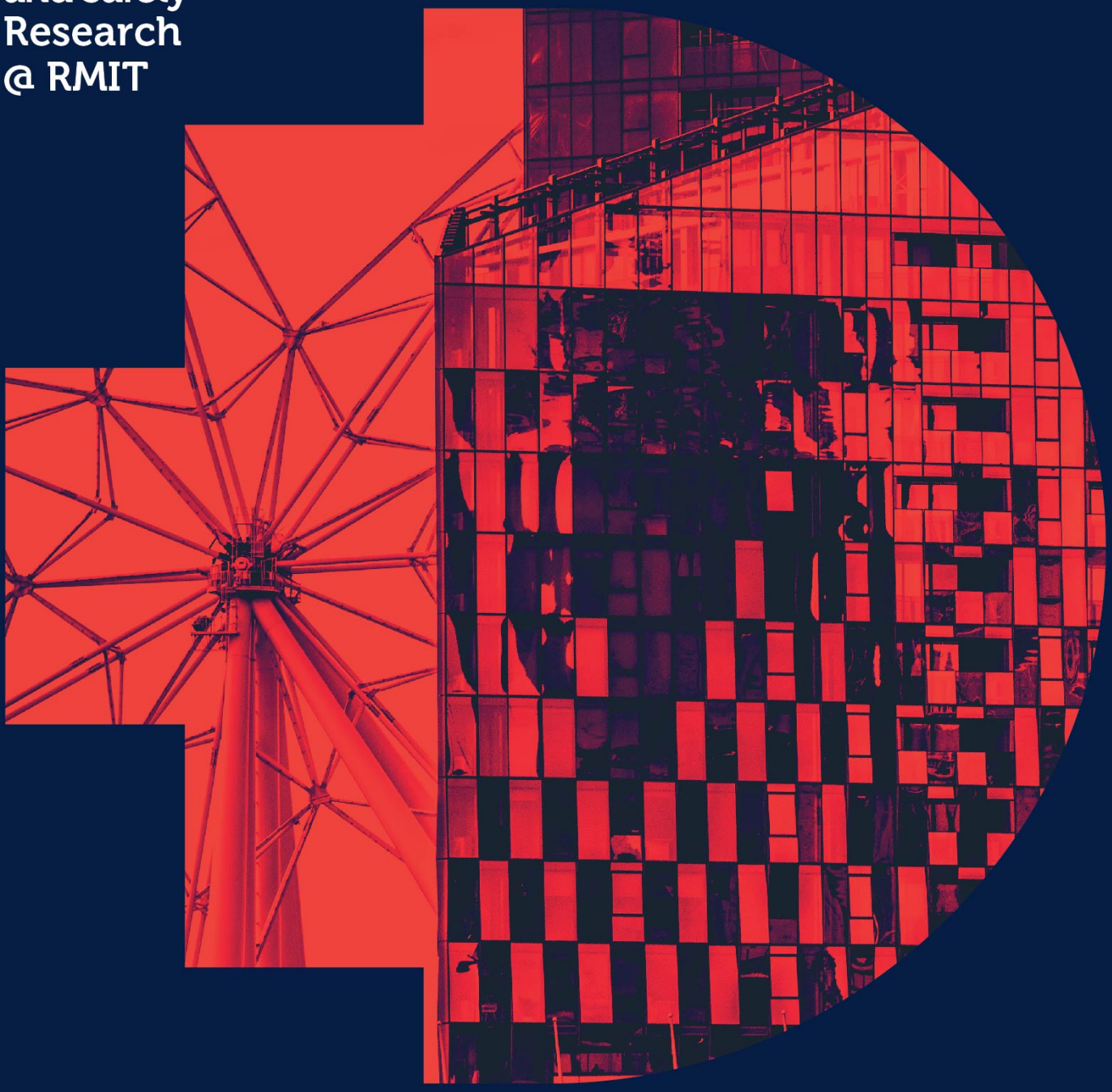
Construction Work Health and Safety Research @ RMIT

RMIT UNIVERSITY



Young and Older Construction Workers' Work Health and Safety

A Literature Review Prepared for icare Foundation NSW

August 2019

Published by
Construction Work Health and Safety Research @ RMIT

Authors
Helen Lingard and Rita Zhang

Acknowledgements
This literature review report was commissioned by icare Foundation NSW

About Construction Work Health and Safety Research @ RMIT

Construction Work Health and Safety Research @ RMIT provides leading-edge, applied research to the construction and property industries. Our members are able to work with organisations to analyse health and safety (H&S) performance and identify opportunities for improvement. We can develop and evaluate innovative solutions, provide specialised H&S programs or undertake other research-based consulting activities. Our work addresses real-world H&S challenges and our strong international linkages provide a global perspective to our research.

Construction Work Health and Safety Research @ RMIT
Building 8, Level 8, Reception
360 Swanston Street
Melbourne VIC 3000
Phone: +61 3 9925 2230
Fax: + 61 3 9925 1939
Email: constructionwhs@rmit.edu.au
www.rmit.edu.au/research/health-safety-research

Young and Older Construction Workers' Work Health and Safety

A Literature Review Prepared for icare Foundation NSW

Authors
Helen Lingard and Rita Zhang

Acknowledgements
This literature review report was commissioned by icare Foundation NSW

Published by Construction Work Health and Safety Research @ RMIT
August 2019

Contents

List of Figures
No table of figures entries found.

List of Tables

Executive summary

The ‘Construction Health and Safety Research@RMIT’ research group was engaged by the icare Foundation to conduct a literature review in relation to:

- injury patterns of work-related injuries experienced by young and older workers
- individual and systemic causes of injuries experienced by younger and older workers, and
- the injury-prevention interventions being implemented for younger and older workers.

The literature review shows that young workers (frequently defined as workers under the age of 25):

- are more prone to workplace safety incidents and injuries than older workers, and male young workers are a particularly high-risk group
- report higher lost-time injury claim rates than older workers, and the injury that accounts for the largest proportion of compensation claims among young workers is sprains or strains
- are at greater risk in construction, agriculture and manufacturing than in other industry sectors
- often hold manual and unskilled jobs, which are linked to increased exposure to hazards
- can also experience very serious and fatal accidents when working in certain high-risk industries such as construction and agriculture, and
- have substantially higher injury claim rates in the first months of employment than when they have been in a job for a period of time.

Differences are reported in work health and safety (WHS) experiences and behaviours among workers aged 15-18, 19-22 and 23-25. The age-related differences suggest workers aged between 15 and 25 should not be treated as a homogeneous group. Different experiences of risk and safety were also identified for young workers in different categories, including:

- skilled workers
- apprentices
- sabbatical (or ‘gap year’) workers
- student workers, and
- people who have ‘dropped out’ of education.

The prevalence of workplace safety incidents and injury among young workers is sometimes attributed to individual developmental and organisational environmental factors, including:

- physical risk factors associated with adolescence, e.g. musculoskeletal and endocrinal development
- inexperience and lack of familiarity with work tasks
- short job tenure
- reluctance to voice WHS concerns
- high job demands or poor work conditions
- lack of control over work conditions

- poor employment condition and work arrangement
- poor safety norms and culture in the workplace
- inadequate supervision or WHS education
- insufficient learning opportunities
- training restrictions associated with the sizes and capabilities of companies, and
- poor workplace psychosocial environment.

The existing interventions for injury reduction among young workers have primarily focused on training and education, which adopts a cognitive or behavioural paradigm aiming to change young workers' attitude and behaviours. The limitations of such intervention programs have been acknowledged. The literature review also identified a relatively small number of interventions that aim to:

- empower young workers to "voice" WHS concerns
- develop youth leadership in health and safety
- use a collaborative and multidisciplinary approach to improving young workers' WHS, and
- foster a positive work environment for young workers.

The term "older workers" is inconsistently defined in the literature. Different age thresholds are used to define older workers depending on the purpose and field of study.

The literature review indicates that older workers:

- are likely to experience lower overall frequency of low severity work-related injuries compared to workers of other age groups
- are reported to experience higher rates of severe and fatal work-related injuries than workers in other age groups
- need a longer time to recover following a work-related injury and experience more long term/disabling conditions than younger workers
- are more susceptible to certain types of workplace risk, with the risk of falling being a particular issue relevant to the safety of older workers
- experience an elevated level of work-related musculoskeletal disorders (MSDs), and
- generally experience a declined work ability, and the decline is more significant for older workers engaged in heavy manual work.

The prevalence of injury among older workers has been associated with a variety of individual and organisational factors, including age-related individual changes, job design, and work environment. The following factors have been linked to older workers' workplace safety experiences including:

- age-related physical changes in musculoskeletal systems, cardiovascular and respiratory systems, sensory system, sleep patterns, etc.
- age-related cognitive changes. However, it is acknowledged that deterioration in certain types of cognitive function (e.g. information processing speed) may be off-set by improvements in other areas (e.g. experience-based judgement).
- aged-related changes in personality and goal orientation
- age-related changes in psychological wellbeing

- the nature of construction work
- perceived high work demands resulting from work design that fails to consider the natural biological and functional changes of older workers
- poor ergonomic conditions in the workplace
- the social context of aging, such as age stereotypes and discriminatory behaviour, and
- unsatisfactory employment conditions.

The literature review reveals that there is very little information or evidence regarding the implementation of actual intervention programs for injury reduction among older workers. However, various recommendations have been made for the development of interventions that support and improve older workers' WHS and work ability. They are related to:

- incorporating age management in WHS risk and management systems
- improving the physical working environment and working conditions (e.g. hours, shift patterns, rest breaks), and
- improving the psychosocial context of work for older workers.

Part 1: Introduction

This report presents the findings of a review of literature related to the work health and safety (WHS) of young and older construction workers.

The literature review supports the icare Foundation's initiatives focused on the prevention of work-related injury in construction workers.

The aim of the literature review is to present a synthesis of the state of knowledge relating to:

- injury patterns of work-related injuries experienced by young and older workers
- individual and systemic causes of injuries experienced by younger and older workers, and
- a summary of the types of injury-prevention interventions being implemented for younger and older workers.

Much of the research concerning the patterns and causes of work-related injury and prevention initiatives relates to young and older workers in industries other than construction. The experience of young and older construction workers may have particular characteristics that warrant primary data collection and analysis. However, some of the observations in other industries (as well as the prevention initiatives implemented) may be applicable or transferable to construction.

Part 2: The work-related injury experience of young workers

International research shows that young workers (frequently defined as workers under the age of 25) are more prone to workplace safety incidents and injuries than older workers. This is particularly the case for young male workers (Salminen, 2004; Breslin & Smith, 2005). For example, in the USA, the rate of non-fatal injuries per 100 young workers (treated in hospital emergency departments) was approximately two times higher than the rate for workers over the age of 25 (CDC, 2010). In Denmark, Ajslev, Dastjerdi, Dyreborg et al. (2017) indicate that the odds ratio for incidents involving young workers is twice as high as that for older workers aged 45 and above. In a sample of Canadian workers, Breslin and Smith (2005) report that the rate of injury requiring medical attention among young workers (aged between 20 and 24 years old) is 1.4 times higher than the rate of injury for older workers (>35 years old). Also, compared to older workers (aged 35 and over), young workers report twice as many scalds, burns and chemical burns, as well as cuts, punctures, bites, scrapes, bruises and blisters. In comparison, older workers in the sample reported more dislocations, sprains and strains (see also the review of older workers' WHS in this report). This is consistent with other studies (e.g., Mujuru and Mutambudzi, 2007). For example, Walters, Christensen, Green, Karam and Kincl (2010) identified that the following types of injuries account for more than 75% of work injury compensation claims among young workers in Oregon in the USA. These injuries include:

- sprains or strains
- fractures
- lacerations, and
- contusions or bruises.

Using workers' compensation claims data in Canada, Breslin, Koehoorn, Smith and Manno (2003) compared lost-time injury rates among adolescent workers (15-19 years), young adult workers (20-24 years) and adult workers (> 25 years), taking into account factors of gender and the industry sector. Overall, the work-related injury claim rate for males was nearly twice the claim rate for females. Among males, young adult males had the highest injury rate (43.2/1000 FTE[1]s), followed by adolescent males (39.3/1000 FTEs) and adult males (34.62/1000 FTEs). Across three age groups, workers involved in the goods industry (e.g. agriculture, manufacturing, and construction) experienced a higher injury rate than those involved in the service industry (e.g. food, health care and retail). Within the goods industry, the injury rate for young adult workers (47.15/1000 FTEs) and adolescent workers (41.8/1000 FTEs) were notably higher than for adult workers (35.32/1000 FTEs).

Breslin, Koehoorn, Smith and Manno (2003) further analysed the nature of lost-time work-related injuries claimed by workers by age group and gender. Specifically, Breslin et al. (2003) identified that, within each age/gender group, sprains and strains constituted the highest proportion of claims. The rates of sprains and strains for young adults and adults were markedly higher than

1 FTE: Full-time equivalent

that for adolescents. In addition, the rate of cuts for adolescents and young adults were much higher than that for adults.

Young workers often hold manual and unskilled jobs and these are strongly linked to increased rates of work-related injury (Breslin, Day, Tompa, Irvin, Bhatacharya, Clarke & Wang, 2007). However, even when job/occupation is controlled for, young workers still have statistically more work-related accidents/injuries than older workers (Breslin & Smith 2005). This is consistent with research in Australia that shows that, holding other factors constant (including, working hours, employment type, industry, occupation and whether or not a job involves nightshift), workers aged between 15 and 24 are exposed to 30 per cent more hazards than workers aged 55 or over. Compared to workers aged 55 years and older, younger workers also have significantly higher odds of reporting exposure to six or more hazards at work, which is considered to be a high level of exposure. Workers aged 15 and 24 also have the highest odds of being co-exposed to noise and vibration, and chemical and airborne hazards compared to workers aged 55 or over (Safe Work Australia, 2015).

This is of particular concern because US research reveals young workers are frequently exposed to occupational hazards and often do not use personal protective equipment, even when they are trained to do so (Runyan, Vladutiu, Rauscher & Schulman, 2008).

In the European Union, the incidence rate of occupational accidents (where more than three days are lost) shows a higher incidence rate for young workers (compared to the average worker) in all industry sectors. Young workers are reported to be at greater risk in construction, agriculture and manufacturing than in other industry sectors (European Agency for Safety and Health at Work, 2007).

However, the European Agency for Safety and Health at Work (2007) reports that the incidence rate of fatal occupational accidents was lower for young workers (compared to industry averages) in all sectors. Notwithstanding this, after agriculture, construction had the highest incidence rate of fatal accidents among young workers. Construction also accounted for the highest number of occupational fatalities aged up to 24 years (European Agency for Safety and Health at Work, 2007). These findings indicate that, generally speaking, young workers are more susceptible to non-serious injuries than older workers. However, young workers in certain high-risk industries also experience very serious accidents (e.g., fatal) at work. This is consistent with US research that found that, after agriculture, the largest proportion of young worker fatalities occurred in the construction industry (Rauscher & Myers, 2016). Higgins, Tierney and Hanrahan (2002) report that fatal injuries among young American workers are most likely to be the result of:

- falling to a lower level
- electrocution, or
- being struck by objects, especially falling objects.

