the results will ultimately lead to workplace implementation and worker injury prevention. There are various types of transfer recipients, as well as methods for researchers to facilitate the transfer of research results to practice. Examples include health communicators and training organizations to translate scientific information into worker-friendly guidance or training materials; manufacturers to develop and market safety technologies; regulators and employers to promulgate new safety policy; consensus standards bodies to develop or modify guidelines and voluntary standards; trade and labor organizations, including trade/labor unions, to advocate for and promote new health and safety practices; and companies to implement new technologies, processes and practices to prevent injuries among their workforce.

Workplace violence

Workplace violence is a subset of occupational injuries. A separate section is provided in this chapter to highlight unique risk factors, circumstances, and prevention strategies for this type of occupational injury.

Definitions and classification of typologies

Workplace violence (WPV) is defined as the act or threat of violence directed toward persons at work or on duty. WPV is broken down into physical and non-physical violence, although a WPV incident may have both physical and non-physical elements. Non-physical WPV can include threats, harassment, verbal abuse, demeaning language and bullying. Physical WPV can include hitting, beating, kicking, choking, stabbing, sexual assault, and homicide. WPV is categorized based on the relationship of the

Table 3 Typology of workplace violence.

Type	Other name	Description
Type I	Criminal intent	The perpetrator has no legitimate relationship to the business or employees and is committing a crime in conjunction with the violence. Crimes may include shoplifting, robbery, or trespassing
Type II	Customer/client	The perpetrator has a legitimate relationship with the business and becomes violent while receiving services. Occupations at high risk may include health care workers, police officers, flight attendants, and teachers
Type III	Worker-on-worker	The perpetrator is a current or past employee of the business who attacks or threatens another employee in the workplace
Type IV	Personal relationship	The perpetrator does not have a relationship with the business but has a personal relationship with the intended victim. This category includes domestic violence in the workplace

Source: University of Iowa (2001) *Workplace Violence: A Report to the Nation*. University of Iowa, Injury Prevention Research Center.

perpetrator to the intended victim or business (University of Iowa, 2001). This typology described in Table 3 is useful in the identification of risk factors and the development of workplace prevention programs and policies:

Why workplace violence is a public health issue

WPV has been a significant public health issue for over 30 years. Acts of violence directed towards people at work can result in physical, psychological, and financial costs to workers and their employers. United States statistics on workplace violence illustrate the magnitude of this public health issue and high-risk occupations. Between 1992 and 2019, almost two workers a day were victims of workplace homicide in the United States (Bureau of Justice Statistics et al., 2022). Workplace homicides are most common among retail workers, police officers, and managers of restaurants and hotels. These three occupations accounted for nearly 50% of all workplace homicides between 2015 and 2019 (Bureau of Justice Statistics et al., 2022). During this same period, an annual average of 1.3 million nonfatal violent crimes (rapes, robberies, assaults) occurred in United States workplaces, and an estimated 529,000 nonfatal injuries due to WPV were treated in hospital emergency departments. The incidence rate for occupational injuries and illnesses that resulted in days away from work due to WPV grew from 1.7 per 10,000 full-time equivalents (FTEs) in 2015 to 2.0 in 2019. The occupations with the highest number of nonfatal injuries and illnesses with days away from work due to WPV were nursing aides (psychiatric and home-health aides), education workers, healthcare practitioners, and protective service workers. WPV has also been shown to negatively affect workers' mental health. WPV is associated with increased depression, anxiety, burnout, sleep issues, and psychological distress (Rudkjobbing et al., 2020).

Workplace violence risk factors by typology

Risk factors for WPV and related prevention strategies vary by type of violence.

