



Measuring Impacts of Young Worker Injury Prevention Programs

Literature Review

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Executive Summary

For many reasons, youth aged 15-24 years are vulnerable in the workplace and are consequently at higher risk of sustaining an occupational injury. The high injury rate for this age group has prompted special interest in developing strategies to protect young workers. Governments, employers, researchers, healthcare providers, schools and parents have long recognized the need to make youth occupational injury prevention a priority.

The reasons that youth are vulnerable to injury at work are reasonably well characterized, but less well understood is how effective injury prevention programs aimed at youth actually are. In order to measure the effectiveness of a targeted intervention, appropriate metrics must be applied. Identifying the correct tools to use is the first step to effectively leveraging these metrics and producing meaningful reductions in injury rates.

A PICO framework was developed to search the international literature for articles about youth workplace injuries. Two independent reviewers screened the resulting list of articles in order to select articles relevant to three injury prevention domains: education, environment and enforcement. Articles selected for in-depth review evaluated some aspect of an intervention to reduce young worker occupational injuries in a context potentially relevant to federally regulated workplaces. The outcome measures, as well as methods applied were especially highlighted and discussed.

The majority of literature describes the epidemiology of young worker injuries. A total of 21 articles evaluated an intervention and approximately half of these concerned an educational intervention. Very few studies overall used injury rates, injury severity or compensation claims to demonstrate effectiveness of the intervention. Many studies relied on worker self-reported changes in behaviour or behavioural intentions as an outcome measure. Educational interventions frequently evaluated a change in knowledge but did not directly link this outcome to injury reductions.

Despite the limited number of studies, potentially useful themes emerged from each of the educational, environmental and enforcement domains. Educational interventions were demonstrated to be effective for increasing knowledge when tailored to the needs of the worker, but not necessarily leading to changes in worker behaviour. Environmental studies focused mainly on the merits of personal protective equipment and used injury or exposure reductions as the outcome measures. Enforcement studies demonstrated that collaborative research networks were powerful drivers of injury reduction by combining quality surveillance with more frequent worksite safety inspections. One additional study outlined a framework of leading and lagging metrics that may be useful for predicting injury rates as part of evaluating future injury prevention programs. A summary list of the metrics used by the studies in this review includes both outcome measures, as well as the methods used.

Introduction

Each year in Canada since 2010, over 2.4 million youth aged 15-24 years have reported being employed, representing approximately 54% of the Canadian population of that age group and 14% of the total working population.(1-3) Young workers are at higher risk of occupational injury than older age groups.(4) Between 2011 and 2013, nearly 93,000 Canadian youth suffered an occupational injury requiring time off from work. (5) Many governments recognize the need for special measures in order to protect young workers and so regulate the conditions under which youth are employed. While responsibility for occupational safety lies primarily with the provincial and territorial governments, the Government of Canada deems certain types of work to be inherently high-risk (in other words, likely to be detrimental in some way to the young person's health, safety or development) and so youth under 17 years of age are prohibited from engaging in these occupations. However, youth aged 17-24 years can work in high-risk settings, such as in an underground mine, nuclear energy plant, with or in proximity to explosives, or in shipping, if the provincial or territorial laws permit.(6,7) High injury rates make young workers a unique health and safety concern, especially in these high-risk occupations.

Workers aged 15-24 years face higher occupational injury risks related to their increased vulnerability.(8) Some known contributors to youth workplace injuries stem from inexperience: being new to the workplace may pose a threat to young workers' health and safety. This incorporates the risk associated with being unfamiliar with the environment and workplace hazards, as well as a potential lack of specific job training. (9) Many youth are not aware of their legal rights and are thus ill equipped to identify potential hazards and request training to appropriately manage these hazards.(9) Youth may also feel intimidated in the workplace. They may feel powerless to change their working conditions, or too shy to voice their concerns if they are new in their working environment.

Other common reasons that young workers face higher injury risks are related to the way that they fit into the "work culture" of their workplaces. Young workers are often part-time, seasonal or temporary employees, which may lead to a weaker safety culture in the workplace, as well as poorer safety training. These circumstances can impact the way that young workers view the issue of occupational health and its relevance to them. Many young workers have a "part of the job" mentality in which minor injuries are perceived as being normal and acceptable because they occur often and are not severe.(10) These injuries include burns, cuts, scrapes and musculoskeletal injuries. In addition, young workers may not report an injury due to concern about eliciting a negative reaction from others, especially supervisors or managers, or a perceived threat to their job security.(10) How young workers perceive their workload has an effect on their risk of injuries as well. As the workload increases, youth feel rushed and overwhelmed, which may lead them to feel pressured to prioritize working quickly over working safely.(8) The unique vulnerability of young workers is a multi-faceted issue: social, cognitive, developmental and environmental factors all contribute.

There are many young worker injury prevention initiatives across Canada. Several provinces have resources and initiatives aimed at young workers to help keep them safe. The CIHR Team in Child & Youth Injury Prevention seeks to create a framework for measuring and assessing these wide-ranging initiatives and link them to the arena of federal regulation. For example, Work Safe Alberta includes interactive eLearning programs with specific resources for youth, public awareness campaigns, and safety awards to recognize the work being done in occupational health and safety. In addition, Work Safe Saskatchewan offers information for youth as well as an online training, including Young Worker Readiness Certificate Course and WHMIS Training, among others. The Canadian Centre for Occupational Health and Safety (CCOHS) has an online Young Workers Zone designed to engage youth and help them stay healthy and safe at work. The CCOHS provides information for young workers, parents, teacher, and employers on worker physical and mental health in order to prevent illnesses, injuries and fatalities. This information, consolidated into an evidence-

based strategy, will form the foundation for the injury prevention initiatives for federally regulated workplaces.

This review will address occupational health and safety issues specific to young workers by outlining and categorizing the appropriate metrics for evaluating youth injury prevention initiatives, thereby informing an evidence-based strategy for how these metrics can be successfully leveraged for optimal use and effectiveness. When we can appropriately measure and assess young worker injury prevention initiatives, we are better positioned to facilitate the harmonization of occupational health and safety standards across jurisdictions.

The specific objectives of this review are:

- To review established epidemiological trends in the international literature on young worker injuries
- To highlight the metrics used to measure the impact of young worker injury prevention programs or workplace safety initiatives
- To categorize these metrics into three domains:
 - Metrics to evaluate a change in knowledge/education
 - Metrics to evaluate a change in environment
 - Metrics to evaluate a change in enforcement/policy
- To summarize the main themes emerging in each domain and discuss the main gaps in the literature

Methods

Specific search criteria were developed in consultation with a university librarian and the research team. A PICO framework (P=problem/person, I=intervention, C=comparator/control, O=outcome) was developed to help define the search terms. The search terms included, but were not limited to, terms that described youth injury or fatality at work. A complete list of terms is presented in the Appendix of this review. These search terms were then used to search Medline, PubMed, OVID, EMBASE, CCOHS, PsychINFO, CINAHL, NIOSHTIC, Google Scholar and the grey literature for articles in English. The original PICO we developed yielded too many articles and so was refined further. In total, 213 articles were selected through a manual review of relevant terms in the titles and abstracts. When terms of interest were not present in the title or abstract, the methods section was searched for the necessary terms. Five articles were excluded by this method. All articles included at the completion of the first phase met the following criteria:

- a. Included youth under 25 years of age in the study population
- b. Addressed some aspect of occupational injuries
- c. Could be relevant to federally regulated workplaces

During the second phase of screening, two independent reviewers then screened 208 articles and categorized the articles according to the main theme of each article: education, environment, enforcement or general (did not fit one of the first three categories). Discrepancies were discussed between reviewers until a consensus was reached. During the final phase, articles were then reviewed in-depth and further classified according to whether they described the epidemiology of worker injuries, some aspect of risk assessment, or an intervention. During this screening a further 33 articles were excluded on the basis of their non-relevance to federally regulated workplaces (for example, homicides occurring in convenience stores). Articles selected for in-depth discussion also met the following additional criteria:

- d) Evaluated some aspect of an intervention to reduce occupational injuries

A flowchart outlining the search and screening process (Figure 1), as well as a detailed summary of the PICO framework and refined framework (Figures 2a and 2b) are located in the Appendix.

Results

One hundred and seventy-four articles about occupational injuries were relevant to young workers. The vast majority (N=127, 73%) were North American studies, 101 of which were from the United States and 23 from Canada. Overall, 84% of articles were primarily concerned with describing the characteristics of the worker and the injury incident. Many focused on injuries occurring in agricultural, manufacturing or health care settings.

Seventy-six articles (44%) described the epidemiology of young worker injuries. This group of studies described in detail the demographic characteristics of the workers who suffered occupational injuries, as well as what they were doing at the time of the injury, what training they had received, what safety practices were violated, if personal protective equipment was used and the characteristics of the injury itself (severity, type, resulting time off work, etc.). The most frequent methods used were medical/hospital records, compensation claims, surveillance databases (such as trauma registries or government records), and surveys (such as the National Health Interview Survey). Injury incidence, rates, and severity (including fatality counts) were the most frequent outcome measures.

Sixty-eight articles (39%) described risk assessment practices applied to young workers and their workplaces. These studies outlined the degree of hazards faced by young workers (the overall safety climate, presence of hazardous materials, risk of workplace violence, etc.) as well as how prepared the workers were to navigate these hazards (receiving safety training, level of supervision, availability of personal protective equipment, etc.). The commonly used methods were questionnaires, surveys, interviews, focus groups and quantitative methods (such as directly measuring hazardous chemical exposure). The main outcome measures included exposure to hazards, risk perceptions, beliefs, attitudes or awareness, quality of safety training and injury incidence or rate.