In Australia, Ehsani, McNeilly, Ibrahim and Ozanne-Smith (2013) identified the most common incident types resulting in fatalities among young workers from 2000 to 2007 as being:

- transport
- contact with object
- crushing
- drowning
- exposure to electricity
- falling, stumbling, jumping, being pushed
- heating
- struck by an explosive blast, and
- mechanical threat to breathing.

Another focused study of work-related traumatic brain injury (WRTBI) in young workers (aged 16-24) found (WRTBI) to be linked to:

- falls (48.3%)
- motor vehicle accidents (21.2%), and
- being struck by/against objects (11.9%) (Graves, Sears, Vavilala & Rivara, 2013).

In Canada, Breslin, Koehoorn, Smith and Manno (2003) investigated whether young workers experience permanent impairment resulting from work-related injuries differently to older workers. Using Canadian workers' compensation claims data, Breslin et al. (2003) reported that adolescents (15-19 years old) had a relatively lower rate of permanent impairment (0.59/1000 FTEs) than young adults (20-24 years old, 1.02/1000) and adults (25+ years old, 2.54/1000). However, the type of injury leading to permanent impairment varied between age groups. Among the adolescent group, amputations led to the highest rate of permanent impairment (0.17/10000 FTEs). Indeed, adolescents experienced a significantly higher rate of permanent impairment as a result of amputation than adults. However, among young adults and adults, sprains and strains resulted in the highest rates of permanent impairment (young adults 0.27/1000; adults, 1.03/1000).

The injury claim rate (adjusted for occupation, industry, and sex) of young workers in the first month of their jobs are three times higher than those with more than one year on the job (Breslin and Smith, 2006). This finding is consistent with research indicating increased injury risk when workers perform new or unusual tasks (Lander et al. 2012). Also, the increased injury risk for new workers may reflect exposure to more hazardous conditions than their more experienced coworkers (Breslin and Smith, 2006, Laberge and Ledoux, 2011).

Turner, Tucker and Kelloway (2015) further examined young workers' experiences of micro-accidents which they defined as minor workplace injuries, including cuts, burns, strains or sprains. Analysis of data collected from 19,547 young workers revealed workers between the ages of 15 and 18 report more frequent micro-accidents than workers between the ages of 19 and 22. Workers between the ages of 19 and 22 report more frequent micro-accidents than workers aged between 23 and 25 (Turner, Tucker & Kelloway, 2015). Turner et al. (2015) also analysed workers' self-reported safety voice, neglect and compliance behaviours. Safety compliance refers to fulfilling "core safety activities that need to be carried out" (p. 40). Safety neglect refers to "taking short-cuts or work-arounds" (p.40) and safety voice refers to "speaking up about hazardous work" (p.40). Significant variation in these safety-related behaviours was observed between workers in the different age groups. Workers aged between 15-18 reported

significantly lower levels of safety voice behaviour than workers aged between 19 and 22. Safety voice scores did not vary between workers aged 19-22 and 23-25. This suggests young workers are reluctant to raise concerns about WHS in their workplaces. Workers aged 15-19 also reported lower levels of safety compliance behaviour and more safety neglect than workers aged 19-22. Workers aged 19-22 also reported lower levels of safety compliance and more safety neglect than workers aged 23-25 (Turner et al. 2015).

These age-related differences suggest workers aged between 15 and 25 should not be treated as a homogeneous group. Not all young workers are the same, and this is reflected in their WHS experiences and behaviours. For example, Breslin, Pole and Tompa et al. (2007) suggest that young workers with low levels of education are a particularly vulnerable group for work-related injury. Other research has considered the WHS experiences of groups of sub-categories of young worker based on their reason for working and position in the labour force. The underlying mechanisms leading to acceptance of WHS risk were found to vary between different categories of young workers. For example, Nielsen, Dyreborg, Kines, Nielsen and Rasmussen (2013) analysed young workers' experiences of safety in the retail sector. They report that five different categories of young worker experience risk and safety differently. These categories are:

- skilled workers
- apprentices
- sabbatical (or 'gap year') workers
- student workers, and
- school dropouts.

Nielsen et al. (2013) report some young workers work full time, have well-developed job skills and possess a sense of risk and safety, positioning themselves as being responsible in relation to risk and safety. Similarly, apprentices take a long-term view of their employment and investment in their chosen job. Apprentices do not consider themselves to be risk-takers and, for them, WHS is a valued component in their development and mastery of a job or trade. In contrast, student or gap year workers have a short-term view of their employment and perceive they are easily replaced. These workers adapt to the 'normal' conditions of work, which may include taking risks. Young workers who have dropped out of high school typically engage in hard physical and routine work. These workers are often treated poorly and see themselves as being at the bottom of the organisational hierarchy. Such workers accept risk as an inevitable part of the work they do. Because young workers who have dropped out of education have transitioned into 'adult' roles, they are not simply working for discretionary income and, thus, they would not necessarily be able to change jobs easily if they experienced persistent unsafe conditions at work (Breslin, Morassi, Wood and Mustard, 2011). Breslin et al. (2011) similarly report that early school leavers have a higher rate of injury than other groups of young workers. These differences are partly attributable to the type of work they do (i.e., physically demanding manual work) but other factors, such as low levels of social support at work, are also likely to be contributing factors.

Work-related musculoskeletal disorders (MSDs) are reported to be common among young construction workers (Beers & Greaves, 2015). A study of construction apprentices found they experience high rates of musculoskeletal injury linked to poor lifting and manual handling practices. The occurrence of work-related MSD indicates that unsafe and unhealthy work

practices can begin early in the working life of young workers (Merlino, Rosecrance, Anton & Cook, 2003). Breslin, Koehoorn, Smith and Manno (2003) highlighted that musculoskeletal injury prevalent in injury compensation claims for all age groups. Research also shows that a history of musculoskeletal injury predicts the occurrence of future injuries and the duration of work disability that occurs as a result (Dasinger, Krause, Deegan, Brand & Rudolph, 2000). Thus, if young workers are at risk of work-related MSDs, this is likely to leave them vulnerable to injury for the remainder of their working lives. Breslin et al. (2003) suggest that intervention programs designed to prevent work-related MSDs should be implemented among young workers.

Part 3: Causal/contributing factors to work-related injury among young workers

The prevalence of workplace accidents and injury among young workers has been attributed to both developmental and environmental factors.

Factors identified as being relevant to the prevalence of safety incidents/injuries among young workers are:

- workers' inexperience and lack of familiarity with work tasks
- short job tenure, and
- the type of industrial environment within which work is performed (Bena, Giraudo, Leombruni & Costa. 2013; Breslin, Polzer, MacEachen, Morrongiello & Shannon, 2007).

3.1 Individual/developmental factors

Some research has identified physical risk factors associated with adolescence, such as size, sleep requirements, musculoskeletal and endocrinal development, cognitive and emotional maturity (Okun, Guerin & Schulte, 2016). Adolescent risk-taking and a sense of invulnerability has also been identified as a factor contributing to accidents and injuries among young workers. 'Youth', in these studies, is seen as a risk factor, i.e. workers are more prone to injury simply because they are young (Nielsen, 2012).

However, research by Breslin and Smith (2005) reveals that young adults (aged 20-24) actually have higher odds of experiencing work-related injury than adolescents (aged 15-19), after controlling for occupation and self-reported levels of physical exertion. This finding raises questions about the plausibility of developmental or maturity factors as an explanation for young workers' increased risk of work accidents or injuries. When comparing young workers' experiences between industries, Breslin, Koehoorn, Smith and Manno (2003) found young workers in goods-type industries (i.e. manufacturing, agriculture, and construction) had higher rates of injury (reflected in workers' compensation claims) than in service industries (e.g. food, health care, retail). This suggests exposure to workplace hazards may be a more important factor in young workers' injury incidence than simply workers' age (or youth). Consistent with this argument, Breslin, Pole, Tompa, Amick, Smith and Johnson (2007) found young workers' injury to be more strongly related to the type of work being performed (manual versus non-manual) than to workers' individual characteristics (e.g. biological age).

Drawing on longitudinal data incorporating a large sample of Canadian young workers, Breslin, Pole, Tompa, Amick, Smith and Johnson (2007) found that young workers:

- engaged in manual jobs are 165% more likely to experience work disability absence than workers in on-manual jobs,
- who work between 61 and 120 hours a month have an increase of 86% in the likelihood of work disability absence than those who work between 0 and 60 hours,
- who work between 120-160 hours a month have a 381% increase in the likelihood of work disability absence,
- who work overtime (more than 160 hours a month) have a 623% increase in likelihood of work disability absence, and
- who have completed high school or post-secondary education are 51% to 60% less likely to experience a work disability absence.

Young workers' experience of work-related injury has also been explained in terms of their inexperience/job tenure. Some research has sought to answer the question, 'for how long should a young worker be considered to be inexperienced in terms of WHS?' The injury incidence rate of younger workers (<25) is reported to increase for the first four years of work, before beginning to decline, suggesting that inexperience could potentially negatively impact WHS for at least four years (Chau, Wild, Dehaene, Benamghar & Touron 2010).

Injuries are sometimes attributed to young workers' poor judgement and/or an inability to perceive risk accurately. However, the research evidence does not fully support this assumption (Karlsson, 2014). Breslin, Polzer, MacEachen, Morrongiello and Shannon (2007) argue that, contrary to frequently made assumptions about accident causation, young workers have a good understanding of the risks they face on a daily basis but perceive they have little power to reduce these risks.

The reluctance to voice WHS concerns was evident in a study of young workers' responses to unsafe conditions undertaken by Tucker and Turner (2013). In this study responses were classified as being of four types:

1. Exit, characterised by leaving or escaping the dangerous situation
2. Voice, characterised as seeking to change an unsatisfactory situation
3. Patience, characterised as taking a 'wait and see' approach and hoping things improve, and
4. Neglect, characterised as letting the situation deteriorate or behaving in a way that undermines the upkeep of safety (Tucker & Turner, 2013).

The research revealed that patience was the most common first response of young workers to an unsafe work situation. The decision to 'wait and see' if a safety problem improved was driven by young workers' fear of job loss which they believed could occur if they actively 'voiced' their WHS concerns (Tucker & Turner, 2013). However, as the seriousness of a hazard, and the potential for serious injury increased, young workers tended to move towards low level 'voice' behaviours. This is consistent with previous research that shows that young workers accept minor injuries as being 'part of the job' (see below). Young workers were also significantly more likely to engage in voice behaviours in relation to WHS when they had discussed WHS concerns with co-workers and garnered collective support for the voice behaviour. This highlights the importance of providing strong social support for WHS among young workers' co-workers, supervisors, friends and relations.

3.2 Job-related factors

Young workers' experience of injury has been linked to job demands/conditions, including:

- requirements to work too fast for their skill level
- inadequate training and supervision
- incorrect equipment use
- lack of awareness of their rights in relation to WHS
- low levels of job control, and
- reluctance to 'voice' WHS concerns (Okun, Guerin & Schulte, 2016).

Breslin, Polzer, Ellen, Morrongiello and Shannon (2007) report young workers who experience minor injuries often accept these injuries as being an inevitable 'part of the job.' When exposed to physical, biological, chemical and environmental hazards, or when they experience frequent pain or injury, young workers often feel powerless to do anything to change their situation (Breslin et al. 2007). This may be related to their employment conditions and the insecure/precarious nature of employment for many young workers.

Insecure or precarious employment affects many young workers but particularly those who are unskilled or who have limited education. Young workers who feel 'replaceable' at work 'individualise' their precarious conditions and feel that they have to 'earn' their unskilled job or trainee position by taking tasks that may pose a hazard to their health and safety. This internalisation can result in risk-taking behaviour, but also in young workers' translating their precarious job conditions into a state of personal stress (Nielsen, Gorloch, Grytnes & Dyreborg, 2017).

Work arrangements and work hours are also linked to young workers' experience of injury. Using statistical data from the Australian Bureau of Statistics (ABS) and the Queensland Injury Surveillance Unit, Loudoun (2010) compared the frequency of injuries sustained by young male workers (aged 19-24) and workers aged over 24 years in the construction industry. Young male workers were consistently more likely to be injured than workers in all other age groups. However, young male workers were at significantly increased risk of injury when they were working a night shift. Two injury ratios were calculated for the comparison purpose. First, the total number of employees at work during the day and night (obtained from ABS data) was expressed as a percentage and divided by the percentage of injuries occurred during these hours. This ratio is labelled as "injuries to employees". Second, the number of hours spent at work during the day and night (taken from ABS data) was expressed as a percentage and divided by the percentage of injuries occurred during these hours. This ratio is labelled as 'injuries to work hours'. Specifically:

- the ratio of injuries to employees for young male workers increased from 1.22 for day shifts to 1.57 for night shifts, and
- the ratio of injuries to work hours for young male workers increased from 1.35 for day shifts to 1.48 for night shifts.

The injury ratio increased substantially on night shift, suggesting that injury prevention strategies should consider the temporal pattern of work for young workers in industries like construction.

In the Australian construction industry, research also shows that young workers (apprentices) do not receive appropriate entitlements, such as payments and break/meal times, and can be exposed to work conditions that reflect serious breaches of WHS legislation, for example, being exposed to asbestos without protective equipment (McCormack, Djurkovic & Casimir, 2013).

3.3 **Organisational/social/environmental factors**

Research has also examined the influence of the workplace social environment and organisational factors on the WHS experiences of young workers.

It is argued that young workers 'make sense' of the prevailing risk culture of their workplace, ultimately reproducing this and adapting to what is considered to be 'the normal' or acceptable risk (Nielsen 2012). Young workers' also develop norms relating to WHS behaviour based on their social interactions with others. For example, Pek, Turner, Tucker, Kelloway and Morrish (2017) examined social influences, associated with interactions with supervisors, co-workers and parents, on young workers' risk-taking behaviour and workplace injury experience. They report that the perceived expectations of supervisors, co-workers and parents shape young workers' risk-taking behaviour through the development of normative behaviours about how workers should behave (injunctive norms). Injunctive norms influence behaviour through the promise of a social sanction, i.e. important others will disapprove of behaviour that is inconsistent with expectations. The findings of Pek et al. (2017) reinforce the importance of good supervision for young workers, however, it also highlights the important social influence of parents and co-workers on young workers' WHS-related behaviour.