Type I: Type I WPV is also called criminal intent violence and is most common in workplaces that have direct public contact, available cash or high value goods, and have late-night hours, such as convenience stores. Type I WPV is generally associated with robberies, shoplifting, or trespassing incidents that involve violence. Employee resistance to a robbery is significantly associated with employee injury (Jones et al., 2015). Research has shown the following workplace characteristics to be risk factors for Type I WPV:

- open 24 h
- open late-night hours
- history of robbery
- limited visibility of the entrance or exit
- lack of bullet-resistant shielding or security systems
- lack of robbery prevention training for employees
- cash availability
- being independently owned or operated (Hendricks et al., 1999; Davis et al., 2021; Schaffer et al., 2002).

Two other important risk factors for Type I WPV include establishment size and the race/ethnicity of the workers (Chaumont Menéndez et al., 2013). Small retail businesses, such as family-owned convenience stores, may have limited resources for implementing strategies to reduce the risk of robbery and WPV. Also, United States workplace fatality data show that workers who are Black, Asian, or born outside of the United States experience higher homicide rates than workers who are White or born in the United States.

Type II: In Type II WPV, the perpetrator is normally the recipient of a service provided by the affected workplace or victim. This could include clients, patients, customers, passengers, criminal suspects, or inmates. Type II WPV is also referred to as client-on-worker violence and is most common in, but not limited to, healthcare settings. Approximately 75% of the nearly 25,000 workplace assaults in the United States occur in health care and social service settings (OSHA, 2016). And most of the violence is

perpetrated by a client or family member. The actual number of Type II WPV incidents is likely much higher. Research has found significant under-reporting of WPV in healthcare, possibly because healthcare workers see WPV as part of their job (Arnetz et al., 2015). Because of these various issues, most of the research in Type II WPV has focused on healthcare settings.

Most healthcare workers (HCWs) have experienced some level of WPV. Nurses and nurses' aides, particularly those in emergency settings and nursing homes, have the highest rates (Pompeii et al., 2015). Physicians in emergency medicine and inpatient psychiatric workers also have high WPV rates (McPhaul and Lipscomb, 2004). The home care setting also presents unique prevention challenges because the environment is less controlled (Phillips, 2016). Some of the most common characteristics of WPV in healthcare settings include the following:

- an altered mental status of the perpetrator
- stressful conditions (long wait times, being given "bad news")
- lack of organizational WPV mitigation policies and training for staff
- gang activity
- presence of firearms
- inadequate security personnel on site
- working in isolation
- no access to emergency communication
- unrestricted public access to rooms
- lack of community mental health care (OSHA, 2016).

Type III: Type III WPV is worker-on-worker violence and is commonly referred to as lateral or horizontal violence. Type III WPV includes a spectrum of events ranging from verbal abuse to homicide.

Workplace bullying is one common form. Workplace bullying is defined as a situation in which a worker repeatedly and over a period of time is exposed to harassment, abuse, offenses, or social exclusion (Einersen et al., 2011). Workplace bullying affects nearly one-third of all United States employees at some point in their career, equating to 48.6 million American workers who have been bullied at work (Workplace Bullying Institute, n.d.). Most bullying perpetrators are supervisors, but this can vary widely based on occupation (Beale and Helge, 2011). For example, among nurses, the perpetrator is commonly a senior nurse, but not necessarily a supervisor (Johnson, 2021). Women are at a higher risk of being bullied than are men (Feijó et al., 2019). Bullying can occur in any industry or occupation and risk is more dependent on the work environment than the occupation itself. A wide range of occupational factors such as work organization and management issues are risk factors for workplace bullying, but poor work organization and poor work processes are the two factors with the greatest amount of evidence. There is a significant body of research on the severe and adverse effects that workplace bullying has on workers' mental health (Nielsen and Einersen, 2012). Workplace bullying also has financial consequences for employers, both directly and indirectly in the form of turnover and sickness absence.