A total of 21 articles (12%) described and evaluated a safety intervention. About half (N=11, 52%) evaluated an educational intervention. Two studies were conducted in Canada, 14 in the United States and the rest were international. Six studies evaluated the impact of the intervention in terms of injury reduction. Other impacts measured included hazard reduction, safety knowledge and behavioural intentions. Detailed descriptions of these studies within the educational, environmental and enforcement domains follow below and are summarized in Table 1.

Education

Education is a very popular approach to injury prevention, as it can often be implemented quickly, broadly and cheaply. In addition, it is very easy to measure the change in knowledge by administering a test pre- and post-intervention. The main weakness of educational interventions is the underlying assumption that the more a person knows about safety, the more likely it is that he or she will behave in a way that is consistent with that knowledge. Among others, Arcury and colleagues established that this is not necessarily true.⁽¹¹⁾ However, behaviour is only one component of safety that can be targeted by education and that is why efforts to increase safety knowledge are still beneficial for reducing injury risks.

Eleven studies evaluated an educational intervention. Many of these used indirect impacts on injury reductions as the outcome measure indicating effectiveness. Indirect impacts include changes to knowledge, perceived risk, intentions, behaviours or curriculum quality. These impacts are indirect because they do not necessarily lead to fewer or less severe injuries. Three studies directly measured injury reductions, one study measured cost reductions and one study measured reductions in hazardous exposures. *A main theme*

of these studies is that training and education are effective ways to increase safety knowledge, but knowledge alone does not always lead workers to change their behaviour.

Pesticide safety among farmworkers: perceived risk and perceived control as factors reflecting environmental justice

Arcury and colleagues interviewed participants in an educational program aimed at increasing workers' knowledge of pesticide safety. The program, called "PACE" (Preventing Agricultural Chemical Exposure Among North Carolina Farmworkers), was a community-based research project designed to decrease pesticide exposures through education. The researchers interviewed 293 Latino field workers from 36 different farm sites. They found that workers who received information about pesticide safety demonstrated increased knowledge, but even when the workers perceived that they were at risk of exposure, they did not modify their behaviours in order to reduce that risk. Thus, increasing safety knowledge can also increase perceptions of risk, but is not necessarily enough to prompt a change in safety behaviours. The researchers found a modest correlation between knowledge and perceived control. Workers who had greater knowledge perceived greater control over exposure and were more likely to take action to reduce their risk. Therefore, the researchers concluded that increasing workers' perceived control over their own risk is the key to modifying safety behaviour.(11)

The safe teen work project: a study to reduce cutting injuries among young and inexperienced workers

This was an experimental study of cutting injuries in grocery store employees. Injuries were tracked via store records for three years prior and approximately one year after the intervention. Nine stores participated, comprising three study groups. The first group received new, safety-improved cutting tools along with safety training, the second group received the tools alone and the third group did not receive new tools or any training. The first group showed the greatest decrease in cutting injuries, associated compensation costs and days off work. Thus, the researchers concluded that a safer tool combined with safety training using the new tool to be the most effective way to reduce injuries and associated costs.(12)

Relative effectiveness of worker safety and health training methods

A systematic review of safety training programs was conducted to see if the type of safety education, specifically learner engagement, would have any effect on knowledge, behaviour and injury rates. Ninety-five quasi-experimental studies published between 1971 and 2003, totalling 20,991 participants, were included in the review. The studies covered a wide scope of occupations and training methods. The researchers found that training programs that required high levels of learner engagement (i.e. active participation and interaction) produced the highest levels of knowledge acquisition and largest changes in injury rates. However, the researchers concluded that all levels of engagement produced some meaningful changes in knowledge, behaviour and injury rates.(13)

Enabling youth to advocate for workplace safety

Chin and colleagues conducted a an analysis of 33 young worker injury prevention programs provided for free on the internet and sponsored by Canadian provincial and territorial governments. Their focus was on how well these programs were supporting youth in advocating for themselves on issues of workplace safety. They framed their evaluation along 4 broad categories: 1) support for developing knowledge of themselves as young workers, 2) support for knowledge of their rights as young workers, 3) support for communicating concerns in the workplace, and 4) support for advocating on behalf of a group. They found that these programs provided a lot of information for youth, but did not support self-advocacy because they failed to include instructions for translating

factual knowledge into meaningful action, address the potential consequences of reporting a safety concern, or help youth consider more deeply the reasons for refusing unsafe work.(14)

Noise-induced hearing loss in agriculture: creating partnerships to overcome barriers and educate the community on prevention

Researchers from the National Institute for Occupational Safety and Health (NIOSH) partnered with key farming advocacy organizations and other community contacts in order to create a network for disseminating educational materials regarding noise-induced hearing loss. This study described the process of creating the network, as well as network activities, such as training workshops, national conferences, journal publications and webinars. NIOSH brochures and newsletters were disseminated among 43 states as a result of the network activities and community partnerships. The researchers concluded that developing community-based partnerships with key trusted organizations is an effective way to widely disseminate educational materials and ensure they reach their target audience.(15)

Workers' right-to-know legislation: does it work?

Kahan and colleagues evaluated the training programs at 50 industrial plants in Israel. By interviewing 552 workers and 33 safety officers, they found that when the training materials did not match the workers' native language, education, or literacy levels, the training did not produce meaningful changes in knowledge. Using interviews and questionnaires, the researchers determined that the workers' knowledge of safety did not increase after receiving the training. They concluded that appropriately tailored training materials would have been more effective and were thus able to highlight an important gap in the relevant legislation.(16)

Health and safety awareness for working teens: developing a successful statewide program for educating teen workers

This case study evaluated the change in knowledge and ease of implementation of a school-based young worker safety training curriculum. The program, called "Health and Safety Awareness for Working Teens" (HSAWT), was designed to be widely implemented across schools in Washington State and apply to a range of occupations and workplaces. The curriculum, which educators were able to access online for free, focused on developing critical thinking skills to teach students how to identify hazards, how to speak up about safety concerns, as well information about child labour laws and worker rights. Student knowledge was measured by pre- and post-intervention tests administered to 200 high school students. The researchers found that the curriculum was effective in increasing safety knowledge and that teachers rated the curriculum highly because it was easy to implement. Limitations of the study were that students were not retested for knowledge retention and no impact on injury rates was measured.(17)

Integrating occupational safety and health information into vocational and technical education and other workforce preparation programs

Schulte and colleagues conducted an environmental scan of workforce preparation programs across the United States, looking for inclusion of occupational safety and health (OSH) information. Workforce preparation programs that fall under the jurisdiction of specific legislation were included. Across vocational, technical and career education programs, career clusters, national skill standards, school-to-work programs, Workforce Investment Act programs and apprentice programs, they found that inclusion of OSH information is not consistent. Some programs were found to lack this information entirely, while others provided the information but did not require any demonstrable

competencies. Many programs were reliant on educator discretion for the depth or scope of information included.(18)

Reaching teen farm workers with health and safety information: an evaluation of a high school ESL curriculum

This study evaluated an educational curriculum that was integrated with an ESL school program in California. Student knowledge was measured by pre- and post-intervention tests and was shown to increase after receiving the safety education. Other benefits of the program were measured by interviews with participants and their parents, as well as through focus groups. Only half of students reported changing their behaviours at work as a result of the educational program, but almost $\frac{3}{4}$ reported sharing the knowledge they had gained with others. Parent involvement in workshops did not result in any additional benefit to students, although the opportunity to participate was enthusiastically received. The researchers successfully demonstrated an impact of the educational program on student knowledge, behaviour and safety attitudes.(19)

Percentage prevalence of patient and visitor violence against staff in high-risk UK medical wards

This study looked at the effectiveness of formal aggression management and violence de-escalation training for staff in high-risk medical wards. The researchers administered a validated questionnaire to 158 participants and found that there was no correlation between training received and exposures to violent incidences. This study did not evaluate a specific training program or use a control group. (20)

Waiting for safety: responses by young Canadian workers to unsafe work

Tucker and Turner conducted a series of focus groups with Canadian high school students to examine their willingness to report an unsafe working condition, report an injury or refuse unsafe work (collectively termed by the researchers “safety voice intentions”). They found that the majority of young workers were reluctant to speak out against unsafe work because of persistent beliefs that they would suffer negative consequences, such as losing their jobs. The researchers concluded that prevalent social marketing campaigns aimed at young workers, as well as workplace safety training programs were not adequately addressing these concerns.(21)

Environment

Making changes to the physical working environment is another way to address worker safety. Two types of changes that can be made are: 1) removal or reduction of hazards in the workplace and 2) mitigation of exposures to hazards by protecting the worker. An example of the first type of change is reducing the risk of cutting injuries by providing a cutting tool that is designed to be safer. An example of the second type of change is providing safety goggles to reduce the risk of eye injuries in an environment that is hazardous to eye health. Environmental modifications can be as simple and cheap as putting up a sign, but others can be more involved and thus costly. The benefit of making changes to the work environment is that, if the change reduces risk, the impact is often measurable in terms of injury reductions. However, it is important to first determine that the intervention does in fact reduce risk (or hazardous exposures) in order to ensure cost effectiveness in advance of implementation.

