Work-related Musculoskeletal Disorders in Australia

2019

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The latest research on work-related musculoskeletal disorders

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Important Notice

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Executive Summary

Musculoskeletal disorders include a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves and supporting blood vessels (Punnett & Wegman, 2004). Despite significant declines in the number of compensation claims in recent years, work-related musculoskeletal disorders (WMSDs) still account for the majority of workers' compensation costs. The mid-term review of the *Australian Work Health and Safety Strategy 2012–2022* (Safe Work Australia, 2018b) highlighted the need for greater improvements across the priority disorders, including WMSDs, over the duration of the strategy.

This report provides an overview of the current evidence base on WMSD aetiology, impacts and intervention. Key workplace hazards are outlined and a range of models to support the complex aetiology of WMSDs are presented. Relevant data on WMSDs are presented, with discussion of the relative strengths and weaknesses of these data, and recommendations are made for improved surveillance. The final sections present key aspects of WMSD intervention literature and perspectives from 20 stakeholders in Australia. The report concludes with some key recommendations for improving current WMSD prevention strategies.

For the general population, musculoskeletal disorders are highly prevalent in the Australian population; in 2014–15 they affected 6.9 million people (Australian Institute of Health and Welfare, 2017). In 2011, MSDs contributed 12 per cent of Australia's total burden of disease and injury and 23 per cent of the non-fatal burden, ranking second after mental health and substance use disorders (Australian Institute of Health and Welfare, 2017), with substantial economic impacts at both societal and individual levels (Schofield et al., 2013). For Australia's workforce, WMSDs continue as the leading work health and safety (WHS) problem, both in frequency and cost which in 2012–13 totalled more than $24 billion (Safe Work Australia, 2015a).

As the population ages there is an increasing economic need, for both individuals and society, for later retirement (Myck, 2015; Oakman & Wells, 2016). Older workers are more prone to a range of chronic health conditions (Bevan, 2015), including WMSDs. Given the need for our increasingly ageing workforce to remain healthy and productive, implementation of more effective workplace risk management practices to reduce WMSD risk is increasingly urgent.

Substantial evidence supports the multifactorial nature of WMSD development, associating it with exposure to a range of physical and psychosocial workplace hazards. Whilst musculoskeletal disorders may result from a single event, more commonly they arise from cumulative exposure to one or more hazards over an extended period. However, a tendency exists to try and pinpoint the exact event which triggered the injury, in part driven by the workers' compensation systems which generally require identification and date of a 'causative incident'. In cases where WMSDs are related to cumulative exposure, this approach can lead to misdiagnosis or omission of the relevant workplace hazards, and then a subsequent development of controls that are not appropriately targeted.

WMSD compensation: 2015–16

The National Data Set for Compensation-based Statistics (NDS) identifies a total of almost 125,000 accepted workers' compensation claims for WMSDs in 2015–16. Of these 62,420 or 50 per cent were serious claims, meaning the worker had at least one claim-related week of absence from work. Serious claims for WMSD diseases and injuries comprised 58 per cent of all serious claims. The median time lost from WMSD injuries has increased from 5.0 to 5.2 since 2011–12.

While the overall rate of serious claims has been declining over time, compensation costs and ongoing issues with lost time both suggest that WMSD claims continue to be a serious challenge. The frequency rate of WMSDs is highest in those aged 45–64, at more than four serious injuries per million hours worked. Males have a higher frequency rate in all age groups and types of WMSD claims except the female 45–54 group for WMSD diseases.

WMSD interventions

Based on a review of the research literature and interviews with 20 key stakeholders (8 regulators, 9 consultants, 3 industry associations) in WMSD prevention, the use of comprehensive strategies to address all workplace hazards—physical and psychosocial—is limited. Most interventions for WMSD prevention are focused on changing an individual's behaviour or reducing task-specific hazards, with no consideration of the broader contextual factors which are associated with the complex aetiology of WMSDs.

A range of barriers to the effective implementation of interventions to prevent WMSDs were identified:

- a failure to adopt a 'systems' approach to risk management
- an inadequate adherence to the hierarchy of risk control

- a lack of management commitment, organisation culture and climate
- a lack of understanding of the importance of worker participation
- the role of legislation, codes of practice and related documents
- the role of competencies in WMSD risk management.

Future directions

WMSDs are a substantial problem and significant changes in practice are required to address this problem, including a shift in emphasis from single-focus strategies aimed at changing behaviour, such as lifting techniques, to more comprehensive approaches which take into account all aspects of an individual's work. Greater focus on a systems approach to intervention development will assist in this process.

The evidence to support a more holistic systems-based approach to managing WMSDs is substantial; however, greater translation of this evidence into every day risk management practice is required. Continuing with a linear, hazard-based approach to address the significant issue of WMSDs will not result in substantial reduction of the problem because it fails to take into account the complexity of the aetiology.

1 Introduction and Overview

Musculoskeletal disorders (MSDs) are highly prevalent in the Australian population; in 2014–15 they affected 6.9 million people (Australian Institute of Health and Welfare, 2017). In 2011, MSDs contributed 12 per cent of Australia's total burden of disease and injury and 23 per cent of the non-fatal burden, ranking second after mental health and substance use disorders (Australian Institute of Health and Welfare, 2017), with substantial economic impacts at both societal and individual levels (Schofield et al., 2013). The subset 'back pain and problems' contributed 31 per cent of Australia's MSD burden, and 17 per cent of such cases have been attributed to *occupational* exposures and hazards (Australian Institute of Health and Welfare, 2017). Previous research has estimated that "37 per cent of all back pain worldwide" is attributable to workplace hazards (Fingerhut et al., 2005). Such variation in estimates of work-relatedness is unsurprising, since key definitions and inclusion criteria are quite variable across surveillance systems (Lowe et al., 2016).

The economic burden of work-related musculoskeletal disorders (WMSDs) is significant and the impacts on individuals and society are extensive. Health care and compensation costs are substantial, along with loss of income and early retirement (Lahelma et al., 2012; van Rijn et al., 2014). The enormous burden of low back pain is highlighted in the 2012 Global Burden of Disease (GBD) Study, which ranks low back pain as the leading cause of physical disability, globally, ahead of 290 other conditions. It was estimated to be responsible for 83 million years lived with a disability. Years lived with a disability (YLD) are the number of incident cases, multiplied by the average duration of the condition (average number of years that the condition lasts until remission or death), multiplied by the disability weight (Buchbinder et al., 2013). This staggering figure provides some indication of the significant impact that musculoskeletal conditions such as low back pain have on individuals and society. Although the GBD figures include all back pain, including that from non-work-related causes, exposure to occupational hazards remains a major risk factor and one that requires attention to reduce this significant issue. Of course, this is only back pain and does not include other body regions, but it provides an indication of the scale of the WMSD problem.

For Australia's workforce, WMSDs continue as the leading work health and safety (WHS) problem, both in frequency and cost which in 2012–2013 totalled more than $24 billion (Safe Work Australia, 2015a). In the five years from 2009–10 to 2013–14, 60 per cent of serious workers' compensation claims were for WMSDs (Safe Work Australia, 2016b). The median time lost from work for serious WMSD claims increased by 35 per cent from 2000–01 to 2012–13, compared with 29 per cent for *all* serious claims (Safe Work Australia, 2016b). The *Australian Work Health & Safety Strategy 2012–2022* identifies WMSDs as the first of its six priority disorders (Safe Work Australia, 2018b).

Work is an important contributing factor to health (Waddell, 2006). People in good work are more likely to have better health than those who are not employed. Conversely, poor-quality jobs may be more harmful to health than being unemployed (Broom et al., 2006). The need for sustainable employment is critical as working lives are extended and the nature of work life shifts. The way we work is changing, the likelihood of having only a few employers over one's working life is low. Hours of work, employment and other work arrangements, and shift patterns have changed significantly over the past decade as a result of changes to communication, technology and the need to compete and collaborate within the international market. Additionally, many of us are working for longer than previous generations and this trajectory is expected to continue (Attorney-General's Department, 2010). This increased length of working life increases our exposure to workplace hazards—physical and psychosocial—linked with WMSDs.

As the population ages there is an increasing economic need, for both individuals and society, for later retirement (Myck, 2015; Oakman & Wells, 2016). Older workers are more prone to a range of chronic health conditions (Bevan, 2015), including WMSDs. Poor health is a significant predictor of premature retirement from the workforce (Lahelma et al., 2012; van Rijn et al., 2014). Once injured and off work, older workers take longer to return to work and are more likely to have additional periods away from work following their return (Berecki-Gisolf et al., 2012). Australia has no mandatory retirement age; access to the aged care pension is often considered a proxy, which is gradually rising along with increasing life expectancy. Most workers' compensation schemes have a general reference to weekly compensation ceasing at a time connected to 'retirement age' or the age at which a person would become entitled to receive the aged pension. However, all of these schemes have specific provisions that allow for weekly compensation to be paid to anyone who is injured after or approaching the nominal 'retirement age'; they would also be entitled to access all other compensation benefits such as medical expenses and permanent impairment payments. However, these entitlements vary across jurisdictions.

People in jobs with high levels of WMSD-related hazards have significantly greater age-related deterioration in their ability to continue working, compared with those in other jobs (Lahelma et al., 2012; Miranda et al., 2010). Given the need for our increasingly ageing workforce to remain healthy and productive, implementation of more effective workplace risk management practices to reduce WMSD risk is increasingly urgent.

Substantial evidence supports the importance of maintaining employment once injured, and that an early return to work is linked with better long-term outcomes (Hoefsmit et al., 2012). Pain is not a reliable indicator of whether someone should be working or not (Nicholas et al., 2011) but the costs associated with not working are substantial, both socially and economically. A high emphasis must be placed on the need to accommodate workers and facilitate a return to work without aggravation of their condition. This involves engagement with all key stakeholders—the worker, treatment providers and the workplace (Carroll et al., 2010; Cullen et al., 2018; Norlund et al., 2009)—to encourage sustainable participation of individuals in the workforce.

This report provides an overview of the current evidence base on WMSD aetiology, impacts and intervention. Key workplace hazards are outlined and a range of models to support the complex aetiology of WMSDs are presented. Currently available statistical data on WMSDs are presented along with a discussion of the relative strengths and weaknesses of the data, recommendations for improved data collection of surveillance data are provided. The final section of the report outlines key aspects of WMSD intervention literature, a discussion of the hierarchy of risk controls and results from interviews with 20 stakeholders on issues related to WMSD interventions in Australia. The report concludes with some key recommendations to improve the current prevention strategies for reduction of WMSDs.

Box 1: Highlights

Overview

- For Australia's workforce, WMSDs continue as the leading WHS problem, both in frequency and cost, which in 2012–2013 totalled more than $24 billion.
- MSDs may result from a single event, but more commonly arise from cumulative exposure to one or more hazards over an extended period (NHC, 2001); these data are not captured accurately in workers' compensation statistics.
- Systematic approaches to appropriate identification and management of all relevant hazards in the development of WMSDs are not being implemented in organisations.
- Priority focus is needed to provide appropriate workplace accommodations and facilitate a return to work without aggravation of their condition.

Workers' compensation landscape

- Most contemporary WMSD-related policy and regulation is informed by workers' compensation surveillance data. Workers' compensation eligibility varies between jurisdictions and is based on traditional work arrangements which usually exclude contingent workers.
- Body stressing, is the most commonly reported mechanism of injury for serious WMSD claims, arising from handling, lifting, carrying or putting down of objects; followed by slips, trips and falls.
- Repetitive movement, with 'low muscle loading', is a relatively uncommon mechanism in relation to the body stressing category.
- The most common agency for serious WMSD claims is 'non-powered hand tools, appliances and equipment' (hand tools, fastening, packing equipment, furniture, fittings, ladders, scaffolding, etc.).
- Compensation data has limited efficacy and reach; it only represents accepted serious claims which suggests the impact of WMSDs is considerably greater than what is reported.

Hierarchy of risk controls

- Risk control actions must be as high as is reasonably practicable, within the general hierarchy of risk control. According to this hierarchy, highest priority must be given to actions that eliminate or at least reduce the severity of a hazard, to be maximally effective. For example, changes to a worker's job design are considered more effective than administrative controls such as training.
- Issues arise with the use of the hierarchy of risk controls for WMSDs. Physical hazards of 'manual handling' work tasks are intrinsic to the physical performance of many work tasks, and it is not desirable to eliminate, or even necessarily to minimise, physical actions and energy expenditure. Much the same holds true for psychosocial hazards; both very high and very low workloads can be hazardous so the aim should be to optimise work load rather than minimise.

Interventions

- Most WMSD hazard identification methods do not take into account the full range of hazards associated with WMSD aetiology. Current methods focus on snapshots of the physical aspects of tasks and not the whole job. The identification of psychosocial hazards is largely absent.
- Substantial challenges exist in developing and measuring workplace interventions.

- Without leadership commitment to prioritisation of evidence-based solutions, change is considered unlikely to be successful.
- Organisations using a participative approach are more likely to implement successful interventions than those without such an approach.
- Managers vary in their 'stage of change' concerning knowledge and understanding of key requirements for effective WMSD risk management. Determining the stage at which an organisation is operating allows advice to be tailored so it is more likely to be effectively implemented.
- Training as a control method to reduce WMSD risk is not effective. It is more effective to provide training in how to identify hazards and risks to which workers might be exposed, and strategies to report and develop controls to address them.
- Interventions need to be multilevel or multimodal and target multiple hazards at once, across different systems levels.
- The significant and persistent problem of WMSDs underpins the need for a change to current approaches to WMSD prevention, to take into account the evidence on aetiology, systems thinking and implementation science, so that comprehensive strategies can be designed and implemented.

Box 2: Key Definitions

- ***Musculoskeletal disorders*** includes a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves and supporting blood vessels (Punnett & Wegman, 2004). A 'disorder' implies a condition with a multifactorial aetiology. WMSDs often develop from exposure to more than one workplace hazard and do not always fit neatly into an 'injury' or 'disease' category. This group of disorders includes the following: 'repetitive strain injuries', 'occupational overuse syndrome', 'back injury', 'osteoarthritis', 'backache', 'sciatica', 'slipped disc', 'carpal tunnel syndrome', 'tendinitis', and others.

  The model *Work Health and Safety Regulations* define musculoskeletal disorders as 'an injury to, or disease of, the musculoskeletal system, whether occurring suddenly or over time'. This definition does not include an injury caused by 'crushing, entrapment or cutting resulting principally from the mechanical operation of plant'.
- ***Hazards*** are considered the source of potential harm or injury (International Organization for Standardisation, 2009). Many different definitions of 'hazard' exist. It is often confused with the term 'risk'; if they are used interchangeably, this further contributes to confusion.
- ***Risks*** refer to outcomes or consequences of exposure to hazards. It is a complex concept that is challenging to concisely define in a meaningful way. It is considered a product of the consequences and likelihood that the outcome will occur. Very simple models of risk (Haddon Jr, 1973; Viner, 1991) assume one hazard and one event lead to one consequence. For complex conditions such as WMSDs this is an inadequate concept of risk; hazards arise from multiple sources or events and so require multiple controls for mitigation. For further discussion of risk see Risk (Chapter 31, Body of Knowledge: https://www.ohsbok.org.au/download-the-body-of-knowledge/).
- ***Psychosocial hazards*** can be considered as organisational factors from within the organisation or the social context of the work environment and include: working hours, high workloads, poor job design, low levels of job control, high pace of work, conflicting work demands, communications with management, being valued, health and safety culture, and relationships with colleagues and supervisors (Leka & Cox, 2008).

The Nature and Classification of WMSDs

The term WMSDs encompasses a wide range of symptoms and conditions with a range of clinical diagnoses, although the reliability of these is poor, and often has few practical implications for workplace risk management (Wells, 2009). More generally, symptoms experienced by individuals with a musculoskeletal disorder, whether it is work-related or not, may include:

- local or generalised pain, aching or discomfort;
- loss or hypersensitivity of sensation to touch, heat or pressure;
- loss of muscle strength, endurance and/or flexibility;
- loss of ability to perform controlled movements, postural or balance reactions; and/or
- physical changes to muscle tone or bulk (atrophy, hypertrophy etc.), skin colour and temperature, inflammation;
- abnormal alignment of joints, loss of joint range of motion or stability (Punnett & Wegman, 2004).

These types of symptoms can potentially increase the risk of further injury, as they reduce both the physical and psychological performance capacity of an individual with a WMSD, both at work and in their other daily activities. Both pain and restrictions to normal ranges of movements usually result in individuals compensating in some way and undertaking awkward, unnatural postures that potentially result in both reduced competency and new areas of discomfort. The impact of pain can also seriously reduce cognitive performance capacities, resulting in loss of concentration and reduced capacity to process information, which in time-pressured work is likely to increase stress levels. Additionally, pain itself can be a significant cause of psychological stress, which can further undermine functional performance. Elevated stress levels are linked with increased susceptibility to WMSDs; this is explored in greater detail in a later section.

Clearly, muscle weakness and neural damage make the performance of manual tasks more physically difficult, and more dangerous as speed and accuracy of movements deteriorate. An individual with limited ability to move is exposed to a range of other workplace hazards beyond WMSDs, such as those caused by interactions with mobile plant or moving objects, or in situations where access is limited.

Classification of musculoskeletal disorders is covered by two core classification systems of the World Health Organization (WHO) that are used worldwide: the International Statistical Classification of Diseases and Related Health Problems (tenth revision: ICD-10) and the International Classification of Functioning, Disability and Health (ICF).

ICF is used to capture information on various domains of human functioning and disability, including factors that can be modified by intervention. It provides a standard language and conceptual basis for the definition and measurement of disability, using classifications and up to 1424 codes (see *the Cochrane review* by Aas et al., 2011, for an example of ICF coding for neck pain in workers). The ICF uses three key health outcomes; impairments, activity limitations, and restrictions in social participation.

The ICD is a reference classification used to capture information on mortality and morbidity, including external causes of injury and disease. ICD contains codes for signs, symptoms, abnormal findings, and factors influencing health status and contact with health services. For further information on the ICD and ICF see: http://www.who.int/classifications/icd/en/.

Table 1.1 contains examples of ICD-10-coded diseases that are potential WMSDs. A range of other systemic diseases such as rheumatoid arthritis, gout, lupus and diabetes can also affect the musculoskeletal and peripheral nerve tissues. These diseases are usually not work-related and so are not within the scope of the current report.

Table 1. 1 Examples of ICD disease diagnoses for WMSDs

Disease Group	ICD-10 code
Diseases of the Nervous System	
Brachial plexus disorders (thoracic outlet syndrome)	G54.0
Carpal Tunnel Syndrome	G56.0
Lesions of the ulnar nerve (cubital tunnel syndrome)	G56.2
Lesions of the radial nerve	G56.3
Diseases of the Circulatory System	
Raynaud’s syndrome	I73.0
Embolism and thrombosis of arteries of the upper extremities	I74.2
Embolism and thrombosis of arteries of the lower extremities	I74.3
Diseases of the Musculoskeletal System and Connective Tissue	
Cervicobrachial syndrome (diffuse)	M53.1
Sciatica	M54.3
Lumbago with sciatica	M54.4
Low back pain	M54.5
Trigger finger (nodular tendinous disease)	M65.3
Radial styloid tenosynovitis (de Quervain’s)	M65.4
Bursitis of the hand	M70.1
Bursitis of the knee	M70.4/5
Rotator cuff syndrome	M75.1
Bicipital tendinitis	M75.2
Lateral epicondylitis (tennis elbow)	M77.1

In Australia, the Type of Occurrence Classification System (TOOCS) is the system primarily used for the coding of workers’ compensation data. The current version, TOOCS3.1, was developed to improve alignment with an Australian modification of the ICD-10 (ICD-10-AM) which takes into account the national health system. The aim was to provide more accurate coding that would assist with population-level analysis (Australian Safety and Compensation Council, 2008). The aim of the TOOCS is to improve the quality of the national disability scheme data through more options for coding so that the tendency to use ‘dump’ codes can be avoided. The availability of consistent data is important as it underpins the development of targeted strategies.

2 The Australian WMSD landscape

Most contemporary WHS and other WMSD-related policy and regulation is informed by surveillance data from Safe Work Australia's National Data Set for Compensation-based Statistics (NDS). These data have been collected and collated for many years from workers' compensation records for all jurisdictions in Australia.