Type IV: In Type IV WPV (also called personal relationship violence), the perpetrator has a relationship with the intended victim, but not necessarily one with the business. The most common example of Type IV WPV is intimate partner violence (IPV) occurring in the workplace. IPV includes physical violence, sexual violence, stalking and psychological aggression (including coercive tactics) by a current or former intimate partner (i.e., spouse, boyfriend/girlfriend, dating partner, or ongoing sexual partner) (Breiding et al., 2015). IPV occurs in all types of workplaces, but it is most common in workplaces where access by non-workers is poorly secured, such as hospitals, public office buildings, and beauty salons (Tiesman et al., 2012). Among women in the United States, only 3% of nonfatal WPV incidents are perpetrated by an intimate partner, but 26% of workplace homicides are committed by an intimate partner (Bureau of Justice Statistics et al., 2022; Tiesman et al., 2012). One reason for this disparity may be the reluctance of women to report IPV events that occur while at work (MacGregor et al., 2022). Aside from the impacts on the intended victim, IPV can also have negative impacts on their co-workers (Showalter, 2016).

Historically, employers have not recognized IPV as a workplace hazard, but this is changing. A scoping review identified 235 research articles on IPV in the workplace and over half were published after 2010 (MacGregor et al., 2022). One important remaining research gap is the lack of intervention research. Thus, many employers grapple with how workplaces can best address IPV. Also, many workplaces do not have IPV prevention policies and if they do, workers are not aware of them (Giesbrecht, 2022). Organizations such as *Workplaces Respond to Domestic and Sexual Violence: A National Resource Center* (n.d.) are attempting to address these gaps by supporting employers in prevention efforts by providing trainings, model policies, and webinars on the topic.

Special workplace violence circumstances

Mass shootings: Mass shootings can occur in workplaces and threaten the life, safety, and security of workers. There are several different, but common, definitions of mass shootings. The Congressional Research Service defined a mass shooting as multiple firearm homicide incidents involving four or more victims at one or more locations close to one another (Krouse and Richardson, 2015). While mass shootings receive significant media attention, they only make up approximately 1% of all firearm deaths in the United States (Gun Violence Archive, n.d.). However, it is still important to include these events in WPV discussions because mass shootings and related fatalities are increasing, and victims often include persons who are working at the time of the incident

(Peterson, 2021). Over the past 50 years, more than half of all mass shootings occurred after 2000. And in the 1970s, mass shootings claimed an average of 8 lives per year, while the average grew to 51 deaths per year between 2010 and 2019.

To assist in obtaining a better understanding of these events, the mass public shooter database was constructed in 2019 using open-source data (Peterson, 2021). These results point towards an important feature of mass shootings that employers should be aware of. The most common locations for mass shootings have been workplaces such as office buildings (28%), restaurants/bars/nightclubs (14%), retail establishments (12.9%), houses of worship (6%), and kindergarten-12th (K-12) grade schools (7.6%). Approximately 69% of mass shootings occurred in common workplaces where employees were at risk. Additionally, mass shooters in K-12 schools and workplaces were most likely “insiders,” which has implications for WPV trainings and policies.

COVID-19 related WPV: In March 2020, COVID-19 was declared a pandemic by the WHO. COVID-19 has affected every aspect of work, including WPV. The pandemic resulted in new types of WPV, an increase in the number of WPV events among some occupations, and WPV targeted towards previously unaffected groups. A new form of biological WPV involved individuals threatening to infect others with SARS-CoV-2 by coughing or spitting on workers or merchandise (Tiesman et al., 2022; Marsh et al., 2022). These made up between 22%–31% of all media-reported WPV events in the United States during the pandemic (Tiesman et al., 2022; Marsh et al., 2022). One occupational group that had not historically been at risk for WPV, but experienced WPV during the pandemic, was public health workers (Tiesman et al., 2023). Twelve percent of state, local, and territorial public health workers in the United States received job-related threats, and 24% were bullied or harassed.

Healthcare workers were one of the groups most affected by COVID-19 related WPV. Because of different study methodologies, populations, time periods, and definitions, the prevalence of WPV against healthcare workers ranged from 8.4%–88.3% (Ramzi et al., 2022). The prevalence of WPV during the pandemic differed across countries, yet the prevalence appeared to be higher in the United States than other high-income countries. Determining if this represents an actual increase in WPV among healthcare workers is difficult. One study used an interrupted time-series analysis to measure attacks against healthcare workers in Italy from 2017 to 2021 and found the pandemic led to a significant increase of 0.05/1000 attacks per month to 4.3/1000 attacks (Brigo et al., 2022).