Five studies evaluated the impact of an environmental intervention. Only three studies measured impacts to hazardous exposures. The remaining two studies gauged effectiveness by the impact on behaviour, intentions and perceived effectiveness of the intervention. *Two important conclusions of these studies is that safety equipment must be tested to confirm its ability to reduce hazardous exposures and that providing safer tools or personal protective equipment alone is sometimes not enough to ensure safer workplaces.*

The effectiveness of warning signs in hazardous work places: cognitive and social determinants

Adams and colleagues administered a questionnaire to 44 students in a lab setting and 40 employees from 4 different heavy-industry companies in order to rate the effectiveness of various warning signs. The researchers hypothesized that signs missing “essential” components, such as a statement of the hazard, a statement of the consequences of the hazard, a statement about how to avoid the hazard and an appropriate signal word (like “danger”), would be perceived to be less effective by workers. They in fact found that workers rated all the signs as equally effective and also found that workers tended to perceive themselves at lower risk than their coworkers. The researchers found that the signs had an impact on the behavioural intentions of the workers, but unfortunately did not measure concrete behavioural changes induced by the signs.(22)

Assessment of hand-transmitted vibration exposure from motorized forks used for beach-cleaning operations

This study looked at the effectiveness of personal protective equipment in reducing hazardous exposures. The researchers measured the transmitted vibration from a motorized fork in workers with and without anti-vibration gloves. Eight fork operators were evaluated using 4 different configurations combining speed and basket options. The vibration was measured as the operator completed a simulated beach-cleaning task for a total exposure of approximately 1.5 minutes per configuration. The researchers found that the gloves actually increased the transmitted vibration and decreased grip strength by approximately 30%, which they argued could lead to increased hand and arm fatigue in the workers.(23)

A community-based participatory worksite intervention to reduce pesticide exposures to farmworkers and their families

Salvatore and colleagues investigated the impact an environmental modification combined with education would have on the safety behaviour of farmworkers. Hand-washing stations were installed and workers were provided with personal protective equipment. In addition, workers were given weekly educational sessions on pesticide exposure. Researchers found that the environmental modifications resulted in improved hand-washing behaviours during the workday, but that these behaviours did not change during after work hours. The researchers measured the changes in behaviour via a questionnaire administered to the workers. The impact of the weekly educational sessions was not clear in this study, as the researchers did not use a control group.(24)

Evaluation of a personal device in reducing the risk of low back disorders during stooped work

The reduction of low-back strain when using a weight transfer device was evaluated in this study. Workers in a laboratory who performed tasks in a stooped posture were evaluated for muscle strain and body positioning with and without using the weight transfer device (called “BNDR”). The researchers found that muscle activity in specific muscles was reduced when using the device. In addition, the angle of certain joints was also decreased. The researchers concluded that the BNDR device reduced muscle strain and pressure on the joints. They predicted that these results would lead to reduced low back injuries, but did not measure injury outcomes in workers using the device. (25)

Interventions to prevent occupational noise-induced hearing loss

This Cochrane review examined various interventions to reduce hearing loss. Legislation limiting noise exposure was effective in one study, but more studies evaluated the impact of personal protective equipment. The review found that overall, ear plugs are effective in reducing exposure to noise only when workers receive training in their correct use and then actually use them correctly. (26)

Enforcement

When they are effective, policy or legislative changes have the advantage of broad scope, thus achieving large cost savings and injury reductions. New rules can be difficult to implement and enforce effectively when workplaces and workers are not convinced of the advantage to themselves or perceive a large cost and/or very little benefit to making the necessary adjustments. Unfortunately, the benefits of a well-designed safety policy are largely proven by the absence of injuries, which cannot be measured in advance.

Five studies evaluated an intervention targeted to enforcing safety policies or procedures. Two studies measured the impact of the interventions on injury reductions (including fatal injuries) and one study also described legislative changes that occurred as a result of the intervention and subsequent injury reductions. Two studies evaluated the impact on safety inspections that were initiated as a result of the intervention and one study described an outcome of reduced hazardous exposures. *The standout message in this group of studies is that safety inspections prevent injuries and good surveillance can help initiate these inspections in a timely manner.*

What kinds of injuries do OSHA inspections prevent?

Haviland and colleagues examined OSHA inspections records, State Department of Labor and Industry records, unemployment insurance records and compensation claims to evaluate the effect of OSHA inspections on manufacturing workplace injury rates. They found that inspections that resulted in penalties affected injury types that were unrelated to a specific safety standard, as well as injury types that were caused by substandard safety conditions. For example, they found that bodily exertion injuries decreased, as well as injuries incurred by being struck by or caught in a specific hazard. Workplaces that were cited for violating personal protective equipment requirements showed the largest decline in injury rates following the inspection. The researchers suggested that managers who underwent OSHA inspections were more motivated to go above and beyond standard safety requirements to ensuring a safe workplace.(27)

The Fatality Assessment and Control Evaluation program's role in the prevention of occupational fatalities

The Fatality Assessment and Control Evaluation (FACE) program is run by NIOSH. The purpose of the program is to prevent fatal occupational injuries by identifying at-risk workers and workplaces, investigating workplace fatalities and providing prevention strategies to key organizations and figures that can implement the recommendations. Review of national datasets, as well as surveillance partnerships with government, help identify fatalities. Detailed site investigations using a standardized, evidence-based protocol are conducted when a fatality occurs. The final component of the FACE project is information dissemination in the form of reports to industry stakeholders. The researchers reported that their umbrella project has contributed to saving lives and reducing injuries through greater dissemination of safety information, as well as changes to the local laws. The researchers attributed these achievements to the superior surveillance system and network of contacts between researchers, industry, media and government.(28)

Application of the predicted heat strain model in development of localized, threshold-based heat stress management guidelines for the construction industry

This study used laboratory data to develop a new protocol to help workers and managers effectively manage heat stress by appropriately altering the cycle of work and rest. Two hundred and sixteen outdoor construction workers at 26 sites were studied during the summer months in Hong Kong. Heart rate and blood pressure were recorded during the workday, along with environmental variables such as temperature and humidity. The researchers then developed a model for calculating recovery time based on the threshold Wet Bulb Globe Temperature (WBGT). They concluded that current international heat stress management standards are insufficient in the case of Hong Kong

construction workers and their new protocol could be used to develop tailored heat stress management guidelines in a variety of contexts.(29)

Surveillance for work-related skull fractures in Michigan

This study compared the number of cases of occupational skull injuries identified by an existing surveillance system to the number of cases identified by a more comprehensive surveillance system in the state of Michigan. The existing process relied on the existing Bureau of Labor Statistics surveillance system to identify workplace injuries that required a Michigan Occupational Safety and Health Administration (MIOSHA) inspection of the worksite. The new, multi-source surveillance system used the same criteria for identifying eligible cases, but drew on hospital records as well as compensation claims records, police reports, death certificates and even newspaper clippings. The researchers found that the new surveillance system identified more cases eligible for MIOSHA site inspections, thus prompting inspections that would have not otherwise happened.(30)

Michigan work-related amputations, 2008

This study is very similar to the previous study; it was published one year earlier and focused on amputation injuries. The findings of this study were comparable to the previous study.(31)

Summary Table

Table 1 - Studies Evaluating an Intervention Within Educational, Environmental and Enforcement Domains

Citation	Intervention	Main Findings	Outcome Measures	Method
EDUCATION				
Arcury TA, Quandt SA, Russell GB. Pesticide safety among farmworkers: perceived risk and perceived control as factors reflecting environmental justice. Environ Health Perspect 2002 Apr;110(Suppl 2):233-240.	Safety education (PACE program)	Receiving information about pesticide safety decreased perceived risk and increased perceived control. Perceived risk was not related to safety behaviour.	Impact on knowledge, perceived risk & behaviour	Interview
Banco L, Lapidus G, Monopoli J, Zavoski R. The safe teen work project: a study to reduce cutting injuries among young and inexperienced workers. Am J Ind Med 1997;31(5): 619-622.	Safety education & improved cutting tool	The new case cutting tool combined with safety education was most effective in reducing cutting injuries. Group that received education alone had similar injury rates to control group.	Impact on knowledge, injury incidence, compensation claims & associated costs	Experiment

<p>Burke MJ, Sarpy SA, Smith-Crowe K, Chan-Serafin S, Salvador RO, Islam G. Relative effectiveness of worker safety and health training methods. Am J Public Health 2006 Feb;96(2):315-324. doi: AJPH. 2004.059840 [pii].</p>	<p>Safety education (various)</p>	<p>As requirements for learner participation increased (engagement), knowledge acquisition increased and injuries/illnesses decreased. All levels of engagement produced meaningful behavioural performance improvements.</p>	<p>Impact on knowledge, behaviour & injury incidence</p>	<p>Systematic review</p>
<p>Chin P, DeLuca C, Poth C, Chadwick I, Hutchinson N, Munby H. Enabling youth to advocate for workplace safety. Saf Sci 2010;48(5):570-579.</p>	<p>Safety education (various) & information dissemination</p>	<p>Young worker injury prevention programs at the Federal and Provincial/ Territorial levels do little to support self-advocacy. Programs are informational, rather than instructional.</p>	<p>Impact on support for self-advocacy within 4 broad categories: 1. knowledge of self 2. knowledge of rights 3. communication 4. leadership</p>	<p>Literature review</p>
<p>Ehlers JJ, Graydon PS. Noise-induced hearing loss in agriculture: creating partnerships to overcome barriers and educate the community on prevention. Noise Health 2011 Mar-Apr;13(51):142-146. doi: 10.4103/1463-1741.77218.</p>	<p>Safety education (?) & information dissemination</p>	<p>Partnerships with key industry organizations allow for wide dissemination of educational materials.</p>	<p>Impact on injury incidence</p>	<p>Workshop</p>
<p>Kahan E, Lemesh C, Pines A, Mehoudar O, Peretz C, Ribski M. Workers' right-to-know legislation: does it work?. Occup Med (Oxf) 1999 Jan;49(1):11-15.</p>	<p>Safety education (company training program)</p>	<p>WRTK legislation did not ensure that workers were aware of rights and job hazards. Training materials did not match workers' language, literacy or educational levels.</p>	<p>Impact on knowledge</p>	<p>Interview & questionnaire</p>