There are eleven main workers' compensation systems in Australia: one for each of the eight Australian states and territories, and three Commonwealth schemes which include cover for Australian Government employees, Australian Defence Force personnel, and certain seafarers (Safe Work Australia, 2017). These jurisdictional claims systems have many common variables but there are also individual nuances between processes across the different systems. The details of these differences and commonalities can be found in the comparison of workers' compensation arrangements in Australia and New Zealand published at the end of each year (Safe Work Australia, 2018d). In practical terms, the inconsistencies in the operation and application of workers' compensation laws between jurisdictions impact data collection, particularly in terms of variables around claims eligibility and processes.

To be eligible for compensation, a person injured in the workplace must fall within the definition of a worker/employee in that jurisdiction. Broadly, a worker is defined as a person who works for an employer on a full-time or part-time basis under a contract of service and receives remuneration in wages or salary (Australian Bureau of Statistics, 2018a). The model WHS legislation defines a worker in terms of work arrangements, including employees, contractors, subcontractors, self-employed persons, outworkers, apprentices or trainees, work experience students, employees of a labour hire company placed with a 'host employer', and volunteers (Safe Work Australia, 2016a), adding further complexity. Each jurisdiction has its own definition of eligibility for a worker for compensation cover, but generally employees and labour hire workers are eligible in most jurisdictions, while independent contractors may not always be covered. Work safety and health regulatory regimes and compliance programs in Australia, including the workers' compensation insurance schemes, were designed to service what were formerly considered to be standard employment arrangements, where full-time and relatively secure employees work in large workplaces. The growth of contingent employment patterns has accentuated gaps in regulation and exclusion of workers in some jurisdictions from workers' compensation coverage (Stuckey et al., 2005).

All contemporary workers' compensation laws require workers covered by the legislation to prove their injuries are work-related and 'arising out of or in the course of employment' (Safe Work Australia, 2018d). Schemes also include a 'no-fault' principle which means workers only have to prove that their injuries were work-related – they do not need to prove negligence on the part of an employer.

Injuries

In the compensation legislation, injuries relate to any harm caused to a person's body as a result of any form of trauma including physical injuries, illnesses, psychological conditions and diseases, as well as aggravations, exacerbations and recurrences of existing injuries. These are generally considered to be acute conditions, linked clearly to an incident or injury event. However, each jurisdiction defines and limits compensable injury differently, and all require demonstration of the relationship between the injury and the worker's employment as well as a contribution by the work to the injury, before the worker can claim workers' compensation. Aggravation and/or acceleration of a pre-existing injury is covered in all jurisdictions.

Diseases

Diseases include any physical or mental ailment, disorder, defect or morbid condition, whether of sudden or gradual onset. They also require a demonstrated relationship between the condition and the employment, or evidence of a related exposure. Each jurisdiction has tables of prescribed lists of diseases and exposures. For diseases not included on the lists, the worker must be able to demonstrate the relationship between the injury and their employment as well as a contribution by the work to the injury, to claim compensation.

National Data Set and WMSDs

Workers' compensation data is collated into the NDS, within which WMSDs are categorised into two main groups: 'Traumatic joint/ligament and muscle/tendon injuries' encompassing codes related to injuries, and 'Musculoskeletal and connective tissue diseases' encompassing codes related to diseases.

Traumatic joint/ligament and muscle/tendon injuries (WMSD injuries – usually acute events) include:

- trauma to joints and ligaments (e.g. sprains, tears and dislocation)
- trauma to muscles and tendons (e.g. strains and tears), and
- soft tissue disorders due to trauma or unknown mechanisms.

Musculoskeletal and connective tissue diseases (WMSD diseases – gradual onset or cumulative disorders) include:

- joint diseases (arthropathies) and other articular cartilage diseases (e.g. inflammatory or infectious arthritis, acquired musculoskeletal deformities)
- spinal vertebrae and intervertebral disc diseases – dorsopathies (e.g. back pain, sciatica, neck pain, disc degeneration)
- diseases involving the synovium and related tissue (e.g. synovitis, tenosynovitis)
- diseases of muscle, tendon and related tissue (e.g. non-traumatic muscle or tendon strain, tendinitis, epicondylitis), and
- other soft tissue diseases (e.g. bursitis, occupational overuse syndrome).

These categories do not align neatly with those in the ICD-10-AM.

The data presented below have been sourced from Safe Work Australia's NDS, unless otherwise stated. Due to privacy requirements, claim numbers have been rounded to the nearest five. In cases where five or fewer claims occur in a category the field is left blank (or replaced with ‘np’). This is primarily descriptive data examining workers’ compensation trends in recent years. Due to the rounding, differences may appear between the reported totals and sums of rows or columns. Rates and percentages are calculated using non-rounded numbers.

WMSD claims in 2015–16

The NDS identifies a total of almost 125,000 WMSD accepted workers’ compensation claims in 2015–16. Of these 62,420 or 50 per cent were serious claims. Safe Work Australia defines a serious claim as an accepted workers’ compensation claim for an incapacity that results in a total absence from work of one working week or more (Safe Work Australia, 2018a). Serious claims exclude compensated fatalities and claims arising from a journey to or from work or during a recess period, which are not compensable in all jurisdictions. Most jurisdictions have an employer excess of one-week or less. However, workers’ compensation authorities generally process claims with an absence of at least one week. Therefore, the exclusion of journey claims and the use of a one-week cut-off improves the comparability of data from the jurisdictions, giving a more accurate national estimate. Serious claims for WMSD diseases and injuries comprised 58 per cent of all serious claims in 2015–16 (Table 2.1).

Safe Work Australia reports two rates of workers’ compensation claims: the ‘frequency rate’ (the number of claims per million hours worked) and the ‘incidence rate’ (the number of claims per 1,000 employees). These rates are derived from estimates of the number of employees and hours worked in each Australian workers’ compensation jurisdiction, supplied by the ABS. The frequency rate is considered the more accurate measure of WHS impacts than the incidence rate as it accounts for significant differences in the number of hours worked by different groups of employees and at different points in time, and therefore different exposures (Safe Work Australia, 2018a). Table 2.1 shows that the frequency rates for WMSD injuries (2.5) and WMSD diseases (0.9) are the greatest of all serious claim frequency rates, and together comprise a frequency rate of 3.4 for all WMSD out of a total rate of 5.8 claims per million hours worked for all serious claims.

Table 2. 1 Serious claims by nature of injury or disease, 2015–16

Nature of injury/disease	Number of claims	Frequency rate
Traumatic joint/ligament and muscle/tendon injury	46,060	2.5
Wounds, lacerations, amputations and internal organ damage	16,775	0.9
Musculoskeletal and connective tissue diseases	16,365	0.9
Fractures	10,795	0.6
Mental disorders	6,935	0.4
Other injuries	2,810	0.2
Digestive system diseases	2,320	0.1
Burn	1,630	0.1
Nervous system and sense organ diseases	1,110	0.1
Intracranial injuries	955	0.1
Skin and subcutaneous tissue diseases	500	0.0
Other claims	320	0.0
Infectious and parasitic diseases	225	0.0
Respiratory system diseases	205	0.0
Injury to nerves and spinal cord	145	0.0
Circulatory system diseases	110	0.0
Other diseases	90	0.0
Neoplasms (cancer)	35	0.0
Total	**107,380**	**5.8**

Frequency rate = number of serious claims per million hours worked.

These WMSD serious claims comprised only 50 per cent of all accepted WMSD claims in 2015–16 (Table 2.2). The frequency rate for both the serious claims injury and disease categories is around half of that for all accepted WMSD claims. The injury category comprises 74 per cent of all serious WMSD claims and 77 per cent all accepted WMSD claims. While the focus in this report is on claims categorised as serious, it is important to note that the 'less serious' group (claims for which workers had less than a week's absence from work) comprised over 62,000 accepted claims.

Table 2. 2 Serious and accepted WMSD claims by nature of injury or disease, 2015–16

Nature of injury/disease	Serious claims			All accepted claims		
	Number	Per cent	Freq. rate	Number	Per cent	Freq. rate
Traumatic joint/ligament and muscle/tendon injury	46,060	73.8	2.5	95,715	76.8	5.1
Musculoskeletal and connective tissue diseases	16,365	26.2	0.9	28,970	23.2	1.6
Total WMSD claims	**62,420**	**100**	**3.4**	**124,690**	**100**	**6.7**

Freq. (frequency) rate = number of serious claims per million hours worked.

Serious claims

The NDS data presented in the rest of this report relates only to *serious claims.* As noted above, a serious claim is an accepted workers' compensation claim for an incapacity that results in a total absence from work of one working week or more. This definition captures comparative claims across all Australian jurisdictions, which have varying periods of absence from work, cost thresholds or employer excess periods. This may mean that claims for injuries and diseases below these thresholds are not reported to workers' compensation authorities and therefore would not be included in the data. As a consequence, successful claims with less than one working week lost time, those with no lost time (receive medical expenses only) and those which are not reported or are reported but for which there is no workers' compensation claim, are not counted. Therefore, it is understood that the data represents only a portion of the total picture, but it is currently the best data available.

Previous NDS reports have used the terms 'sprains and strains' and 'diseases of the musculoskeletal system and connective tissue' to describe WMSD claims (Australian Safety and Compensation Council, 2006; Safe Work Australia, 2010). Due to a change in coding practices in Victoria since 2002–03, many claims previously coded as sprains and strains have been recoded as 'diseases of the musculoskeletal system and connective tissue'. These definitional changes make it difficult to compare longitudinal data. The frequency rate of serious WMSD claims has declined slowly but steadily from 2011–12 to 2015–16, which is also reflected in the overall number of serious claims (see Table A.1 in Appendix A). However, the percentage of and frequency rates for WMSD serious claims as a proportion of all serious claims continues to be high, with only a very slight percentage decline of all claims to 58 per cent in 2015–16.

The frequency rate (serious claims per million hours worked) for WMSDs has continued to decline steadily but slowly in both the disease and injury groups. There has been a greater decline in the WMSD injury rate, but this change is minimal. The same trend can be seen in all serious claims, which is unsurprising as WMSD claims comprise almost 60 per cent of all serious claims. When also considering that the frequency rate for all accepted WMSD claims is 6.7 (Table 2.2), this diagnostic group is clearly overrepresented in serious injuries.

Within the WMSD serious claims categories in these recent years, the 'Traumatic joint/ligament and muscle/tendon injury' group consistently represented between 73 and 75 per cent of all serious WMSD claims. This group, which can also be described as 'sprains and strains', has comprised at least 43 per cent of all serious claims over this time. Both this overrepresentation of WMSDs in all serious claims, and the injuries within the WMSD categories, suggest an ongoing need for a WHS focus on WMSDs, with a specific focus on sprains and strains.

Time lost from work is measured in working weeks lost from work and excludes estimates of future absences. It reflects the total period of time for which compensation was paid, which does not have to occur in consecutive days and weeks. The median time lost from WMSD injuries has increased from 5.0 to 5.2 since 2011–12 (see Table A.2 in Appendix A). The time lost for all WMSD serious claims remains at six weeks, which suggests that WMSD claims continue to be serious challenges for rehabilitation and return to work interventions. Musculoskeletal and connective tissue diseases persistently have a median lost-time of almost ten weeks, a particular concern as increasing length of time off work has been demonstrated to reduce the likelihood of successful rehabilitation outcomes (Costa et al., 2017). Although fewer in number than other serious WMSD claims types, these disease claims comprised 15 per cent of all serious claims.

Median compensation costs of both types and all claims for serious WMSDs have risen between 2011–12 and 2015–16 (see Table A.3 in Appendix A). The median compensation is adjusted using the ABS Price Wage Index to remove effects of wage inflation and allow a more meaningful comparison of the median time in time lost series. This has continued to rise, not surprisingly, as this is also likely to reflect time off work. The median compensation costs for all serious claims in 2013–14 was $10,200, less than that for all types of WMSD claims. These costs and the ongoing issues with lost time both suggest that WMSD claims continue to be a serious challenge for return to work. Clearly, although these costs are insurance-related, the broader costs to individuals, families and the community are also extensive and significant.

Table 2.3 shows percentage and frequency rates of WMSDs by age (see Table A.4 in Appendix A for the separate WMSD categories by age and sex). Across the age groups these are not notably different from those for all serious claims, unsurprisingly, as the WMSD claims comprise the majority of all claims in all age groups except those less than 25 years. In 2015–16, workers aged 35–54 years had 50 per cent of serious WMSD serious claims (compared with 47 per cent for all serious claims). Those aged more than 45 years comprised nearly 50 per cent of WMSD claims, and this pattern of slightly more claims in the older groups and less in younger groups persists in comparison to those in all serious claims. Sixty percent or more of serious claims are WMSD claims when all age groups more than 34 years and less than 65 years are combined. WMSD serious claims are clearly overrepresented in all age groups. The frequency rate of WMSDs is highest in those aged 55–64, at 4.6 serious claims per million hours worked. Males have a higher frequency rate in all age groups and types of WMSD claims except the female 45–54 group for WMSD diseases (Table A.4).

While there is no notable difference between sexes in claim numbers in 2015–16, males have slightly more WMSD injury claims than females, and more females have disease claims than males (see Table A.5 in Appendix A). Men have more spinal, vertebrae and intervertebral disc diseases and women have more muscle and tendon-related diagnoses. In the broader population, it has been reported that both arthritis and osteoporosis are significant health issues and are more prevalent in females in younger age groups, and that prevalence is increasing for both sexes as they age (Australian Bureau of Statistics, 2018b).

Table 2. 3 Serious WMSD claims by age, 2015–16

Age group	WMSD serious claims		
(years)	Number	Per cent	Frequency rate
Under 25	6,265	10	2.6
25–34	11,835	19	2.5
35–44	13,985	22	3.3
45–54	17,190	28	4.2
55–64	11,700	19	4.6
65 and over	1,450	2	3.3
Total	**62,420**	**100**	**3.4**

Frequency rate = number of serious claims per million hours worked.

Note: This table is a summary of more detailed data contained in Appendix A, Table A.4.

Table 2.4 shows the numbers of serious WMSD for the year 2015–16 with percentages of WMSD claims in each industry and in comparison to all claims. These data show that WMSDs are a serious issue in all industry groups. Health care and social assistance is the group with the greatest proportion of WMSD claims of all serious claims, and within that group workers in hospitals and residential care services are the most commonly injured (see Table A.6 in Appendix A for sub-industries). The 'Other industries group', which comprises a broad range of industries, has 40 per cent of all serious WMSD claims, most of them in the 'Education and training' and 'Public administration and safety' categories, which include schools, police and other emergency services. The last column in Table 2.4 describes the number of WMSD claims as a percentage of all serious claims in each industry group. Again, hospitals and residential care services form the greatest claim group, but other health care, social assistance, heavy and civil engineering and construction, all the retailing and transport groups, electricity, gas, water and waste services, mining, and the wholesale trade all comprise more than 60 per cent of all serious claims in their categories (Table A.6).

Table 2. 4 Serious WMSDs and all serious claims by industry, 2015–16

Industry	Number of WMSD serious claims	Number of all serious claims	WMSD serious claims as a proportion of all serious claims (%)
Health care and social assistance	11,370	16,705	68.1
Manufacturing	7,095	13,270	53.5
Construction	6,980	13,085	53.3
Retail trade	6,115	9,450	64.7
Transport, warehousing and postal	5,520	8,615	64.1
Other industries	25,280	46,155	54.8
Total	62,420	107,380	58.1

Note: This table is a summary of more detailed data contained in Appendix A, Table A.6.

These figures may be impacted by changes in work arrangements and other industrial issues, with an increasing number of workers self-identified in industry groups as not employees. For example, in the 2016 Australian census only 67 per cent of those working in the construction industry identified themselves as employees, suggesting that a significant number of workers in this group are contractors and therefore not likely to be eligible for workers' compensation (Australian Bureau of Statistics, 2018b). For other groups such as those working in agriculture, where self-employment or sole trader work arrangements are common, there is a small but trending rise in WMSD claims. The census data in 2016 has only 58 per cent of workers in retail identifying as employees, also showing an increasing claims trend and a higher percentage of WMSD claims compared to that of all claims.

Table 2.5 shows serious WMSD claims by occupation group. Again, serious WMSD claims are consistently overrepresented in all occupations, comprising more than 50 per cent of all serious claims, and over 60 per cent among 'Community and personal service workers' and 'Machinery operators and drivers'. The sub-categories most affected within these groups are 'Carers and aides' and 'Storepersons' (see Table A.7 in Appendix A). Other health professionals and nurses are overrepresented even within these already high numbers. This overrepresentation across most occupations and sub-occupations suggests a broad range of hazards which need to be addressed, with targeted interventions specific to the type of work undertaken in the particular occupational contexts. This requires much more detailed data to enable appropriate hazard identification.

Table 2. 5 Serious WMSDs and all serious claims by occupation, 2015–16

Occupation	Number of WMSD serious claims	Number of all serious claims	WMSD serious claims as a proportion of all serious claims (%)
Labourers	15,610	26,960	57.9
Community and personal service workers	11,220	17,600	63.8
Technicians and trades workers	9,865	19,460	50.7
Machinery operators and drivers	9,725	15,320	63.5
Professionals	5,680	9,975	56.9
Other occupations	9,350	15,995	58.5
Total	**62,420**	**107,380**	**58.1**

Note: This table is a summary of more detailed data contained in Appendix A, Table A.7.

The breakdown agency of injury/disease (Table 2.6 and Table A.8 in Appendix A) identifies 'the object, substance or circumstance that was principally involved in, or most closely associated with, the point at which things started to go wrong and which ultimately led to the most serious injury or disease' (Australian Safety and Compensation Council, 2008). The most common breakdown agency for all serious WMSD claims was 'non-powered hand tools and appliances and equipment' followed by 'environmental agencies'. This first group includes hand tools, fastening, packing and packaging equipment, furniture and fittings and other utensils, ladders, mobile ramps and stairways, and scaffolding. Environmental agencies include the indoor, underground and outdoor environments, buildings, roofs and other structures, and traffic and ground surfaces.

The mechanism of injury identifies the overall action, exposure or event that best describes the circumstances that resulted in the most serious injury or disease. Body stressing is clearly the most commonly reported mechanism, consistent with the prevalence of sprain and strain-related WMSDs (Table 2.7). The second most common mechanism is slips, trips and falls, consistent with the data related to environmental agencies above. The bodily location of injury/disease classification identifies the part of the body affected by the most serious injury or disease. The trunk (34%), upper limbs (32%) and lower limbs (26%) were the three most common bodily locations for WMSD claims, with trunk or back (45%) issues predominantly reported for musculoskeletal diseases. Upper limbs (34%) were the second most common report (see Table A.9 in Appendix A). Looking at all serious WMSD claims, reports related to back and upper limb problems account for 66 per cent of all claims. The 26 per cent of reports related to lower limb WMSD suggests a need for further investigation as these are less likely to arise from the physical risk factors usually associated with WMSDs such as cumulative loads or repetitive movements. The low percentage of neck-related claims (3%), commonly reported in workers doing sedentary work, is consistent with the higher proportion of claims in the agency and occupational groups identified above.

Table 2. 6 Serious WMSD claims by breakdown agency of injury/disease, 2015–16

Breakdown agency of injury/disease	WMSD serious claims	
	Number	Per cent
Non-powered hand tools, appliances and equipment	16,920	27.1
Environmental agencies	11,055	17.7
Materials and substances	8,330	13.3
Animal, human and biological agencies	7,540	12.1
Other and unspecified agencies	7,095	11.4
Mobile plant and transport	6,475	10.4
Powered equipment, tools and appliances	2,585	4.1
Machinery and (mainly) fixed plant	2,255	3.6
Chemicals and chemical products	165	0.3
Total WMSD claims	62,420	100

Note: This table is a summary of more detailed data contained in Appendix A, Table A.8.

Table 2. 7 Serious WMSD claims by mechanism of injury, 2015–16

Mechanism of injury	WMSD serious claims	
	Number	Per cent
Body stressing	**37,660**	**60.3**
Muscular stress while handling objects	15,915	25.5
Muscular stress while lifting, carrying or putting down objects	14,100	22.6
Muscular stress with no objects being handled	4,930	7.9
Repetitive movement, low muscle loading	2,720	4.4
Falls, trips and slips of a person	**14,845**	**23.8**
Falls from a height	3,485	5.6
Falls on the same level	9,635	15.4
Stepping, kneeling or sitting on objects	1,725	2.8
Being hit by moving object	**4,410**	**7.1**
Vehicle incidents and other	**3,835**	**6.1**
Hitting objects with a part of the body	**1,585**	**2.5**
Other mechanisms	**85**	**0.1**
Total WMSD claims	**62,420**	**100**

Note: This table is a summary of more detailed data contained in Appendix A, Table A.9.