Effects of workplace violence

The effects of WPV can be observed at a personal, organizational, and community level and have been relatively well-studied, particularly among healthcare providers. WPV is associated with the following in workers:

- adverse mental health
- depression
- anxiety
- burnout
- sleep problems
- use of antidepressants
- headaches
- decreased job satisfaction
- decreased quality of life
- psychological distress
- post-traumatic stress disorder (Rudkjoebing et al., 2020; Mento et al., 2020).

A meta-analysis confirmed many of the associations between WPV and adverse mental health but noted that bias and confounding could not be definitively ruled out in these relationships (Rudkjoebing et al., 2020). Physiological studies appear to support these epidemiological findings. WPV incidents were shown to induce a biological stress response including acute cardiovascular changes, blood pressure increases, and changes in heart rate variability among nurses (Shishavan et al., 2023). While WPV certainly has short-term effects, WPV can also have long-term consequences (Hogh and Viitasara, 2005).

WPV also has direct and indirect financial impacts on employees, employers, businesses, and communities. Direct costs may include workers’ compensation and legal fees associated with lawsuits and settlements. Indirect costs may include losses in productivity, increased employee turnover and replacement, decreased morale, and decreases in the quality of patient care. WPV is expensive, but the exact cost of WPV is difficult to estimate. A systematic review estimated the cost of WPV in the United States to range from \$2.36 million to \$55.86 billion (figures adjusted to 2017 \$US) across different studies (Hassard et al., 2019).

Workplace violence prevention approaches

WPV prevention efforts differ markedly across the different types of WPV. Approaches to WPV prevention can be broken down into three types: legislative/regulatory, administrative/behavioral, and environmental. Legislative/regulatory approaches include making laws, policies, and regulations related to WPV prevention in the workplace. When properly enforced, these regulations can be a WPV deterrent. Administrative/behavioral approaches are “those directed at altering management practices, worker practices, or both, for preventing workplace violence.” While a wide variety of administrative/behavioral approaches have been employed, few have been adequately evaluated. Environmental approaches involve making physical changes to the workplace. One example is the Crime Prevention Through Environmental Design (CPTED) model, discussed in more detail below.

Type I: There has been significant progress towards the prevention of Type I WPV events. In 2009, OSHA published guidance to retail employers of late night retail establishments (OSHA, 2009). In the publication, OSHA reported on the four components of an effective safety and health management system: management commitment and worker involvement, worksite analysis, hazard prevention and control, and safety and health training.

For over 20 years, the approach to prevent Type I WPV has been CPTED. CPTED is a multidisciplinary approach to deterring criminal behavior by changing how physical environments are laid out. This approach is recommended by OSHA, included in state and local ordinances, and the basis of United States convenience store industry guidelines. The CPTED model focuses on four elements: natural surveillance, access control, territoriality, and activity support. Natural surveillance includes increasing and balancing lighting so that that visibility is clear. Access control refers to the number of entrances and door placement to control customer movement. Territoriality includes location of the store within the community. Activity support includes features that increase presence of customers and traffic flow to increase natural surveillance.

Type II: Significant attention has also been paid towards the prevention of Type II WPV, particularly in healthcare. OSHA, the United States Government Accountability Office (GAO), and Joint Commission have all published WPV prevention guidelines for healthcare workers and in healthcare settings (OSHA, 2016; United States GAO, 2016; Joint Commission, 2018). Also, in 2013, NIOSH developed a free and interactive course designed to help healthcare workers understand WPV in their workplaces (NIOSH, 2013). The course is available online and nurses can earn free continuing education credits. Evaluations of the course have been positive, and the course has been taken by more than 45,000 healthcare workers (Brann and Hartley, 2017).