<p>Linker D, Miller ME, Freeman KS, Burbacher T. Health and safety awareness for working teens: Developing a successful, statewide program for educating teen workers. Fam Community Health 2005;28(3):225-238.</p>	<p>Safety education (high school curriculum)</p>	<p>Student knowledge increased after receiving the educational intervention.</p>	<p>Impact on knowledge as well as teacher ratings of ease of implementation</p>	<p>Questionnaire & pre-test/post-test evaluations</p>
<p>Schulte PA, Stephenson CM, Okun AH, Palassis J, Biddle E. Integrating occupational safety and health information into vocational and technical education and other workforce preparation programs. Am J Public Health 2005 Mar;95(3):404-411.</p>	<p>Safety education (workforce preparation programs)</p>	<p>Inclusion of OHS info is not consistent across a very broad range of workforce preparation programs.</p>	<p>Inclusion/exclusion of OHS information in training program</p>	<p>Environmental scan</p>
<p>Teran S, Strohlic R, Bush D, Baker R, Meyers J. Reaching teen farm workers with health and safety information: an evaluation of a high school ESL curriculum. J Agric Saf Health 2008 Apr;14(2):147-162.</p>	<p>Safety education (ESL curriculum)</p>	<p>School based ESL curriculum is an effective way to reach teen farmworkers. Nearly half of intervention group reported implementing behaviours and 73% reported sharing their new knowledge with others. Parent involvement with community workshops was received with enthusiasm but demonstrated no impact on student outcomes.</p>	<p>Impact on knowledge, attitudes & behaviour</p>	<p>Interview, focus groups & pre-test/post-test evaluations</p>

Lepping P, Lanka SV, Turner J, Stanaway SE, Krishna M. Percentage prevalence of patient and visitor violence against staff in high-risk UK medical wards. Clin Med 2013 Dec; 13(6):543-546. doi: 10.7861/clinmedicine.13-6-543.	Aggression management training	No correlation between aggression management training (formal de-escalation training or violence management training) and lower frequency of violence exposures.	Impact on frequency of exposure to hazard (violence & aggression)	Validated questionnaire (Survey of Violence Experienced by Staff)
Tucker S, Turner N. Waiting for safety: responses by young Canadian workers to unsafe work. J Safety Res 2013 Jun;45:103-110. doi: 10.1016/j.jsr.2013.01.006.	Safety education (various) & social marketing campaigns (various)	Young workers are reluctant to speak out against unsafe work because of beliefs about the perils of doing so persist, despite prevalence of social marketing campaigns and targeted high school curricula.	Impact on safety voice intentions (reporting an injury or safety concern)	Focus groups
ENVIRONMENT				
Adams A, Bochner S, Bilik L. The effectiveness of warning signs in hazardous work places: cognitive and social determinants. Appl Ergon 1998;29(4): 247-254.	Warning signs	Third person effect: workers rate their own risk lower relative to other employees. Signs are rated equally effective even if one "essential" component is missing.	Impact on behavioural intentions, as well as perceived effectiveness	Questionnaire
McDowell TW, Welcome DE, Warren C, Xu XS, Dong RG. Assessment of hand-transmitted vibration exposure from motorized forks used for beach-cleaning operations. Ann Occup Hyg 2013 Jan;57(1):43-53. doi: 10.1093/annhyg/mes049.	Personal protective equipment	Anti-vibration gloves are not effective at attenuating the vibration frequencies and may even increase transmitted vibration and arm/hand fatigue.	Exposure to hazard (transmitted vibration) & severity of hazard (vibration frequency)	Specialized apparatus

<p>Salvatore AL, Chevrier J, Bradman A, Camacho J, Lopez J, Kavanagh-Baird G, et al. A community-based participatory worksite intervention to reduce pesticide exposures to farmworkers and their families. <i>Am J Public Health</i> 2009 Nov;99(Suppl 3):S578-81. doi: 10.2105/AJPH.2008.149146.</p>	<p>Hand-washing stations, PPE & weekly educational sessions</p>	<p>Use of PPE and hand-washing behaviour improved during work hours, but end of day/ after work behaviours did not.</p>	<p>Impact on behaviour</p>	<p>Questionnaire</p>
<p>Ulrey BL, Fathallah FA. Evaluation of a personal device in reducing the risk of low back disorders during stooped work. <i>Work</i> 2012;41(Suppl 1): 2381-2383. doi: 10.3233/WOR-2012-0469-2381.</p>	<p>Weight transfer device (BNDR)</p>	<p>The device reduced low back strain during tasks performed with a stooped posture.</p>	<p>Impact on muscle activity & body positioning</p>	<p>Specialized apparatus (electromyography)</p>
<p>Verbeek JH, Kateman E, Morata TC, Dreschler WA, Mischke C. Interventions to prevent occupational noise-induced hearing loss. <i>Cochrane Database Syst Rev</i> 2012;10:006396. doi: 10.1002/14651858.CD006396.</p>	<p>PPE & engineered noise controls</p>	<p>Legislation limiting noise exposure was effective in reducing hazardous exposure in one study. Effectiveness of wearing ear plugs depends on training and their correct use.</p>	<p>Impact on injury rate, exposure to hazard (noise) & injury incidence</p>	<p>Systematic review (Cochrane)</p>

ENFORCEMENT

<p>Haviland A, Burns R, Gray W, Ruder T, Mendeloff J. What kinds of injuries do OSHA inspections prevent? J Saf Res 2010;41(4):339-345.</p>	<p>OHSA inspections</p>	<p>Inspections with penalties affected injury types related and unrelated to standards. Citations for violations of PPE requirements had the largest impact on preventing injuries. Inspections may spur managers to undertake safety measures that go beyond standard compliance.</p>	<p>Impact on injury rate</p>	<p>OSHA inspection records, State Department of Labour and Industry records, UI records, compensation claims</p>
<p>Higgins DN, Casini VJ, Bost P, Johnson W, Rautiainen R. The Fatality Assessment and Control Evaluation program's role in the prevention of occupational fatalities. Inj Prev 2001 Sep;7 Suppl 1:i27-33.</p>	<p>Improved surveillance through site inspections using FACE model</p>	<p>Investigations of sites of fatal occupational injuries using the FACE model have contributed to greater information dissemination, change in state laws and reductions in fatal occupational injuries.</p>	<p>Impact on data quality, reducing deaths & new legislation</p>	<p>Surveillance data (Fatality Assessment and Control Evaluation)</p>
<p>Rowlinson S, Jia YA. Application of the predicted heat strain model in development of localized, threshold-based heat stress management guidelines for the construction industry. Ann Occup Hyg 2014 Apr;58(3):326-339. doi: 10.1093/annhyg/met070.</p>	<p>A protocol to manage heat stress at both the worker and management levels</p>	<p>A new protocol for developing heat stress management systems for managers deciding on work-rest regimens and workers' self-regulation.</p>	<p>Impact on heat strain & workflow</p>	<p>Specific apparatus (Wet Bulb Globe Temperature monitor)</p>

<p>Kica J, Rosenman KD. Surveillance for work-related skull fractures in Michigan. <i>J Safety Res</i> 2014 Dec; 51:49-56. doi: 10.1016/j.jsr.2014.09.003.</p>	<p>Improved surveillance to trigger site inspections by the Michigan Occupational Safety and Health Administration (MIOSHA)</p>	<p>The new surveillance system identified a significantly higher number of injury cases that prompted site inspections. These inspections would not have otherwise occurred.</p>	<p>Impact on site inspections initiated</p>	<p>Comparison of cases identified by Bureau of Labor Statistics and new surveillance (includes hospital records & compensation claims)</p>
<p>Largo TW, Rosenman KD. Michigan work-related amputations, 2008. <i>J Occup Environ Med</i> 2013 Mar; 55(3):280-285. doi: 10.1097/JOM.0b013e31827945be.</p>	<p>Improved surveillance to trigger site inspections by MIOSHA</p>	<p>The new surveillance system identified a significantly higher number of injury cases that prompted site inspections. These inspections would not have otherwise occurred.</p>	<p>Impact on site inspections initiated</p>	<p>Comparison of cases identified by Bureau of Labor Statistics and new surveillance (includes hospital records & compensation claims)</p>

Discussion

When it comes to occupational injuries in young workers, there is a vast body of research describing who is getting injured or killed and under what circumstances. A substantial subset of this work describes injury risks and relates these risks to injury rates and severity. Emergent in the field is work that attempts to explore ways to remove or reduce these risks through interventions that target the worker on an individual or population level, or the workplace environment or culture. Many studies describe these interventions, but few evaluate them, especially in terms of their impact on reducing injuries.

Education

There appears to be a relative wealth of studies describing injury prevention initiatives with an educational approach. This makes sense because evaluating a change in knowledge is a task that our society is very practiced at performing. Knowledge test scores are very easy to compare before and after an educational intervention and can even be evaluated periodically to track knowledge retention. In addition, educational interventions are popular because they can be very flexible in scope, application and cost, making them an attractive option for many employers. From a public health perspective, education is a practical approach because an intervention can be integrated into existing school curricula, thus efficiently targeting workers just as they are entering the workforce. The studies included in this review effectively demonstrated that educational interventions (of many types) are a very good way to produce the desired changes in knowledge.