Supportive management and supervision of young workers is critical, yet research suggests supervisors and managers may not always be supportive of young workers' WHS. For example, Breslin, Polzer, MacEachen, Morrongiello and Shannon (2007) report that, even when young workers raise questions or concerns about WHS these are often 'systematically silenced' by managers. Further, while young females' complaints are raised but largely dismissed by managers, young male workers report that they deliberately stifle concerns or complaints in order to 'prove themselves' as worthy participants in the adult world of work (Breslin et al. 2007). Nielsen (2012) similarly observes that pressures to work fast require young workers to take risks in order to demonstrate mastery of the tasks that they are required to perform. Notwithstanding this, when young workers experience accidents or injuries, their managers often attribute these to youth and carelessness (Nielsen, 2012).

Zierold (2017) similarly reports many young workers do not feel comfortable talking to their supervisors about WHS. Yet, the 'approachability' of supervisors is an important factor shaping young workers' WHS behaviour. Research shows that when supervisors are seen as unapproachable or unhelpful and do not listen well, young workers are more than twice as likely to report that they would perform a dangerous task if requested (Zierold, 2017). Young male workers are also more likely to do a dangerous task if asked by their supervisor than young female workers (Zierold, 2017). Zierold argues that supportive supervision is important for keeping young workers safe at work and recommends providing targeted education and training in communication, interaction and relationships to people who will supervise young workers.

Research also shows young workers do not always receive adequate WHS education in the vocational training they receive. In Sweden, Andersson, Gunnarsson, Rosèn and Moström Åberg (2014) examined the level of WHS knowledge and among 239 young workers involved in a 3-year vocational education program. Work environment education addressing WHS was provided during the first year of the workers' program. However, Anderson et al. (2014) report that many of the young workers:

- were not aware that their employers had the legal responsibilities in relation to WHS risk management
- considered themselves to having the main responsibility for performing their work tasks safely
- did not know that they had a responsibility to inform their workmates of WHS hazards they observed, and
- had limited knowledge about effective control measures for WHS risks, apart from the use of personal protection equipment.

The results highlight the importance of an effective and systematic education approach to develop young workers' understanding of WHS while undergoing vocational training.

Impediments to learning about working safely have also been embedded in the social context of work experienced by young workers. Examples include:

- the use of unfamiliar jargon by co-workers
- inappropriate assumptions made about what is 'common sense', and
- adverse work conditions (for example, damaged tools, poor work layout or unreasonable task requirements) (Laberge, MacEachen & Calvet, 2014).

Laberge et al. (2014) studied the learning opportunities afforded to apprentices in a variety of trades and found that:

- apprentices are often given insufficient time to properly practise and master manual tasks, for which the motor skills required are not easy to learn, and
- work-based learning is provided to apprentices is often narrowly focused on a single (usually boring, repetitive or unpleasant) task given to them at the discretion of more experienced workers. Consequently, they are unable to develop global skills associated with the trade they are learning.

Company size has also been linked to young workers' WHS experiences. Research indicates that workers engaged in small companies experience a higher risk of work-related injury than those working for larger employers (Hasle & Limborg, 2006). A cross-sectional survey of building/construction apprentices in Norway found that injury prevalence was:

- highest among apprentices employed by companies with 10-19 employees (33.3%), and
- lower among apprentices employed by companies with 50-99 employees (22.4%) and companies with above 100 employees (22.8%) (Holte, Kjestveit & Lipscomb, 2015).

This may be explained, at least in part, by differences in management approaches taken towards young workers by companies of varying sizes. Holte and Kjestiveit (2012) compared the

experiences of eleven young workers engaged in seven different sized companies in Norway. For each worker, interviews were conducted with the worker, a co-worker, the worker's supervisor, and safety personnel. Holte and Kjestiveit (2012) report that:

- large companies have formalised systems, e.g. training and mentorship programs, for apprentices and new workers
- small companies (<20 employees) have neither specific WHS training nor mentorship programs for young workers, and
- small companies are more likely assign young workers to production work tasks as soon as they join the organisation, with little induction or orientation support.

These differences are attributed to the legislative requirements imposed on large and smaller companies in Norway (Holte & Kjestiveit, 2012).

3.4 Health risk factors for young construction workers

Previous research highlights significant health risk factors experienced by young construction workers and apprentices. Mental health is a particularly serious concern for young construction workers. Critically, Australian construction apprentices are two and a half times more likely to commit suicide than other young men their age (Mates in Construction, 2016). In Australia, construction apprentices are also reported to:

- experience gambling-related problems and financial difficulties (Dowling, Clarke, Memery & Corney, 2005; duPlessis & Green, 2013),
- have higher rates of smoking (Barbeau et al. 2006), illicit substance use (du Plessis & Corney, 2011a) and potentially harmful alcohol consumption, and
- experience higher levels of bullying and alcohol-related violence compared to other worker groups (du Plessis, Corney & Burnside, 2013).

In a more recent study, Pidd, Duraisingam, Roche and Trifonoff (2017) conducted a survey among 169 Australian construction industry apprentices in their first year of training. The survey results show that:

- a large proportion of the apprentices (72.2%) reported hazardous drinking (or active alcohol use disorders)
- many of the apprentices reported that they used cannabis in the 12 months prior to data collection (44.4%) or in the month preceding the data collection (24.9%), and
- smaller proportions reported that they used meth/amphetamine in the 12 months prior to data collection (8.3%) or in the month preceding the data collection (3.6%).

The apprentices' prevalence of cannabis and meth/amphetamine use in the 12 months prior to data collection was substantially higher than national prevalence data (25.3% for cannabis and 3.3% for meth/amphetamine) for Australians of similar age and gender (Australian Institute of Health and Welfare, 2017; cited in Pidd et al. 2017).

The survey conducted by Pidd et al. (2017) also revealed that Australian construction apprentices may not be fully aware of the potential negative impact of alcohol and drug (AOD) use on WHS. The survey results indicate that:

- more than half of the apprentices (58%) believed that heavy drinking is only associated with low or moderate health risk, and 5.9% believed that heavy drinking has no health risk
- while most of the apprentices (93.5%) believed that regular use of meth/amphetamine presents a high health risk, they were less likely to think that regular cannabis use is a high health risk (43.8%), and
- while large proportions of the apprentices believed drinking alcohol or using cannabis or using meth/amphetamine at work (89.9%, 81.6% and 95.2% respectively) presents a high safety risk, much smaller proportions of apprentices believed working with a hangover (50.3%), heavy drinking the night before work (20.7%), and cannabis use the night before work (40.3%) are risk factors for workplace safety incidents.

Workplace psychosocial factors are also reported to have a significant influence on apprentices' psychological wellbeing. Pidd, Duraisingam, Roche and Trifonoff (2017) report that Australian construction apprentices experience a high level of psychological distress, with the mean score of psychological distress (17.04) being substantially higher than national normative data (14.9) for Australian young men. Pidd et al. (2017) further reported that job stress and workplace bullying are significant predictors of psychological distress among construction apprentices, while general social support moderated the influence of these two predictors on psychological distress.

This is consistent with the findings of McCormack, Djurkovic and Casimir (2013) who report building and construction apprentices experience a variety of bullying behaviours in their workplaces, including:

- banter leading to further behaviours that are unacceptable, and
- personal harassment in the form of inappropriate and unacceptable teasing.

McCormack et al. (2013) also found that building and construction apprentices feel reluctant to confront bullies or report instances of workplace bullying. They explain this in terms of workplace power relations in which young apprentices feel powerless when faced with older, more experienced workers. As a result of this power imbalance, young workers are likely to adopt avoidance behaviour, rather than seeking formal help to resolve the situation or asserting themselves (Djurkovic, McCormack & Casimir 2005). McCormack et al. (2013) also identified a number of other reasons explaining why young apprentices are reluctant to report or confront the perpetrators of workplace bullying. These include apprentices':

- fear that reporting bullying behaviour may result in job loss and difficulty finding a new employer, thus jeopardising their apprenticeship
- fear of escalation of bullying, i.e. reporting the bullying may make the situation even worse and lead to more intense bullying
- lack of knowledge about who they should report the bullying to,
- concern that the position of the perpetrator (in a position of power) makes reporting risky, for example where the perpetrator is a supervisor or a respected co-worker, and

- concerns about appearing to be ‘weak’. This fear is driven, in part, by the construction industry’s culture.

The hyper-masculine culture of the construction industry has previously been reported to discourage young workers from seeking help, which is potentially very harmful at a time when these workers are transitioning into adulthood and reducing their emotional and financial dependence on family (Iacuone, 2005).

McCormack et al. (2013) maintain that there is an urgent need for vigilance from employers, training providers and regulatory bodies, regarding the non-acceptability of bullying behaviours in the construction industry. Training programs should emphasise the responsibility of all parties in preventing bullying behaviour in the workplace. Previous research also shows that construction industry apprentices can better cope with school-to-work transition challenges if they have supportive mentoring relationships with “significant others” in both their work and life domains (Corney & Du Plessis, 2010; Du Plessis & Corney, 2011b).

Part 4: Interventions for injury reduction among young workers

4.1 Training and education

The need to provide education and training for young workers has been recognised, although some research suggests young workers do not receive sufficient WHS training (Rohlman, Parish, Elliot, Montgomery & Hanson, 2013). However, Laberge, MacEachen and Calvert (2014) observe that WHS training for young workers is often developed on the assumption that young workers' attitudes and behaviours are the main cause of their injuries. Thus, training adopts a cognitive or behavioural paradigm focused on changing young workers' attitudes and encourages them to follow WHS procedures and rules. Laberge et al. (2014) suggest that these programs focus on one-way knowledge delivery (from a trainer to a trainee) and are inconsistent with contemporary theories of competency-based pedagogy, which see learning as deriving from activity rather than being a precursor to it.

It is now widely accepted that providing young workers with WHS-related information is insufficient because, as newcomers to a workplace, young workers may lack the self-confidence or ability to transfer information gained during training into practice in the workplace (Nyakänen, Sund & Vuori, 2018).

Breslin, Polzer, MacEachen, Morrongiello and Shannon (2007) express similar concerns about WHS training programs targeting young workers. Many WHS training interventions for young workers are predicated on the assumption that, once they are equipped to recognise WHS risks in their workplaces, young workers will assert their rights and act to reduce their personal exposure to WHS risks (Breslin et al, 2007). Thus, young workers are expected to take on an 'internal responsibility' for their own WHS that may be unrealistic, given their 'newcomer' status (Nyakänen et al. 2018). Although well-intentioned, Breslin et al. (2007) suggest this approach is limited by young workers' self-confidence and practical ability to influence change in their workplaces.

Consequently, there is an international trend towards training for young workers to go beyond the provision of information about WHS risks or WHS policies/procedures, and address issues such as self-advocacy and self-determination (Chin, DeLuca, Poth, Chadwick, Hutchinson & Munby, 2010). For example, Chin et al. (2010) argue that "to reframe workers' expectations about injury on the job, youth need to be engaged in safety learning that questions their beliefs, rights and knowledge of self, and teaches them how to communicate with colleagues, employers, unions, and compensation agencies, as well as their family and friends" (p.572). In an analysis of 33 youth workplace training programs in Canada, Chin et al. (2010) observe that most are informational but not instructional. These programs frequently inform young workers of their rights and the need to work safely, but none of the programs studied adequately addressed the social, economic or pragmatic barriers present in a workplace that hinder young workers from advocating for their right to safe and healthy workplaces and processes.

A socio-ecological model to developing WHS capability in apprentices has also been recommended. This acknowledges that, in order to support apprentices in learning work skills, appropriate resources in the work environment need to be factored into the design of apprentices' development experiences. Laberge, MacEachen and Calvert (2014) also argue that it is difficult to distinguish WHS skills from general job skills and therefore teaching young workers about WHS does not constitute young workers' learning about how to work safely. More integrated approaches in which WHS is deeply embedded in vocational training (rather than treated as a stand-alone module) are recommended.

It is also recommended that young workers are trained in 'soft skills' in order to appropriately respond to work environments or practices that are unsafe (Kincl, Anton, Hess & Weeks, 2016). Some examples of such programs are provided below.

The 'Safety Voice for Ergonomics' program

The '*Safety Voice for Ergonomics*' program provides masonry apprentices with training in ergonomic principles to counteract the high prevalence of musculoskeletal injury in masonry work. It incorporates elements of:

- self-direction
- self-control
- accountability
- responsibility
- communication strategies, and
- leadership to help apprentice workers to develop their 'safety voice.'

This training incorporates elements of self-direction, self-control, accountability, responsibility, communication strategies and leadership to help apprentice workers to develop a 'safety voice.' Kincl et al. (2016) suggest that, although apprentices may face pressure from experienced workers to conform to the way that 'things have always been done', they may also be more open to new concepts and ways of working than older workers. The '*Safety Voice for Ergonomics*' program is delivered using a blended learning approach and incorporates e-learning with interactive problem-solving face-to-face delivery. Knowledge of safe and healthy work techniques is supplemented with 'safety voice' activities in which apprentices practise dealing with situations in which they have to raise WHS issues with 'difficult' co-workers or supervisors. The program also includes the delivery of refresher training through SMS text messages and emails.

The 'Attitude to Work' program

Nyakänen et al. (2018) describe a training program developed in Finland, designed to provide young workers with readiness and confidence to put their skills into practice and advocate for their WHS in unfamiliar work environments. The '*Attitude to Work*' program focuses on the delivery of psychosocial resources for young workers. A component of the program is the development of 'safety preparedness'. Safety preparedness is defined as the "readiness to implement actions that support occupational safety, and their resilience to deal with barriers or problems related to occupational safety and safe working" (p. 46). The safety preparedness

concept thus combines self-efficacy with 'inoculation' against setbacks, or "skills that help an individual maintain active behaviour when facing barriers or setbacks" (Nyakänen et al., 2018, p. 46). Potential barriers include unclear instructions, risky work behaviour of co-workers, unfamiliar work tasks or pressure to work faster than young workers' skills allow them to safely (Nyakänen et al. 2018). The content and delivery approach utilised in the '*Attitude to Work'* program is presented in Table 4.1.