The bodily locations which have blank (‘np’) cells in Table A.9 relate to those with fewer than five reports. These are therefore not included in the more detailed data in Appendix A.

To further explore risks and hazards, Table A.10 in Appendix A shows serious WMSD claims by bodily location, mechanism of injury and occupation. Although it results in a large and complex table, combining data in this manner enables more detailed examination of where and how and to whom WMSD injuries and diseases are occurring. ‘Body stressing’ and ‘Falls, slips and trips’ of a person are consistently the most commonly reported mechanisms of injury across all occupational groups. However, the percentage of claims for these mechanisms varies between occupations, as do the sub-categories.

Managers' 'body stressing' (55% of all their WMSD) claims related to 'muscular stress while lifting, carrying or putting down objects', and 'falls on the same level' comprise 62 per cent of all their falls, slips and trips, while 24 per cent of their falls groups of claims are 'falls from a height'. Their primary bodily locations for injury are trunk (34%), lower limbs (29%) and upper limbs (27%).

Professionals also have 55 per cent of all WMSDs related to body stressing, of which 47 per cent are related to muscular stress while handling objects and 26 per cent to muscular stress with no object being handled. Professionals' most-injured body locations are trunk (33%), lower limbs (30%) and upper limbs (27%).

Technicians and Trades workers have 61 per cent of all WMSD claims related to body stressing, with 42 per cent of these related to muscular stress while handling objects and 39 per cent to muscular stress with no object being handled. Thirty-five percent of their WMDS claims on bodily locations were to their trunks, 32 per cent to their upper limbs and 27 per cent to lower limbs.

Fifty-nine percent of all community and personal service workers' WMSD claims related to body stressing; of these 52 per cent were for muscular stress while handling objects. Twenty-two percent of their WMSD claims related to falls, slips and trips; of these, 73 per cent were falls on the same level. Their most common bodily locations for injuries were trunk (35%), upper limbs (29%) and lower limbs (26%).

Clerical and Administrative workers had 58 per cent of claims related to body stressing, 64 per cent of which related to muscular stress while lifting, carrying or putting down objects (34%) and handling objects (30%). Seventy-one percent of their falls-related claims were on the same level. Bodily locations for their claims were primarily upper limbs (37%), trunk (28%) and lower limbs (24%).

Sales workers had 67 per cent of their WMSD claims related to body stressing, most of them linked to muscular stress while lifting, carrying or putting down objects (52%) or handling objects (29%). A relatively low number of their claims related to falls, trips and slips (20%); of these, 72 per cent were at the same height. Sales workers' affected bodily locations were primarily trunk (37%), upper limbs (33%) and lower limbs (23%).

Machinery Operators and Drivers had 61 per cent of their WMSD related to body stressing; of these, 42 per cent related to lifting, carrying or putting down objects and 42 per cent related to handling objects. Of their falls, slips and trips (24%), 56 per cent were on the same level. Their primary bodily locations for injury were trunk (34%), upper limbs (32%) and lower limbs (26%).

Labourers had a similar distribution, with 62 per cent of WMSD claims related to body stressing, with the same mechanisms and distributions as those that affect Machinery Operators and Drivers. Their slips, trips and falls comprised 22 per cent of all their WMSD claims with 65 per cent being falls at the same level, and they had a slightly higher number than any other group (11%) for 'stepping, kneeling or sitting on objects'. They had very similar bodily locations of injuries, with slightly more to the trunk and upper limb (both 35%) and 25 per cent to the lower limb.

Some other points of note in Table A.10 are that 'repetitive movement, with low muscle loading', a primary focus of intervention advice for many years (Safe Work Australia, 2018c), is a relatively uncommon mechanism in relation to the body stressing category, with Clerical and Administrative workers (not surprisingly, considering their work tasks) most commonly (20%) experiencing this mechanism within their body stressing group, followed by Labourers (10%). Being hit by moving objects is linked to a relatively small number of WMSDs but comprises 10 per cent of Professionals' claims, and 11 per cent of Community and Personal Service workers' claims, affecting upper limbs for both groups. The 'falls from height' within the falls, trips and slips category comprises 32 per cent of those WMSD claims for Machinery Operators and Drivers, and 25 per cent for Labourers, as well as the 24 per cent for Professionals mentioned above, most commonly affecting lower limbs in all cases.

This type of detail begins to tease out subtle differences between occupational groups, as does the industry data, all of which assists to inform interventions to reduce risks and hazards.

NDS data summary

The data presented suggests that WMSD claims are a significant group of all serious claims, that they are significantly overrepresented within all serious injuries, and that the number and type of claims has remained relatively consistent in recent years. This suggests, in turn, that current interventions are not successfully identifying or controlling hazards and that risks persist.

There are limits to the efficacy and reach of the NDS data, and the fact that they represent only accepted serious claims is an important one which suggests that the real impact of WMSDs is considerably greater than what has been identified. The data section below will briefly address other forms of surveillance, which may assist to some extent to quantify these issues and identify other strategies which may improve our understanding of the impact of WMSDs.

Other data

Although workers' compensation data is widely considered the most comprehensive surveillance data available to inform WHS and risk management, the limitations of the use of insurance data are many and well-researched. Seminal papers by Webb et al. (1989) and Azaroff et al. (2002) identified barriers and filters undermining accurate reporting of work-related incidents in workers' compensation insurance schemes, and the importance of workplace surveillance extending beyond simply consideration of accepted claims. These studies were undertaken in the US, but the same issues have been identified in other cultures and systems including Australia (O'Neill et al., 2013; Stuckey et al., 2007). A pertinent study is Rivière et al. (2014) which examined the underreporting of WMSDs in ten French regions. It found that between 59 and 73 per cent of WMSDs were not reported. Estimates of this magnitude of underreporting of WMSD claims have been consistent for many years, with reports of 75–94 per cent of claims not made (Morse et al., 2001; Rosenman et al., 2000). Although now an older study, Zakaria et al. (2002) explored the epidemiological literature on the rate of reports of work-related cumulative trauma disorders in upper extremities, and identified a series of advantages and limitations on the use of compensation data, issues which continue to resonate in the contemporary context. These include a number of systemic issues such as generation of suitable 'at risk' workforce denominators; variations in compliance and reporting requirements; incomplete coverage of workers; difference between reporting of acute and gradual onset conditions; obtaining benefits through other systems such as sick leave; lack of consistent, validated and qualitative case definitions; inadequacy of coded variables; and missing and misclassified data and errors.

Other data sources including the National Health Survey (NHS), the Work-related Injury Survey (WRIS), the 2016 Australian Census and other Australian Bureau of Statistics (ABS) data can provide contextual information to assist our understanding and interpretation of the NDS data. Each of these sources also has relevant limitations and even cumulatively do not provide a full picture of the prevalence and impact of WMSDs, but they can serve to better inform both our understanding of the bigger picture and improvements to surveillance. Relevant contributions and limitations for some of these data sources are presented below.

National Health Survey

The NHS uses ICD-10 codes to categorise WMSD-related conditions including sciatica, disc disorders, back pain/problems and curvature of the spine. This survey data is collected by interviews 'as reported' by respondents. The data relates to all injuries/diseases and does not specifically identify those conditions which are work-related. The 2017–18 NHS was one in a series conducted every few years from 1989 to 1990 to present key indicators of the health status of the population; health risk factors, and demographic and socioeconomic characteristics. The 2017–18 survey sampled around 21,300 people in 16,400 households. This relatively small number of participants results in data quality indicators (e.g. relative standard errors) that suggest much of the data is difficult to use with confidence as specific occupational injuries are relatively uncommon, resulting in small denominators for subsequent segmentation analyses. The results are weighted to adjust the results from the sample survey to infer results for the total in-scope population. The results are essentially 'as reported' by respondents, and it is therefore likely that those health conditions which impact wellbeing or lifestyle or about which there have been specific questions, are likely to have been better reported than others (Australian Bureau of Statistics, 2018b).

The 2017–18 NHS survey reports that "just under half (47.3%) of Australians had one or more chronic condition in 2017-18, an increase from 2007-08 when two-fifths (42.2%) of people had one or more chronic conditions" (p.11). Of these chronic conditions, back problems were reported by 4 million people (16.4%); arthritis (referring to a range of musculoskeletal conditions) by 3.6 million people (15.0%); and osteoporosis by 924,000 people (3.8%).

In terms of physical activity and work, adults aged 18–64 years described their day at work as:

- mostly sitting (43.7%)
- mostly walking (22.8%)
- mostly standing (19.5%)
- mostly heavy labour or physically demanding work (13.6%). This work was almost four times more likely to be reported by men than women (p.13).

While this is not specifically work-related data, it does tell us that there are many Australians who report having musculoskeletal conditions. Their physical work is largely sedentary and only a small group, mostly men, do heavy or physically demanding work. The definitions relating to WMSD in the NHS are not consistent with those used in the NDS, or other ABS reports in some instances, which undermines the ability to make comparative data analysis.

Work-related Injury Survey (WRIS)

The WRIS is compiled from data collected in the Multipurpose Household Survey which was conducted throughout Australia in the 2017–18 financial year, supplementary to the monthly Labour Force Survey. Data was collected by ABS interviewers by telephone or at selected dwellings. The work-related injuries topic involved a sample of 28,200 people. The previous WRIS was conducted in the 2013–14 financial year (ABS 6324.0). The work-related injury or illness classifications in the survey are based on the TOOCS nature of injury codes and the classification of how work-related injury or illness occurred is based on the TOOCS mechanism of injury codes. The WMSD categories included in the WRIS are:

- Chronic joint or muscle conditions
    - Arthritis
    - Disorders of the joints
    - Disorders of the spinal vertebrae and intervertebral discs
    - Disorders of muscle, tendons and other soft tissues (e.g. Occupational Overuse Syndrome and Repetitive Strain Injury if this is the only description given)
    - Acquired musculoskeletal deformities (e.g. flat feet, mallet finger, hammer toe)
- Sprains/strains
    - Sprains and strains of joints and adjacent muscles
    - Acute trauma sprains and strains
    - Sprains and strains of cartilage
    - Dislocations

Again, these are not consistent with the categories used in the NDS or the NHS, making comparisons difficult. Also, the relatively small number of survey participants potentially undermines data reliability and extrapolation. However, this survey specifically asks questions around work-related injuries. It provides some useful insight into injuries which may or may not have been reported, involved lost time, claimed for or accepted by the workers' compensation system.

Table A.11 in Appendix A, copied directly from the WRIS page on the ABS website (see: https://www.abs.gov.au/ausstats/abs@.nsf/mf/6324.0), presents what, when, where and how injuries were sustained at work. More males than females reported experiencing a work injury. Twelve percent of these were not reported to anyone at work; of those reported (87.5%), most were reported to line managers or supervisors (66.1%). Just over 39 per cent did not involve any lost time, 24.9 per cent involved more than five days lost time, and almost 32 per cent incurred lost time of less than five days and therefore would not be classed as serious claims if claims were made and accepted. Over half (53%) involved workplace-based financial assistance, but only 27.4 per cent received compensation payments. The others received regular sick leave (17.5%) or other employer payments (6.3%). This is a reduction from 34.5 per cent who received workers' compensation in the same survey in 2013–14, and the use of regular sick leave (19.8% in 2013-14), but an increase in the use of other employment payments, 5.8 per cent in 2013-2014 (ABS, 2014). Forty-seven per cent did not receive any form of support for medical expenses or income loss for their most recent work-related injury or illness in 2017–18, an increase from the 38.7 per cent reported in 2013–14. The shaded sections of the table under the 'Most recent work-related injury or illness sustained' category have been highlighted to identify the WMSD specific categories. These two categories are the most commonly reported injury/disease type, both singly and combined, and comprise almost 47 per cent of all reports. Males reported slightly more chronic joint and muscle conditions (18.7% compared to 17.9%), while females reported more sprains and strains (29.6% compared to males' 27.5%). The most commonly reported agency was 'lifting, pushing, pulling or bending', reported more often by males (27.1%) than females. The other two categories which are likely to relate most to WMSDs were not identified as major contributors to injury, being 'repetitive movement with low muscle loading' (8.9%) and 'prolonged standing, working in cramped or unchanging positions' (2.7%). Over 90 per cent of these injuries were identified as occurring at the workplace.

Although there are issues with the reliability of many of the estimates contained in both the WRIS and the NHS, they provide valuable insights into other aspects of population-wide WMSDs and work-related injuries, many of which it appears are unlikely to have been captured in the NDS.

2016 Census data

Other issues, which are not addressed in these data but can be quantified to some extent using Census and other labour force data, relate to the changing work arrangements and the increasing number of contingent or precarious workers. These can include a number of different worker groups including:

- Casual employees—employees with no access to paid leave
- Restricted-tenure employees (contractors)—employees who have pre-set periods of employment, i.e., seasonal, temporary and fixed-term employees
- Employees paid by a labour-hire firm, who may or may not have pre-set periods of employment
- Self-employed or own-account workers, who work in their own unincorporated businesses without employees.

The terms ‘precarious’ and ‘contingent’ are often used interchangeably. Contingent employment growth has corresponded with a decline in permanent fulltime employment and increases in self-employment, home-based work, and casual employment (Stuckey et al, 2007). The definitions used currently to collect data on contemporary work arrangements have changed and therefore longitudinal data around changes are difficult to track. ABS Census data provides high-level data on worker identification of their employment status. The 2016 Census (Australian Bureau of Statistics, 2018b) identifies workers who describe themselves as employees and those who work in other work arrangements. The industry group with the highest number of employees is Public Administration and Safety (98.5%) while that with the fewest is Agriculture, Forestry and Fishing (57.9%). The industry categories Other Services, Administrative and Support Services, Professional, Scientific and Technical Services, Rental, Hiring and Real Estate Services, and Construction all had fewer than 80 per cent of workers identified in the category ‘employees’. These data identify 85.5 per cent of the total workforce as being employees, suggesting that the other 14.5 per cent would not likely be eligible for workers’ compensation or work-related entitlements.

3 The causes of WMSD

Multifactorial development of WMSDs

Substantial evidence supports the multifactorial nature of WMSD development, associating it with exposure to a range of physical and psychosocial workplace hazards (e.g. Coenen et al. 2014; Hauke et al. 2011; Hoefsmit et al. 2012; Lang et al. 2012a; Lang et al. 2012b; Macfarlane et al. 2009). While musculoskeletal disorders may result from a single event, more commonly they arise from cumulative exposure to one or more hazards over an extended period (NRC, 2001). However, a tendency exists to try and pinpoint the exact event which triggered the injury, in part driven by the workers' compensation systems which generally require identification and date of a 'causative incident' (Oakman & Chan, 2015). In cases where WMSDs are related to cumulative exposure, this approach can lead to misdiagnosis or omission of the relevant workplace hazards, and then a subsequent development of controls or interventions that are not appropriately targeted.

Much of the early research into the development of WMSDs and related hazards has focused on physical work demands and individual worker characteristics. However, evidence to support the role of psychosocial factors in the development of a WMSD is not new. Since the early 1990s, researchers have been proposing multifactorial pathways in the development of WMSDs. A number of conceptual models are highlighted below, each based on empirical evidence. These models have many elements in common, but each has a different focus on the contribution of hazards to the risks associated with developing a WMSD. These are presented in historical order and demonstrate that knowledge of the multifactorial aetiology of WMSDs is not new; translation into workplace practice has lagged significantly behind the evidence (for examples of early work in the 1990s see Bongers et al. (1993); Chaffin (1997); Hagberg et al. (1995); National Institute for Occupational Safety and Health (1997); Sauter et al. (1996)). The model by Kuorinka and Forcier (1995) incorporates hazards of a physical and psychosocial nature along with the pathophysiological processes resulting from both external biomechanical loads and those associated with the stress response (see Figure 3.1).

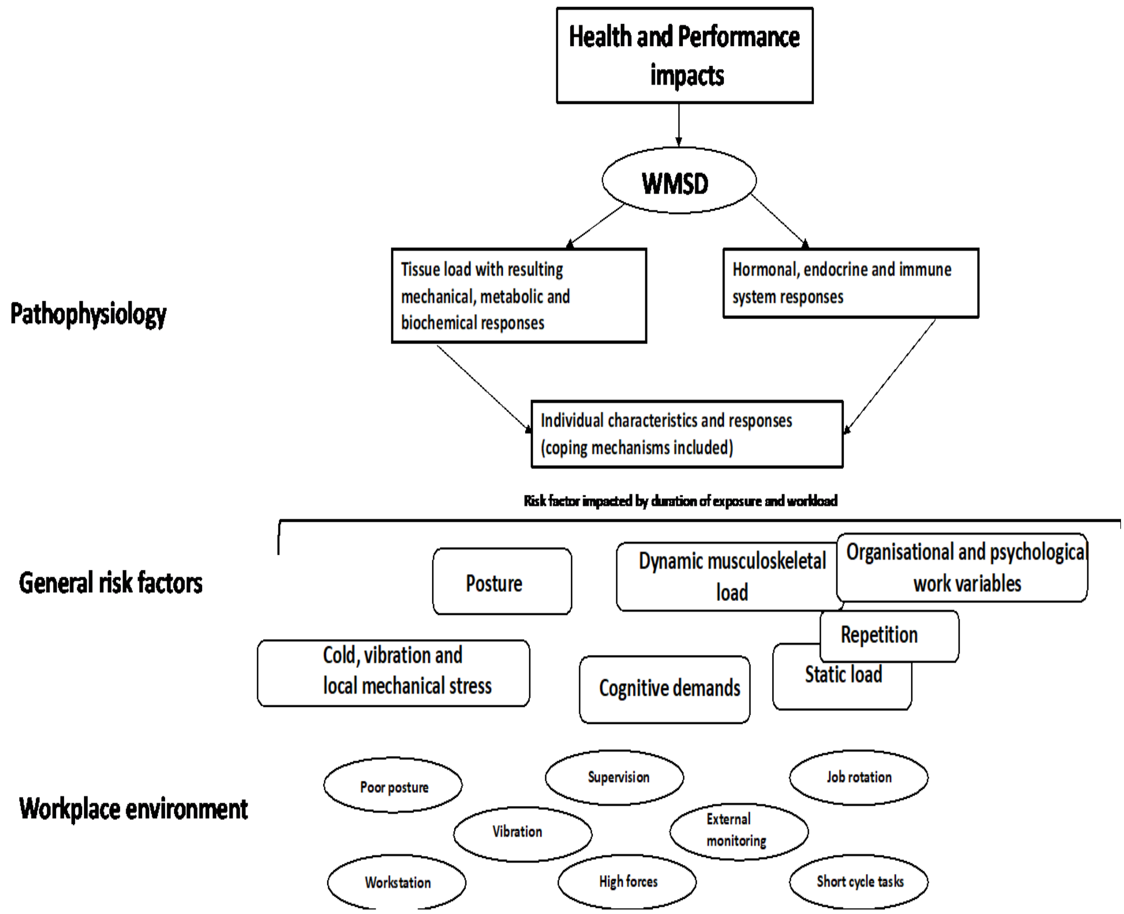

Figure 3. 1 A model of hazard and risk factors related to WMSD development

Source: adapted from Kuorinka and Forcier (1995).

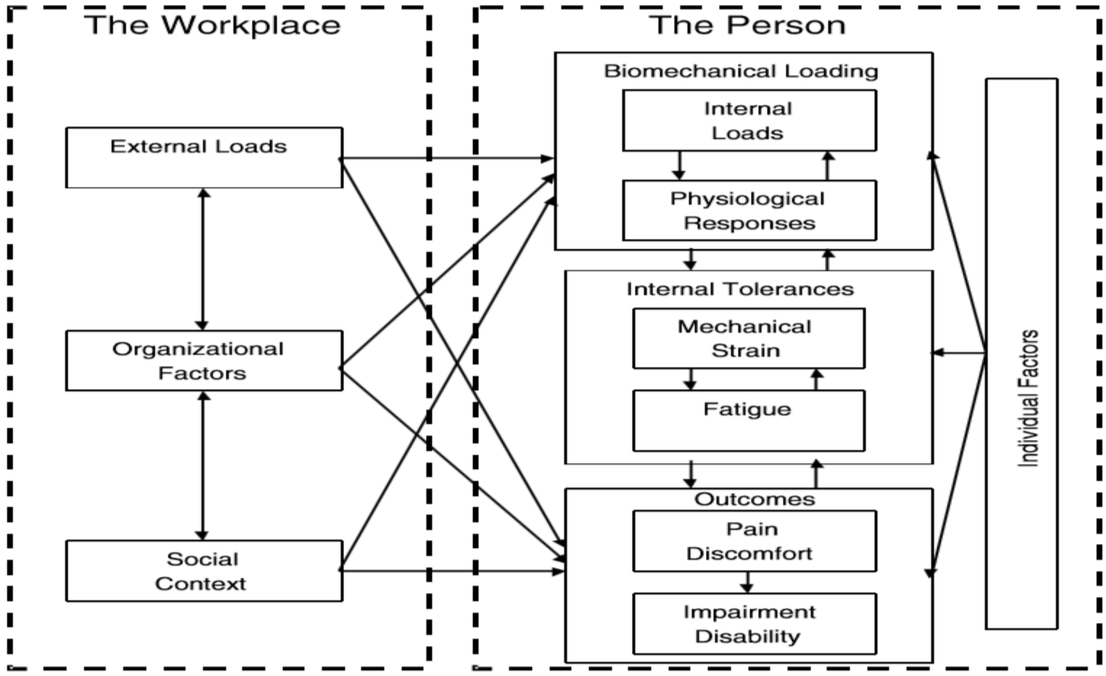

Figure 3. 2 Model of hazards and risk factors for WMSD

Source: US National Research Council (2001). Reproduced with permission.