Less straightforward is the link between education and injury prevention. The goal of educating a worker is ultimately to elicit specific safety behaviours at the appropriate times. Objectively measuring behaviour in a real-world setting is a very challenging and potentially expensive task, which is why studies in this review opted to measure behavioural intentions, or self-reported safety behaviours. These measures provide valuable information about part of the impact of education, but still do not establish a direct link to reduced injuries. Some studies found that injuries were significantly reduced following education, while others found only modest reductions, suggesting that other factors could be confounding this relationship.

When weighing the value of an educational curriculum or training program for young workers, the studies included in this review provide the following conclusions to take into consideration:

- In terms of preventing injuries, some education or training is invariably better than no education or training
- Workers are motivated to take action to increase their safety when they feel they have control over their own risk level
- Knowledge is enhanced when the curriculum is tailored to the worker's language, education, literacy level and developmental stage
- Knowledge is enhanced when the educational curriculum is highly engaging
- Increasing knowledge leads to increased perception of risk and creation of behavioural intentions
- Knowledge alone does not necessarily lead directly to changes in behaviour

However, the studies included in this review do not address a number of questions relevant to the value of education for young workers:

- What is the direct impact of educational or training programs on injury severity and injury rates?
- How long do changes in knowledge last and what is the best way to improve retention?
- What other factors might contribute to changing behaviour?

Environment

We found far fewer studies evaluating an environmental intervention. Making changes to the working environment or providing personal protective equipment for workers both require a substantial investment. In addition, two studies were conducted in a laboratory setting using sophisticated apparatus for taking precise measurements. The costs associated with generating data in this way seem to be a significant barrier for researchers, which may help to explain the low number of relevant studies.

Despite limited numbers, this group of studies yields some interesting and potentially useful conclusions:

- Personal protective equipment should be evaluated for its impact on risk in the context of a specific task
- In terms of reducing risk, personal protective equipment seems to be more effective when combined with education
- Personal protective equipment is only effective if used properly
- Removing hazards leads to reduced injuries
- Hazard warnings affect behavioural intentions, but are also subject to the “third-person effect” (people tend to think that others are more vulnerable than themselves)

More studies are needed to address the specific impact of environmental interventions on injury risk, injury severity and injury rates. Studies that go beyond the use of personal protective equipment and evaluate the design of the physical working environment are needed, as this is another way to mitigate risks and protect workers that was not explored in-depth by the studies found by this review.

Enforcement

Making changes at the level of management (or higher) has very broad implications for workers and employers. Safety policy affects all aspects of a workplace and thus managers and other decision-makers can be in the position of needing to balance productivity or efficiency with safety requirements, especially when one places direct limits on the other. Developing, implementing, communicating and enforcing a change in policy is so time- and labour-intensive that reversing the change if it does not work has enormous negative consequences for everyone involved. Aside from the expenses incurred by the intervention, too many changes can cause confusion at all levels of organization, as well as undermine worker trust in management, potentially affecting future compliance with safety regulations. Thus, changes to safety policy (and on a larger scale, legislation) happen slowly because they require extensive consultation, stakeholder input and investment to ensure that the desired outcome results from the change.

In light of these considerations, very few studies evaluating a policy or legislative intervention were found. In addition, the studies in this group were mostly qualitative, rather than experimental, but they contained very detailed descriptions of how meaningful changes to policy or legislation were achieved, as well as direct impacts on injury rates and occupational fatalities. The key messages of this group of studies are:

- Safety inspections have direct impact on injury reduction
- Good surveillance is key in initiating inspections
- Changes to laws help save lives
- Changes to laws can be achieved with solid empirical evidence to justify the change, especially when combined with sufficient civic pressure
- Research networks that include stakeholders from a variety of perspectives are key in both assembling sufficient empirical evidence and putting the evidence to practical use

It is worth highlighting that two of the five studies explored the role that quality surveillance plays in injury reduction. In these studies, the researchers demonstrated that quality surveillance should not only obtain data from multiple sources, but must also be connected to a network in order to leverage the data in a timely manner. In these studies, safety inspections were initiated more quickly and in more cases because the surveillance network included OSHA contacts. Clearly, collaboration is a necessary feature of an injury prevention framework to ensure that useful data is first generated and then leveraged effectively.

Metrics

One more study that did not fit with our review framework but is nonetheless relevant and important to discuss is a study by Wurzelbacher and Jin. The researchers developed and tested a tool for predicting future worker compensation outcomes. They defined groups of metrics that could be used to assess interventions that address injury or illness events directly (termed “primary prevention”), as well as interventions to detect injury or illness early before it progresses in severity (“secondary prevention”) and interventions that reduce the duration of time off work following an injury or illness (“tertiary prevention”). They grouped their metrics according to predictive ability: “leading metrics” that indicate risk or potential causes of injury and are thus useful for predicting what might occur in future, or “trailing metrics” that describe what has happened previously, but are not necessarily reliable for projecting into the future. This project was accomplished through a preliminary literature review to define key injury prevention program elements, then, detailed questionnaires administered to participating companies. The researchers successfully demonstrated the application of the tool, predicting worker compensation cases based on metrics applied to the occupational health and safety programs of these companies.(32)

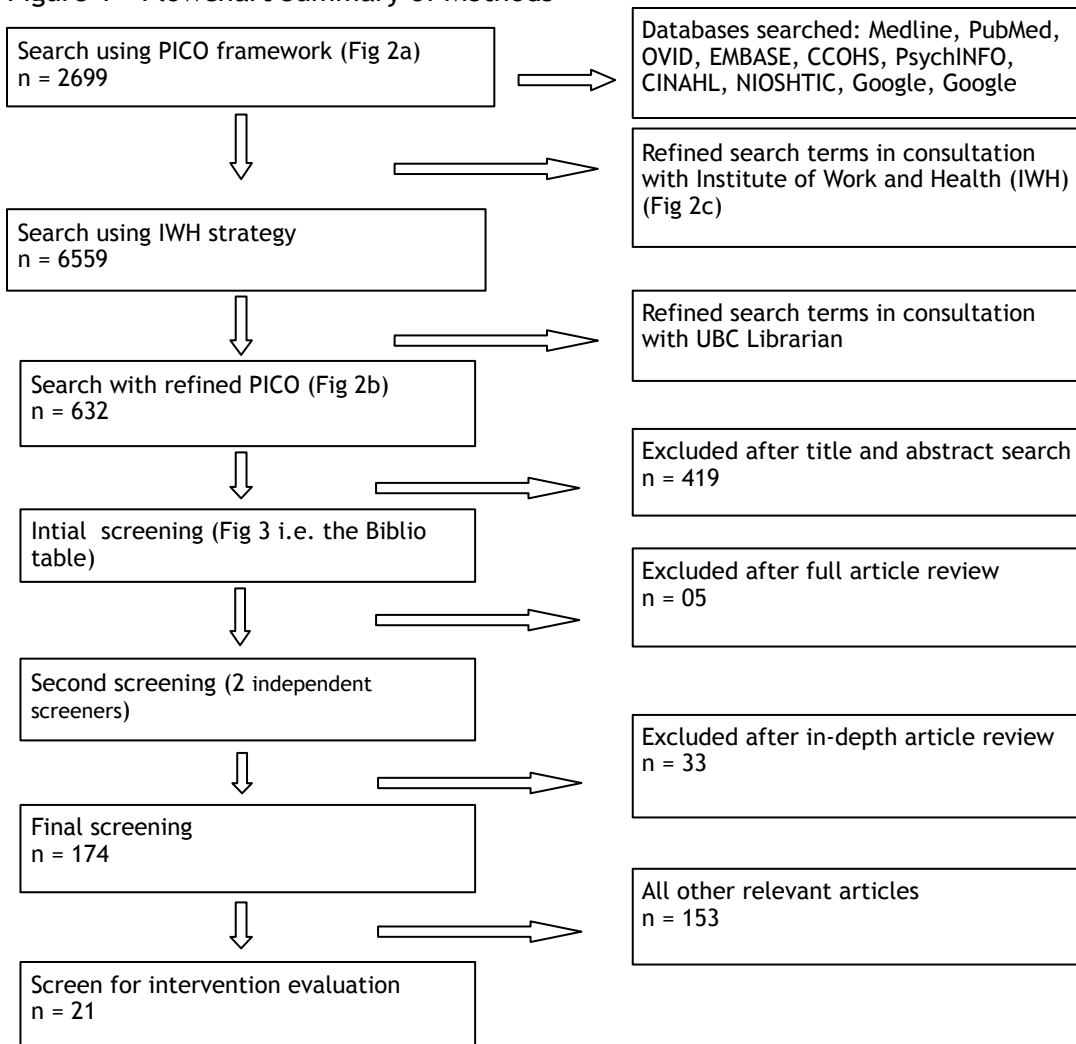
Conclusions

The literature evaluating young worker injury prevention efforts is still in its infancy. The few studies found by this review provided some information about how to determine the quality of an intervention, but very few demonstrated effectiveness in terms of the ultimate goal of such efforts: reducing injuries. More studies are needed that will establish links between injury prevention interventions and concrete reductions in injury rates. In addition, future work is needed to explore the reasons why these interventions work or do not work. Based on the findings of this review, current literature suggests that injury prevention interventions for young workers should include aspects from each of the educational, environmental and enforcement domains. Quality training, safer working conditions and safety inspections have been shown by the studies in this review to be concrete ways to reduce injuries and protect young workers. The framework developed by Wurzelbacher and Jin may be a useful tool to incorporate in future injury prevention program evaluations.