Type III: While Type III WPV remains prevalent, especially workplace bullying, less attention is paid towards prevention of these events. One reason for this may be that workplace bullying is not always defined in a standardized way, making prevention efforts complicated (Kemp, 2014). Another potential reason is that the prevention of Type III events is not a one-size fits all. It is dependent on the workers' industry, culture, and who is perpetrating the violence (a supervisor versus a co-worker) (Török et al., 2016). Finally, at least one study found that reliance on training is ineffective in reducing Type III WPV (Miedema et al., 2011). The Workplace Bullying Institute offers workers, organizations, and unions help in the form of books, strategies, policies, interventions. and trainings for a fee. More work is needed towards the development, evaluation, and implementation of Type III WPV prevention efforts in workplaces.

Type IV: The literature evaluating workplace interventions for Type IV WPV, particularly IPV, is also quite sparse (Adhia et al., 2019). A systematic review found only six intervention studies published through late 2017. The interventions focused on recognizing signs of abuse, responding to victims, and referring workers to community-based resources. While the methodological rigor of the studies varied, the evidence suggested these interventions had benefits including increased knowledge and provision of resources. There are also several groups working in this domain. Futures without Violence is funded by the United States Department of Justice' Office on Violence Against Women and supports a national resource hub called Workplaces Respond to Domestic and Sexual Violence. This hub includes resources, fact sheets, and training modules.

Conclusion

Occupational injuries continue to be a public health problem warranting sustained efforts through a multidisciplinary approach to address new and emerging hazards, such as robotics and automation, as well as the continuing toll from motor vehicle crashes, falls, violence and other hazards. Given the human and economic impact occupational injuries have on employers, workers, their families, and society, the public health model for research and prevention provides an effective approach to identify, implement, and evaluate strategies to reverse the increasing trends of global workplace injuries.

References

- Adhia A, Gelaye B, Friedman LE, et al. (2019) Workplace interventions for intimate partner violence: A systematic review. *Journal of Workplace Behavioral Health* 34(3): 149–166.
- American National Standards Institute (ANSI)/American Society of Safety Professionals (ASSP) (2021) *Prevention Through Design Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes*. Washington, DC: ANSI.
- Arnetz JE, Hamblin L, Ager J, et al. (2015) Underreporting of workplace violence comparison of self-report and actual documentation of hospital incidents. *Workplace Health & Safety* 63(5): 200–210.
- Beale D and Helge H (2011) Workplace bullying and the employment relationship. *Work, Employment and Society* 25: 5–18.
- Bloom G, Alsulami B, Nwafor E, and Bertolotti IC (2018) Design patterns for the industrial Internet of Things. In: *2018 14th IEEE International Workshop on Factory Communication Systems*, pp. 1–10. New York: Institute of Electrical and Electronics Engineers (IEEE).
- Brann M and Hartley D (2017) Nursing student evaluation of NIOSH workplace violence prevention for nurses online course. *Journal of Safety Research* 60: 85–91.
- Braveman P, Egerter S, and Williams DR (2011) The social determinants of health: Coming of age. *Annual Review of Public Health* 32: 381–398.
- Breiding MJ, Basile KC, Smith SG, Black MC, and Mahendra RR (2015) *Intimate Partner Violence Surveillance: Uniform Definitions and Recommended Data Elements, Version 2.0*. National Center for Injury Prevention and Control, Centers for Disease Control and Prevention: Atlanta (GA).
- Brigo F, Zabolli Z, Rella E, et al. (2022) The impact of COVID-19 pandemic on temporal trends of workplace violence against healthcare workers in the emergency department. *Health Policy* 126(11): 1110–1116.
- Bureau of Justice Statistics, Bureau of Labor Statistics, and National Institute for Occupational Safety and Health (2022) In: Harrell E, Langton L, Petosa J, Pegula S, Zak M, Derk S, Hartley D, and Reichard A (eds.) *Indicators of Workplace Violence, 2019*. Washington, DC: United States Department of Justice, Office of Justice Statistics. NCJ 250748. Washington, DC: United States Department of Labor, Office of Safety, Health, and Working Conditions, Bureau of Labor Statistics. Morgantown, WV: United States Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 2022-124.