A seminal paper published in 2001, based on an extensive review of the literature (see Figure 3.2), categorised WMSD risk as: (a) external loads or physical hazards (e.g. heavy lifting, repetitive actions, adverse postures); (b) organisational factors (e.g. high workloads, night shifts) and (c) social context (e.g. low supervisor support, low recognition) (National Research Council, 2001).The model is similar to that shown in Figure 3.1, the key differences being the major subdivisions between workplace factors and personal factors. The personal factors in this model are most closely aligned with pathophysiology in the Kuorinka and Forcier model.

In the 2000s, the role of psychosocial factors contributing to WMSD risk was examined further (Côté et al., 2008; Karsh, 2006; Marras, 2008). Karsh (2006) developed an integrated model, based on an extensive review of the literature, which specified different aspects of the social context and included safety and political climate and organisational culture.

A simplified composite model of causation for WMSD risk was proposed by Macdonald and Oakman (2015), which highlights the importance of fit between individual factors and workplace factors, and states that an imbalance between these two will result in an increased WMSD risk (Figure 3.3). It was developed from an extensive literature review (Macdonald & Evans, 2006), and builds on previous models (e.g. Carayon et al., 1999; Kuorinka & Forcier, 1995; National Research Council, 2001). This particular model incorporates the stress response, unlike the model in Figure 3.2, and outlines the importance of hazardous personal states which arise from poor fit, such as fatigue and stress, which then increase the WMSD risk. A common misconception is that stress and fatigue are the negative health outcomes in themselves, rather than the increased risk that arises from actual hazardous personal states. The premise for the model is as follows.

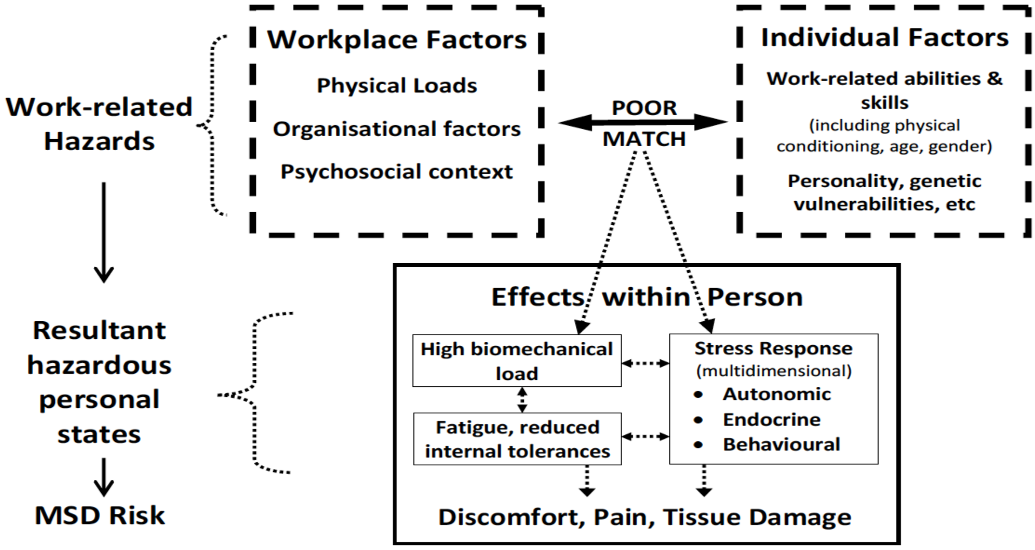

Figure 3. 3 A simplified composite model of WMSD risk

Source: Macdonald and Oakman (2015).

Physical loads. The physical demands of task performance are usually the most obvious work-related cause of WMSDs. Hazards of this type are task-specific, stemming from the postures adopted (static and dynamic) and forces exerted during task performance. These are influenced by the design of workstations and tools, the characteristics of objects handled, such as their weight, size and shape, and more general characteristics of the task itself.

Organisational factors. WMSD risk is influenced by how work is organised and how tasks are combined to create whole jobs. Work organisational hazards may include high workload, high work rates, inadequate personal control or autonomy, role conflicts, lack of variety, social isolation, inadequate rest breaks, excessively long working hours, night shifts, and so on. Many of these factors can increase exposures to external loads and related physical hazards as well as increasing the likelihood of workers experiencing chronic fatigue and/or prolonged stress.

Psychosocial context. The term ‘psychosocial hazard’ is often used to include the organisational factors described above, particularly in relation to risk of psychological injuries and mental health problems. However, for WMSD risk management it is useful to distinguish effects of work organisation and job design from effects of work's social context, including the attitudes and behaviours of managers, supervisors and co-workers.

The importance of psychological stress and its physiological and behavioural correlates in WMSD aetiology is now widely acknowledged. The individual's ‘stress response’ is multidimensional, including a complex physiological dimension along with behavioural, cognitive and affective dimensions (Cox, 1978). Stress is sometimes presented as a psychosocial hazard affecting the risk of various occupational health problems including WMSDs. However, at the workplace level where a key goal is to identify and control risk from work-related hazards, it is arguably more useful to view stress as a product of such hazards, which, in combination with individual factors, partially mediates the effects of workplace hazards on WMSD risk (Eatough et al., 2012), as indicated by a dotted line in Figure 3.3. Job satisfaction, which has been shown to mitigate WMSD risk (Schoenfisch & Lipscomb, 2009), may play a similar mediating role.

Individual factors. Organisations cannot normally select employees on the basis of their age or sex, but they can ensure that the work required of people in a particular job is matched to their capacities and skill levels, thus reducing WMSD risk.

Evidence to support the complex aetiology of WMSDs

A substantial evidence base exists to support the important influence of both physical and psychosocial hazards in the development of WMSDs. Some evidence is presented here from high-quality reviews which examined longitudinal studies. This is important as it enables the examination of causation; that is, the influence of the work environment on an individual over time. A sample of recent systematic reviews are presented: this is not an exhaustive list, but it demonstrates the important influence of multiple interacting factors on WMSD risk. It is worth noting that substantial challenges exist in developing and measuring workplace interventions. The absence of evidence should not be ignored; it does not provide conclusive evidence that the hazard does not exist, but that further investigation is required.

A systematic review by da Costa et al. (2010), of longitudinal studies, found that hazards with at least reasonable evidence of a causal relationship with the development of WMSDs include heavy physical work, smoking, high body mass index, high psychosocial work demands, and the presence of co-morbidities. The most commonly reported biomechanical risk factors with at least reasonable levels of supporting evidence for causing WMSD include excessive repetition, awkward postures, and heavy lifting. Findings related to the relationship between psychosocial factors and symptoms in the neck and back are outlined in Table 3.1. No strong evidence was identified for any of the body parts reported.

Table 3. 1 Summary of hazards related to increased WMSD risk

Bodily location	Reasonable evidence	Insufficient evidence
Neck	Psychosocial factors	Heavy physical work
	Smoking	Lifting
	Sex	Sedentarism
	Posture	Older age
	Co-morbidity	High BMI
Low back	Awkward posture	Sex
	Heavy physical work	Race
	Lifting	Smoking
	Psychosocial factors	Co-morbidity
	Younger age	
	High BMI	

Source: da Costa and Vieira (2010).

Two rigorous systematic reviews were undertaken in 2011 (Hauke et al., 2011) and 2012 (Lang et al., 2012b) both examining the role of psychosocial stressors on the development of WMSDs in different body regions. Table 3.2 provides a summary of the findings from both reviews, showing the significant relationships between different psychosocial stressors and body regions. Both reviews used high-quality longitudinal studies, which strengthened the robustness of their findings, and rigorous statistical methods. The use of longitudinal studies enables aspects of causality to be determined. Key findings from these reviews provide support for the role of workplace psychosocial factors as an important independent predictor of WMSDs and that these are likely to affect body regions differently.

Table 3. 2 Summary of relationships between psychosocial factors and WMSDs

Psychosocial factors	Neck/shoulders	Upper extremities	Low back
High job demands	+	++	++
Low job control	++	+	++
High job strain	++		++
Low social support	+	+	+
Low job satisfaction		+	+
Low job security			++

+ = 1 study showed significance; ++ = 2 studies reported significance

Sources: Lang et al. (2012); Hauke et al. (2011).

Eatough and colleagues (2012) examined the link between work-related stressors and WMSD complaints. They measured 277 workers and found that high levels of role conflict, low job control, and low safety-specific leadership were associated with increased employee strain which was related to higher levels of WMSD symptoms in the wrist/hand, shoulder and lower back. This provides further support for the key role of psychosocial hazards in the development of WMSDs. It was of particular interest to note that while none of the physical hazards measured were directly related to the reporting of WMSD symptoms, the psychosocial hazards were related.

A recent prospective longitudinal study by Gerr and colleagues (2014) utilised high-quality measures of both physical and psychosocial hazards affecting WMSD risk (neck/shoulders, upper extremities) of manufacturing workers, statistically controlled for a large set of potentially confounding variables. The study analysed and reported results for physical and psychosocial hazards separately and did not discuss their comparative influence on risk. However, it is noteworthy that hazard ratios (HRs) for physical hazard exposures were mostly very low and few were statistically significant, whereas many of the HRs for psychosocial hazards were high and most were significant.

The sample of reviews and studies presented here demonstrate the substantial support for the complex aetiology in the development of WMSDs and provide valuable context for the consideration of required risk management strategies. The next section undertakes a more detailed analysis of the different hazard groups and considers them in line with currently available hazard identification tools.

Work-related hazards

The ergonomics systems model shown in Figure 3.4 represents the large and diverse range of factors known to influence WMSD risk, as outlined in previous sections. It includes two groups of factors that are largely beyond the control of the workplace: workers' personal characteristics, and external factors. Workers' personal characteristics are the unique physical and psychological strengths and weaknesses that people bring with them to work, including vulnerabilities arising from fatigue or stress due to inadequate sleep, non-work personal responsibilities and problems, pre-existing injuries or health problems and so on. These can be contextual and/or inherent and may change with time. Second, external factors include injury compensation legislation and practices; the state of the job market, pay levels and other economic factors; general societal norms concerning absenteeism and a 'fair day's work'; and of course, WHS legislation and associated codes, regulatory standards and related guidance information, and many other regulatory drivers including those related to equity, trade, work arrangements, and so forth.

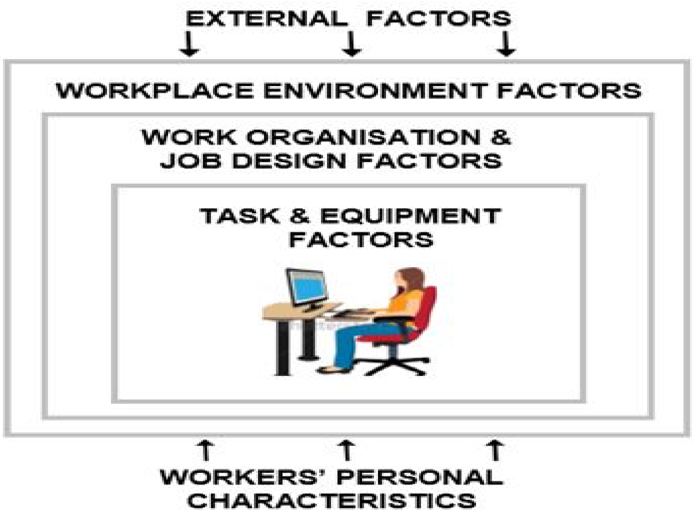

Figure 3. 4 The ergonomics systems model

Source: Macdonald and Oakman (2015).

Table 3.3 outlines the workplace factors and specific hazards that workers are exposed to. These are defined in further detail below.

Table 3. 3 Summary of hazard sources and examples

Hazard source	Hazard groups	Specific examples
Specific work tasks: task and equipment factors	Task-specific	Hazardous postures, repetitive actions, static loads, high forces, vibration, inadequate time to cope with perceptual, cognitive or psychomotor (precision) task demands, excessive emotional demands
Work organisation and job design factors	Job demands	Excessive amounts of work, long shifts, inadequate rest breaks, long week, time pressures, onerous responsibilities
Workplace environment factors	Inadequate coping resources	Low levels of workplace support: poor materials/information, poor supervisor support, poor social cohesion, low morale, inadequate training provisions Physical environment hazards: excessive cold/heat Low levels of individual resources: low physical tolerances or capacities, poor skills
Work organisation and job design factors	Additional psychosocial hazards	Inadequate personal control and autonomy Inadequate task variety and opportunities for skill utilisation Inadequate job security
Combination	High fatigue levels	At specific body locations or whole-body system fatigue

Task and equipment factors: characteristics of specific work tasks and the tools or equipment used in performing these tasks. These include the physical hazards associated with ‘manual handling’ tasks, which are widely recognised as affecting WMSD risk.

Work organisation and job design factors: how work is organised, and jobs are designed. These factors include very long working hours, pressure to complete excessively large amounts of work in the time available, inadequate rest breaks, night shifts, jobs with low control over work rate (e.g. due to a moving assembly line, frequent deadlines), little variety or interest, few opportunities to use existing skills or develop new ones, little opportunity to interact with others, inadequate support from supervisors or colleagues, and low rewards (not only financial) in relation to personal effort invested.

Workplace environment factors: This category includes both physical and psychosocial factors. Physical environment factors include air quality, extreme heat or cold, and loud noise. The psychosocial environment includes factors arising from the general workplace culture or climate, such as widespread perceptions that getting work done quickly is more important than workers’ health and safety. The psychosocial factors related to organisational climate are often considered with job design, and both act as ‘stressors’.

Although the categories here appear clearly delineated, in reality hazards interact and arise from various levels within an organisation. A systematic approach is required to identify and then control all relevant hazards for a particular organisation. Risk controls need to take into account potential interactions between the hazards and where they occur within or external to the organisation to maximise effectiveness. Beyond identification of all relevant hazards, the organisational context is important to ensure that implementation of controls is appropriately targeted and thus more likely to be effective.

Relative influence of different hazards on WMSD risk

A common perception is that physical hazards are more important than psychosocial hazards in terms of WMSD development. In reality, there is huge variation in the contribution of these two hazard groups to WMSD risk. Multiple reasons exist for this variation, including correlation between the two hazards regardless of their type, variation in measurement methods to identify hazards in workplaces, and differences between workplaces and the contextual influences of hazards on WMSD development. Workplaces vary significantly in the type of work performed there, and in the way they operate their work. In organisations that operate the same type of work in multiple locations, there may be differences in how work is managed at a local level due to the way supervisors manage the work and the resulting culture of the workplace.

Confusion remains with regard to the terminology of what constitutes psychosocial hazards, which undermines what is measured and then what is effectively controlled. Psychological health, which relates to an individual's health, is different from workplace psychosocial hazards but the two terms are often conflated. Clarity around the different psychosocial hazards and who influences these in a workplace is important as it will impact the control strategies that are most likely to be effective.

The relative influence of physical versus psychosocial hazards on WMSD risk is variable but both can have a substantial influence (Gerr et al., 2014; Lang et al., 2012b; Marras, 2008; Marras et al., 2009; Oakman et al., 2014). However, organisations and the type of work undertaken within them vary significantly. Therefore, it is hardly surprising that the influence of various workplace hazards on WMSD development is widely different (Marras et al., 2009). For example, Marras and colleagues (2008) concluded that:

> *between 11 and 80% of low-back injuries and 11–95% of extremity injuries, are attributable to workplace physical factors, whereas, between 14 and 63% of injuries to the low back and between 28 and 84% of injuries of the upper extremity are attributable to psychosocial factors.*

It is clear that psychosocial hazards are not peripheral to physical hazards. That is, psychosocial hazards can be directly involved in the development of an injury and in some cases are more important than physical hazards. Therefore, control of both sources of hazard—physical and psychosocial—is critical for the effective management of WMSDs. Importantly, the cumulative nature of WMSD development (as highlighted in Figure 3.5), along with the complex aetiology, means that focusing only on the events that occur at the time of injury is likely to lead to missing key causal factors. Risk management approaches that identify hazards early (when symptoms begin) are likely to result in more accurate identification of the relevant factors contributing to the hazards that impact individuals in a work environment.

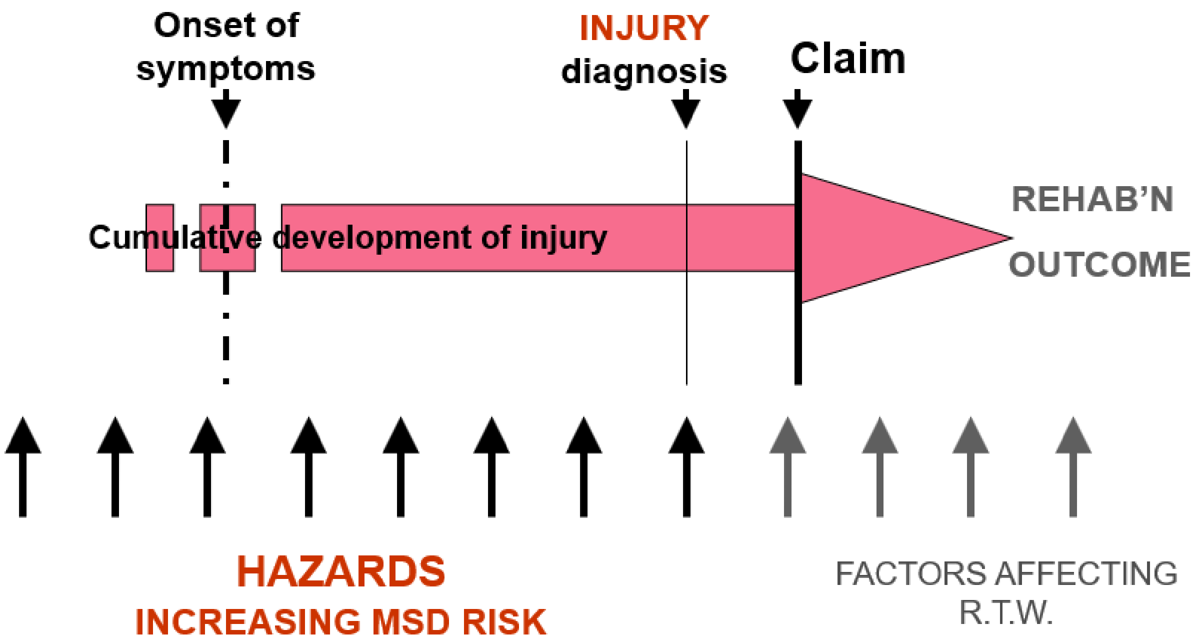

Figure 3. 5 Cumulative WMSD development

Note: The large arrow in this figure represents the cumulative development of many WMSDs, which in this case leads to diagnosis of an injury, possibly leading to submission of a compensation claim followed by rehabilitation and eventual return to work.

Source: Macdonald and Evans (2006).

WMSD hazard identification strategies

A range of methods exist to support the identification of workplace hazards associated with the development of WMSDs, most of which involve the analysis of snapshots of tasks undertaken by workers as part of their overall job (Figure 3.6). A key criticism of such an approach is that this does not take into account the interactions between different hazards that workers are exposed to, which is an important part of WMSD aetiology (Marras et al., 2009). Given the extensive list of potential hazards related to increased WMSD risk, discussed above, it is important that appropriate methods are available to assist with the identification of all relevant hazards. Traditional methods used to identify hazards do not readily support the identification of interactions between different hazards. An interaction can occur when the effect of one hazard is related to the effect of another. That is, the presence of two different hazards on WMSD risk may be greater than the impact of each one separately. Interactions can occur between physical hazards, psychosocial hazards or a combination of both.