Table 4.1: Attitude to Work training content and delivery

Topic	Purpose	Method
Day 1		
Introduction to behaviours that support workplace safety	To share beliefs and experiences about safety at work	Group discussion with opinion line-up exercise
Identifying hazards at the workplace	To increase awareness of job-specific hazards and preventive actions	Small group exercise, hazard visualiation with flip charts
Analysing factors preceding accidents, relationship between unsafe behaviour and accidents, identifying behavioural strategies for preventing accidents	To strengthen positive attitudes towards accident prevention and safety	Group discussions about case stories, sharing previous experiences of accidents, near misses or safety-related events
Day 2		
Negative consequences of staying silent about safety issues and positive consequences of information seeking and speaking about safety at work	To identify how workers can communicate with co-workers, supervisors and safety representatives, as questions and report problems. To practice social skills that support safe behaviour at work and to strengthen positive attitudes towards workplace safety	Group discussion, role-playing exercises
Safety inoculation training	To develop behavioural strategies to help overcome barriers to safe work and strengthen workers' self-confidence when faced with such barriers	Problem-solving exercises based on case stories
Personal safety goals	To foster personal commitment and motivation towards safe work and accident prevention	Group discussion with goal setting activity

Source: Nyakänen et al. (2018)

Nyakänen et al. (2018) undertook a randomised controlled trial to evaluate the impact of the '*Attitude to Work'* program. They report that participants in the program showed a greater increase in safety preparedness and internal safety locus of control (i.e. the belief that they can

individually influence workplace safety) at follow up compared to a group of matched-paired participants who received some of the training content without the active learning delivery component. The use of a randomised controlled trial to evaluate the impact of the training program is rare because the majority of evaluation studies for interventions designed to improve young workers' WHS adopt less rigorous experimental designs (Sámano-Ríos, Ijaz, Ruotsalainen, Breslin, Gummesson & Verbeek, 2019). Thus, the conclusions reached by Nyakänen et al. (2018), that safety training for young workers is more effective when it acknowledges psychological factors that shape motivation and behaviour, are strongly evidenced.

Youth@work: Talking Safety

There is also a trend to introduce WHS training for young workers before they commence employment, i.e. in high schools and through youth programs. For example, Okun et al. (2016) describe a framework of core work health and safety competencies for young workers. This framework is intended to provide foundational knowledge and skills to enable young workers to engage in WHS learning throughout their working lives. Foundational knowledge and skills are not job or workplace-specific, but are "fundamental, portable skills necessary for conveying and receiving information critical to training and workplace success" (Okun et al., 2016, p. 44). Okun et al. (2016) describe how the US National Institute for Occupational Safety and Health (NIOSH) – through its '*Youth@Work: Talking Safety'* initiative - developed a foundational WHS program comprising eight core competencies. The objective was to prepare young workers to be cognisant of workplace risks and controls and to equip them to participate in promoting healthy and safe workplaces.

These competencies are aligned with the health belief model, such that young workers are provided with knowledge and skills to:

- perceive their susceptibility to work-related injury or ill-health and understand how workplace risks can affect their lives and/or families
- perceive the severity of hazards/risks, be able to identify hazards, evaluate risks and predict how workers could be injured or made sick due to work exposures
- perceive the benefits of working in a safe and healthy manner, and understand that work-related injuries and illnesses are predictable and can be prevented
- understand the potential barriers to safe and healthy working, recognise that employers are responsible for and workers have a right to safe and healthy work
- recognise and respond to cues to action, develop strategies to activate readiness to participate in workplace health and safety activity (e.g. knowledge of legislation, willingness and skills to raise WHS concerns), and
- develop a sense of self-efficacy or confidence in one's ability to take action and behave in the way required to achieve improvements or outcomes.

4.2 POWER project: Fostering youth leadership in health and safety

Delp, Brown and Domenzian (2005) described a pilot project named the "POWER (*People Organising for Workplace and Environmental Rights*) Project' to develop youth leadership in

workplace and community health and safety. This project adopts a social-ecological approach and is based on an empowerment model of education. This approach goes beyond the individual behaviour change emphasised by traditional training programs and recognises that health and safety interventions need to consider the social environment in which individuals live and work (Delp et al., 2005). Empowerment is the means to strengthen individual and community capacity to influence health and safety-related decisions and policies within the social, economic and political context (Rappaport, 1987; cited in Delp et al., 2005).

The POWER project is the result of a collaboration between a university, high schools, and community based-organisations. A key element of the project was to value, identify and build on existing community capacity, such as community-based organisations, government agencies, unions, etc. (Delp et al., 2005). The empowerment process in this project recognises youth as important community resources with leadership potential to address important workplace and community health and safety issues (Delp et al., 2005). The empowerment education model consisted of three steps, including listening, dialogue, and action (Wallerstein, 1992; cited in Delp et al., 2005). Specifically:

- listening - education starts from participants' own experiences, so it must include community participation and the opportunity for youth to discuss their collective knowledge and experiences,
- dialogue - empowerment education must include dialogue to build critical consciousness, i.e. the ability to analyse and address the root causes of social problems, and
- action - education programs should build skills, confidence, and opportunities for individual and collective action.

The implementation of the POWER project was built on close collaboration between school and community-based activities. It occurred at three levels:

- level 1 - a 2-week curriculum unit, '*Safe Jobs for Youth*', was designed to educate 9th-grade students about teen workers' health and safety rights. This was the first step in analysing and addressing WHS issues.
- level 2 - a 16-week leadership curriculum, '*Healthy Jobs, Healthy Communities*', was designed to develop critical analysis skills and environmental leadership through the development of research, peer education, and community-organising skills, and
- level 3 - the community-based component of the project placed students from the level 2 leadership curriculum into internships to enhance students' empowerment and to strengthen organisational and community capacity to change workplace and environmental policies. Both short-term internships (2-month) and long-term internships (3-year) were organised with community organisations.

The curriculum at levels 1 and 2 featured a typical empowerment education approach in which the learning activities began with students' own experiences. For example, in the level 1 curriculum, students identified hazards by drawing 'risk maps' of their own workplaces and discussing common problems and potential solutions. Students were also provided with workplace scenarios and stories that presented risks to young workers, through which students learned about their rights in the workplace and discussed strategies to develop support and to exercise WHS-related rights on the job. In the level 2 leadership class, students mapped their

neighbourhoods and constructed ‘power analysis’ to identify the political structures responsible for the environmental decisions that affect their community. Class projects were designed to teach leadership skills for community-based campaigns. All students became peer educators and taught other students and youth in the community about their workplace rights.

Delp et al. (2005) evaluated both the impact of the program, as well as the process of the intervention. They used individual and community level measures as intermediate indicators of progress toward longer-term empowerment goals. Various evaluation methods were used for the intervention programs, including:

- pretests-posttests (level 1 & level 2)
- classroom observations (level 1 & level 2)
- focus groups with students (level 1 & level 2)
- interviews with teachers (level 1 & level 2)
- observations of presentations by student peer education teams (level 2)
- 6-month follow up interviews with students (level 2)
- focus groups with short-term interns and interviews with supervisors (level 3), and
- quarterly focus groups with long-term interns and interviews with supervisors (level 3).

The key evaluation methods and results are listed in Table 4.2

Table 4.2: The evaluation methods and results

Intervention levels	Education methods	Evaluation results
Level 1 – Safe Jobs for Youth 9th – Grade curriculum	Pretest-posttest	Students' knowledge of resource organisations (e.g. unions and government agencies) significantly increased
	Focus groups with students	Students' awareness of their WHS rights was increased, particularly in the aspects of: • awareness of workplace problems and available resources and support • knowledge of hazards and legal rights • responses to hazardous and/or abusive workplace scenarios • dissemination of information learned in the class Students also described a sense of confidence and empowerment as a result of learning that they have rights at work and that resource organisations exist
Level 2 - Healthy Jobs, Healthy Communities Leadership Class	Pretest-posttest	Students' awareness and knowledge of resource organisations increased
	Focus groups with students	Key observations from the focus groups note that students: • developed critical consciousness of the causes of workplace and environmental abuses • put in the knowledge of the hazards and abuses they discussed in class into a larger social and political context • described how peer education and research and organising skills empowered them by increasing their self-efficacy and competency to "work together to get more done" • translated the consciousness and skills they acquired from class into action beyond their immediate classroom, and became more aware of job hazards and environmental problems
	The 6-month follow-up interviews	Students continued to play the important role as conduits of information in their community, for example, they spoke with supervisors and co-workers about issues at work
Level 3 - Community internship	Focus groups with students and interviews with their supervisors	The internship has further raised students' health and safety awareness and provided students with the opportunities to apply the information and skills they acquired from the class to collective action to enhance community empowerment

Source: Delp, Brown and Domenzian (2005)

These results suggest that interventions like the POWER project can serve as an important foundation to develop youth leadership in health and safety in a variety of communities, including the construction environment. Communities of Practice (CoPs) can also be established for young

workers to engage in peer learning and experience sharing to enhance their awareness of and capabilities in WHS. However, those programs do require a strong commitment and input from partners. For example, schools and training providers need to be willing to implement relevant curriculum, and employers and community-based organisations should be committed to supervising and supporting young workers in their learning and development.

4.3 Social marketing campaigns

Social marketing can be defined as "the use of marketing principles and techniques to influence a target audience to voluntarily accept, reject, modify, or abandon a behaviour for the benefit of individuals, groups, or society as a whole" (Kotler, Roberto & Lee, 2002, p.5). Social marketing campaigns aimed at addressing the issue of young workers' safety have been implemented in Canada (Tucker & Turner, 2013). Lavack, Magnuson, Deshpande, Basil, Basil and Mintz (2008) suggest that social marketing campaigns designed to enhance young workers' safety are best developed for narrowly defined target audiences. This is likely to be particularly important given the different mechanisms influencing the WHS experiences of different categories of young workers (see Nielsen et al. 2013). Tucker and Turner (2013) point out that these campaigns often focus on workers' right to ask questions and refuse unsafe work are based on three assumptions:

- that voicing safety concerns is the right thing to do
- that it is permissible and legitimate to voice safety concerns because it is legally sanctioned, and
- that supervisors and managers are open to hearing concerns and will respond to these because they understand the importance of providing a healthy and safety workplace.

However, as previously noted, supervisors/managers may not be open to hearing young workers' WHS concerns and therefore social marketing approaches need to be supplemented with work-based interventions.

Lavack et al. (2008) argue that social marketing campaigns should communicate the 'value' of WHS to young workers by linking the 'product' of WHS with other valued outcomes such as health, wellness and the enjoyment of life. It is also recommended that:

- a variety of communication styles be adopted to accommodate different learning styles
- young worker representatives participate in the development of WHS communication materials, and
- 'peer-to-peer delivery opportunities are pursued (Lavack et al., 2008).

Rohlman et al. (2013) describe a program called '*Promoting U through Health and Safety*' which blends existing programs relating to young workers' health promotion and occupational health protection into an on-line curriculum. This program seeks to address both work and non-work influences on young workers' health in the provision of online *Total Worker Health* training. However, Rohlman et al. (2013) recommend that such programs are designed based on a needs analysis of the target population of young workers. Importantly, in social marketing campaigns

and educational programs, the reality of the work context, in particular unequal power relationship between workers and managers do not receive sufficient attention.

Given the fact that young workers are particularly vulnerable when they first start a job, are reluctant to speak up and may not yet have established relationships with co-workers, Tucker and Turner (2013) recommend that social marketing campaigns acknowledge and address the psychological barriers (e.g. fear of consequences) as well as the structural impediments (e.g. precarious employment) to voice behaviour. Extending messages about young workers' WHS to older workers, co-workers, supervisors and managers is also recommended.

4.4 Collaborative and multidisciplinary approach to young workers' WHS

Sámano-Ríos, Ijaz, Ruotsalainen, Breslin, Gummesson and Verbeek (2019) suggest that protecting young workers' WHS requires greater participation of young workers in the design and development of interventions, as well as the involvement of parents and other key social actors, including employers, supervisors, educators, policy makers and WHS regulators. A collaborative and multidisciplinary approach to the design and delivery of intervention programs is likely to be more effective than narrowly focused programs.

For example, in the US, Ward, de Castro, Tsai, Linker, Hildahl and Miller (2010) proposed a *ProSafety* program of injury prevention for young restaurant workers. The *ProSafety* program was the product of a collaboration among occupational health nurses, professional bodies, employers, educators, and government. The *ProSafety* program was integrated with an existing career and educational program for the culinary arts, i.e. ProStart. The ProStart program is a national system of high school and restaurant partnerships developing young workers' vocational skills in the classroom, coupled with mentored workplace experience. The *ProSafety* program was implemented in two stages, i.e. classroom learning, followed by internship practice. Specifically, young workers first learned WHS knowledge and skills in the classroom as an integrated component of the ProStart training program. The WHS-related training content was developed by the *ProSafety* team in collaboration with curriculum liaisons, who then provided the materials and information to the ProStart teachers for delivery. The WHS-related training content was delivered in a highly interactive manner (e.g. with discussion, games and activities) and focused on real-life scenarios and consequences. When students completed the classroom modules, they were then assigned to internship settings with trained mentors. As part of the *ProSafety* program, the internship mentors also received *ProSafety*-compatible training titled "*Supervising-for-safety*", which aimed to equip mentors with information to facilitate appropriate supervision and WHS skills reinforcement during students' internships.

The implementation process and intervention effects were not reported in Ward et al. (2010). Nevertheless, the proposed *ProSafety* program provides ideas related to how more integrated, collaborative interventions for protecting young workers' WHS can be designed and delivered. These include:

- a collaborative approach to involving all relevant stakeholders in program design, and implementation is important, and

- training workplace supervisors/mentors being part of the process to ensure WHS messages are consistently communicated and reinforced when trainees are placed in workplaces for practical learning.

4.5 Fostering a supportive work environment

Social support in the work environment is important to young workers Young workers are significantly more likely to engage in 'voice' behaviours in relation to WHS when they:

- openly and frequently discuss WHS concerns with their co-workers (Tucker & Turner, 2013), and
- believe that their supervisors are approachable in relation to discussing WHS (Zierold, 2017).

The European Agency for Safety and Health at Work (2013) suggests that, as well as providing training and effective supervision, young workers should be engaged in WHS through:

- communication, involving a two-way dialogue to ensure that young workers' views are sought, and their opinions taken into account, and
- empowerment, i.e., giving young workers the confidence to challenge experienced workers and managers in relation to WHS and their right to a healthy and safe workplace and system of work.

The European Agency for Safety and Health at Work provide best practice examples. For instance, a UK-based energy company that engages apprentices adopted a process whereby a skills coordinator is engaged to contribute to the supervision of apprentices. Every three months a progress review is carried out to evaluate the apprentices' performance. At this evaluation, the coordinator asks the apprentices to report on their WHS experiences and views. Young workers are also assigned real-life WHS projects to work on and are asked to make recommendations for improvements. Communication forums using bulletin boards and text messages are used to communicate WHS information and more experienced apprentices are encouraged to share information and experiences with newcomers. Other best practice examples, included peer-to-peer learning, mentors and the dissemination of information about worker-led WHS improvements in company newsletters. Also important is that employee WHS representatives talk to young workers about WHS and ensure that young workers understand the role of WHS representatives in acting as a communication conduit between employees and the employer in relation to WHDS issues (European Agency for Safety and Health at Work, 2013).