- Castillo D, Pizatella TJ, and Stout NA (2017) Injuries and occupational safety. In: Levy BS, Wegman DH, Baron SL, and Sokas R (eds.) *Occupational and environmental health*, 7th edn., pp. 411–432. Oxford, NY: Oxford University Press.
- Chaumont Menéndez CK, Konda S, Hendricks SA, et al. (2013) Disparities in work-related homicide rates in selected retail industries in the United States, 2003–2008. *Journal of Safety Research* 44: 25–29.
- Davis JD, Chaumont Menéndez CK, and Casteel C (2021) Impact of a crime prevention ordinance for small retail establishments. *American Journal of Industrial Medicine* 64(6): 488–495.
- Einarsen S, Hoel H, and Diate-Zap CLC (eds.) (2011) *Bullying and Harassment in the Workplace: Developments in Theory, Research, and Practice*, 2nd edn. Boca Raton, FL: CRC Press.
- Feijó FR, Gräf DD, Pearce N, et al. (2019) Risk factors for workplace bullying: A systematic review. *International Journal of Environmental Research and Public Health* 16(11): 1945.
- Flynn MA, Check P, Steege AL, Siven JM, and Syron LN (2022) Health equity and a paradigm shift in occupational safety and health. *International Journal of Environmental Research and Public Health* 19: 349.
- Giesbrecht CJ (2022) Toward an effective workplace response to intimate partner violence. *Journal of Interpersonal Violence* 37(3–4): 1158–1178.
- Guerin RJ, Glasgow RE, Tyler A, Rabin BA, and Huebschmann AG (2022) Methods to improve the translation of evidence-based interventions: a primer on dissemination and implementation science for occupational safety and health researchers and practitioners. *Safety Science* 152: 105763.
- GVA: Gun Violence Archive. <https://www.gunviolencearchive.org/>.
- Haddon W (1968) The changing approach to the epidemiology, prevention, and amelioration of trauma: The transition to approaches etiologically rather than descriptively based. *American Journal of Public Health* 58: 1431–1438.
- Hagberg M, Christiani D, Courtney TK, et al. (1997) Conceptual and definitional issues in occupational injury epidemiology. *American Journal of Industrial Medicine* 32: 106–115.
- Hassard J, Teoh KRH, and Cox T (2019) Estimating the economic burden posed by work-related violence to society: A systematic review of cost-of-illness studies. *Safety Science* 116: 208–221.
- Hendricks SA, Landsittel DP, Amandus H, et al. (1999) A matched case control study of convenience store robbery risk factors. *Journal of Occupational and Environmental Medicine* 44(11): 995–1004.
- Hogh A and Viitasara E (2005) A systematic review of longitudinal studies of nonfatal workplace violence. *European Journal of Work and Organizational Psychology* 14: 291–313.
- Johnson SL (2021) Workplace bullying in the nursing profession. In: D'Cruz P, Noronha E, Keashly L, et al. (eds.) *Special Topics and Particular Occupations, Professions and Sectors. Handbooks of Workplace Bullying, Emotional Abuse and Harassment*, vol. 4, p. 341. Singapore: Springer.
- Joint Commission (2018) *Sentinel Event Alert: Physical and Verbal Violence against Health Care Workers*. Sentinel Event: Issue 59, Washington, D.C.: Joint Commission.
- Jones J, Casteel C, and Peek-Asa C (2015) Employee resistance and injury during commercial robberies. *Journal of Occupational and Environmental Medicine* 57(5): 531–536.
- Kemp V (2014) Antecedents, consequences and interventions for workplace bullying. *Current Opinion in Psychiatry* 27(5): 364–368.
- Krouse WJ and Richardson DJ (2015) *Mass Murder with Firearm: Incidents and Victims, 1999–2013*. Washington, DC: Congressional Research Service.
- MacGregor JCD, Naeemzadah N, Oliver CL, et al. (2022) Women's experiences of the intersections of work and intimate partner violence: A review of qualitative research. *Trauma, Violence & Abuse* 23(1): 224–240.
- Marsh SM, Rocheleau CM, Carbone EG, et al. (eds.) (2022) Occurrences of workplace violence related to the COVID-19 pandemic, United States, March 2020 to August 2021. *International Journal of Environmental Research and Public Health* 19(21): 14387.
- McPhaul KM and Lipscomb JA (2004) Workplace violence in health care: Recognized but not regulated. *The Online Journal of Issues in Nursing* 9(3): 7.
- Mento C, Silvestri MC, Bruno A, et al. (2020) Workplace violence against healthcare professionals: A systematic review. *Aggression and Violent Behavior* 51: 101381.
- Miedema B, Tatemichi S, Hamilton R, et al. (2011) Effect of colleague and coworker abuse on family physicians in Canada. *Canadian Family Physician* 57: 1424–1431.
- National Institute for Occupational Safety and Health (NIOSH) (2013) *Workplace Violence Prevention for Nurses*. Cincinnati, OH: United States Department of Health and Human Services, Centers for Disease Control and Prevention. NIOSH. CDC Course No. WB4525; DHHS (NIOSH) Publication No. 2013-55.