Participative approaches are essential. Worker participation is particularly important to assess risk from psychosocial hazards, since few of these hazards are directly observable by others, and the extent to which they generate stress, and hence their effect on risk, depends on workers' personal perceptions of them (Kop et al., 2016; Way, 2012). Even with purely physical hazards, there is evidence that workers' own ratings can be more valid indicators of the extent of WMSD risk than are observation-based measures (Barrero et al., 2009). Unsurprisingly, empirical evidence supports the concept that WMSD risk is reduced more effectively when workers are active participants in risk management (Burgess-Limerick, 2018; van Eerd et al., 2010).

Most of the tools listed in Table 3.4 focus on individual tasks, and a snapshot of an individual's job. While this may be useful for identification of some hazards, it does not take into account an individual's total exposure over a day, i.e. the job level exposure.

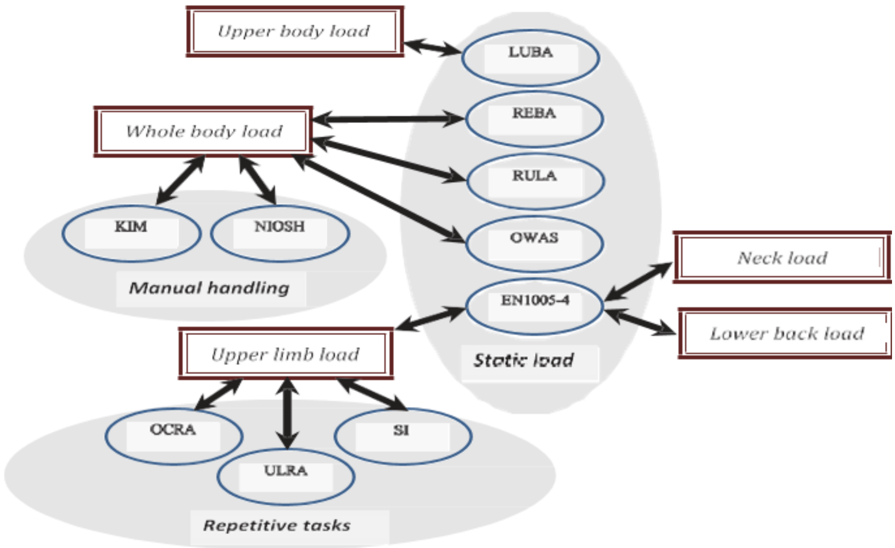

Figure 3. 6 Division of methods according to the body part assessed and work tasks

Source: Roman-Liu (2014). Reproduced with permission.

WMSD hazard exposure and dose

Risk assessment using the range of tools outlined above, or others, provides an indication of the overall level of risk that occurs through exposure to one or more hazards. Duration of hazard exposure and hazard severity are important. Overall risk is likely to depend on the total dose (hazard exposure) required to increase the injury risk to which workers are exposed. Many WMSD hazards arise from the hazardous nature of people's activities. This means that hazard severity may be highly variable throughout a work shift, to an extent depending on how repetitive the workplace activities are. The design of an individual's work, and work pattern, are critical aspects of hazard exposure.

Dosage in relation to WMSD hazard exposure is a contentious issue and is widely debated amongst the WHS profession. Two key issues emerge: firstly, what are the most appropriate measures to identify hazard exposure (dosage); secondly, what are the levels at which injury risk increases (dose-response). At present there are no definitive answers and it remains a topic for debate and future research. However, the importance of taking a comprehensive view of the work environment is not debatable, and better dissemination of the linkages between different aspects of the work system and their impact on employees are critical so that all relevant hazards to which a worker is exposed can be identified and controlled.

Table 3. 4 Hazard identification/risk assessment methods for WMSD risk

Method	Summary of hazards assessed	Code reference*
Methods assessing loads and postures		
OWAS: Ovako Working Posture Analysis System (Karhu et al., 1977, 1981)	Analyst assess risk across 84 whole body postures	WSV
Revised Strain Index. (RSI)	Assesses six variables: intensity of exertion, duration of exertion efforts per min, hand/wrist posture, speed of work and duration of task per work shift	WSV
RULA: Rapid Upper Limb Assessment Tool (McAtmney and Corlett,1993)	Assesses risk due to postures: focus on upper body	WSV
REBA: Rapid Entire Body Assessment (Hignett and McAtamney, 2000).	Extension of RULA but covers the whole body	SWA
Snook (Liberty Mutual) tables	Tables to provide what comprises and acceptable load based on a range of task parameters	WSV
3D Static Strength Prediction Program™ (3DSSP)	3D SSPP software predicts static strength requirements for tasks such as lifts, presses, pushes, and pulls.	SWA WSV
Methods assessing repetition		
OCRA (Occupational Repetitive Actions) (Occhipinti, 1998; EN 1005-5:2007)	Assessment based on a recommended number of reference technical actions. The number is derived from a product of multipliers describing repetitiveness of task postures of the upper limbs, exerted forces and cycle times considers movement of the forearm only.	SWA WSV
ACGIH TLV for hand activity (HAL)	Assessment of repetition, peak finger force	
NIOSH Lifting Equation (NIOSH LE)	Assessment of overall risk, taking account of loads, distances, postures, rate, duration each generate a numeric "multiplier"	WSV
Methods assessing a wider range of physical hazards		
ManTRA – Manual Tasks Risk Assessment	Assessment of daily duration (5 levels), repetition (5), force (5), speed (5) [force and speed combined as exertion (5)], awkwardness – deviations from joint mid-range (5), vibration – WBV or HAV (5)	SWA WSV
Participative Ergonomics for Manual Tasks (PErforM)	Provides a framework to help employers engage with workers at all levels to identify, assess and control manual tasks risks within their workplace	SWA
Methods assessing physical and psychosocial hazards		

Method	Summary of hazards assessed	Code reference*
A Participative Hazard Identification and Risk Management Toolkit (APHIRM) (developed by researchers at La Trobe University)	Assessment of physical and psychosocial hazards, the results are used to develop a top 10 hazards list for workplaces to use to develop an action plan	
Quick Exposure Check - worker questionnaire (QEC)	Assessment of posture (back, shoulder/arm, wrist/hand, neck; loads, repetition, duration, exertion, visual demand, vibration, and some psychosocial hazards	WSV
Methods assessing psychosocial hazards		
Australian Workplace Barometer (AWB)	Assessment of psychosocial safety climate through a 12-item scale which measures a range of psychosocial risk factors	
PAS 1010 (http://www.prima-ef.org/pas1010.html)	Provides practical guidance on the policies and key principles involved in the management of psychosocial risks in work environments and how organisations can help tackle these issues.	
Copenhagen Psychosocial Questionnaire (COPSOQ) (based on composite (Danish) stress model)	Assessment of risk from multiple types of psychosocial hazard and hazardous states: constructs include demands, influence, development, control, and psychosocial environmental factors	WSV
Job Content Questionnaire (JCQ)	Based on the Demand-Control-Support model – one of the most widely used and best validated means of assessing psychosocial hazards for stress-related health problems but has rarely been applied specifically in assessing WMSD hazards.	WSV
Work Organisation Assessment Questionnaire (WOAQ)	The Work Organisation Assessment Questionnaire (WOAQ) was developed as part of a risk assessment tool for the manufacturing setting, since validated for use in other sectors	SWA WSV
Methods assessing hazards personal states: fatigue and discomfort		
Nordic Musculoskeletal Questionnaire	Survey to identify body part discomfort across	
Fatigue Index Calculator (developed by UK Health and Safety Executive)	A calculator with two separate indices, one which relates to fatigue (Fatigue Index) and one that relates to risk (Risk Index)	

*Referred to in SWA Model Code (SWA) or WorkSafe Victoria Compliance Code (WSV). The other relevant compliance code for WA: Code of practice for Manual tasks (2010) does not refer to any additional tool.

4 WMSD intervention

Overview

This section presents evidence on interventions to prevent WMSDs. Interviews with a range of key stakeholders on the current approaches to WMSD prevention in Australia are presented, along with a review of barriers to effective implementation of interventions.

WMSD prevention activities are often considered within the following three levels, although the third level is not strictly prevention as it occurs after an injury has occurred (Steenkamer et al., 2017):

- Primary intervention—interventions are proactive to eliminate or reduce exposure to hazards and associated risk levels within a healthy workplace population
- Secondary intervention—activities that are ameliorative to promote early detection of WMSD, at a stage when symptoms are mild and potentially reversible
- Tertiary intervention—activities are reactive and include return to work and rehabilitation for individuals with clinically diagnosed WMSDs.

In occupational health and safety, primary prevention activities should underpin effective risk management to reduce WMSDs. Hazard identification, assessment of risk and development of appropriate controls are all fundamental aspects of risk management.

Two basic requirements are needed for effective workplace management of occupational health problems that have multiple potential causes, such as WMSDs. The first is that risk from all potentially important hazards must be taken into account: this includes both physical and psychosocial hazards. An extensive list of hazards associated with WMSD development was outlined earlier in this report. Effective intervention can only occur if these hazards are measured to identify their particular significance in a workplace. The intervention must be relevant, taking into account the contextual environment, and include development of targeted controls relevant to a particular organisation.

The second requirement is that the risk control actions must be as high within the general hierarchy of risk control as is reasonably practicable (see Model WHS regulations). According to this hierarchy, highest priority must be given to actions that eliminate or at least reduce the severity of a hazard, since this kind of action is most reliably effective. Figure 4.1 shows the general hierarchy as adapted for workplace use in WMSD risk management by WorkSafe Victoria.

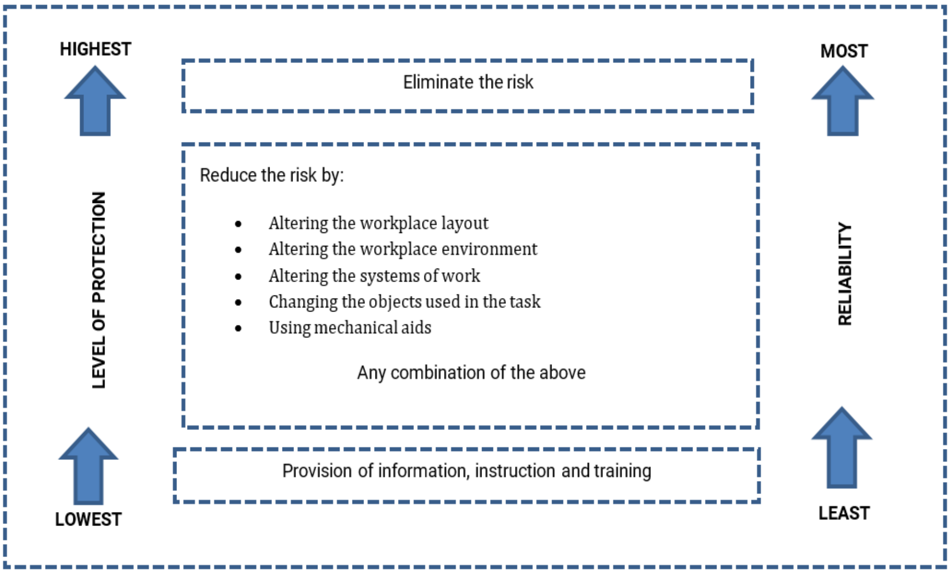

Figure 4. 1 Effectiveness and reliability of risk control measures to reduce risk of musculoskeletal disorders

Source: WorkSafe Victoria (2016). Reproduced with permission.

In the conventional hierarchy, priority order is: eliminate the hazard; reduce severity of the hazard; and prevent or minimise exposure to the hazard by various means that are also prioritised. It was initially formulated during the 1950s by the US National Safety Council (Ruschena, 2017), with a clear focus on physical hazards of various kinds—chemical and biological substances, air quality and temperature, noise, radiation, electricity, and various physical characteristics of work equipment and workplace environments. Consistent with this physical focus, Olishifski (1976), p.439) specified the hierarchy as “substitution, alteration of the workplace, isolation or enclosure, wet methods to reduce dust exposure, local exhaust, general ventilation, personal protective devices, good housekeeping, medical controls, and training.” More recent versions all include ‘Elimination’ at the top of the hierarchy. Table 4.1 provides a comparison of five different versions of the hierarchy of risk controls used internationally.

The hierarchies of the US National Institute for Occupational Health and Safety and the Model WHS Regulations (Safe Work Australia) retain the original focus on physical hazards, implicit in terminology such as ‘physically remove the hazard’, ‘replace the hazard’ and ‘isolate people from the hazard’. The International Labour Organisation, UK Health & Safety Executive and EU Directive hierarchies still have a largely physical focus but also recognise the potential importance of organisational means of controlling risk, particularly the UK version. That puts ‘redesign the job’ at the top of the hierarchy, and second ‘it suggests substituting the ‘process’ (alongside ‘material’) to reduce risk. The ILO hierarchy identifies ‘organisational measures’ as the second-highest priority, on a par with ‘engineering controls’, while the EU Directive includes ‘organisational measures’, following ‘technical measures’ as a means of reducing risk. The greater recognition and prioritising of organisational means of controlling risk in these three versions of the hierarchy is probably due to greater awareness among WHS regulators and international NGOs of the need to control risk from work-related psychosocial hazards and stress, which are now known to be key factors in the complex aetiologies of various occupational health problems including mental, musculoskeletal and cardiovascular disorder.

Table 4. 1 Comparison of different versions of the hierarchy of risk controls

Priority order	US National Institute for Occupational Health and Safety[a]	Model WHS Regulations[b]	International Labour Organisation[c]	UK Health & Safety Executive[d]	EU Directive 89/391/EEC—OSH Framework Directive[e]	
Highest	**Elimination:** physically remove the hazard	**Level 1** – **Eliminate** the hazards	**Eliminate** t he hazard/risk	**1. Elimination: redesign the job** or **substitute a substance** so that the hazard is removed or eliminated	**Avoid** risks, **eliminate** hazards	
	Substitution: replace the hazard	**Level 2** – **Substitute** the hazard with something safer – **Isolate** the hazard from people – Reduce the risks through **engineering** controls	Control the hazard/risk **at source**, through … **engineering** controls or **organisational** measures	**2. Replace the material or process** with a less hazardous one	**Reduce, minimise hazards** AND **separate hazards** from persons (workers, visitors, etc.)	… by **technical** measures
	Engineering controls: **isolate** people from the hazard			**3. Engineering** controls [including] … **separate the hazard from operators** … [Prioritise measures that] **protect collectively** over individual measures		… by **organisational** measures
Lowest	**Administrative** controls: change the way people work	**Level 3** – Reduce exposure to the hazard using **administrative** actions – Use **personal protective equipment**	Minimise the hazard/risk by the design of **safe work systems**, which include **administrative** control measures	**4. Administrative** controls: … **procedures [needed] to work safely**. For example: … job rotation … safety signage … risk assessments		… by **personal** measures
	PPE: protect the worker with **personal protective equipment**		Where residual hazards/risks cannot be controlled by collective measures, … **personal protective equipment**	**5. Personal protective clothes and equipment**	Improve **safe behaviour**	

[a] https://www.cdc.gov/niosh/topics/hierarchy/
[b] https://www.safeworkaustralia.gov.au/system/files/documents/1702/how_to_manage_whs_risks.pdf
[c] https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_107727.pdf (Section 3.10.1)
[d] http://www.hse.gov.uk/construction/lwit/assets/downloads/hierarchy-risk-controls.pdf
[e] Interpreted by Kuhl and Bruck (2017) https://oshwiki.eu/wiki/Hierarchy_of_prevention_and_control_measures

This makes sense when exposure to the hazard is intrinsically harmful, at least at levels above some objectively measurable point, as is typically the case for the many, widely-recognised physical hazards. Noise is a good example: there are clearly defined levels at which exposure can cause damage, and therefore clearly defined controls to bring the hazard down to a level within acceptable ranges.

However, the hazards affecting WMSD risk are not of this type, as outlined earlier in this report. In the case of the physical hazards of 'manual handling' work tasks, they are intrinsic to the physical performance of many work tasks, and it is not desirable to eliminate, or even necessarily to minimise, physical actions and energy expenditures. Much the same holds true for psychosocial hazards; for example, both very high and very low workloads can be hazardous (Bakker et al., 2010; de Jonge et al., 2010; Lang et al., 2012b), so the aim should be to optimise rather than minimise (Macdonald, 2006). However, currently available hierarchies of risk controls do not provide sufficient guidance on how to do this.

Significant challenges exist in determining a level for psychosocial hazards which constitutes 'safe'. To address this issue we need a revised hierarchy of risk controls, one that is more nuanced and provides guidance for managers and supervisors in identifying, assessing and then controlling hazards and risks in their own workplaces. Given the wide variability in how work is done, and the organisational environments, workplaces must have autonomy in developing suitable controls that can be implemented and are sustainable. Involving workers in that process is paramount and well supported by research evidence as an effective way of improving the development of risk controls that are accepted by workers and therefore are more successfully implemented. A need exists for a revised hierarchy of risk control, and Australian researchers are currently working on one.

To reduce WMSD risk, the lowest-priority actions include provision of information or training intended to modify the behaviour of workers so as to reduce their risk (Oakman et al., 2019; WorkSafe Victoria, 2016). For example, training workers in 'safe' lifting techniques falls at the bottom of the hierarchy; there is substantial empirical evidence that such training is ineffective (C. Haslam et al., 2007; Verbeek et al., 2012). Job redesign to eliminate or reduce the need for heavy lifting is placed at the top of the hierarchy. Providing workers with opportunities to schedule their work so they can prioritise important tasks or break up more difficult tasks across the day to optimise performance is a higher priority than training someone in time management, for example. A currently popular option in workplaces is the provision of resilience training, designed to change individuals' inherent ability to better 'survive' the work. While this type of training may have merit for particular situations and individuals where fitness is a requirement in a workplace setting, if the work is organised so a worker is overloaded with too many tasks the training is unlikely to be effective. Changes to job design to reduce overload are more likely to result in positive outcomes for the worker and their employer (Safe Work Australia, 2015b).

Evidence for the effectiveness of WMSD interventions

This section presents a sample of the research literature on interventions to prevent WMSDs. The key aim of this review is to identify primary intervention research undertaken to reduce the incidence of WMSDs, and to provide examples of the range of interventions. An inclusive approach to the review was adopted and examples of interventions are grouped into categories, based on a modified macro ergonomics framework (see Figure 3.4). Interventions are categorised according to the level at which they occur within the framework, from the individual up to the organisational level and beyond the workplace. Macro ergonomics, based on sociotechnical systems theory, can be defined as a systematic approach which considers the organisational and sociotechnical context of work activities and processes with their subsequent impact on an individual's health, wellbeing and ultimately productivity (Hendrick et al., 2002). It is used here to consider the large range of factors that influence WMSD risk, as presented earlier in this report. The framework provides a useful approach to consider these factors within a workplace system, and the level at which hazard reduction strategies are being targeted. Examples of interventions within each category are provided below.

Individual. These interventions are focused on changes to an individual's behaviour. They include training, exercises, education and other behaviour change approaches.

Task-specific and equipment factors. These interventions are focused on changes to an individual's equipment. They may include workstation adjustments, or the provision of a tool or piece of equipment to reduce physical demands on an individual. Changes to the broader physical or psychosocial environment were not included in this category.

Work organisation and job design factors. These interventions are targeted at making changes at an organisation level, such as working hours, overall job design or manager training in comprehensive WHS risk management. Interventions might cover addressing workload, inadequate rest breaks, and reducing work hours, for example.

Workplace environment factors. Interventions are focused on addressing risk arising from the physical and psychosocial environment. These include air quality, extreme heat or cold, and loud noise. The psychosocial environment includes factors arising from the general workplace culture or climate, such as widespread perceptions that getting work done quickly is more important than workers' health and safety, low job security, autocratic style of management with minimal participation by employees at lower levels, and so on.

Multifactorial. These interventions include a combination of interventions, such as a change to an individual's workstation and training. Changes might be at the same levels in the system but include multiple aspects of intervention.

Individual focused interventions

Individually focused interventions target an individual worker's behaviour. Interventions in this category included education of individuals in how to set up a workstation, body biomechanics or what constitutes good working postures in lifting (technique training) or seated work.