Appendix

Methods Flowchart

Figure 1 - Flowchart Summary of Methods



PICO Framework and Search Terms

Figure 2a - Original PICO Framework

P = Injury	I = Intervention	C1 = Work	C2 = "Young Worker"	C3 = Place	O = Prevention
injury	intervention	work	youth	America	prevent
accident*	program	workplace	young	Canada	safety
"wounds and injury"	metrics	work*	peer pressure	developing countries	prevention and control [pc.fs.]
injury	metric*	jobsite	adolescent		safety
injur*	indicator	job*	student		safe*
hazard	indicat*	occupation	young adult		health
risk	assess*	occupation*	apprentice		health*
risk factors	standard*	employ*	apprenticeship		promotion
exposure	measure*	employment			promot*
death	strateg*	organization			education
fatal	methods [mt.fs.]	family business			educat*
die	standards [st.fs.]	worker			health promotion
hurt*	statistical and numerical data [sn.fs]	industry			health education
	predictor	training			
	predict*	train*			
		supervisor			
		supervis*			

Figure 2b - Refined PICO Framework

P = Injury	I = Intervention	C1 = Age	C2 = Workplace	O = Outcome
injury	data collection	young adult	workplace	guideline
"wounds and injuries"	focus groups	adolescent	workplace*	legislation
wound*	health impact assessment	Student	jobsite	law*
injur*	health surveys	vocational education	Workplace	policy
hazard*	health status indicators	young adj2 adult*	workplace*	polic*
accident*	standards [st.fs.]	teen	jobsite	program*
exposure*		adolescen*		

Summary of Metrics

Table 2 - Summary of Metrics Used to Evaluate Young Worker Injury Prevention Interventions

Domain	Metrics	Methods
All	Injury incidence Injury rates Deaths Injury risk Population demographics	National databases National surveys Compensation claims Hospital data Death certificates Coroner case files Police records
Education	Knowledge Beliefs Attitudes Perceptions Behaviours Behavioural intentions Information spread Curriculum quality Self advocacy	Interview Questionnaire Focus group Workshop Knowledge test Literature review Systematic review Environmental scan
Environment	Hazardous exposures Exposure risk Behaviours Behavioural intentions	Questionnaire Systematic review Lab experiment
Enforcement	Change to policy Change to law Data quality Inspection incidence Hazardous exposure	Government records Research networks Compensation claims National databases

Complete Article List

Table 3 - All Other Articles Relevant to Young Workers (N=153)

Title	Category	Country	Methods	Outcome Measures
Medical surveillance practices of blue collar and white collar hazardous waste workers(33)	GENERAL	USA	correlation, epidemiology	injury risk
Epidemiology of occupational injury among cleaners in the healthcare sector(34)	GENERAL	CANADA	lost time from work, payroll	injury risk and exposure incidence
Demographic factors in a population-based survey of hospitalized, work-related, ocular injury(35)	GENERAL	USA	hospital data, compensation claims	injury incidence
Female homicides in United States workplaces, 1980-1985(36)	GENERAL	USA	surveillance data (National Traumatic Occupational Fatality surveillance system)	deaths
Is the societal burden of fatal occupational injury different among NORA industry sectors?(37)	GENERAL	USA	surveillance data (Bureau of Labor Statistics Census of Fatal Occupational Injuries data)	deaths, societal costs, direct and indirect
A commentary on the unique developmental considerations of youth: Integrating the teenage cortex into the occupational health and safety context(38)	GENERAL	CANADA	correlation, epidemiology	injury risk
Non-agricultural work injuries among youth: a systematic review(39)	GENERAL	NORTH AMERICA	systematic review	multiple
Systematic review of risk factors for work injury among youth(40)	GENERAL	NORTH AMERICA	systematic review	injury risk

Age-related differences in work injuries: a multivariate, population-based study(4)	GENERAL	CANADA	questionnaire	injury risk, injury rate
Injuries in adolescent workers. Health promotion and primary prevention(41)	GENERAL	USA	review	vulnerability, injury risk, lifestyle factors
Maxillofacial injuries in the workplace(42)	GENERAL	UNITED KINGDOM	hospital data	injury incidence
Industries and occupations at high risk for work-related homicide(43)	GENERAL	USA	surveillance data (National Traumatic Occupational Fatality surveillance system)	deaths
Fatal injuries among grounds maintenance workers: United States, 2003--2008(44)	GENERAL	USA	surveillance data (US Department of Labor)	injury incidence
Occupational injuries and deaths among younger workers--United States, 1998-2007(45)	GENERAL	USA	surveillance data (US Department of Labor)	injury incidence
Work-related fatalities associated with tree care operations--United States, 1992-2007(46)	GENERAL	USA	surveillance data (US Department of Labor)	injury incidence
Nonfatal occupational injuries and illnesses--United States, 2004(47)	GENERAL	USA	surveillance data (US Department of Labor)	injury incidence
Nonfatal occupational injuries and illnesses among workers treated in hospital emergency departments--United States, 2003(48)	GENERAL	USA	surveillance data (US Department of Labor)	injury incidence
The global burden due to occupational injury(49)	GENERAL	MULTIPLE	review	injury rate, fatality rate
Occupational health indicators: a guide for tracking occupational health conditions and their determinants(50)	GENERAL	USA	surveillance data (state dependent)	multiple

The epidemiology of life-threatening work-related injury--a demonstration paper(51)	GENERAL	NEW ZEALAND	compensation claims, hospital data	injury incidence, injury seriousness
Workplace homicides of Texas males(52)	GENERAL	USA	death certificates	deaths
Racial and ethnic variations in office-based medical care for work-related injuries and illnesses(53)	GENERAL	USA	national survey	incidence of medical visit, quality of medical visit
Improving agricultural injury surveillance: a comparison of incidence and type of injury event among three data sources(54)	GENERAL	USA	ambulance reports, hospital data, community surveillance (newspapers/state department contacts/ community safety officers)	injury incidence
Electrocution in Western Australia, 1976-1990(55)	GENERAL	AUSTRALIA	hospital data, autopsy records	deaths
Epidemiology of lifetime work-related eye injuries in the US population associated with one or more lost days of work(56)	GENERAL	USA	survey, interview	injury incidence
A state trauma registry as a tool for occupational injury surveillance(57)	GENERAL	USA	trauma registry	injury incidence
Farm fatalities to youth 1995-2000: a comparison by age groups(58)	GENERAL	USA	death certificates	deaths
The incidence of eye injuries in Canada(59)	GENERAL	CANADA	survey	injury incidence
Occupational injuries due to violence(60)	GENERAL	USA	compensation claims	injury incidence, deaths
Injury surveillance for youth on farms in the U.S., 2006(61)	GENERAL	USA	survey (Childhood Agricultural Injury Survey)	injury incidence
Youth on racial minority operated U.S. farms, 2008(62)	GENERAL	USA	survey	injury rate

Trends in workplace homicides in the US, 1993-2002: a decade of decline(63)	GENERAL	USA	surveillance data (Census of Fatal Occupational Injuries: Bureau of Labor Statistics)	deaths
Health and child labor in agriculture(64)	GENERAL	MULTIPLE	review	exposure to hazard (multiple)
Incidence and risk of work-related fracture injuries: experience of a state-managed workers' compensation system(65)	GENERAL	USA	compensation claims	injury incidence
Non-fatal occupational injuries and illnesses treated in hospital emergency departments in the United States(66)	GENERAL	USA	surveillance data (National Electronic Injury Surveillance System)	injury incidence
Obesity and its relationship with occupational injury in the Canadian workforce(67)	GENERAL	CANADA	survey, interview	injury risk, presence of risk factors
Occupational injuries among U.S. correctional officers, 1999-2008(68)	GENERAL	USA	surveillance data (Census of Fatal Occupational Injuries), surveillance data (National Electronic Injury Surveillance System-Occupational Supplement)	injury incidence, death
Homicide while at work: persons, industries, and occupations at high risk(69)	GENERAL	USA	death certificates	deaths
Aging and occupational accidents. A review of the literature of the last three decades(70)	GENERAL	MULTIPLE	literature review	injury risk, injury incidence

The age-related risk of occupational accidents: the case of Swedish iron-ore miners(71)	GENERAL	SWEDEN	surveillance data (Statistics Sweden), surveillance data (ISA - Sweden's National Board of Occupational Safety and Health)	injury incidence
Workplace violence: female occupational homicides in metropolitan Chicago(72)	GENERAL	USA	medical records, coroner records	deaths
Does obesity contribute to non-fatal occupational injury? Evidence from the National Longitudinal Survey of Youth(73)	GENERAL	USA	survey	injury risk, presence of specific risk factor (obesity)
A descriptive analysis of Canadian youth treated in emergency departments for work-related injuries(74)	GENERAL	CANADA	hospital records, surveillance data (Canadian Hospitals Injury Reporting and Prevention Program)	injury incidence
Homicide in the workplace in Ontario: occupations at risk and limitations of existing data sources(75)	GENERAL	CANADA	coroner records, surveillance data (Ontario Mortality Database)	injury incidence, deaths
Nonfatal injuries to young workers in the retail trades and services industries in 1998(76)	GENERAL	USA	survey, surveillance data (National Electronic Injury Surveillance System), hospital data	injury incidence
Occupational eye injury and risk reduction: Kentucky workers' compensation claim analysis 1994-2003(77)	GENERAL	USA	compensation claims, survey	injury incidence
Utilizing hospital discharge data (HD) to compare fatal and non-fatal work-related injuries among Hispanic workers in New Jersey(78)	GENERAL	USA	hospital records	injury rate, deaths