4.6 Limitations associated with existing intervention programs

Sámano-Ríos, Ijaz, Ruotsalainen, Breslin, Gummesson and Verbeek (2019) conducted a systematic review of preventive WHS interventions that aim to protect young workers from hazards at work. The target population of this review was young workers aged between 12-18 years (i.e. teens). Sámano-Ríos et al. (2019) observed the following patterns associated with existing intervention programs:

- Of the 39 studies incorporated in the review, most of the intervention programs were behaviour-related, i.e. they aimed to change young workers' health and safety beliefs, attitudes and behaviours through education and learning. Very few interventions targeted environmental factors, such as workplace, organisational or legislative change.
- Most of the 39 intervention programs assessed were developed within the agricultural sector, a small number were focused on service and manufacturing sectors, very few were related to the construction sector.
- Most of the 39 intervention programs focused solely on young workers themselves, with a limited number of programs involving other stakeholders, such as community organisations, families, employers, supervisors and educators.
- A third of the intervention programs addressed the developmental characteristics (physical, cognitive and social) of young workers, however, in most of these cases attention was paid to the design of training content and the use of teaching/training methods. Addressing young workers' ability to respond to unsafe work conditions or the workplace social environment was largely overlooked.
- Few intervention programs were grounded in a robust theoretical framework leading Sámano-Ríos et al. (2019) to describe them as "shallow and ambiguous".
- Fewer than half of the intervention programs assessed the effect of intervention using an internally valid methodological approach (e.g. cluster-randomised trials or controlled/uncontrolled before-after study). This substantially weakens the evidence of their impact/effectiveness.

Part 5: The work-related injury experience of older workers

The Australian Bureau of Statistics refers to older workers as those who are 55 years old and above (Australian Bureau of Statistics, 2016). However, the term ‘older worker’ is inconsistently defined in the literature. For example, the age at which workers are considered to be “older workers” ranges from 40 years and above (Ng & Feldman, 2013), 50 years and over (Black et al., 2017), 55 years and above (Costa & Sartori, 2007), to 65 and over (Bande & López-Mourelo, 2015). Ng and Feldman (2013) also refer individuals who are 60-74 as the “young-old” and individuals who are age 75 or above as “old-old”.

For the purposes of this report, and to avoid confusion, the age threshold for defining “older workers” is specified for each study reported.

Research indicates that older workers are likely to experience lower overall frequency of work-related injuries compared to workers of other age groups (Chau, Wild, Dehaene, Benamghar, Mur & Touron 2010). However, older workers are reported to experience higher rates of severe and fatal work-related injuries (Grandjean, McMullen, Miller et al. 2006; Peng & Chan, 2019; Bande & López-Mourelo, 2015).

Through a meta-analysis of 20 studies, Peng and Chan (2019) reported that aging has an aggravating effect on workers’ health and safety. Specifically, their analysis results show that:

- older workers have lower risks of experiencing occupational health problems and non-fatal safety incidents than younger workers, and
- older workers are at higher risk of experiencing severe or fatal incidents (e.g. lost working days, fatal falls, permanent occupational disabilities) compared to young workers.

Using data from the Spanish Statistics on Accidents at Work, Bande and López-Mourelo (2015) analysed the association between workers’ age and severity of occupational safety incidents. They reported that:

- severe and fatal incidents account for larger proportions of incidents among older workers than among younger workers, and
- minor safety incidents are more prevalent among young workers.

Previous research has provided a number of potential explanations for older workers’ lower rate of non-fatal injuries. These include the belief that older workers are more likely to comply with WHS-related rules and procedures, behave more safely and take fewer risks than young workers (Ng & Feldman, 2008). Older workers are also more experienced and believed to be more risk averse than young workers (Bande & López-Mourelo, 2015). The higher incidence of fatal incidents among older workers has been attributed to the fact that older workers are more vulnerable to WHS hazards due to their deteriorated physical strength, postural control and are more likely to have visual, hearing or cognitive impairment (Chau et al., 2010).

Research also shows that older workers need a longer time to recover following a work-related injury and experience more long term/disabling conditions than younger works (Rogers & Wiatrowksi 2005). For instance, in Spain, Bande and López-Mourelo (2015) reported that the average number of lost working days due to occupational injuries among workers aged 65 and over is 36.6 days, which is twice as high as for workers aged 16 to 24 (17.3 days). The difference in the consequences of injuries between older and younger workers potentially reflects the negative impact of aging on physical capacity.

Research suggests that older workers are also more susceptible to certain types of workplace risk. For example, by studying permanently employed male workers at a French national railway company for three years, Chau et al. (2010) observed that older workers (50-55 years) are at a high risk of injury resulting from:

- fall on the same level or to a lower level
- handling materials/machine parts during assembly
- lifting/handling objects or equipment
- collision with/by moving objects/vehicles, and
- using hand tools.

In Spain, Bande and López-Mourelo (2015) identify that, for workers aged 65 and over, the most common physical activities contributing to injuries are:

- bodily motion (42.1%)
- handling of object (22.4%), and
- working with hand-held tools (11.9%).

Bande and López-Mourelo (2015) further identified that the most frequent causes of injuries for workers aged 65 include:

- acute overloading of the body (27.3%)
- a fall (23.4%), and
- being struck by or collided with something (17.5%).

In addition, research has identified that the risk of falling is a major threat to older workers. For example, Peng and Chan (2019) reported that fatal falls, and slip and fall-related injuries were key moderators to the relationship between ageing and WHS. Similarly, Bohle, Pitts and Quinlan (2010) suggest that falls from the same height are prominent across all occupations in workers aged 65 and over. In many cases these incidents result in a fracture or even a fatality for older workers.

In the US, Grandjean, McMullen, Miller et al. (2006) retrospectively examined data relating to severe injuries[2] collected from a mid-Atlantic regional trauma centre. They reported that 250 individuals in the data set were given an Index Severity Score of ≥ 20. Of these, 64 were older

2 Severe injury was defined as an Index of Severity Score (ISS) of ≥ 20, indicating that the patient had a ≥ 20% chance of dying from his or her injuries.

workers (defined by Grandjean et al. as being ≥ 50 years of age). The 64 severely injured older workers were analysed in greater depth.

Of the 64 older workers, 16 (25%) were industrial workers (e.g. those who work in warehouses and manufacturers) representing the largest proportion. Construction workers (n=12, 19%) comprised the second largest group in the sample of severely injured older workers. Grandjean et al. (2006) also report that:

- the most common mechanism of severe injury in the older workers group was a fall (n=26, 40%). Of the 64 severely injured older workers, 13 (20%) died from a fall.
- the second most frequent mechanism of injury was crushing (n=7, 21%)
- crush injuries were also most frequently associated with fatal consequences
- collisions involved in driving a vehicle were the third most common mechanism of injury (n=8, 12%)
- orthopaedic injuries were the most common type of injury (n=27, 42%)
- nineteen (30%) wounds were reported, and
- neurologic injuries were experienced by 11 patients (17%).

Work-related musculoskeletal disorders (MSDs) are a significant issue for construction workers in many countries (Hoonakker & van Duivenbooden 2010). Older construction workers are likely to experience an elevated risk of MSDs due to a number of age-related factors, including:

- biological changes related to the aging process
- the increasing number of years of exposure to harmful work demands, and
- a chronic overload caused by the imbalance between physical workload and physical work capacity with advancing age (De Zwart, Frings-Dresen & Van Duivenbooden, 1999).

However, it is also difficult to draw a clear conclusion about the association between age and musculoskeletal disorders (MSDs), as MSDs can be the outcome of a complex interplay between individual factors (e.g. age, body mass index, personal habits), the physical and psychological work environment, and the broader social economic and cultural context (Hoonakker & van Duivenbooden 2010). In addition, age effects on MSDs are also reported to vary by body part, making it problematic to make general statements about age and work-related MSD experience (Hoonakker & van Duivenbooden, 2010).

Using the multi-wave data collected from the Periodic Occupational Health Survey (POSH) in the Dutch construction industry between 1993 and 2003, Hoonakker and van Duivenbooden (2010) reported that older workers (≥ 55 years):

- have lower complaints about work being physically demanding than other age groups
- consistently have the highest complaints about working in awkward postures
- do not have more complaints about psychological demands compared to workers in other age groups
- consistently have the highest complaints of upper extremity injuries compared to workers in other age groups. Most of these complaints are related to the shoulder.
- consistently have the highest complaints of lower extremity injuries compared to workers in other age groups. Most of these complaints involve the knee, and

- are more likely than young workers to report their health complaints to be work-related.

Hoonakker and van Duivenbooden (2010) also report that:

- back and neck complaints generally increase with age. However, the incidence of back and neck complaints experienced by older workers (≥ 55 years) and workers between 45-54 are similar.
- participants reporting medical treatment (medication, surgery, diet, radiation, physical therapy, or living rules) for prolonged back and neck complaints (in the five years preceding data collection) increases with age. However, the percentage of older workers (≥ 55 years) who report receiving treatment is consistently lower than among workers aged between 45–54 years, and
- participants reporting medical treatment (medication, surgery, diet, radiation, physical therapy, or living rules) for muscle and joint complaints (in the five years preceding data collection) increases with age. The percentage of older workers (≥ 55 years) who received treatment is similar to that of workers aged between 45-54.

Hoonakker and van Duivenbooden (2010) also point out that the survey results need to be interpreted with caution, as the results have the potential to be biased by the 'healthy worker effect'. This relates to the phenomenon where workers who remain in employment as they age are inherently healthier than those who may have already left due to ill health or injury, which introduced bias into sampling of older adults in employment in health-related research. The results could also be influenced by the encouragement of early retirement in Western European countries that occurred in the 1980s and 1990s.

Costa and Sartori (2007) analysed the health condition of workers in Italy, and reported that work-related musculoskeletal disorders (WMSDs), primarily represented by low back pain and arthritis/ arthrosis, were the most prevalent disorders both in working men (51.3%) and women (55.6%). In particular, workers in heavy manual occupations (mainly represented by construction workers) experienced WMSDs frequently (compared with other groups). The prevalence of WMSDs also increased with the worker's age.

Age is commonly understood in chronological terms. However, it can also be conceptualised using different dimensions, one of which is functional age (Sterns and Doverspike, 1989; cited in Varianou-Mikellidou, Boustras, Dimopoulos et al., 2019). This means, even with the same chronological age, individuals can vary widely in terms of their functional capabilities (Crawford, Davis, Cowie et al., 2016). Therefore, work ability has been recommended as an alternative method of measuring age for the purposes of understanding performance and fitness at work (Tepas and Barnes-Farrell, 2002).

Work ability takes into account individuals' human resources and related associations with work demands and work conditions (Varianou-Mikellidou et al., 2019). Work ability has been defined as "a dynamic process that changes through its components throughout life, and it is the result of the interaction between individual resources (including health, functional capacity, education, know-out, motivation), working conditions (environment, tools, human relations), and the surrounding society" (Costa & Sartori, 2007; p1916).

Costa and Sartori (2007) examined the health conditions and work ability of 1,449 workers across different working sectors in Italy. A work ability index (WAI) was calculated for each worker by assessing the following items:

- current work ability compared with lifetime best
- work ability in relation to job demands (mental, physical)
- number of current diseases diagnosed by a physician
- estimated work impairment due to diseases
- sick leave during the past 12 months
- own prognosis of work ability two years from now, and
- mental resources.

The results indicate that WAI scores declined progressively over the age groups, from an average WAI score of 41.2 for workers under 25 years old to an average score of 37.8 for workers over 55 years old. Specifically, the most notable decline in WAI over age was recorded for workers engaged in heavy manual work, primarily represented by construction workers (Costa & Sartori, 2007).

Part 6: Causal/contributing factors to work-related injury among older workers

6.1 Individual factors

With increasing age, the functional capacity of physiological systems typically declines as a result of natural ageing processes. However, it should be acknowledged that this change is specific to individuals, depending on individual lifestyles and fitness levels.

Drawing on a number of studies (Varianou-Mikellidou, Boustras, Dimopoulos et al., 2019; Crawford, Graveling, Cowie & Dixon, 2010), the following age-related physical changes are observed to occur which may have an impact on older workers' work ability and injury experiences on their:

- musculoskeletal system, including declined physiological function, decreased flexibility, decreased aerobic capacity, reduced physical strength and endurance, reduced mobility, stiffer joints and increase bone fragility
- cardiovascular and respiratory systems, including reduced ability to regulate body temperature, and reduced functional breathing capacity
- sensory system, including changes in hearing, decreased ability of vision, decreased ability in balance control
- skin as it becomes thinner and dryer, and less tolerance to heat and cold, and
- changing sleep patterns.

The age-related physical changes, particularly declined physical strength and endurance, may explain why older workers:

- are vulnerable to certain type of risks (such as falls and overexertion)
- experience a higher rate of severe and fatal injuries than younger workers, and
- require longer recovery time after injury (Choi, 2015).

Research also indicates that older workers experience more difficulty in physically adjusting to nonstandard work arrangements (e.g. night shift work) due to longer recovery times associated with sleep disturbance (Blok & De Looze, 2011).

Aging is also associated with cognitive changes. Ng and Feldman (2013) highlighted two aspects of cognitive change that have the potential to impact work performance: information processing speed and experience-based judgement. It is argued that a decline in information processing speed can be explained by two underlying mechanisms:

1. the limited time mechanism - which refers to increased difficulty in completing cognitive tasks under time pressure, and

2. the simultaneity mechanism – which refers to increased difficulty in retrieving information from the early stages of a cognitive task performance for use in later stages of cognitive task performance (Ng & Feldman, 2013).

Ng and Feldman (2013) argue that the change in information processing speed makes it harder for older workers to engage in multiple tasks simultaneously, especially when working under time pressure. However, Ng and Feldman (2008) report no consistent negative relationship between age and job performance. This may be related to the fact that deterioration in certain types of cognitive function may be off-set by improvements in other areas.

For example, Ng and Feldman (2013) suggest that experience-based judgement can compensate for a potential decline in cognitive capacity and can be a positive predictor for workplace performance. It is argued that, with increasing age, people accumulate a variety of experiences and more nuanced understanding of their work environment, which enables older workers to make better decisions about appropriate actions for a given set of circumstances (Cornelius & Caspi, 1987; cited in Ng & Feldman 2013). Improved experience-based judgement may explain why older workers are reported to have a lower incidence of non-fatal injuries compared to young workers.

Truxillo, Cadiz and Hammer (2015) also categorised cognitive change in terms of the type of intelligence that is impacted. Fluid intelligence describes cognitive processing speed, reaction time, working memory and selective attention. These are believed to be negatively associated with age (Truxillo, Cadiz & Hammer 2015; Varianou-Mikellidou, Boustras, Dimopoulos et al., 2019) however, crystallised intelligence describes accumulated knowledge, skills, and wisdom which typically increase with age (Truxillo, Cadiz & Hammer 2015).