Education

Education of workers includes training in how to apply 'correct' manual handling techniques, which is a popular intervention in WMSD prevention. A number of reviews on interventions that have used training in 'correct lifting techniques' as a primary prevention strategy have been undertaken (C. Haslam et al., 2007; Hogan et al., 2014; Martimo et al., 2007; Verbeek et al., 2012). The conclusions from each of these reviews are consistent—that training as a control method to reduce WMSD risk is not effective. This is an expected finding and is consistent with the hierarchy of risk controls, which considers training as the least effective method of reducing risk.

A Cochrane review of workplace interventions to reduce neck pain reported that the quality of evidence was very low in relation to the reduction of pain as a result of workplace interventions (Aas et al., 2011). However, moderate-quality evidence supported the impact of workplace interventions on reducing sick leave related to neck pain. A key recommendation was the need for higher-quality research, as this was likely to influence the findings. Of note is that all interventions were targeted at people who already had neck pain, rather than more general prevention for all workers. The interventions used in the analysis were education-based and included information about stress management, principles of ergonomics, anatomy, musculoskeletal disorders, and the importance of physical activity. Interventions related to the teaching of 'pause gymnastics' included how to use a relaxed work posture, proper positioning, the importance of rest breaks, and strategies to improve relaxation. Some studies also included how to modify work tasks, work load, working techniques, working positions and working hours. Several studies suggested how to make adjustments and recommended alternatives to the existing furniture and equipment at the workplace.

Exercise programs

A further group of individually focused interventions included those which provided exercise-based activities for a range of different occupational groups. A range of challenges exist with this type of intervention, one of which is adherence to the intervention. At the start of an intervention, engagement is high but dropout rates are also often very high, making it challenging to determine effectiveness.

Task-specific interventions

Task-specific interventions are focused on the provision of equipment or aids to reduce the physical loads required by workers to undertake specific tasks within their job. These include addition or change to a component of the workstation. The overarching aim of these interventions is to reduce loads on individuals while working. Many examples in the literature are descriptive case studies, some with pre and post measures. Examples of task-specific interventions from the literature include the following:

- seating to move work from floor to seated position (Afshari et al., 2015)
- a chair to facilitate access in car manufacturing (Ferguson et al., 2012)
- a new method for brick layers (Luijsterburg et al., 2005)
- devices to improve visual acuity (Aghilinejad et al., 2016; Hayes et al., 2014)
- motorised devices to reduce worker wrist and arm rotation (Albers et al., 2007)
- motorised lifting devices to reduce the carrying load of workers (Armstrong et al., 2017; Dormohammadi et al., 2012)
- redesigned agricultural equipment to accommodate body shapes of workers (Kotowski et al., 2009; May et al., 2008; Singh et al., 2012)
- adjustable keyboards to accommodate various worker body shapes (Smith et al., 2015)

- tripods to assist with overhead drill elevation (Rempel et al., 2010)
- provision of overhead hoists (Silverwood et al., 2006)
- changes to a woodwork bench design (Sudiajeng et al., 2012)
- biofeedback equipment to foster worker behaviour change (King et al., 2013)
- changes to the type of footwear used by workers (Vieira et al., 2016).

In relation to the hierarchy of risk controls, changes to a worker's task are considered more effective than administrative controls such as training. In this category of task-specific interventions, a reduction in the loads and forces to which a worker is exposed is likely to reduce WMSD injury risk. A challenge with the research evidence in this category of interventions is that many of the studies are descriptive in nature and do not provide evidence of change over time or demonstrate sustained injury reduction. That is, although the intervention may reduce discomfort levels at the time of the intervention, changes may or may not be sustained. A need for improved evaluation is required (discussed in a later section). However, reducing exposures is in line with principles of effective risk management.

Burdof and colleagues (2013) undertook a data simulation and used relevant literature which described the impact, in health care organisations, of introducing lifting devices. The study compared the effect of mechanically aided versus manual lifting of patients on the occurrence of low back pain (LBP) or WMSDs. They found that significant attention in the implementation phase was required to demonstrate changes in LBP or WMSDs. That is, unless the equipment is introduced so that there is a substantial reduction in manual handling of patients, limited change in injury rates will be demonstrated.

Multifactorial interventions

Work organisation and job design factors

Organisational interventions can be defined as planned, behavioural, theory-based actions that aim to improve employee health and wellbeing through changing the way work is designed, organised and managed (Nielsen, 2013; Richardson et al., 2008). A limited number of work organisation and job design interventions to reduce WMSD risk have been reported in the literature.

A recent review by Stock and colleagues (2018) examined whether interventions that target the work organisation or the psychosocial work environment are effective in preventing or reducing work-related musculoskeletal disorders. They examined 28 studies using rigorous review principles and found moderate evidence that supplementary breaks, compared to conventional break schedules, are effective in reducing symptom intensity in various body regions. For all other interventions the evidence was low-to-very-low quality, primarily due to risk of bias related to study design, high attrition rates, co-interventions and insensitive indicators. The authors concluded that the design of interventions was problematic, and this required further attention so that more categorical conclusions could be drawn from the studies.

Fujishiro and colleagues (2005) undertook an intervention study in health care facilities. The program was administered at a state level, and involved ergonomics consultation and financial support for the installation of devices to reduce WMSD risk. Institutions were required to fulfil a range of criteria to participate in the program. Over the follow-up period, WMSD rates decreased in three-quarters of participating facilities. An interesting finding was that despite variation in what individual organisations did, there was no difference in the size of the change; that is, doing something rather than nothing was successful. A contradictory finding is that single and multifaceted interventions were as effective as each other, which is not in line with other studies which found greater impact on WMSD reduction with multifactorial interventions (Wilson, 2014). This study has a range of limitations, but it highlights the importance of funding for implementation devices, which may have contributed to the success of the overall program.

Comper and colleagues (2017) undertook a randomised control trial which examined use of job rotation verses training of workers, with sick leave related to musculoskeletal disorders as an outcome. Although job rotation is an administrative control in relation to the hierarchy of risk controls, in this context it was considered a change to the person working, resulting in reduced exposure. The training program had previously been evaluated and was not effective, so this was the control group. Despite the rigor of this intervention, sick leave due to musculoskeletal symptoms actually increased; that is, the intervention of job rotation was not effective. Job rotation involves reducing exposure to hazards associated with tasks and is an administrative control. However, this intervention was administered at an organisation level. The results from this intervention support the concept that administrative controls are an ineffective substitute for changing the characteristics of the job, or physical design changes.

Leyshon and colleagues (2010) reviewed effectiveness of workstation design and various personal equipment changes, describing effectiveness of all interventions reviewed, but called for additional research to enhance the credibility of specific interventions. This is supported by Andersen and colleagues (2011) in their review of interventions for computer workers, stating that evidence is inconclusive as to specifics of effectiveness but that the most effective interventions were those that included a combination of workstation redesign and equipment change in conjunction with educational programs.

Australian stakeholders' perspectives

To explore the context of WMSD interventions in Australia, semi-structured interviews were undertaken with 20 key stakeholders. Participants comprised regulators, WHS consultants and industry association representatives (Table 4.2).

Interviews were conducted over the telephone and ranged from 30–45 minutes in duration. Question topics included: what constitutes effective interventions to reduce WMSDs, what data is used to inform the development of interventions, and what gaps exist in the current implementation of interventions in Australia.

To maintain the confidentiality of participants, the use of direct quotations has been limited.

Table 4. 2 Interview participants' demographics

Area of employment	Number of participants	Jurisdictions represented
Regulators	8	NSW, WA, VIC, SA, QLD
Consultants (external and internal to the organisation)	9	VIC, SA, QLD, National
Industry associations	3	National, NSW

Overview of the current landscape

Participants reported on their observations of current WMSD intervention strategies and were concerned about the role of the regulator, the changing nature of employment and the complexity of risk management systems. It was proposed that the role of the regulator in the WMSD landscape needs redefining. Some interview participants considered expertise had been lost and that existing specialist resources, staff and tools are now insufficient to support the development of good-quality interventions that reflect the complex aetiology of WMSDs. One participant referred to the 'linear' approach to guidance material, which often prevented a more creative or holistic approach to problem solving.

Many participants reported a need for simplification of the overall approach to WMSD risk management, so that all organisations, large and small, are able to develop effective strategies to reduce their incidence of WMSDs. For example, a participant suggested that the manual task code of practice was not clear or succinct enough for SMEs. Several participants raised a need for a focus on risk controls rather than the assessment process.

Precarious work (e.g. contracting or labour hire) was considered an issue, because workers are much less likely to report injuries where they consider future work opportunities may be negatively impacted. This systemic under-reporting means that compensation data does not accurately reflect WMSD rates, particularly in sectors with high rates of casualisation and temporary contracts. In these sectors, injured workers were considered to be invisible. One participant noted that, despite recent trends in the labour force, the focus is still primarily on the permanent workforce.

Accessing resources

Participants spoke about access to, and use of, various resources like data, research evidence and online tools. Consultants raised the value of academic literature but reported being frustrated by not being able to gain access to peer reviewed journal articles. In contrast, regulators reported having access to multiple resources such as libraries, advisers, association memberships, and survey data.

Using evidence

Participants reported that the use of evidence to design and implement interventions was inconsistent. Issues of concern included the terms of a consultant's engagement, and a tendency to use interventions not grounded in evidence, such as training and other administrative controls. Some reported that organisations were hopeful that bringing in a consultant would solve their WMSD problems. Regulators, consultants and industry association-participants were consistent in their views on the need for evidence-informed interventions. A common theme among participants was the lack of a contemporary evidence base and an over-reliance on doing things the way they have always been done including recommending manual handling training. One participant noted that the business arrangement between the organisation and the consultant can involve potential conflicts of interest and therefore undermine the task of identifying WMSD problems.

Accurate data

Workers' compensation data is frequently used to inform WMSD intervention decisions. However, a number of participants raised concerns about the quality of such data, and its use to inform prevention strategies. Participants supported using information beyond the current compensation data to inform intervention development and improving the quality of data being collected to better capture the information needed to inform prevention strategies. It was suggested a need exists to move beyond a single focus on targets to collecting and evaluating data which addresses workplace WHS issues more holistically.

Interventions

Participants discussed a range of enablers and barriers to the success of WMSD interventions. Key enablers included having appropriate management support, high levels of worker participation and accurate hazard identification. These enablers are consistent with a comprehensive approach to risk management. However, such an approach is not consistently used, with organisations tending to focus on individual hazards, and thereby failing to take into account the system of work.

Management support was considered imperative to the success of interventions. Despite challenges for small and medium-sized organisations, the commitment of leaders in organisations was considered an integral component of making a difference, rather than the size of the business. Also reported was that commitment to continuous improvement and making the link between safety and efficiency leads to better outcomes.

Participants suggested that success was possible once the (unsupportive) leadership had changed and trust between management and employees was regained through demonstrable changes and input from senior leaders. One participant suggested that very clear management interest and visibility was important to reduce scepticism about tokenism in relation to safety.

Reflecting on the current state of current knowledge of WMSD prevention, one participant suggested that, compared to 20 years ago, the problem is not a gap in knowledge but rather difficulty in achieving senior management 'buy-in' to support evidence-based strategic approaches.

Worker participation was considered an essential part of ensuring the success of interventions. Organisations using a participative approach were considered by interview participants to be more likely to implement successful interventions than those without such an approach. Participants suggested this includes risk management programs that acknowledge the complex nature of hazards within organisations along with appropriate provision of resources to support interventions, with active participation of workers.

Barriers

Barriers to effective interventions included organisational priorities, reliance on administrative controls, inadequate resourcing and the skills of key stakeholders.

Organisational priorities

Conflicting organisational priorities made implementing change problematic. Without leadership commitment, as presented above, and a decision to prioritise evidence-based solutions and implementing higher order controls rather than modifying worker behaviours, substantial change was considered unlikely to be successful. The failure to provide financial resources was also described as a barrier to the development of effective interventions. One participant gave an example from the aged care sector, in which staff were instructed to manually lift residents who didn't want to be moved on a lifting machine, thereby risking injury to staff.

Administrative controls

An over-reliance on administrative controls was a common theme raised by participants. Manual handling technique training and stretching were still being used by organisations as control measures to reduce WMSD risk, despite the lack of evidence to support their effectiveness. Higher-level controls such as reducing the risk through design were often overlooked. One participant recalled that a proposed solution to the difficulty of pushing new trolleys with undersized wheels along thick carpets was for staff to 'brace their core', rather than fix the wheels.

Lifting technique training or 'safe-lifting' was raised repeatedly as a common intervention strategy, because it was considered cheap and easy to implement. One participant also suggested that because manual handling is considered a low-risk activity in most instances, businesses often prioritised chemicals or the more obvious 'high risk' physical hazards.

Skills of key stakeholders

The development and implementation of effective interventions requires all key stakeholders to understand the complexity of WMSD aetiology and the important role of psychosocial and physical hazards in their development. However, the level of understanding across key stakeholders of the role of psychosocial hazards in WMSD development was variable. Some participants stated that organisations were sufficiently challenged by the physical hazards and considered psychosocial hazards to be the next level and beyond their ability to manage. A common view was the need for further education of managers and supervisors on the connection between psychosocial hazards and WMSDs. Some participants noted that mental health and psychosocial hazards are often conflated, despite the former being an outcome and the latter a workplace environmental hazard. Two participants from different employment areas pointed to a lack of expertise among safety practitioners around the health aspects of WHS, especially concerning psychosocial hazards.

Participants also noted that a focus on establishing the incident that caused the WMSD often exacerbates the problem. Most WMSDs are cumulative in nature and the focus on a single incident is unlikely to be relevant. Nevertheless, one participant noted that questions like ‘When did it happen?’ and ‘What were you doing?’ were still the focus of incident reporting and workers’ compensation. It was also suggested there is a common focus on ‘safety’ without recognition of the health aspects of WHS.

Synthesis of intervention evidence

Comprehensive interventions that address all workplace hazards - physical and psychosocial - are limited. Most interventions for WMSD prevention are focused on changing an individual’s behaviour or reducing task-specific hazards, with no consideration of the broader contextual factors which are associated with the complex aetiology of WMSDs. Of particular note is that most interventions do not address risk from psychosocial hazards at their workplace sources that is taking a systematic approach to identification and then control of the identified hazards (e.g. changes to job design). Even studies at an organisational level that involved changing aspects of a person’s job, often used administrative-based controls to achieve change. This finding is supported by the stakeholder interviews, where a continued focus on the use of training and individual approaches was reported. Interview participants outlined very limited examples of systematic approaches to WMSD prevention that addressed the wide range of hazards known to be associated with the development of WMSDs.

This significant gap in current practice offers important opportunities in primary prevention strategies to improve the effectiveness of interventions to reduce the significant burden of WMSDs. To effectively address the multifactorial nature of WMSDs, interventions will need to move beyond simple approaches to identification and then control of workplace hazards. Hazard identification will need to capture physical and psychosocial hazards and enable these to be used to inform relevant risk controls that are at an appropriate level in the hierarchy of risk controls; that is, at a higher level than is currently the focus. Relevant tools and education are needed for workplace practitioners to facilitate these changes. The research evidence supports the need for this type of education, but uptake by workplaces has not been widely adopted as supported by interview participants. A clear message from research evidence is lifting technique training is not effective, yet it remains a widely-used prevention strategy. A comprehensive strategy is needed to address such gaps, which educates workplace managers and supervisors, and external consultants engaged by organisations. A further issue is the need for more rigorous evaluation of interventions so that useful conclusions can be drawn, to inform future prevention strategies.

Barriers to effective implementation of WMSD interventions

The complexity of workplaces and developing sustainable, effective interventions is widely acknowledged. A range of barriers impede successful implementation and must be considered in order to improve uptake and sustainability of effective WMSD prevention strategies.

Failure to adopt a ‘systems’ approach to risk management

A need exists for a broad, integrated ‘systems’ approach to risk management, rather than the current focus of WMSD risk management on specific tasks.

Inadequate adherence to the hierarchy of risk control

There appears to be inadequate adherence to the hierarchy of risk control; for example, the continuing use of low-level forms of risk control such as training in lifting techniques, despite strong evidence that it is an ineffective WMSD countermeasure. There is limited evidence of a focus on the prevention of hazards by high-level strategies, including design of buildings and facilities, to ensure ample space for work performance using optimal equipment or organisation of work to enable flexible scheduling.

Role of management commitment, organisation culture and climate

Employers and senior managers should play a key role in establishing a workplace culture and climate that is conducive to the development and implementation of effective interventions. However, managers vary in their ‘stage of change’ concerning knowledge and understanding of key requirements for effective WMSD risk management. The stage of change model (R. Haslam, 2002) makes an assumption that behaviour change is a dynamic process. An individual's readiness to change is assessed using a short series of closed questions after which a participant is assigned to one of five stages: 1. Pre-contemplation (unaware or unconcerned about workplace hazards); 2. Contemplation (considering change but not yet ready to act); 3. Preparation (intend to change in the near future); 4. Action (made changes in the previous six months); 5. Maintenance (made change and are working to consolidate gains and avoid relapse). Determining the range of stages at which individuals are operating allows advice to be tailored so it is more likely to be effectively implemented (Oakman et al., 2016; Rothmore et al., 2017).

Importance of worker participation

The active participation of stakeholders, including workers at risk, appears to be a key element in effective interventions—particularly ‘participative ergonomics’. Therefore, workers at risk of developing WMSDs (or their representatives) should be actively involved in implementing ergonomics knowledge during the process of identifying hazards, reviewing possible controls, and implementing changes. Under all Australian WHS and OHS legislation, there is a duty to consult with workers on WHS matters.

Role of legislation, codes of practice and related documents

Relevant codes and guidance documents are the primary means by which workplace ‘duty holders’ are expected to identify and control WMSD risk. Documents are typically narrow in approach and not easily transferrable into everyday practice, particularly in the identification and control of psychosocial hazards.

Role of competencies in WMSD risk management

As already noted, training to develop staff competencies in lifting or other manual handling techniques does not provide substantial protection, if any, against WMSD risk. However, programs to enhance managers’ skills in WMSD risk management competencies would be an effective means of reducing risk. There is now a considerable amount of research evidence that shows programs to enhance workers’ competencies in hazard identification and risk control related to their own jobs can make a significant contribution to reducing WMSD risk.

Participation

Participation in the development of effective interventions to reduce WMSDs is critical, and is supported by range of reviews and intervention studies (Cole et al., 2005; Rivilis et al., 2008; van Eerd et al., 2010). For a recent, extensive summary of participative ergonomics (PE) evidence, see Burgess-Limerick (2018).

PE refers to the active involvement of workers in developing and implementing workplace changes which will improve productivity and reduce risk to safety and health (Burgess-Limerick, 2018). The basic underlying assumptions are as follows: workers are the experts and, given appropriate knowledge, skills, tools, facilitation, resources and encouragement, they are best placed to identify and analyse problems and to develop and implement solutions which will be effective in reducing injury risk and improving productivity, and be acceptable (Brown, 2005).

A large range of industries and organisations have reported on interventions using participative approaches (Cantley et al., 2014; Dale et al., 2016; de Jong et al., 2000; Haims et al., 1998; Jaegers et al., 2014; Rasmussen et al., 2015). The way in which programs are developed and implemented varies according to the specific needs of the organisation or industry. Comparisons between different programs are challenging, due to the variability between the needs of organisations and the interventions required to address the specific issues relating to WMSDs. However, a number of reviews have found support for the effectiveness of PE interventions in reducing WMSDs.

Rivilis et al. (2008) reviewed 23 articles that met the criteria for a review of the effectiveness of PE interventions on health outcomes. They found partial to moderate evidence that PE interventions have a positive impact on the reduction of musculoskeletal symptoms, injuries and workers' compensation claims, days lost from work or sickness absence (Rivilis et al., 2008).

Van Eerd et al. (2010) reviewed 52 articles which met the content and quality criteria for a review of the process and implementation of PE interventions. Different ergonomic teams were described in the documents, as were the type, duration and content of ergonomic training. PE interventions tended to focus on physical and work process changes and mostly reported positive impacts. Resources, program support, ergonomic training, organisational training and communication were the most often noted facilitators or barriers. The study concluded that successful PE interventions require the right people to be involved, appropriate ergonomic training and clear responsibilities. Addressing key facilitators and barriers such as program support, resources and communication is paramount. PE interventions have some effect on reducing symptoms, lost days of work and claims. Based on the literature, a number of key attributes have emerged as essential requirements for the successful implementation of PE programs to reduce WMSDs:

1. Commitment of management to ensure there are adequate resources, both financial and personnel. Middle managers need to be committed and this needs to be sustained across the duration of the program to ensure both the uptake and engagement by workers with the program and to ensure the sustainability of any changes made.
2. Targets for control measures across the organisation assist with ensuring programs focus on implementation.
3. Genuine participation by team members is vital but can be challenging in very hierarchical organisations or where there is a history of grievances between management and workers. Good-quality facilitation of the program is required to overcome this hurdle.