- National Institute for Occupational Safety and Health (NIOSH) (2016) In: Lee MP, Hudson H, Richards R, Chang CC, Chosewood LC, Schill AL, and On behalf of the NIOSH Office for Total Worker Health (eds.) *Fundamentals of Total Worker Health Approaches: Essential Elements for Advancing Worker Safety, Health and Well-Being*. Cincinnati, OH: United States Department of Health and Human Services, Centers for Disease Control and Prevention. NIOSH. DHHS (NIOSH) Publication No. 2017-112.
- National Institute for Occupational Safety and Health (NIOSH) (2023a) *Hierarchy of Controls*. www.cdc.gov/niosh/topics/hierarchy/.
- National Institute for Occupational Safety and Health (NIOSH) (2023b) *Prevention Through Design*. www.cdc.gov/niosh/topics/PTD/.
- National Institute for Occupational Safety and Health (NIOSH) (2023c) *Research to Practice (R2P) Program*. www.cdc.gov/niosh/r2p/default.html.
- Nielsen MB and Einarsen S (2012) Outcomes of exposure to workplace bullying: A meta-analytic review. *Work and Stress* 26: 309–332.
- Occupational Safety and Health Administration (OSHA) (2009) *Recommendations for Workplace Violence Prevention Programs in Late-Night Retail Establishments*. Washington, D.C.: Department of Labor, OSHA. OSHA 3153-12R.
- Occupational Safety and Health Administration (OSHA) (2016) *Guidelines for Preventing Workplace Violence for Healthcare and Social Service Workers*. Washington, D.C.: United States Department of Labor, Occupational Safety and Health Administration. OSHA, 3148-04R.
- Occupational Safety and Health Administration (OSHA) (2021) OSHA technical manual (OTM). In: *Section IV: Chapter 4. Industrial Robot Systems and Industrial Robot System Safety*. Washington, DC: United States Department of Labor, OSHA, Directorate of Technical Support and Emergency Management.
- Oregon State FACE (Fatality Assessment & Control Evaluation) Program (2020) In: Hanley B (ed.) *Forklift Operator Crushed by Full Pallet of Soft Drink Cans—Oregon*. Portland, OR: Oregon Health & Science University, Oregon Institute of Occupational Health. Report# 2020OR010.
- Peterson J (2021) *A Multi-Level, Multi-Method Investigation of the Psycho-Social Life Histories of Mass Shooters: Final Report*. Washington, DC: Department of Justice, Office of Justice Programs. Award# 2018-75-CX-0023.
- Phillips JP (2016) Workplace violence against health care workers in the United States. *New England Journal of Medicine* 374(17): 1661–1669.
- Pompeii LA, Schoenfisch AL, Lipscomb HJ, et al. (2015) Physical assault, physical threat, and verbal abuse perpetrated against hospital workers by patients or visitors in six U.S. hospitals. *American Journal of Industrial Medicine* 58(11): 1194–1204.
- Porta MS (ed.) (2014) *A Dictionary of Epidemiology*. New York, NY: Oxford University Press.
- Ramzi ZS, Fatah PW, and Dalvandi A (2022) Prevalence of workplace violence against healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. *Frontiers in Psychology* 13: 1–8.
- Rudkjoebing LA, Bunghum AB, Flachs EM, et al. (2020) Work-related exposure to violence or threats and risk of mental disorders and symptoms: A systematic review and meta-analysis. *Scandinavian Journal of Work, Environment & Health* 46(4): 339–349.
- Schaffer KB, Casteel C, and Kraus JF (2002) A case-site/control-site study of workplace violent injury. *Journal of Occupational and Environmental Medicine* 44: 1018–1026.
- Shishavan HH, Garza J, Henning R, et al. (2023) Continuous physiological signal measurement over 24-hour periods to assess the impact of work-related stress and workplace violence. *Applied Ergonomics* 108: 103937.
- Showalter K (2016) Women's employment and domestic violence: A review of the literature. *Aggression and Violent Behavior* 31: 37–47.
- Takala J (2019) Burden of injury due to occupational exposures. In: Bultmann U and Siegrist J (eds.) *Handbook of Disability, Work and Health. Handbook Series in Occupational Health Sciences*, vol. 1, pp. 1–22. Switzerland: Springer. https://doi.org/10.1007/978-3-319-75381-2_5-1.
- Tiesman HM, Gurka KK, Konda S, et al. (2012) Workplace homicides among U.S. women: The role of intimate partner violence. *Annals of Epidemiology* 22(4): 277–284.
- Tiesman HM, Marsh S, Konda S, et al. (2022) Workplace violence during the COVID-19 pandemic: March–October, 2020, United States. *Journal of Safety Research* 82: 376–384.
- Tiesman HM, Hendricks SA, Wiegand DM, et al. (2023) Workplace violence and the mental health of public health workers during COVID-19. *American Journal of Preventive Medicine* 64: 315–325. In press.