Disparities in work-related homicide rates in selected retail industries in the United States, 2003-2008(79)	GENERAL	USA	surveillance data (Census of Fatal Occupational Injuries), surveillance data (National Electronic Injury Surveillance System-Occupational Supplement)	deaths
Occupational injuries among adolescents in Washington State, 1988-1991(80)	GENERAL	USA	compensation claims	injury rate
Occupational injury mortality: New Mexico 1998-2002(81)	GENERAL	USA	surveillance data (Census of Fatal Occupational Injuries), surveillance data (National Electronic Injury Surveillance System-Occupational Supplement)	injury incidence, injury rate
Workplace injuries and the take-up of Social Security disability benefits(82)	GENERAL	USA	compensation claims, Social Security Disability Insurance claims	injury incidence
Metallic corneal foreign bodies: an occupational health hazard(83)	GENERAL	TURKEY	hospital data, questionnaire	injury incidence, injury severity
Use of employer administrative databases to identify systematic causes of injury in aluminum manufacturing(84)	GENERAL	USA	surveillance data (employer administrative files)	injury incidence, injury risk
Nonoccupational and occupational injuries to US workers with disabilities(85)	GENERAL	USA	survey (National Health Interview Survey)	injury rate, injury risk

Work-related fatalities among youth ages 11-17 in North Carolina, 1990-2008(86)	GENERAL	USA	coroner records	deaths
Methamphetamine use among Australian workers and its implications for prevention(87)	GENERAL	AUSTRALIA	survey (2004 National Drug Strategy Household Survey)	injury incidence, presence of risk factor (drug use)
The utility of Poison Control Center data for assessing toxic occupational exposures among young workers(88)	GENERAL	USA	surveillance data (Poison Control Center)	exposure to hazard (toxin)
Health and Safety of Young Workers: Proceedings of a US and Canadian Series of Symposia(89)	GENERAL	NORTH AMERICA	NA	NA
Epidemiology and prevention of injuries among adolescent workers in the United States(90)	GENERAL	USA	literature review	injury incidence, deaths
Ocular injury requiring hospitalisation in the south east of Ireland: 2001-2007(91)	GENERAL	IRELAND	hospital data	injury incidence
Have young workers more injuries than older ones? An international literature review(92)	GENERAL	MULTIPLE	literature review	injury risk, injury incidence, deaths
Non-fatal construction industry fall-related injuries treated in US emergency departments, 1998-2005(93)	GENERAL	USA	surveillance data (National Electronic Injury Surveillance System)	injury rate, injury risk
Minor injuries, cognitive failures and accidents at work: incidence and associated features(94)	GENERAL	UNITED KINGDOM	questionnaire	injury incidence, injury rate
Occupational Injury in America: An analysis of risk factors using data from the General Social Survey (GSS)(95)	GENERAL	USA	survey (General Social Survey), surveillance data (NIOSH)	injury incidence

Occupational ladder fall injuries - United States, 2011(96)	GENERAL	USA	surveillance data (NIOSH)	injury incidence, injury rate
Occupational fall injuries presenting to the emergency department(97)	GENERAL	KOREA	hospital data	injury incidence, injury severity, injury risk
Fatal injuries to teenage construction workers in the US(98)	GENERAL	USA	surveillance data (US Occupational Health and Safety Administration)	deaths
Eleven years of occupational mortality in law enforcement: The census of fatal occupational injuries, 1992-2002(99)	GENERAL	USA	surveillance data (CFOI)	deaths
Work-related injury underreporting among young workers: prevalence, gender differences, and explanations for underreporting(10)	GENERAL	CANADA	questionnaire	injury incidence, injury reporting
The organizational context of non-lethal workplace violence: its interpersonal, temporal, and spatial correlates(100)	GENERAL	USA	police records, university records	injury risk, exposure to hazard (violence)
A framework for evaluating OSH program effectiveness using leading and trailing metrics(32)	GENERAL	USA	compensation claims, questionnaire	exposure to hazard (multiple), compensation claims
Work-related eye injuries treated in hospital emergency departments in the US(101)	GENERAL	USA	surveillance data (work-related injury statistics query system)	injury incidence
Summer work and injury among middle school students, aged 10-14 years(102)	GENERAL	USA	questionnaire	injury incidence, injury risk, child labour violations, exposure to hazard (near miss)
Psychosocial factors contributing to occupational injuries among direct care workers(103)	GENERAL	USA	questionnaire	job tenure, injury risk, exposure to hazard (psychosocial), injury incidence

A national childhood agricultural injury prevention initiative(104)	GENERAL	USA	expert panel, research grants, government agency task force, workshop	fulfillment of NIOSH mandate for initiative
Occupational injury proneness in young workers: a survey in stone quarries(105)	GENERAL	INDIA	interviewer-administered questionnaire	morbidity and injury details, injury risk
Workplace toxic exposures involving adolescents aged 14 to 19 years: one poison center's experience(106)	GENERAL	USA	secondary analysis of computer-coded calls to poison control center	injury severity, injury risk, injury incidence, hazardous exposures
Worker Education Level is a Factor in Self-compliance with Dust-preventive Methods among Small-scale Agate Industrial Workers(107)	EDUCATION	INDIA	questionnaire, structured interview	knowledge, injury risk, exposure, use of prevention methods, perceived risk
New recruit safety expectations: Relationships with trust and perceived job risk(108)	EDUCATION	NEW ZEALAND	questionnaire	perceived risk, safety expectations, perceived trust
Work-related injuries in trade apprentices(109)	EDUCATION	AUSTRALIA	questionnaire	injury incidence, safety expectations
Organizational safety climate and work experience(110)	EDUCATION	GHANA	questionnaire	injury incidence, safety perceptions, safety behaviour
Patient and visitor violence in the general hospital, occurrence, staff interventions and consequences: a cross-sectional survey(111)	EDUCATION	SWITZERLAND	questionnaire	exposure
Delicate dances: immigrant workers' experiences of injury reporting and claim filing(112)	EDUCATION	CANADA	interview	injury incidence, claim filed, claim filed correctly, knowledge about worker rights
Perceptions and attitudes toward workplace transport risks: a study of industrial lift truck operators in a London authority(113)	EDUCATION	UNITED KINGDOM	questionnaire	knowledge, risk perception, attitude, injury rate, deaths

The role of employers and supervisors in promoting pesticide safety behavior among Florida farmworkers(114)	EDUCATION	USA	interview, survey, site assessment	knowledge, risk perception, attitudes, estimated exposure
Assessing pesticide safety knowledge among Hispanic migrant farmworkers in Oregon(115)	EDUCATION	USA	specific validated questionnaire (Pesticide Knowledge Test)	knowledge
Adequacy of health and safety training among young Latino construction workers(116)	EDUCATION	USA	interview	knowledge
Validity of self reported occupational exposures to hand transmitted and whole body vibration(117)	EDUCATION	UNITED KINGDOM	questionnaire, site inspection, observation	accuracy of self report, knowledge
A comparison of the perceptions and beliefs of workers and owners with regard to workplace safety in small metal fabrication businesses(118)	EDUCATION	USA	questionnaire, workplace safety audit	knowledge, perceived risk, safety committee
Building for health? The construction managers of tomorrow(119)	EDUCATION	UNITED KINGDOM	interview	attitude, knowledge, awareness, perceived risk
Characterizing the needs of a young working population: making the case for total worker health in an emerging workforce(9)	EDUCATION	USA	questionnaire	knowledge, behaviour, perceived risk
Attitudes and beliefs about adolescent work and workplace safety among parents of working adolescents(120)	EDUCATION	USA	survey	attitudes, beliefs
Awareness of occupational hazards and utilization of safety measures among welders in Kaduna metropolis, northern Nigeria(121)	EDUCATION	NIGERIA	questionnaire	hazard awareness, safety behaviour, safety compliance

Age differences in safety attitudes and safety performance in Hong Kong construction workers(122)	EDUCATION	CHINA	questionnaire	injury rate, injury risk, safety behaviours, attitude
Time trends and predictive factors for safety perceptions among incoming South Australian university students(123)	EDUCATION	AUSTRALIA	questionnaire	injury incidence, safety training, perceived risk, knowledge, attitude
Young worker safety behaviors: development and validation of measures(124)	EDUCATION	CANADA	focus groups, questionnaire	safety behaviours
Safety management practices and safety behaviour: assessing the mediating role of safety knowledge and motivation(125)	EDUCATION	INDIA	questionnaire	knowledge, attitude, engagement, safety behaviour
Perceptions regarding workplace hazards at a veterinary teaching hospital(126)	EDUCATION	USA	experts panel, questionnaire	perceived risk, exposure to hazard (chemical and biological)
Severe injury and the need for improved safety training among working teens(127)	EDUCATION	USA	questionnaire	knowledge, safety training, injury incidence, exposure to hazard (near miss), child labour violations
Attitudes of teenagers towards workplace safety training(128)	EDUCATION	USA	interview, focus groups	safety training, injury incidence, attitudes, perceived risk
Effect of summer outdoor temperatures on work-related injuries in Quebec (Canada)(129)	ENVIRONMENT	CANADA	injury compensations, temperatures	exposure to hazard (temperature) and compensation claims
Job hazards for musculoskeletal disorders for youth working on farms(130)	ENVIRONMENT	USA	focus groups, questionnaire	perceived risk, injury incidence
Factors affecting heat illness when working in conditions of thermal stress(131)	ENVIRONMENT	AUSTRALIA	specific apparatus (sweat collection)	sodium and potassium concentration, core body temperature, subject's weight