Some fundamental principles for workplace interventions are provided here, acknowledging that organisations are complex and changes will be required (Leka & Cox, 2008).

1. Interventions need to be developed using theory and evidence-informed practices.
2. Interventions need clear aims and goals with appropriate support from all levels of the organisation.
3. Appropriate hazard identification is required, to identify all relevant hazards that need to be addressed by the intervention.
4. Interventions need to be developed within the context of the relevant industrial sector, occupation or workplace size.
5. The most effective interventions are those which are accessible and user-friendly in their format, process and content for individuals at all levels of an organisation, from workers to senior managers.
6. The use of a systematic approach is required, to ensure that intervention captures all levels, from the individual to organisational level.
7. Interventions should be developed using high levels of participation to ensure they are self-sustaining and improve uptake and effectiveness.

Evaluation of interventions

Evaluation of interventions is a critical part of improving strategies to reduce the incidence of WMSDs. As identified in the literature review, the evidence on the effectiveness of interventions is of variable quality and provides limited insight into what worked and what did not (Nielsen, 2013). The inclusion of process evaluations in workplace intervention design is important. The challenges with workplace interventions and controlling the environmental conditions need to be systematically documented to ensure meaningful information.

Workplace interventions are challenging, difficult to implement and difficult to measure in their effectiveness. The gold standard evaluation measures, such as randomised control trials (Guyatt et al., 1995), used in evaluating medical research, are often not the best study design or feasible to undertake in workplace interventions (A Burdorf et al., 2016). However, many systematic reviews of work-based interventions continue to use the randomised control trial as the standard to which everything is measured. The subsequent impact is that very limited useful information can be derived from the results and used to inform future interventions. Research needs to move beyond simple before and after measurements of intended outcomes, to include measurements of process and implementation on an ongoing basis (Nielsen, 2017). These more nuanced measurements can be used to inform future intervention development. Process and effectiveness evaluations need to be developed along with the planned intervention to ensure that relevant questions can be addressed - namely, what works and why did it work?

Workplace interventions are more likely to be successful with high levels of participation; however, this is not possible with designs such as randomised control trials, adding further weight to the inappropriate nature of this study design for workplaces where engagement is required to facilitate uptake and sustainability of changed practices.

Conclusions

Some key messages arise from the summary of literature presented above - notably, the very limited number of interventions which are targeted at the organisational level. This is an important gap in intervention practice and much more work is required to ensure interventions are targeting all levels of the organisation. A growing body of evidence supports the need to use multilevel or multimodal interventions that target multiple hazards at once, across different levels in the system.

The stakeholder interviews provided important insights into the current practices being used to address WMSDs. The findings support the need for significant changes in practice to shift the emphasis from single-focus strategies aimed at changing behaviour, such as training in 'safe' lifting techniques, to more comprehensive approaches which take into account all aspects of an individual's work. Greater focus on a systems approach to intervention development will assist in this process. Rather than teaching someone how to lift, a more effective approach is training how to identify hazards and risks that they might be exposed to, and strategies to report and develop controls to address them. This involves worker participation, a process in risk prevention that is well supported by research as an effective strategy to improve workplace risk management. Those charged with managing WMSD risk prevention will need to be educated in what they should expect will be effective WMSD risk management. Thus, they should engage with appropriately qualified consultants who will use contemporary evidence-informed practices that move beyond simple linear approaches, which appear to be widely used.

While in some areas further research may be required, a real need exists for increased use of prevention strategies which take into account the evidence-based principles of implementation science to improve knowledge uptake and translation into real world practice. A need exists for a change to current approaches to WMSD prevention, to more effectively manage the significant and persistent problem of WMSDs.

Appendix A: Statistical tables

Table A. 1 Serious WMSD claims by nature of injury or disease, 2011–12 to 2015–16

Selected nature of injury or disease	2011–12		2012–13		2013–14		2014–15		2015–16	
	Number	Freq. rate	Number	Freq. rate	Number	Freq. rate	Number	Freq. rate	Number	Freq. rate
Traumatic joint/ligament and muscle/tendon injury	58,655	3.4	53,785	3.0	50,805	2.8	48,090	2.6	46,060	2.5
Musculoskeletal and connective tissue diseases	19,125	1.1	18,470	1.0	17,935	1.0	17,660	1.0	16,365	0.9
All WMSDs	**77,780**	**4.5**	**72,255**	**4.1**	**68,735**	**3.8**	**65,750**	**3.6**	**62,420**	**3.4**

Freq. (frequency) rate = number of serious claims per million hours worked.

Table A. 2 Median time lost (weeks) for serious WMSD claims by nature of injury or disease, 2011–12 to 2015–16

Selected nature of injury or disease	2011–12	2012–13	2013–14	2014–15	2015–16
Traumatic joint/ligament and muscle/tendon injury	5.0	5.0	5.2	5.1	5.2
Musculoskeletal and connective tissue diseases	10.0	9.8	9.6	9.8	9.7
All WMSDs	**6.0**	**5.9**	**6.0**	**6.0**	**6.0**

Table A. 3 Median compensation paid for serious WMSD claims, 2011–12 to 2015–16

Selected nature of injury or disease	2011–12	2012–13	2013–14	2014–15	2015–16
Traumatic joint/ligament and muscle/tendon injury	$8,200	$8,300	$9,100	$9,800	$10,600
Musculoskeletal and connective tissue diseases	$14,400	$13,900	$14,100	$15,000	$15,400
All WMSDs	**$9400**	**$9500**	**$10,200**	**$11,000**	**$11,700**

Table A. 4 Serious WMSD injury and disease claims by sex and age, 2015–16

Age group (years)	Traumatic joint/ligament and muscle/tendon injury									Musculoskeletal and connective tissue diseases									All WMSDs		
	Female			Male			Persons			Female			Male			Persons			Persons		
	No.	%	Freq rate	No.	%	Freq rate	No.	%	Freq rate	No.	%	Freq rate	No.	%	Freq rate	No.	%	Freq rate	No.	%	Freq rate
<25	1,815	11	1.6	3,200	11	2.4	5,020	11	2.1	460	7	0.4	785	8	0.6	1,245	8	0.5	6,265	10	2.6
25–34	2,690	16	1.4	6,135	21	2.1	8,830	19	1.8	1,005	15	0.5	2,000	20	0.7	3,005	18	0.6	11,835	19	2.5
34–44	3,480	21	2.1	6,700	23	2.5	10,185	22	2.4	1,435	22	0.9	2,365	24	0.9	3,800	23	0.9	13,985	22	3.3
45–54	5,050	30	2.8	7,310	25	3.1	12,360	27	3.0	2,230	34	1.3	2,600	27	1.1	4,830	30	1.2	17,190	28	4.2
55–64	3,325	20	3.1	5,215	18	3.5	8,540	19	3.3	1,340	20	1.3	1,825	19	1.2	3,160	19	1.2	11,700	19	4.6
65+	375	2	2.5	755	3	2.6	1,130	2	2.6	110	2	0.7	210	2	0.7	320	2	0.7	1,450	2	3.3
Total	**16,740**	**100**	**2.2**	**29,320**	**100**	**2.7**	**46,060**	**100**	**2.5**	**6,580**	**100**	**0.9**	**9,780**	**100**	**0.9**	**16,365**	**100**	**0.9**	**62,420**	**100**	**3.4**

Freq (frequency) rate = number of serious claims per million hours worked.

Table A. 5 Serious WMSD claims by nature of injury or disease and sex, 2015–16

Nature of injury/disease	Male		Female		Persons	
	Number	Per cent	Number	Per cent	Number	Per cent
Traumatic joint/ligament and muscle/tendon injury						
Soft tissue disorders due to trauma or unknown mechanisms	11,275	38	6,305	38	17,580	38
Trauma to muscles and tendons	11,280	38	6,605	39	17,885	39
Trauma to joints and ligaments	6,760	23	3,835	23	10,595	23
Total WMSD injuries	***29,320***	***75***	***16,740***	***72***	***46,060***	***74***
Musculoskeletal and connective tissue diseases						
Spinal vertebrae and intervertebral disc diseases	**4,695**	**48**	**2,590**	**39**	**7,285**	**45**
Back pain, lumbago and sciatica	2950	63	1,710	66	4,660	64
Disc displacement, prolapse, degeneration or hernia	1455	31	630	24	2,080	29
Neck pain, cervicalgia	240	5	230	9	470	6
Other spinal vertebrae and intervertebral disc diseases	50	1	25	1	75	1
Diseases of the muscle, tendon and related tissue	**2,570**	**26**	**2,005**	**30**	**4,575**	**28**
Joint diseases (arthropathies) and other articular cartilage diseases	**1,035**	**11**	**455**	**7**	**1,490**	**9**
Diseases involving the synovium and related tissue	**265**	**3**	**405**	**6**	**670**	**4**
Other soft tissue diseases	**965**	**10**	**910**	**14**	**1,875**	**11**
Other musculoskeletal and connective tissue diseases	**250**	**3**	**215**	**3**	**465**	**3**
Total WMSD diseases	**9,780**	**25**	**6,580**	**28**	**16,365**	**26**
Total WMSD injuries and diseases	**39,100**	**63**	**23,325**	**37**	**62,420**	**100**

Table A. 6 Serious WMSDs and all serious claims by industry and sub-industries, 2015–16

Industry/sub-industry	WMSD serious claims				All serious claims	WMSDs as a proportion of all serious claims
	Number Injuries	Number Diseases	Number WMSDs	Per cent of all WMSDs	Number	Per cent
Health care and social assistance	**8,520**	**2,850**	**11,370**	**18.2**	**16,705**	**68.1**
Residential care services	3,085	855	3,940	6.3	5,475	72.0
Hospitals	2,860	1035	3,895	6.2	5,525	70.5
Social assistance services	1,410	475	1,885	3.0	3,050	61.8
Medical and other health care services	1,165	485	1,650	2.6	2,655	62.1
Manufacturing	**4,870**	**2,225**	**7,095**	**11.4**	**13,270**	**53.5**
Food product manufacturing	1,285	670	1,955	3.1	3,460	56.5
Fabricated metal product manufacturing	750	265	1,015	1.6	2,195	46.2
Machinery and equipment manufacturing	535	195	730	1.2	1,380	52.9
Transport equipment manufacturing	375	270	645	1.0	1,135	56.8
Other manufacturing	1,925	825	2,750	4.4	5,095	54.0
Construction	**5,355**	**1,625**	**6,980**	**11.2**	**13,085**	**53.3**
Construction services	3,540	1,030	4,570	7.3	8,635	52.9
Heavy and civil engineering construction	890	330	1,220	2.0	1,965	62.1
Building construction	925	265	1,190	1.9	2,480	48.0
Retail trade	**4,090**	**2,025**	**6,115**	**9.8**	**9,450**	**64.7**
Food retailing	1,605	1000	2,605	4.2	3,940	66.1
Other store-based retailing	1,810	795	2,605	4.2	4,080	63.8
Motor vehicle and motor vehicle parts retailing	540	165	705	1.1	1,125	62.7
Other retail trade	130	60	190	0.3	310	61.3
Transport, warehousing and postal	**3,995**	**1,525**	**5,520**	**8.8**	**8,615**	**64.1**
Road transport	1,935	685	2,620	4.2	4,230	61.9
Transport support services	545	180	725	1.2	1,115	65.0
Other transport	175	70	245	0.4	385	63.6
Other industries	**19,185**	**6,095**	**25,280**	**40.5**	**46,155**	**54.8**
Public administration and safety	3,465	1,045	4,510	7.2	8,075	55.9
Education and training	2,615	815	3,430	5.5	6,705	51.2
Accommodation and food services	2,400	670	3,070	4.9	6,325	48.5
Wholesale trade	1,960	865	2,825	4.5	4,635	60.9
Administrative and support services	1,940	610	2,550	4.1	4,280	59.6
Agriculture, forestry and fishing	1,380	355	1,735	2.8	3,620	47.9

Industry/sub-industry	WMSD serious claims				All serious claims	WMSDs as a proportion of all serious claims
	Number Injuries	Number Diseases	Number WMSDs	Per cent of all WMSDs	Number	Per cent
Mining	1,220	185	1,405	2.3	2,140	65.7
Arts and recreation services	900	370	1,270	2.0	2,200	57.7
Professional, scientific and technical services	665	250	915	1.5	1,765	51.8
Electricity, gas, water and waste services	565	170	735	1.2	1,175	62.6
Rental, hiring and real estate services	385	125	510	0.8	985	51.8
Financial and insurance services	205	130	335	0.5	680	49.3
Information media and telecommunications	225	90	315	0.5	545	57.8
Other services	1,260	415	1,675	2.7	3,035	55.2
Total	**46,060**	**16,365**	**62,420**	**100**	**107,380**	**58.1**

Table A. 7 Serious WMSDs and all serious claims by occupation and sub-occupation, 2015–16

Occupation/sub-occupation	WMSD serious claims	All serious claims		WMSDs as a proportion of all serious claims
	Number	Number	Per cent	Per cent
Labourers	**15,615**	**26,960**	**25.1**	**57.9**
Factory process workers	2,655	4,640	4.3	57.2
Cleaners and laundry workers	2,465	3,535	3.3	69.8
Construction and mining labourers	2,060	3,575	3.3	57.6
Farm, forestry and garden workers	1,345	2,625	2.4	51.2
Other labourers	6,250	10,900	10.2	57.3
Community and personal service workers	**11,220**	**17,595**	**16.4**	**63.8**
Carers and aides	5,245	7,250	6.8	72.4
Protective service workers	2,375	4,405	4.1	54.0
Health and welfare support workers	1,945	2,885	2.7	67.3
Machinery operators and drivers	**9,720**	**15,315**	**14.3**	**63.5**
Road and rail drivers	4,560	7,265	6.8	62.8
Machine and stationary plant operators	1,905	3,200	3.0	59.6
Storepersons	1,890	2,755	2.6	68.6
Mobile plant operators	1,355	2,090	1.9	64.8
Technicians and trades workers	**9,860**	**19,455**	**18.1**	**50.7**
Automotive and engineering trades workers	2,590	5,140	4.8	50.4
Construction trades workers	2,380	4,880	4.5	48.8
Other technicians and trades workers	1,230	2,265	2.1	54.3
Electrotechnology and telecommunications trades workers	1,105	1,985	1.8	55.7
Skilled animal and horticultural workers	1,080	1,935	1.8	55.8
Professionals	**5,675**	**9,970**	**9.3**	**56.9**
Health professionals	2,220	3,250	3.0	68.3
Education professionals	1,515	3,140	2.9	48.2
Sales workers	**3,965**	**6,020**	5.6	65.9
Clerical and administrative workers	**2,905**	**5,225**	4.9	55.6
Managers	**2,485**	**4,750**	4.4	52.3
Total	**62,420**	**107,380**	**100**	**58.1**

Table A. 8 Serious WMSD claims by breakdown agency of injury/disease, 2015–16

Breakdown agency of injury/disease	WMSD injury		WMSD diseases		All WMSD	
	Number	Per cent	Number	Per cent	Number	Per cent
Non-powered hand tools, appliances and equipment	12,460	27.0	4,460	27.3	16,920	27.1
Environmental agencies	9,225	20.0	1,830	11.2	11,055	17.7
Materials and substances	5,575	12.1	2,755	16.8	8,330	13.3
Animal, human and biological agencies	5,740	12.5	1,800	11.0	7,540	12.1
Other and unspecified agencies	4,775	10.4	2,320	14.2	7,095	11.4
Mobile plant and transport	4,935	10.7	1,540	9.4	6,475	10.4
Powered equipment, tools and appliances	1,565	3.4	1,020	6.2	2,585	4.1
Machinery and (mainly) fixed plant	1,665	3.6	590	3.6	2,255	3.6
Chemicals and chemical products	125	0.3	40	0.2	165	0.3
Total	**46,060**	**100**	**16,365**	**100**	**62,420**	**100**

Table A. 9 Serious WMSD claims by mechanism of injury and bodily location, 2015–16

Mechanism of injury	Bodily location										
	Head	Lower limbs	Multiple locations	Neck	Systemic locations	Trunk	Unspecified locations	Upper limbs	All WMSDs	% of all WMSD	Freq. rate
Body stressing	**np**	**5,510**	**1,310**	**925**	np	**16,740**	**70**	**13,100**	**37,660**	**60.3**	**2**
Muscular stress while handling objects	np	2,065	645	425	np	6,390	30	6,360	15,915	25.5	na
Muscular stress while lifting, carrying or putting down objects	np	795	430	300	np	7,920	30	4,620	14,100	22.6	na
Muscular stress with no objects being handled	np	2,360	130	110	np	1,840	np	490	4,930	7.9	na
Repetitive movement, low muscle loading	np	285	105	90	np	595	10	1,630	2,720	4.4	na
Falls, trips and slips of a person	**25**	**8,200**	**990**	**170**	np	**2,575**	**25**	**2,855**	**14,845**	**23.8**	**0.8**
Falls from a height	10	1,675	255	45	np	700	5	795	3,485	5.6	na
Falls on the same level	20	5,165	705	115	np	1,635	20	1,980	9,635	15.4	na
Stepping, kneeling or sitting on objects	np	1,365	25	10	np	245	np	75	1,725	2.8	na
Being hit by moving object	**90**	**1,180**	**405**	**225**	np	**770**	**10**	**1,735**	**4,410**	**7.1**	**0.2**
Vehicle incidents and other	**10**	**775**	**385**	**360**	np	**1,025**	**np**	**1,250**	**3,835**	**6.1**	**0.2**
Hitting objects with a part of the body	**20**	**485**	**50**	**90**	np	**210**	**np**	**730**	**1,585**	**2.5**	**0.1**
Other mechanisms	np	**10**	**10**	np	**15**	**10**	**np**	**35**	**85**	**0.1**	**0**
% of bodily location of all WMSD	*0.2*	*25.9*	*5.0*	*2.8*	*0.0*	*34.2*	*0.2*	*31.6*	*100.0*	*100*	*na*
Total	150	16,165	3,145	1770	20	21,335	140	19,705	62,420	100	3.4

np = data not published due to confidentiality restrictions; na = not applicable. Freq. (frequency) rate = number of serious claims per million hours worked.