Research also shows that an individual's personality, indicated by the 'Big Five' personality traits, can change over the life course (Ng & Feldman, 2013; Truxillo, Cadiz & Hammer, 2015). Generally, two of the 'Big Five' traits, i.e. conscientiousness and agreeableness are likely to increase with age, while the other two personality traits, i.e. extraversion and openness to experience, are more likely to decrease with age (Ng & Feldman, 2013). The changes in the trait of neuroticism, however, are much smaller in magnitude and less systematic across the lifespan (Ng & Feldman, 2013). Research indicates that increased conscientiousness and agreeableness are linked to better core task performance and more work-related citizenship behaviours (Ng & Feldman, 2008). Thus, older workers may be more willing to participate in extra-role WHS behaviours, potentially including the mentorship of young workers, new to the work environment.

The aging process has been related to individuals' goal orientation. Socioemotional selectivity theory (Carstensen, 1991) suggests that individuals' goal orientation changes as time horizons shrink with age. Normally young adults have more focus on growth-oriented goals, while older adults place more emphasis on preventing resources losses (Ebner, Freund & Baltes, 2006). In other words, as people age, they tend to shift their focus from maximising gain to minimising losses (Ng & Feldman, 2013). The increased intention to minimise losses has the potential to reduce risk taking. Previous research supports this by indicating that older workers are more risk-averse, less likely to engage in risk-taking behaviours and be more compliant with safety rules than young workers (Ng & Feldman, 2008).

Age-related changes in psychological wellbeing have also been identified. For example, Varianou-Mikellidou et al. (2019) report that older workers may experience increased work stress when required to adapt to new technology, when presented with demanding work hours or when experiencing worries about future. Similarly, Hansson, Robson and Lima (2001) suggest that older workers have increased vulnerability to work stress due to physical, cognitive, or health status, need for training, and the inflexible demands of their work environment.

6.2 Job related factors

The nature of work has been identified as a factor contributing to the injury experience of older workers. For example, Peng and Chan (2019) reported that occupation was a significant moderator for the relationship between aging and work health and safety issues. Specifically, Peng and Chan (2019) identified that age increases the likelihood of injury in certain industries (including construction and manufacturing) than it does in other industries. Thus, the effects of aging on WHS may be felt more acutely in some industries (including construction).

Warr (1993) suggests that work activities can be classified into four categories, including:

- age-impaired activities
- age-counteracted activities
- age-neutral activities, and
- age-enhanced activities.

The classification was developed using the following criteria:

I. whether task demands are likely to exceed work capacity with increasing age; or
II. whether performance is likely to be enhanced by longer work experience (associated with age-related tenure).

Work activities are classified as age-impaired if task demands are likely to exceed work capacity with increasing age, and performance is unlikely to be enhanced by longer work experience. Warr (1993) posits that age will have a negative impact on workers' WHS if they occupy age-impaired jobs (Warr, 1993). Thus, understanding how construction job roles fit in terms of Warr's classification may be helpful in understanding the link between age and WHS in construction. However, the emphasis should be on designing jobs that are not age impairing so that workers can continue to work productively and safely as they age. In manual construction work the adoption of technologies that reduce the physical demands associated with performing work tasks is an important avenue for eliminating age-impaired jobs.

Work design has been identified as a factor contributing to older workers' work ability and work-related injury experience. This is because work design often does not take into account the natural biological and functional changes of individuals, which leads to the consequence that perceived work demands are higher for older workers than younger age groups (Costa & Sartori, 2007). The effects of job design on workers' WHS are likely to be particularly significant in heavy manual work, such as that involved in many construction occupations.

The time-related demands of work can also impact older workers. For example, Costa and Sartori (2007) examined the work ability of 1,449 Italian workers and reported that shift workers have a higher percentage of 'poor and moderate' work ability (as measured using the Work Ability Index) than day workers. They further identify a much higher significant effect of both age and sex on work ability in shift workers than in day workers. Specifically, WAI shows a significant decrease with increasing age among shift workers. This effect applies to male and female workers but was more evident among women shift workers.

Costa and Sartori (2007) further examined the effect of shift work arrangement on the relationship between age and work ability among male blue-collar workers (mainly represented by construction workers). They examined the effects of three shift arrangements:

1. Day workers: working from 7–8 a.m. to 4–5 p.m. on week days,
2. Semi-continuous three-shift workers, working morning (6a.m to 2.00p.m.), afternoon (2.00p.m. to 10.00p.m.) or night (10.00p.m. to 6:00 a.m.) shifts, from Monday to Saturday morning, on a weekly rotation, and
3. Continuous three-shift workers, working the same three shifts, but on a continuous (every seven days) and backward rotating shift system. For example, a worker:

    - works two morning shifts, two afternoon shifts, and three night shifts in the first seven days followed by a break
    - then works two morning shifts, three afternoon shifts and two night shifts in the second seven days followed by a break
    - works three morning shifts, two afternoon shifts and two night shifts in the third seven days.

A higher negative association between age and work ability was observed in both continuous and semi-continuous shift workers than was seen in day workers (Costa & Sartori, 2007). In particular, comparing the groups aged between 46-55 and those aged 55 and over, the decline in work ability with age is the highest for semi-continuous three-shift workers, followed by continuous three-shift workers, and the least for day workers.

Tuomi, Huuhtanen, Nykyri and Ilmarinen (2001) identify job-related factors that have an impact on older workers' work ability, including:

- work demands and facets of the work environment, such as poor work postures, low quality work tools and rooms, an inability to take rest and recovery breaks during work, and a poor physical work environment or climate
- aspects of work organisation and the work community, such as poor management and lack of freedom, uninspiring work, and dissatisfaction with working time arrangements, and
- a requirement for the maintenance of work-related skills, such as job retraining and updating skills, possibilities for development and influence at work.

Varianou-Mikellidou, Boustras, Dimopoulos et al. (2019) suggest that poor ergonomic conditions in the workplace, especially in physically demanding jobs, such as construction work, are key

contributing factors to older workers' experience of work-related musculoskeletal disorders (MSDs).

6.3 Organisational/social/environmental factors

Older workers' health and safety can also be affected by the social context of aging. For example, age stereotypes, age discrimination, and the organisational age climate are all believed to negatively impact older workers (Truxillo, Cadiz & Hammer 2015).

Age stereotypes are beliefs and expectations about employees that are related to the age of employees, irrespective of actual job performance (Hamilton & Sherman, 1994; cited in Posthuma & Campion, 2009). They are judgements made about employees based on their age rather than based on actual knowledge, skills, and capabilities. Age stereotypes can lead to unlawful age discrimination behaviour in the workplace. Posthuma and Campion (2009) identified a few common stereotypes concerning older workers, including that they:

- demonstrate poorer job performance
- are resistant to change
- have a lower ability to learn
- are likely to have shorter job tenure (when taking new employment), and
- are more costly.

However, in a meta-analysis, Ng and Feldman (2012) reported that these age stereotypes are not empirically supported. Notwithstanding the lack of evidence for them, age stereotypes are known to influence decisions about the allocation of resources and support to employees. For example, older workers may be given restricted or differential access to WHS and other work-related training due to the erroneous belief that older workers are less ready to accept new technology, less adaptable to change, less able to learn new ideas, and less interested in training (Bohle, Pitts & Quinlan, 2010). Johnson, Mermin and Resseger (2011) reports that older workers (aged 55 and over) receive less formal training from their employers and obtain less intensive instruction than their younger counterparts because employers think older workers are slow to learn new skills and fear that the training cost will not be recouped via learning and improved performance (Johnson et al. 2011). These age-based decisions, driven by stereotypes, constitute age discrimination, i.e. decisions made about older worker are different from those made about younger workers (Truxillo, Cadiz & Hammer, 2015).

The potential for discriminatory behaviour has an impact on the way that older workers interact with employers in relation to health and safety-related issues. For example, Drake, Haslam and Haslam (2017) interviewed UK employers to understand concerns regarding the aging force. One key theme that emerged from these interviews was the poor reporting culture and the consequent 'hidden' health problems experienced by older workers. Specifically, older workers were reported to be less likely to disclose information about health-related problems due to fear of discrimination. In one case, Drake et al. (2017) report that a worker was overlooked for promotion after advising his manager about a degenerative knee condition. Older workers were also unwilling to self-report taking medication that could have safety-relevant side-effects (e.g. drowsiness, dizziness and inability to concentrate) – even when they were involved in operating

machinery or vehicles – because they feared they would be discriminated against. Older workers reported:

- they have witnessed colleagues, who previously reported health issues, either being "sacked" or made redundant
- they do not trust their managers and feared breach of confidentiality and potential ridicule from other workers, and
- they experience a lack of respect from younger managers and feel a 'loss of dignity' in relation to the way others perceive their work capacity and performance (Drake et al., 2017).

Older employees also believed all employees, but particularly supervisors and managers, should receive age awareness training (Drake et al., 2017). Such training may provide information about:

- the challenges that older workers face in the workplace, and
- measures that organisations can possibly take to better manage and support the older workforce.

Older workers are also more likely to be engaged in contingent (precarious) work and perceive high job insecurity, which is closely associated with poor WHS outcomes (Bohle, Pitts & Quinlan, 2010). Job insecurity has been found to be related to decreased safety motivation and unsafe behaviour, which is, in turn, linked to a higher incidence of workplace injuries and accidents (Probst & Brubaker, 2001).

Part 7: Intervention for injury reduction among older workers

7.1 Incorporating age management in work health and safety (WHS) management system

Age management refers to the consideration of “age related factors…in daily management, including work arrangements and individual work tasks, so that everybody, regardless of age, feels empowered in reaching [their] own and corporate goals” (Ilmarinen, 2012; pp. 2). By recognising that age-related physiological and psychological changes have implications for the management of WHS, Varianou-Mikellidou et al. (2019) argue that an age-sensitive risk assessment, which considers workforce diversity and older workers’ needs, should be included in organisational WHS management processes.

Varianou-Mikellidou et al. (2019) proposed a P-D-C-A approach to incorporating age management into the WHS management system:

- Plan - policy should recognise ageing issues (recruitment, career development), structure of organisation and risk assessment should consider new risks due to ageing; plan knowledge transfer.
- Do - safety committees should include representatives from all age groups, training methods adapted to older workers, develop WHS culture without age discrimination; carry out knowledge transfer; use flexible working time practices.
- Check - health monitoring, measure performance; accident investigation (consider age in these); check whether age-related plans are also carried out.
- Act - review performance, lessons learned, adaptation measures (flexible working time, job rotation, adjustment of the workplace with e.g. use of ergonomic tools); strive for continuous improvement.

Varianou-Mikellidou et al. (2019) suggest that the WAI be used as a supporting tool to this approach to WHS management. This would allow factors that improve the work ability of older workers to be systematically identified and addressed.

7.2 Working environment and working conditions

Costa and Sartori (2007) proposed some specific recommendations in relation to flexible work time and health promotion that can be considered for ageing workers, including:

- consider possible limitation or abstention from night work after 45–50 years of age
- give priority to transfer to day work
- let workers’ choose their preferred shifts (e.g. morning shifts)
- reduce workloads if practicable
- shorten working hours and/or increase rest periods

- arrange more frequent health checks
- give proper counselling and training on the best coping strategies concerning sleep, and
- provide sufficient time and support to promote diet, stress management, and regular exercise.

McMahan and Phillips (1999; cited in Kowalski-Trakofler, Steiner & Schwerha, 2005) made three recommendations in relation to ergonomic work design that can be implemented by employers to combat work-related MSDs in older workers. These are:

1. Reduce extreme joint movement - keep motions within acceptable range of motion, use distinct textures and shape for controls, minimize twisting and reaching.
2. Reduce excessive force - opting for mechanical assist devices, use padding to reduce pressures, keep cutting edges sharp.
3. Reduce highly repetitive tasks - use power tools, job rotation, variety work.

Lingard, Raj, Lythgo, Troynikov and Fitzgerald (2019) report how the use of ergonomically designed tools for steel-fixing, a manual construction task, can significantly reduce the risk of musculoskeletal injury to the wrist and back.

Following a series of focus groups with older workers engaged in the manufacturing sector, Drake et al. (2017) report the following suggestions were made by workers in regard to things that support WHS and work ability including:

- fairer/consistent actions/support
- a policy on age that is communicated to everyone
- flexible working or job sharing options
- health checks and inclusion of capability questions during any personal development reviews with supervisors
- environmental improvements, e.g. improved lighting, flooring etc
- age awareness training for managers
- confidential access to occupational health advice
- options to change jobs or work in different ways
- options to change shift times or patterns
- more frequent rest breaks
- improved succession planning
- person/equipment/job profiling as part of risk assessment processes
- physical fitness programs, facilities or supports
- focus on removing time pressures/work overload
- ensuring an age-balanced workforce
- job rotation
- better rest facilities/quiet areas
- discussion groups for older workers to identify their specific needs
- training opportunities for older workers, and
- processes to capture and share knowledge and experience that is held by older workers.

Griffiths, Knight and Mahudin (2009) made a list of recommendations that aim to make the work environment more positive and to reduce work-related stress and injury for older workers. These included:

- control over work
  - give older workers more control over how they do their work
  - give older works the choice of engaging with the level and type of work they prefer including any involvement in shift work
  - allow older workers control over the pace of work, and
  - allow older workers more control over work-rest schedules.
- job demands
  - work tasks and demands should be adapted to be age-appropriate
  - allow older shift workers to work day shifts rather than night or afternoon shift, and
  - reduce the need for overtime.
- recognition at work
  - recognise the contribution of older workers
- working hours and flexibility
  - increase the flexibility of work arrangements
  - allow more flexible task organisation
  - allow extra time for mental and physical recovery, and
  - recognise the need for older workers to balance work and family life.
- social support
  - improve management understanding of ageing in the context of work, and
  - encourage supportive relationships between the managers and older workers.

7.3 Improve the context of work for older workers

Griffiths et al. (2009) also made recommendations for improving workplace culture and context so that older workers are better supported. Suggestions include:

- organisational culture
  - promote an age-aware and age-tolerant organisational culture, and
  - promote the unacceptability of both direct and indirect age discrimination
- education and training
  - educate managers and workers about aging and its implications for work and health
  - challenge stereotypes about age in the workplace, and

  - continue to offer job training to older workers, ensuring that training methods are appropriate.

- health promotion
  - encourage and support older workers engaging in physical activity and relaxation, and
  - conduct regular work ability checks and discuss supportive development programs.