Paramedic self-reported exposure to violence in the emergency medical services (EMS) workplace: a mixed-methods cross-sectional survey(132)	ENVIRONMENT	CANADA	questionnaire	exposure
Five years of work-related injuries and fatalities in Minnesota. Agriculture: a high-risk industry(133)	ENVIRONMENT	USA	surveillance data (Fatality Assessment and Control Evaluation)	deaths, injury risk
Circumstances of fatal lockout/tagout-related injuries in manufacturing(134)	ENVIRONMENT	USA	surveillance data (OSHA Integrated Management Information System)	deaths
The special severity of occupational accidents in the afternoon: "the lunch effect"(135)	ENVIRONMENT	SPAIN	interview, questionnaire	injury risk, injury rate
Occupational hazard exposure and at risk drinking(136)	ENVIRONMENT	USA	survey, questionnaire	injury risk, presence of hazards, stress
Factors influencing restaurant worker perception of floor slipperiness(137)	ENVIRONMENT	USA	self report, questionnaire	injury risk, presence of hazards
Long workhours, work scheduling and work-related injuries among construction workers in the United States(138)	ENVIRONMENT	USA	survey, interview	injury rate, presence of risk factors
Assessment of human exposures to animal vaccines using poison control records, 2000-2009(139)	ENVIRONMENT	USA	National Poison Control Center data	exposure to hazard (vaccine)
Working conditions of Brazilian immigrants in Massachusetts(140)	ENVIRONMENT	USA	questionnaire	exposure to hazard (multiple)

Work design and management in the manufacturing sector: development and validation of the Work Organisation Assessment Questionnaire(141)	ENVIRONMENT	UNITED KINGDOM	questionnaire	injury risk, injury incidence
Behavioural accident avoidance science: understanding response in collision incipient conditions(142)	ENVIRONMENT	USA	experiment	avoidance response, avoidance experience
Divergent effects of transformational and passive leadership on employee safety(143)	ENVIRONMENT	CANADA	questionnaire	injury incidence, safety climate, leadership traits
Psychological distress and occupational injury: findings from the National Health Interview Survey 2000-2003(144)	ENVIRONMENT	USA	interview, validated tool (Kessler 6-item Psychological Distress Scale K-6)	injury incidence, presence of specific risk factor
Risk factors for work-related fatigue in students with school-year employment(145)	ENVIRONMENT	CANADA	interview, questionnaire	presence of specific risk factor (fatigue)
Association between workplace and housing conditions and use of pesticide safety practices and personal protective equipment among North Carolina farmworkers in 2010(146)	ENVIRONMENT	USA	questionnaire	knowledge, safety behaviour
Nail gun injuries in residential carpentry: lessons from active injury surveillance(147)	ENVIRONMENT	USA	industry surveillance data, questionnaire	injury incidence, presence of specific risk factor (tool)
Evaluating the mechanical injury problem in the wood-bamboo furniture manufacturing industry(148)	ENVIRONMENT	TAIWAN	site investigation, compensation claims	injury incidence, injury risk

Work-time sun behaviours among Canadian outdoor workers: results from the 2006 National Sun Survey(149)	ENVIRONMENT	CANADA	interview, survey	exposure to specific hazard (sun)
Does daily exposure to whole-body vibration and mechanical shock relate to the prevalence of low back and neck pain in a rural workforce?(150)	ENVIRONMENT	NEW ZEALAND	questionnaire, specific apparatus (tri-axial accelerometer)	exposure to specific hazard (vibration), injury incidence
Electronic noses for monitoring benzene occupational exposure in biological samples of Egyptian workers(151)	ENVIRONMENT	EGYPT	lab measures of biological markers, specialized apparatus (e-nose)	exposure to hazard (benzene)
Geographic variation in work injuries: a multilevel analysis of individual-level data and area-level factors within Canada(152)	ENVIRONMENT	CANADA	survey	injury incidence, injury rate
Exposure to psychosocial work factors in 31 European countries(153)	ENVIRONMENT	EUROPE	interview	presence of risk factors (psychosocial)
Exploring risk groups workplace bullying with categorical data(154)	ENVIRONMENT	BELGIUM	questionnaire, survey	presence of risk factor (bullying)
Vibration sensibility testing in the workplace. Day-to-day reliability(155)	ENVIRONMENT	USA	questionnaire, specific apparatus (vibrometer)	reliability of re-test, vibration sensibility
Work-related suicide in Victoria, Australia: a broad perspective(156)	ENVIRONMENT	AUSTRALIA	coroner records	deaths
Work hazards and workplace safety violations experienced by adolescent construction workers(157)	ENVIRONMENT	USA	questionnaire	exposure to hazard (child labour violations)
Work-related hazards and workplace safety of US adolescents employed in the retail and service sectors(158)	ENVIRONMENT	USA	survey	exposure to hazard (multiple), safety training, safety violations (child labour laws)

Overview of the relationship between organizational and workplace factors and injury rates(159)	ENVIRONMENT	CANADA	systematic review	presence of risk factor (joint health and safety committees), presence of risk factor (management style and culture), presence of risk factor (organizational philosophy regarding health and safety), presence of risk factor (multiple), injury rate
Are there health effects of harassment in the workplace? A gender-sensitive study of the relationships between work and neck pain(160)	ENVIRONMENT	CANADA	questionnaire	injury incidence, presence of hazard (psychosocial)
Workplace engagement and workers' compensation claims as predictors for patient safety culture(161)	ENVIRONMENT	USA	questionnaire	compensations claims, injury risk, workplace engagement
Safety voice among young workers facing dangerous work: A policy-capturing approach(162)	ENVIRONMENT	CANADA	online experimental scenario	safety voice intentions (reporting an injury or unsafe working condition)
Workers' experience of slipping in U.S. limited-service restaurants(163)	ENVIRONMENT	USA	questionnaire	injury risk, exposure to hazard (slipping)
Patients' aggressive behaviours towards nurses: development and psychometric properties of the hospital aggressive behaviour scale- users(164)	ENVIRONMENT	SPAIN	questionnaire, interview, focus group	injury risk (psychosocial), exposure to hazard (violence)
Adolescent occupational toxic exposures: a national study(165)	ENVIRONMENT	USA	surveillance data (Toxic Exposure Surveillance System, Poison Control)	exposure to hazard (toxin)
Improving safety for teens working in the retail trade sector: opportunities and obstacles(166)	ENVIRONMENT	USA	interview, focus groups	injury risk, presence of psychosocial risk factors, knowledge, perceived risk, attitude

Workplace injury or "part of the job?": towards a gendered understanding of injuries and complaints among young workers(167)	ENVIRONMENT	CANADA	focus groups	perceptions, beliefs, acceptance of risk, experiences reporting injuries to management, gender differences
Safety goggles should be worn by Australian workers(168)	ENVIRONMENT	AUSTRALIA	survey	injury severity, injury risk, use of PPE
A national survey of regional poison control centers' management of occupational exposure calls(169)	ENFORCEMENT	USA	experiment, trial of procedure	match between policy and practice
Occupational amputations in Illinois 2000-2007: BLS vs. data linkage of trauma registry, hospital discharge, workers compensation databases and OSHA citations(170)	ENFORCEMENT	USA	trauma registry, hospital data, compensation claims	injury incidence
CityCenter and Cosmopolitan Construction Projects, Las Vegas, Nevada: lessons learned from the use of multiple sources and mixed methods in a safety needs assessment(171)	ENFORCEMENT	USA	questionnaire, validated tool (Likert-scale safety climate scale)	injury incidence, deaths, safety climate perceptions
Young workers in the construction industry and initial OSH-training when entering work life(172)	ENFORCEMENT	NORWAY	interview	quality of training, training procedures
Exploring the usefulness of occupational exposure registries for surveillance: the case of the Ontario Asbestos Workers Registry (1986-2012)(173)	ENFORCEMENT	CANADA	surveillance data (Ontario Asbestos Workers Registry), surveillance data (Statistics Canada Labour Force Survey), census data (Statistics Canada census)	concordance
Drug violations and aviation accidents: findings from the US mandatory drug testing programs(174)	ENFORCEMENT	USA	random drug testing, post incident testing	injury incidence, presence of specific risk factor (drug violation)

A survey on management perspectives of the state of workplace health and safety practices in Kenya(175)	ENFORCEMENT	KENYA	questionnaire, workshop	workplace OHS practices, managers knowledge of OHS requirements
Developing a model policy on youth employment in agriculture(176)	ENFORCEMENT	USA	NA	NA
Reducing health risks arising from child and adolescent labor(177)	ENFORCEMENT	POLAND	questionnaire, workshop	pre-placement medical examination, knowledge, expectations, training components (ex. Chance to ask questions)
New methods and data sources for measuring economic consequences of workplace injuries(178)	ENFORCEMENT	UNITED KINGDOM	literature review	availability of the database, potential of database to link to other sources, detail of information available in database
Workplace violence against K-12 teachers: implementation of preventive programs(179)	ENFORCEMENT	USA	NA	NA
The influence of individual and contextual work factors on workers' compliance with health and safety routines(180)	ENFORCEMENT	NORWAY	questionnaire	compliance with OHS routines
Students enrolled in school-sponsored work programs: the effect of multiple jobs on workplace safety and school-based behaviors(181)	ENFORCEMENT	USA	questionnaire	injury incidence, exposure to hazard (near miss), child labour violations

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