Török E, Hansen AM, Grynderup MB, et al. (2016) The association between workplace bullying and depressive symptoms: The role of the perpetrator. *BMC Public Health* 16: 993.

United States Government Accountability Office (GAO) (2016) *Workplace Safety and Health: Additional Efforts Needed to Help Protect Health Care Workers From Workplace Violence*. GAO-16-11, Washington, D.C: United States Government Accountability Office. GAO-16-11.

University of Iowa (2001) *Workplace Violence: A report to the nation*. Iowa City, IA: University of Iowa, Injury Prevention Research Center. Available at: <https://iprc.public-health.uiowa.edu/wp-content/uploads/2015/09/workplace-violence-report-1.pdf>.

Workplace Bullying Institute. www.workplacebullying.org/.

Workplaces Respond to Domestic and Sexual Violence: A National Resource Center. www.workplacesrespond.org/.

Relevant websites

www.cdc.gov/niosh—Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

www.ilo.org—International Labour Organization.

www.iso.org/home.html—International Organization for Standardization.

www.osha.gov—United States Department of Labor, Occupational Safety and Health Administration.

www.workplacebullying.org—Workplace Bullying Institute.

www.who.int/health-topics/occupational-health—World Health Organization, occupational health topic.

<https://www.cdc.gov/violenceprevention/communicationresources/pub/technical-packages.html>—Preventing Intimate Partner Violence Across the Lifespan: A Technical Package of Programs, Policies, and Practices (cdc.gov).

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