7.4 Recommendations for future intervention development

Truxillo, Cadiz and Hammer (2015) put forward a number of recommendations for developing interventions and practices that can be used to support older workers and an age-diverse workforce. Those recommendations are listed in Table 7.1:

Table 7.1: Recommendations for age-related workplace interventions

Intervention category	Examples
Selection, optimisation, and compensation (SOC) training programs	• Training for older workers on how to best select skills and tasks that fit their abilities and interests • Organisational reflection as to the limits regarding what tasks might be off-loaded by older workers
Work redesign	• Increased autonomy and skill variety • Decreased task variety • Support older workers in crafting their jobs to fit their needs with cooperation from supervisors and co-workers • Increase older workers' intrinsic motivation such as mentoring young workers
Increasing positive relations between groups	• Positive intergenerational exposure • Team interventions • Improved age diversity climate through training of supervisors and teams • Leadership training for supervisors to deal with age differences • Reduction of negative stereotypes (explicit and implicit)
Age-supportive human resources (HR) practices	• Interventions to allow flexible human resource (HR) practices for different age groups • Emphasis on different HR bundles for different age groups
Work–life supportive policies	• Flexible work arrangements • Part-time work • Eldercare support
Training practices for older workers	• Additional time • Smaller groups • Self-paced learning • Emphasis on learning goal orientation • Error management training (allow participants to make mistakes in training)

Intervention category	Examples
Training for leaders/supervisors to support worker safety and health	• Training for supervisors to provide improved leadership and employee support • Training for older workers to support and mentor younger colleagues regarding safety
Ergonomic interventions	• Redesign of physical aspects of jobs • Use of technology to support older workers
Health promotion	• Interventions to increase physical activity and intellectual activity and improve nutrition
Helping workers throughout the life span	• Career management interventions
Total Worker Health approaches	• Comprehensive interventions to reduce occupational hazards and improve health, safety, and well-being

Source: Truxillo, Cadiz and Hammer (2015).

Part 8: Construction industry characteristics and implications

Construction work is inherently dangerous, combining a constantly changing work environment with work at height, continuous movement of people, materials and vehicles, the use of power-driven machinery, plant and equipment and exposures to wide range of hazardous substances.

The construction industry has features that distinguish it from other industries and potentially exacerbate the WHS challenges for both young and older workers. These include:

- a complex system of multi-level sub-contracting
- project-based work
- precarious forms of employment
- a prevalence of small businesses, and
- a hyper-masculine work culture.

The multi-level sub-contracting system operates on a payment-by-results basis – that is, payment is based on the amount of work completed rather than the time spent on work (Mayhew & Quinlan, 1997; Wadick, 2010). This arrangement can drive subcontractors to work excessively long hours, take ‘shortcuts’ in relation to WHS, and continue working in spite of injury.

Construction work is undertaken by semi-autonomous (usually sub-contracted) work teams and projects are delivered in locations geographically separated from companies’ head offices. Thus, localised climates/cultures develop within projects and workgroups.

In the construction project environment, supervisors and co-workers have a stronger influence on WHS practices (through the formation of local climates) than the senior managers who establish formal WHS policies and practices (Lingard, Cooke & Blismas, 2012). Supervisors’ communication patterns and leadership styles are also linked to workgroup WHS climates (Lingard, Pirzadeh & Oswald, 2019). In this context, the influence of supervisors and co-workers on young workers’ WHS behaviour is likely to be greater in the construction industry than in other industrial sectors.

Many chronic health-risk factors are prevalent in construction work. The environmental conditions experienced by project-based construction workers are also reported to contribute to unhealthy behaviours and lifestyle factors. Long work hours are typical of project-based construction work, and work-family conflict and burnout levels are high compared to international norm scores (Lingard & Francis, 2004).

Australian construction workers have themselves attributed their high levels of alcohol use to working long hours (MacKenzie, 2008). Construction workers also state that long hours, insufficient recovery opportunities, and exhaustion, prevent them from participating in healthy lifestyle activities such as sport and physical exercise (Lingard, Francis & Turner, 2010). This inevitably has a negative impact on workers’ work ability as construction workers age.

Construction work is also physically and psychologically demanding. Musculoskeletal disorders (MSDs) are the most common work-related conditions in Australia and are associated with hazardous manual tasks and poorly designed work. Construction is a high risk industry for work-related MSDs (Hartmann and Fleischer, 2005; Latza et al., 2000; Schneider, 2001; Boschman et al., 2012). Further, construction workers suffering work-related MSDs are less likely to return to work and more likely to retire with a disability than workers in other occupations (Welch et al, 2009; Arndt et al. 2005).

In this context, re-designing work processes to reduce the risk of long term work disability is important to assist older construction workers to maintain their workforce participation, as well as to prevent the early onset of bodily pain, leading to long term health problems in young workers.

Part 9: Concluding observations

This report presents a summary of material relating to the WHS of young and older workers. The following points are made in conclusion:

- Most of the studies reported concerning young workers' WHS were conducted in countries of the European Union or North America. Few of the studies focused primarily on construction workers. Thus, the applicability of the findings to the Australian construction industry context is not known. It is important that the applicability of findings to the Australian context and the construction industry be carefully considered when designing strategies focused on addressing young workers' WHS in the Australian construction context.
- The majority of the intervention programs identified for protecting young workers' WHS focused on addressing individual level factors, such as enhancing young workers' skills and increasing young workers' safety voice. Our literature search produced few studies that report interventions targeting organisation or environmental factors contributing to young workers' poor WHS. Further, few intervention studies have been rigorously evaluated using strong and internally valid evaluation designs. Thus, the reported findings must be treated with some caution. The use of stronger evaluation strategies are encouraged in any future intervention activity.
- The research discovered thus far tends to attribute poor WHS outcomes of older workers to age-related physiological changes, decreased person-environment 'fit' and diminished work ability. Few studies have focused on the design of work or need to address issues of ergonomic and job design to support older workers. In the context of an ageing workforce and shortage of skilled labour experienced in the Australian construction industry, there is potentially value in encouraging the adoption (and/or development) of new technologies to reduce the need for heavy manual labour to reduce long term chronic injury in the construction workforce and maintain the active workforce participation of older workers.
- Lastly, the majority of recommendations for improving older workers' work ability and WHS are conceptual. There is very little information or evidence regarding the implementation of actual intervention programs. For example, it is widely acknowledged that work should be re-designed for older workers by considering flexible work arrangements, reducing workload, and addressing ergonomic aspects. However, there are few reported examples of these strategies being put into practice. Best practice case studies describing the practical implementation of strategies designed to improve work ability among older workers in the construction industry may be valuable, particularly if these are evaluated for their impact on cost, performance, employee retention and WHS outcomes.

Part 10: References

Ajslev, J., Dastjerdi, E. L., Dyreborg, J., Kines, P., Jeschke, K. C., Sundstrup, E., . . . Andersen, L. L. (2017). Safety climate and accidents at work: cross-sectional study among 15,000 workers of the general working population. *Safety science, 91*, 320-325.

Andersson, I.-M., Gunnarsson, K., Rosèn, G., & Moström Åberg, M. (2014). Knowledge and Experiences of Risks among Pupils in Vocational Education. *Safety and health at work*, 5(3), 140-146.

Arndt, V., Rothenbacher, D., Daniel, U., Zschenderlein, B., Schuberth, S., and Brenner, H. (2005). Construction work and risk of occupational disability: a ten year follow up of 14 474 male workers. *Occupational and Environmental Medicine*, 62(8), 559-566.

Australian Bureau of Statistics. (2016). Older workers finding more acceptance. Retrieved from https://www.abs.gov.au/AUSSTATS/abs@.nsf/mediareleasesbyCatalogue/AF302A921D62B018CA2581F000191700?OpenDocument

Bande, R., & López-Mourelo, E. (2015). The Impact of Worker's Age on the Consequences of Occupational Accidents: Empirical Evidence Using Spanish Data. [journal article]. *Journal of Labor Research*, 36(2), 129-174.

Barbeau, E. M., Li, Y., Calderon, P., Hartman, C., Quinn, M., Markkanen, P., Roelofs, C., Frazier, L., Levenstein, C. 2006. Results of a Union-based Smoking Cessation Intervention for Apprentice Iron Workers (United States). *Cancer Causes & Control*, 17(1), 53-61.

Beers, H. & Greaves, D., (2015). Employers' perceptions of the health and safety of young workers, Health and Safety Executive, HSE Books: London.

Bena, A., Giraudo, M., Leombruni, R., & Costa, G. (2013). Job tenure and work injuries: a multivariate analysis of the relation with previous experience and differences by age. *BMC Public Health*, *13*(1), 869.

Black, J. K., Balanos, G. M., & Whittaker, A. C. (2017). Resilience, work engagement and stress reactivity in a middle-aged manual worker population. *International Journal of Psychophysiology, 116*, 9-15.

Blok, M., & De Looze, M. (2011). What is the evidence for less shift work tolerance in older workers? Ergonomics, 54(3), 221-232.

Bohle, P., Pitts, C., & Quinlan, M. (2010). Time to call it quits? The safety and health of older workers. *International Journal of Health Services*, 40(1), 23-41.

Boschman, J. S., Van der Molen, H. F., Sluiter, J. K., and Frings-Dresen, M. H. W. (2012). Musculoskeletal disorders among construction workers: a one-year follow-up study. *BMC Musculoskeletal Disorders*, 13(1), p.1.

Breslin, F. C., Day, D., Tompa, E., Irvin, E., Bhattacharyya, S., Clarke, J., & Wang, A. (2007). Non-agricultural work injuries among youth: a systematic review. *American Journal of Preventive Medicine*, *32*(2), 151-162.

Breslin, C., Koehoorn, M., Smith, P., & Manno, M. (2003). Age related differences in work injuries and permanent impairment: a comparison of workers' compensation claims among adolescents, young adults, and adults. *Occupational and Environmental Medicine*, 60(9), E10.

Breslin, F. C., Morassaei, S., Wood, M., & Mustard, C. A. (2011). Assessing occupational health and safety of young workers who use youth employment centers. *American Journal of Industrial Medicine*, *54*(4), 325-337.

Breslin, F. C., Pole, J. D., Tompa, E., Amick III, B. C., Smith, P., & Johnson, S. H. (2007). Antecedents of work disability absence among young people: A prospective study. *Annals of Epidemiology*, *17*(10), 814-820.

Breslin, F. C., Polzer, J., MacEachen, E., Morrongiello, B., & Shannon, H. (2007). Workplace injury or “part of the job”?: Towards a gendered understanding of injuries and complaints among young workers. *Social Science & Medicine*, *64*(4), 782-793.

Breslin, F. C., Pole, J. D., Tompa, E., Amick III, B. C., Smith, P., & Johnson, S. H. (2007). Antecedents of work disability absence among young people: A prospective study. *Annals of Epidemiology*, *17*(10), 814-820.

Breslin, F. C., & Smith, P. (2005). Age-related differences in work injuries: A multivariate, population-based study. *American Journal of Industrial Medicine*, *48*(1), 50-56.

Breslin, F. C. & Smith, P, (2006). Trial by fire: a multivariate examination of the relation between job tenure and work injuries. *Occupational and environmental medicine*, 63(1), 27-32.

Carstensen, L. L. (1991). Selectivity theory: Social activity in life-span context. *Annual review of gerontology and geriatrics, 11*(1), 195-217.

Centers for Disease Control and Prevention (2010). Occupational injuries and deaths among younger workers: United States, 1998-2007. *Morbidity and Mortality Weekly Report*, 59 (15), 449-455.

Chau, N., Wild, P., Dehaene, D., Benamghar, L., Mur, J. M., & Touron, C. (2010). Roles of age, length of service and job in work-related injury: a prospective study of 446 120 person-years in railway workers. *Occupational and Environmental Medicine*, *67*(3), 147-153.

Chin, P., DeLuca, C., Poth, C., Chadwick, I., Hutchinson, N., & Munby, H. (2010). Enabling youth to advocate for workplace safety. *Safety Science*, *48*(5), 570-579.

Choi, S. D. (2015). Aging Workers and Trade-Related Injuries in the US Construction Industry. *Safety and Health at Work*, 6(2), 151-155.

Corney, T., & du Plessis, K. (2010). Apprentices' mentoring relationships: The role of 'significant others' and supportive relationships across the work-life domains. *Youth Studies Australia, 29*(3), 18.

Costa, G., & Sartori, S. (2007). Ageing, working hours and work ability. *Ergonomics*, 50(11), 1914-1930.

Crawford, J. O., Davis, A., Cowie, H., Dixon, K., Mikkelsen, S. H., Bongers, P. M., . . . Dupont, C. (2016). *The ageing workforce: implications for occupational safety and health: A research review*. Luxembourg: European Agency for Safety and Health at Work.

Crawford, J. O., Graveling, R. A., Cowie, H. A., & Dixon, K. (2010). The health safety and health promotion needs of older workers. *Occupational Medicine*, 60(3), 184-192.

Dasinger, L. K., Krause, N., Deegan, L. J., Brand, R. J., & Rudolph, L. (2000). Physical Workplace Factors and Return to Work After Compensated Low Back Injury: A Disability Phase-Specific Analysis. *Journal of Occupational and Environmental Medicine*, 42(3), 323-333.

De Zwart, B. C. H., Frings-Dresen, M. H. W., & Van Duivenbooden, J. C. (1999). Senior workers in the Dutch construction industry: a search for age-related work and health issues. *Experimental aging research*, 25(4), 385-391.

Delp, L., Brown, M., & Domenzain, A. (2005). Fostering youth leadership to address workplace and community environmental health issues: A university-school-community partnership. *Health Promotion Practice*, 6(3), 270-285.

Djurkovic, N., McCormack, D., & Casimir, G. (2005). The behavioral reactions of victims to different types of workplace bullying. *International Journal of Organization Theory & Behavior*, 8(4), 439-460.

Dowling, N., Clark, D., Memery, L., & Corney, T. (2005). Australian apprentices and gambling. *Youth Studies Australia*, 24(3), 17.

Drake, C., Haslam, R., & Haslam, C. (2017). Facilitators and barriers to the protection and promotion of the health and safety of older workers (vol 15, pg 4, 2017). *Policy and Practice in Health and Safety, 15*(1), 84-84.

du Plessis, K., & Corney, T. (2011a). Construction industry apprentices' substance use: A survey of prevalence rates, reasons for use, and regional and age differences. *Youth Studies Australia, 30*(4), 40.

du Plessis, K., & Corney, T. (2011b). Trust, respect and friendship: the key attributes of significant others in the lives of young working men. *Youth Studies Australia, 30*(1), 17.

du Plessis, K., Corney, T., & Burnside, L. (2013). Harmful Drinking and Experiences of Alcohol-Related Violence in Australian Male Construction Industry Apprentices. American Journal of Men's Health, 7(5), 423-426.

du Plessis, K., & Green, E. (2013). Financial awareness education with apprentices in the Australian construction industry: Program evaluation. *International Journal of Training Research*, 11(3), 225-233.

Ebner, N. C., Freund, A. M., & Baltes, P. B. (2006). Developmental changes in personal goal orientation from young to late adulthood: from striving for gains to maintenance and prevention of losses. *Psychology and aging, 21*(4), 664.

Ehsani, J. P., McNeilly, B., Ibrahim, J. E., & Ozanne-Smith, J. (2013). Work-related fatal injury among young persons in Australia, July 2000–June 2007. *Safety Science, 57*, 14-18.

European Agency for Safety and Health at Work (2007), OSH in the figures: Young workers – facts and figures: Exposure to risks and health effects, https://osha.europa.eu/en/tools-and-publications/publications/reports/7606507, accessed 4 July 2019.

European Agency for Safety and Health at Work (2013), Involving young workers in OSH, https://osha.europa.eu/en/tools-and-publications/publications/e-facts/e-fact-78-involving-young-workers-in-osh/view, accessed 5 July 2019.

Grandjean, C. K., McMullen, P. C., Miller, K. P., Howie, W. O., Ryan, K., Myers, A., & Dutton, R. (2006). Severe occupational injuries among older workers: demographic factors, time of injury, place and mechanism of injury, length of stay, and cost data. *Nursing & Health Sciences*, 8(2), 103-107.

Graves, J. M., Sears, J. M., Vavilala, M. S., & Rivara, F. P. (2013). The burden of traumatic brain injury among adolescent and young adult workers in Washington State. *Journal of Safety Research*, *45*, 133-139.

Griffiths, A., Knight, A., & Mahudin, D. N. M. (2009). *Ageing, work-related stress and health*. London: The Age and Employment Network.

Hansson, R. O., Robson, S. M., & Limas, M. J. (2001). Stress and coping among older workers. *Work*, 17(3), 247-256.

Hartmann, B. and Fleischer, A. G., 2005. Physical load exposure at construction sites. *Scandinavian Journal of Work, Environment and Health*, 31 (supplement 2),88-95.

Hasle, P., & Limborg, H. J. (2006). A review of the literature on preventive occupational health and safety activities in small enterprises. *Industrial Health*, 44(1), 6-12.

Higgins, D. N., Tierney, J., & Hanrahan, L. (2002). Preventing young worker fatalities: the fatality assessment and control evaluation (FACE) program. *Aaohn Journal, 50*(11), 508-514.

Holte, K. A., & Kjestveit, K. (2012). Young workers in the construction industry and initial OSH-training when entering work life. *Work*, 41(Supplement 1), 4137-4141.

Holte, K. A., Kjestveit, K., & Lipscomb, H. J. (2015). Company size and differences in injury prevalence among apprentices in building and construction in Norway. *Safety Science*, 71, 205-212.

Hoonakker, P., & van Duivenbooden, C. (2010). Monitoring working conditions and health of older workers in Dutch construction industry. *American Journal of Industrial Medicine, 53*(6), 641-653.

Iacuone, D. (2005). Real men are tough guys': hegemonic masculinity and safety in the construction industry. *The Journal of Men's Studies*, 13(2), pp. 247-66.

Ilmarinen, J. (2012). *Promoting active ageing in the workplace*. European Agency for Safety and Health at Work.

Johnson, R. W., Mermin, G. B., & Resseger, M. (2011). Job demands and work ability at older ages. *Journal of aging & social policy, 23*(2), 101-118.

Karlsson, J. C. (2014). Factoids of working life. *Nordic Journal of Working Life Studies*, *4*(4), 5-6.

Kowalski-Trakofler, K. M., Steiner, L. J., & Schwerha, D. J. (2005). Safety considerations for the aging workforce. *Safety Science*, 43(10), 779-793.

Kincl, L. D., Anton, D., Hess, J. A., & Weeks, D. L. (2016). Safety voice for ergonomics (SAVE) project: protocol for a workplace cluster-randomized controlled trial to reduce musculoskeletal disorders in masonry apprentices. *BMC Public Health*, *16*(1), 362.

Kotler, P., Roberto, N. & Lee, N. (2002). *Social marketing: Improving the quality of life*. Thousand Oaks, CA: Sage Publications.

Laberge, M., & Ledoux, E. (2011). Occupational health and safety issues affecting young workers: A literature review. *Work, 39*(3), 215-232.

Laberge, M., MacEachen, E., & Calvet, B. (2014). Why are occupational health and safety training approaches not effective? Understanding young worker learning processes using an ergonomic lens. *Safety Science*, *68*, 250-257.

Lander, L., Sorock, G., Stentz, T. L., Smith, L. M., Mittleman, M., & Perry, M. J. (2012). A case-crossover study of laceration injuries in pork processing. *Occup Environ Med, 69*(6), 410-416.

Latza, U., Karmaus, W., Stürmer, T., Steiner, M., Neth, A., and Rehder, U. (2000). Cohort study of occupational risk factors of low back pain in construction workers. *Occupational and Environmental Medicine*, 57(1), 28-34.

Lavack, A. M., Magnuson, S. L., Deshpande, S., Basil, D. Z., Basil, M. D., & Mintz, J. J. H. (2008). Enhancing occupational health and safety in young workers: the role of social marketing. *International Journal of Nonprofit and Voluntary Sector Marketing*, 13(3), 193-204.

Lingard, H., Cooke, T., & Blismas, N. (2012). Do perceptions of supervisors' safety responses mediate the relationship between perceptions of the organizational safety climate and incident rates in the construction supply chain?. *Journal of Construction Engineering and Management*, 138(2), 234-241.

Lingard, H., & Francis, V. (2004). The work-life experiences of office and site-based employees in the Australian construction industry. *Construction Management and Economics, 22*(9), 991-1002.

Lingard, H. & Francis, V., (2006), Does a supportive work environment moderate the relationship between work-family conflict and burnout among construction professionals? *Construction Management and Economics*, 24(2), 185-196.

Lingard, H., Francis, V. & Turner, M., (2010), The rhythms of project life: A longitudinal analysis of work-life experiences in construction. *Construction Management and Economics*, 28(10), 1085-1098.

Lingard, H., Harley, J., Zhang, R. & Ryan, G., (2017), Work Health and Safety Culture in the Australian Capital Territory, RMIT University, Melbourne.

Lingard, H., Pirzadeh, P., & Oswald, D. (2019). Talking Safety: Health and Safety Communication and Safety Climate in Subcontracted Construction Workgroups. *Journal of Construction Engineering and Management*, 145(5), 04019029.

Lingard, H., Raj, I. S., Lythgo, N., Troynikov, O., & Fitzgerald, C. (2019). The impact of tool selection on back and wrist injury risk in tying steel reinforcement bars: a single case experiment. *Construction Economics and Building*, *19*(1), ID-6279.

Loudoun, R. J. (2010). Injuries sustained by young males in construction during day and night work. *Construction Management and Economics, 28*(12), 1313-1320.

Loughlin, C. & Frone, M. (2004). *Young workers occupational safety*. In Julian Barling & Michael R. Frone (Eds), The Psychology of Workplace Safety. Washington: APA.107-125.

MacKenzie, S. (2008). A close look at work and life balance/well-being in the Victorian commercial building and construction sector. Melbourne, Australia: Building Industry Consultative Council.

Mardis, AL & Pratt, SG 2003, 'Nonfatal injuries to young workers in the retail trades and services industries in 1998', *Journal of Occupational and Environmental Medicine*, vol. 45, no. 3, pp. 316-323.

Mates in Construction. (2016). *Suicide in the Construction Industry*. Retrieved from http://micaus.bpndw46jvgfycmdxu.maxcdn-edge.com/wp-content/uploads/2015/11/MIC-Annual-suicide-report-MIC-and-Deakin-University.pdf

Mayhew, C. & Quinlan, M. (1997). Subcontracting and occupational health and safety in the residential building industry. *Industrial Relations Journal*, 28(3), 192-205.

Merlino, L. A., Rosecrance, J. C., Anton, D., & Cook, T. M. (2003). Symptoms of musculoskeletal disorders among apprentice construction workers. *Applied Occupational and Environmental Hygiene,* 18, 57-64.

McCormack, D., Djurkovic, N., & Casimir, G. (2013). Workplace bullying: the experiences of building and construction apprentices. *Asia Pacific Journal of Human Resources*, 51(4), 406-420.

Mujuru, P., & Mutambudzi, M. (2007). Injuries and seasonal risks among young workers in West Virginia—a 10-year retrospective descriptive analysis. *Aaohn Journal, 55*(9), 381-387.

Ng, T. W., & Feldman, D. C. (2008). The relationship of age to ten dimensions of job performance. *Journal of applied psychology*, 93(2), 392.

Ng, T. W., & Feldman, D. C. (2012). Evaluating six common stereotypes about older workers with meta-analytical data. *Personnel psychology*, 65(4), 821-858.

Ng, T. W. H., & Feldman, D. C. (2013). How do within-person changes due to aging affect job performance? *Journal of Vocational Behavior*, 83(3), 500.

Nielsen, M. L. (2012). Adapting 'the normal'–examining relations between youth, risk and accidents at work. *Nordic journal of working life studies, 2*(2), 71-85.

Nielsen, M. L., Dyreborg, J., Kines, P., Nielsen, K. J., & Rasmussen, K. (2013). Exploring and expanding the category of young workers' according to situated ways of doing risk and safety-a case study in the retail industry. *Nordic Journal of Working Life Studies*, 3(3), 219.

Nielsen, M. L., Görlich, A., Grytnes, R., & Dyreborg, J. (2017). Without a safety net: precarization among young Danish employees. *Nordic Journal of Working Life Studies*, 7(3).3-22.

Nykänen, M., Sund, R., & Vuori, J. (2018). Enhancing safety competencies of young adults. A randomized field trial (RCT). *Journal of Safety Research*, *67*, 45-56.

Okun, A. H., Guerin, R. J., & Schulte, P. A. (2016). Foundational workplace safety and health competencies for the emerging workforce. *Journal of Safety Research*, *59*, 43-51.

Pek, S., Turner, N., Tucker, S., Kelloway, E. K., & Morrish, J. (2017). Injunctive safety norms, young worker risk-taking behaviors, and workplace injuries. *Accident Analysis & Prevention*, *106*, 202-210.

Peng, L., & Chan, A. H. S. (2019). A meta-analysis of the relationship between ageing and occupational safety and health. *Safety Science, 112*, 162-172.

Pidd, K., Duraisingam, V., Roche, A., & Trifonoff, A. (2017). Young construction workers: substance use, mental health, and workplace psychosocial factors. *Advances in Dual Diagnosis, 10*(4), 155-168.

Posthuma, R. A., & Campion, M. A. (2009). Age stereotypes in the workplace: Common stereotypes, moderators, and future research directions. *Journal of management*, 35(1), 158-188.

Probst, T. M., & Brubaker, T. L. (2001). The effects of job insecurity on employee safety outcomes: Cross-sectional and longitudinal explorations. *Journal of occupational health psychology*, 6(2), 139

Rauscher, K. J., & Myers, D. J. (2016). Occupational fatalities among young workers in the United States: 2001–2012. *American Journal of Industrial Medicine*, *59*(6), 445-452.

Rogers, E., & Wiatrowksi, W. J. (2005). Injuries, illnesses, and fatalities among older workers. *Monthly Lab. Rev.*, 128, 24.

Rohlman, D. S., Parish, M., Elliot, D. L., Montgomery, D., & Hanson, G. (2013). Characterizing the needs of a young working population: making the case for total worker health in an emerging workforce. *Journal of Occupational and Environmental Medicine*, *55*, S69-S72.

Runyan, C. W., Vladutiu, C. J., Rauscher, K. J., & Schulman, M. (2008). Teen workers' exposures to occupational hazards and use of personal protective equipment. *American Journal of Industrial Medicine*, *51*(10), 735-740.

Safe Work Australia, (2015), *Exposure to multiple hazards among Australian workers*. Canberra: Safe Work Australia.

Sámano-Ríos, M. L., Ijaz, S., Ruotsalainen, J., Breslin, F. C., Gummesson, K., & Verbeek, J. (2019). Occupational safety and health interventions to protect young workers from hazardous work – A scoping review. *Safety Science*, 113, 389-403.

Salminen, S. (2004). Have young workers more injuries than older ones? An international literature review. *Journal of Safety Research*, *35*(5), 513-521.

Schneider, S. P. (2001). Musculoskeletal injuries in construction: a review of the literature. *Applied Occupational and Environmental Hygiene*, 16(11), 1056-1064.

Smith, P, Bielecky, A, Mustard, C, Beaton, D, Hogg-Johnson, S, Ibrahim, S, Koehoorn, M, McLeod, C, Saunders, R & Scott-Marshall, H 2013, 'The relationship between age and work injury in British Columbia: examining differences across time and nature of injury', *Journal of occupational health*, vol., pp. 12-0219-OA.

Tepas, D. I., & Barnes-Farrell, J. L. (2002). Is Worker Age a Simple Demographic Variable? *Experimental Aging Research, 28*(1), 1-5.

Truxillo, D. M., Cadiz, D. M., & Hammer, L. B. (2015). Supporting the aging workforce: A review and recommendations for workplace intervention research. *Annu. Rev. Organ. Psychol. Organ. Behav.*, 2(1), 351-381.

Tucker, S., & Turner, N. (2013). Waiting for safety: Responses by young Canadian workers to unsafe work. *Journal of Safety Research*, *45*, 103-110.

Tuomi, K., Huuhtanen, P., Nykyri, E., & Ilmarinen, J. (2001). Promotion of work ability, the quality of work and retirement. *Occupational Medicine*, 51(5), 318-324.

Turner, N., Tucker, S., & Kelloway, E. K. (2015). Prevalence and demographic differences in microaccidents and safety behaviors among young workers in Canada. *Journal of Safety Research*, *53*, 39-43.

Varianou-Mikellidou, C., Boustras, G., Dimopoulos, C., Wybo, J.-L., Guldenmund, F. W., Nicolaidou, O., & Anyfantis, I. (2019). Occupational health and safety management in the context of an ageing workforce. *Safety Science, 116*, 231-244.

Wadick, P. (2010) Safety culture among subcontractors in the domestic housing construction industry. *Structural Survey*, 28(2), 108-120.

Walters, J. K., A. Christensen, K., K. Green, M., E. Karam, L., & D. Kincl, L. (2010). Occupational injuries to oregon workers 24 years and younger: An analysis of workers' compensation claims, 2000–2007. *American journal of industrial medicine, 53*(10), 984-994.

Ward, J. A., de Castro, A. B., Tsai, J. H.-C., Linker, D., Hildahl, L., & Miller, M. E. (2010). An Injury Prevention Strategy for Teen Restaurant Workers: Washington State's ProSafety Project. *AAOHN Journal*, 58(2), 57-65.

Warr, P. (1993). In what circumstances does job performance vary with ages? *The European Work and Organizational Psychologist, 3*(3), 237-249.

Welch, L., Haile, E., Boden, L. I., and Hunting, K. L. (2009). Musculoskeletal disorders among construction roofers—physical function and disability. *Scandinavian Journal of Work, Environment & Health*, 35(1), pp. 56-63.

Westaby, J.D. and Lowe, J.K. (2005), Risk-taking orientation and injury among youth workers: examining the social influence of supervisors, coworkers and parents, *Journal of Applied Psychology*, 90, 1027-35.

Zierold, K. M. (2017). Youth doing dangerous tasks: Supervision matters. *American Journal of Industrial Medicine*, *60*(9), 789-797.