Table A. 10 Serious WMSD claims by occupation, mechanism of injury and bodily location, 2015–16

Occupation	Mechanism of injury	Lower limbs		Multiple locations		Neck		Trunk		Upper limbs		Total all bodily locations	WMSD of mechanism
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Managers	**Being hit by moving objects**	**50**	**30.3**	**15**	**9.1**	**10**	**6.1**	**25**	**15.2**	**55**	**33.3**	**165**	**6.6**
	Body stressing	**200**	**14.7**	**50**	**3.7**	**40**	**2.9**	**625**	**45.8**	**450**	**33**	**1,365**	**54.9**
	Muscular stress while handling objects	75	15.8	15	3.2	20	4.2	190	40	180	37.9	475	34.8
	Muscular stress while lifting, carrying or putting down objects	30	5.2	20	3.5	15	2.6	330	57.4	175	30.4	575	42.1
	Muscular stress with no objects being handled	85	39.5	10	4.7	np	0	90	41.9	25	11.6	215	15.8
	Repetitive movement, low muscle loading	10	10	5	5	np	0	15	15	65	65	100	7.3
	Falls, trips and slips of a person	**400**	**52.6**	**60**	**7.9**	np	**0**	**155**	**20.4**	**135**	**17.8**	**760**	**30.6**
	Falls from a height	90	50	15	8.3	np	0	35	19.4	40	22.2	180	23.7
	Falls on the same level	230	48.4	45	9.5	np	0	100	21.1	95	20	475	62.5
	Stepping, kneeling or sitting on objects	80	76.2	np	0	np	0	25	23.8	np	0	105	13.8
	Hitting objects with a part of the body	**25**	**41.7**	**5**	**8.3**	np	**0**	**10**	**16.7**	**25**	**41.7**	**60**	**2.4**
	Vehicle incidents and other	**35**	**26.9**	**15**	**11.5**	**15**	**11.5**	**30**	**23.1**	**35**	**26.9**	**130**	**5.2**
	Total	***710***	***25.2***	***140***	***5.6***	***70***	***2.8***	***845***	***34***	***700***	***28.2***	***2485***	***100***
Professionals	**Being hit by moving objects**	**105**	**18.4**	**75**	**13.2**	**40**	**7**	**130**	**22.8**	**195**	**34.2**	**570**	**10.0**
	Body stressing	**580**	**18.7**	**135**	**4.4**	**85**	**2.7**	**1,370**	**44.2**	**925**	**29.8**	**3,100**	**54.6**
	Muscular stress while handling objects	190	13.1	85	5.9	30	2.1	665	45.9	480	33.1	1,450	46.8
	Muscular stress while lifting, carrying or putting down objects	55	6.7	25	3.1	25	3.1	445	54.6	270	33.1	815	26.3
	Muscular stress with no objects being handled	320	53.8	10	1.7	20	3.4	210	35.3	40	6.7	595	19.2
	Repetitive movement, low muscle loading	20	8.3	15	6.3	15	6.3	50	20.8	140	58.3	240	7.7

Occupation	Mechanism of injury	Lower limbs		Multiple locations		Neck		Trunk		Upper limbs		Total all bodily locations	WMSD of mechanism
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	Falls, trips and slips of a person	**865**	**56.4**	**145**	**9.4**	**20**	**1.3**	**250**	**16.3**	**250**	**16.3**	**1,535**	**27.0**
	Falls from a height	135	50	25	9.3	np	0	60	22.2	45	16.7	270	17.6
	Falls on the same level	605	55.5	115	10.6	15	1.4	155	14.2	195	17.9	1,090	71.0
	Stepping, kneeling or sitting on objects	125	71.4	np	0	np	0	35	20	10	5.7	175	11.4
	Hitting objects with a part of the body	**55**	**40.7**	np	**0**	**5**	**3.7**	**20**	**14.8**	**50**	**37**	**135**	**2.4**
	Vehicle incidents and other	**70**	**21.2**	**55**	**16.7**	**30**	**9.1**	**80**	**24.2**	**90**	**27.3**	**330**	**5.8**
	Total	***1,680***	***29.6***	***415***	***7.3***	***185***	***3.3***	***1,845***	***32.5***	***1,515***	***26.7***	***5,680***	***100***
Technicians and Trades Workers	**Being hit by moving objects**	**175**	**32.7**	**35**	**6.5**	**20**	**3.7**	**50**	**9.3**	**255**	**47.7**	**535**	**5.4**
	Body stressing	**890**	**14.7**	**140**	**2.3**	**150**	**2.5**	**2,760**	**45.7**	**2,095**	**34.7**	**6,045**	**61.3**
	Muscular stress while handling objects	305	12.1	70	2.8	65	2.6	995	39.5	1,080	42.9	2,520	41.7
	Muscular stress while lifting, carrying or putting down objects	140	5.9	50	2.1	60	2.5	1,395	58.6	730	30.7	2,380	39.4
	Muscular stress with no objects being handled	400	51.9	15	1.9	10	1.3	275	35.7	70	9.1	770	12.7
	Repetitive movement, low muscle loading	40	11	np	0	15	4.1	90	24.7	220	60.3	365	6
	Falls, trips and slips of a person	**1,425**	**57.8**	**120**	**4.9**	**20**	**0.8**	**405**	**16.4**	**495**	**20.1**	**2,465**	**25**
	Falls from a height	315	45.3	50	7.2	10	1.4	140	20.1	180	25.9	695	28.2
	Falls on the same level	830	57.6	65	4.5	10	0.7	230	16	300	20.8	1,440	58.4
	Stepping, kneeling or sitting on objects	280	86.2	np	0	np	0	30	9.2	15	4.6	325	13.2
	Hitting objects with a part of the body	**65**	**21.7**	**5**	**1.7**	**25**	**8.3**	**40**	**13.3**	**165**	**55**	**300**	**3**
	Vehicle incidents and other	**130**	**25.2**	**40**	**7.8**	**40**	**7.8**	**145**	**28.2**	**155**	**30.1**	**515**	**5.2**
	Total	***2680***	***27.2***	***335***	***3.4***	***250***	***2.5***	***3,400***	***34.5***	***3,175***	***32.2***	***9,865***	***100***
Community and Personal	**Being hit by moving objects**	**225**	**18.6**	**125**	**10.3**	**70**	**5.8**	**260**	**21.5**	**500**	**41.3**	**1,210**	**10.8**
	Body stressing	**1,120**	**16.8**	**310**	**4.7**	**165**	**2.5**	**3,010**	**45.2**	**2,045**	**30.7**	**6,665**	**59.4**

Occupation	Mechanism of injury	Lower limbs		Multiple locations		Neck		Trunk		Upper limbs		Total all bodily locations	WMSD of mechanism
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Services Workers	Muscular stress while handling objects	445	12.9	195	5.7	85	2.5	1,495	43.3	1,225	35.5	3,450	51.8
	Muscular stress while lifting, carrying or putting down objects	110	6.1	75	4.2	50	2.8	1,020	57	530	29.6	1,790	26.9
	Muscular stress with no objects being handled	535	47.8	25	2.2	25	2.2	420	37.5	115	10.3	1,120	16.8
	Repetitive movement, low muscle loading	35	11.3	15	4.8	10	3.2	75	24.2	175	56.5	310	4.7
	Falls, trips and slips of a person	**1,340**	**54.7**	**195**	**8**	**25**	**1**	**470**	**19.2**	**405**	**16.5**	**2,450**	**21.8**
	Falls from a height	190	48.1	35	8.9	np	0	85	21.5	75	19	395	16.1
	Falls on the same level	945	52.6	155	8.6	20	1.1	335	18.7	325	18.1	1,795	73.3
	Stepping, kneeling or sitting on objects	205	77.4	np	0	np	0	45	17	10	3.8	265	10.8
	Hitting objects with a part of the body	**75**	**35.7**	**10**	**4.8**	**10**	**4.8**	**35**	**16.7**	**75**	**35.7**	**210**	**1.9**
	Vehicle incidents and other	**135**	**20.3**	**65**	**9.8**	**75**	**11.3**	**190**	**28.6**	**190**	**28.6**	**665**	**5.9**
	Total	***2,900***	***25.8***	***710***	***6.3***	***345***	***3.1***	***3,970***	***35.4***	***3,225***	***28.7***	***11,220***	***100***
Clerical and Administrative Worker	**Being hit by moving objects**	**30**	**23.1**	**20**	**15.4**	**10**	**7.7**	**25**	**19.2**	**45**	**34.6**	**130**	**4.5**
	Body stressing	**225**	**13.3**	**70**	**4.1**	**70**	**4.1**	**570**	**33.6**	**750**	**44.2**	**1,695**	**58.3**
	Muscular stress while handling objects	65	13	30	6	30	6	155	31	225	45	500	29.5
	Muscular stress while lifting, carrying or putting down objects	30	5.3	20	3.5	15	2.6	300	52.6	205	36	570	33.6
	Muscular stress with no objects being handled	130	45.6	5	1.8	10	3.5	100	35.1	35	12.3	285	16.8
	Repetitive movement, low muscle loading		0	20	5.9	15	4.4	15	4.4	280	82.4	340	20.1
	Falls, trips and slips of a person	**375**	**49**	**70**	**9.2**	**15**	**2**	**150**	**19.6**	**150**	**19.6**	**765**	**26.3**
	Falls from a height	60	37.5	15	9.4	np	0	45	28.1	30	18.8	160	20.9
	Falls on the same level	265	48.6	55	10.1	15	2.8	95	17.4	120	22	545	71.2

Occupation	Mechanism of injury	Lower limbs		Multiple locations		Neck		Trunk		Upper limbs		Total all bodily locations	WMSD of mechanism
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	Stepping, kneeling or sitting on objects	50	76.9	np	0	np	0	10	15.4	np	0	65	8.5
	Hitting objects with a part of the body	**30**	**42.9**	np	**0**	np	**0**	**5**	**7.1**	**35**	**50**	**70**	**2.4**
	Vehicle incidents and other	**50**	**20.4**	**35**	**14.3**	**30**	**12.2**	**50**	**20.4**	**80**	**32.7**	**245**	**8.4**
	Total	***705***	***24.3***	***195***	***6.7***	***125***	***4.3***	***800***	***27.5***	***1,060***	***36.5***	***2,905***	***100***
Sales Workers	**Being hit by moving objects**	**70**	**35**	**15**	**7.5**	**10**	**5**	**35**	**17.5**	**70**	**35**	**200**	**5**
	Body stressing	**350**	**13.3**	**95**	**3.6**	**40**	**1.5**	**1,200**	**45.5**	**950**	**36.1**	**2,635**	**66.5**
	Muscular stress while handling objects	115	14.9	30	3.9	15	1.9	300	39	310	40.3	770	29.2
	Muscular stress while lifting, carrying or putting down objects	75	5.5	50	3.7	20	1.5	750	54.9	475	34.8	1,365	51.8
	Muscular stress with no objects being handled	135	51.9	5	1.9	5	1.9	95	36.5	20	7.7	260	9.9
	Repetitive movement, low muscle loading	30	12.2	10	4.1	np	0	55	22.4	145	59.2	245	9.3
	Falls, trips and slips of a person	**405**	**51.3**	**80**	**10.1**	**10**	**1.3**	**145**	**18.4**	**145**	**18.4**	**790**	**19.9**
	Falls from a height	80	51.6	25	16.1	0	0	25	16.1	20	12.9	155	19.6
	Falls on the same level	270	47.4	55	9.6	5	0.9	120	21.1	120	21.1	570	72.2
	Stepping, kneeling or sitting on objects	55	91.7	np	0	np	0	np	0	np	0	60	7.6
	Hitting objects with a part of the body	**30**	**33.3**	np	**0**	np	**0**	**10**	**11.1**	**45**	**50**	**90**	**2.3**
	Vehicle incidents and other	**50**	**20**	**15**	**6**	**30**	**12**	**65**	**26**	**90**	**36**	**250**	**6.3**
	Total	***905***	***22.8***	***210***	***5.3***	***90***	***2.3***	***1,460***	***36.8***	***1,295***	***32.7***	***3,965***	***100***
	Body stressing	**880**	**14.9**	**175**	**3**	**165**	**2.8**	**2,590**	**43.8**	**21,00**	**35.5**	**5,920**	**60.9**
	Muscular stress while handling objects	395	15.8	85	3.4	90	3.6	875	34.9	1,055	42.1	2,505	42.3
	Muscular stress while lifting, carrying or putting down objects	150	6	65	2.6	45	1.8	1,405	56.3	825	33.1	2,495	42.1

Occupation	Mechanism of injury	Lower limbs		Multiple locations		Neck		Trunk		Upper limbs		Total all bodily locations	WMSD of mechanism
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	Muscular stress with no objects being handled	280	47.1	25	4.2	20	3.4	215	36.1	55	9.2	595	10.1
	Repetitive movement, low muscle loading	55	16.7	np	0	15	4.5	90	27.3	165	50	330	5.6
	Falls, trips and slips of a person	**1,285**	**54.2**	**115**	**4.9**	**30**	**1.3**	**380**	**16**	**555**	**23.4**	**2,370**	**24.4**
	Falls from a height	350	46.7	45	6	15	2	130	17.3	210	28	750	31.6
	Falls on the same level	710	53.6	70	5.3	15	1.1	200	15.1	330	24.9	1,325	55.9
	Stepping, kneeling or sitting on objects	230	76.7	np	0	np	0	50	16.7	20	6.7	300	12.7
	Hitting objects with a part of the body	**80**	**32**	**5**	**2**	**20**	**8**	**40**	**16**	**100**	**40**	**250**	**2.6**
	Vehicle incidents and other	**105**	**16.4**	**105**	**16.4**	**90**	**14.1**	**180**	**28.1**	**160**	**25**	**640**	**6.6**
	Total	***2,520***	***25.9***	***455***	***4.7***	***330***	***3.4***	***3,280***	***33.7***	***3,110***	***32***	***9,720***	***100***
Labourers	**Being hit by moving objects**	**335**	**34.7**	**45**	**4.7**	**35**	**3.6**	**135**	**14**	**400**	**41.5**	**965**	**6.2**
	Body stressing	**1,185**	**12.2**	**285**	**2.9**	**205**	**2.1**	**4,380**	**45**	**3,645**	**37.5**	**9,730**	**62.3**
	Muscular stress while handling objects	465	11.4	135	3.3	95	2.3	1,620	39.7	1,755	43	4,080	41.9
	Muscular stress while lifting, carrying or putting down objects	200	5.1	110	2.8	75	1.9	2,175	55.3	1,360	34.6	3,930	40.4
	Muscular stress with no objects being handled	445	43.8	20	2	20	2	410	40.4	125	12.3	1,015	10.4
	Repetitive movement, low muscle loading	75	10.7	20	2.9	20	2.9	175	25	410	58.6	700	10.4
	Falls, trips and slips of a person	**1,995**	**57**	**180**	**5.1**	**40**	**1.1**	**585**	**16.7**	**685**	**19.6**	**3,500**	**22.4**
	Falls from a height	435	50.6	45	5.2	10	1.2	170	19.8	195	22.7	860	24.6
	Falls on the same level	1,250	55.1	130	5.7	25	1.1	375	16.5	475	20.9	2,270	64.9
	Stepping, kneeling or sitting on objects	310	82.7	5	1.3	np	0	40	10.7	20	5.3	375	10.7
	Heat, electricity and other environmental factors	np	**0**	np	**0**	np	**0**	np	**0**	np	**0**	**5**	**0**
	Hitting objects with a part of the body	**125**	**28.1**	**15**	**3.4**	**25**	**5.6**	**45**	**10.1**	**225**	**50.6**	**445**	**2.8**

Occupation	Mechanism of injury	Lower limbs		Multiple locations		Neck		Trunk		Upper limbs		Total all bodily locations	WMSD of mechanism
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	Vehicle incidents and other	**180**	**18.8**	**45**	**4.7**	**45**	**4.7**	**260**	**27.1**	**420**	**43.8**	**960**	**6.1**
	Other mechanisms (a)	np	**0**	np	**0**	np	**0**	np	**0**	np	**0**	**15**	**0.1**
	Total	***3,825***	***24.5***	***570***	***3.7***	***355***	***2.3***	***5,410***	***34.6***	***5,385***	***34.5***	***15,615***	***100***
All occupations	***Grand total***	***16,165***	***25.9***	***3,145***	***5***	***1,770***	***2.8***	***21,335***	***34.2***	***19,705***	***31.6***	***62,420***	

np = data not published due to confidentiality restrictions.

Table A. 11 Most recent work-related injury or illness by sex, 2017–18

	Males		Females		Persons	
	'000	Per cent	'000	Per cent	'000	Per cent
How most recent work-related injury or illness occurred						
Lifting, pushing, pulling or bending	83.3	27.1	52.6	20.5	135.9	24.1
Hitting or being hit or cut by an object or vehicle	69.6	22.7	32.8	12.8	102.4	18.2
Fall on same level (including slip or fall)	35.0	11.4	51.9	20.2	87.0	15.4
Repetitive movement with low muscle loading	27.3*	8.9*	23.0	9.0	50.3	8.9
Exposure to mental stress	11.1*	3.6	23.2	9.0	34.3	6.1
Fall from a height	14.7*	4.8*	12.1*	4.7*	26.8	4.7
Vehicle accident	16.4	5.4	7.3*	2.9*	23.8	4.2
Contact with a chemical or substance	9.6*	3.1*	10.4*	4.0*	20.0*	3.5*
Prolonged standing, working in cramped or unchanging positions	8.4*	2.7*	6.8*	2.6*	15.2*	2.7*
Other	29.3	9.6	36.6	14.3	66.0	11.7
Most recent work-related injury or illness sustained						
Sprain/strain	**84.3**	**27.5**	**76.0**	**29.6**	**160.3**	**28.4**
Chronic joint or muscle condition	**57.4**	**18.7**	**45.8**	**17.9**	**103.2**	**18.3**
Cut/open wound	61.7	20.1	27.0*	10.5*	88.8	15.8
Fracture	29.0	9.5	18.8	7.3	47.8	8.5
Crushing injury/internal organ damage	21.9*	7.2*	21.2	8.3	43.2	7.7
Stress or other mental condition	10.4*	3.4	22.8	8.9	33.2	5.9
Burns	9.9*	3.2*	16.2*	6.3*	26.1*	4.6*
Superficial injury	5.6*	1.8*	4.6*	1.8*	10.2*	1.8*
Other	26.6	8.7	24.3	9.4	50.9	9.0
Location where most recent work-related injury or illness occurred						
Work place	278.7	90.8	240.9	93.8	519.6	92.2

	Males		Females		Persons	
	'000	Per cent	'000	Per cent	'000	Per cent
Travelling on business	11.3*	3.7*	5.8*	2.3*	17.1*	3.0*
Lunchtime or break activities	3.9*	1.3*	8.3*	3.2*	12.2*	2.2*
Travelling to or from work	6.1*	2.0*	0.8*	0.3*	6.9*	1.2*
Days or shifts absent from work in the last 12 months due to most recent work-related injury or illness						
None	106.1	34.6	115.4	44.9	221.5	39.3
Part of a day/shift	15.5*	5.1*	20.8	8.1	36.3	6.4
1–4 days	91.4	29.8	51.8	20.2	143.2	25.4
5–10 days	27.4	8.9	25.9	10.1	53.3	9.5
11 days or more	52.3	17.1	34.6	13.5	86.9	15.4
Has not returned to work since illness or injury occurred	13.1*	4.3*	7.2*	2.8*	20.3*	3.6
All sources of financial assistance for medical expenses or income loss for most recent work-related injury or illness						
Received financial assistance	158.4	51.6	140.3	54.6	298.7	53.0
Workers' compensation	91.5	29.8	62.8	24.5	154.3	27.4
Employer - regular sick leave	46.7	15.2	51.9	20.2	98.6	17.5
Employer - other payment	15.9	5.2	19.8	7.7	35.7	6.3
Medicare/Social Security/Centrelink	17.9*	5.8*	17.1*	6.7*	35.0	6.2
Private health/income protection insurance	14.5	4.7	4.3*	1.7*	18.8	3.3
Other	7.7*	2.5*	7.6*	3.0*	15.3*	2.7*
Did not know	3.3*	1.1*	4.0*	1.6*	7.3*	1.3*
Did not receive any financial assistance	148.4	48.4	116.5	45.4	264.9	47.0
Reported most recent work-related injury or illness to someone in the workplace						
Did report most recent work-related injury or illness to someone in the workplace	257.4	83.9	235.7	91.8	493.1	87.5
Supervisor/line manager	185.0	60.3	187.4	73.0	372.4	66.1
Colleague	64.3	21.0	57.4	22.3	121.7	21.6
Health and safety representative	47.7	15.6	29.0	11.3	76.8	13.6

	Males		Females		Persons	
	'000	Per cent	'000	Per cent	'000	Per cent
Employer	46.6	15.2	29.5	11.5	76.1	13.5
Work health and safety coordinator	26.8	8.7	25.7	10.0	52.5	9.3
Human resources	20.1	6.6	20.6	8.0	40.7	7.2
First aid officer	22.9	7.5	11.4*	4.4*	34.3	6.1
Other	17.8*	5.8*	15.2	5.9	33.0	5.9
Did not report most recent work-related injury or illness to someone in the workplace	49.4	16.1	21.0	8.2	70.5	12.5
Total	**306.8**	**100**	**256.8**	**100**	**563.6**	**100**

* Estimate has a relative standard error of 25% to 50% and should be used with caution

Source: ABS 6324.0 Work-Related Injuries, Australia, July 2017 to June 2018, Released at 11:30 am (Canberra time) Tue 30 Oct 2018 (Table 5.1 Persons Who Experienced a Work-related Injury or Illness, Selected details about the most recent work-related injury or illness–By sex).

Appendix B: Australian WMSD prevention resources

State-based regulators have a range of programs targeted at the reduction of WMSDs. For further information on these activities see the following websites.

- SafeWork New South Wales: http://www.safework.nsw.gov.au/resource-library/hazardous-manual-tasks/musculoskeletal-disorder-strategy
- SafeWork Victoria: https://www.worksafe.vic.gov.au/resources/improving-manual-handling-risk-controls-after-musculoskeletal-disorders
- SafeWork South Australia: https://www.safework.sa.gov.au/resources/hazardous-manual-tasks#
- WorkSafe Western Australia: https://www.commerce.wa.gov.au/worksafe/preventing-manual-task-injuries
- WorkSafe Queensland: https://www.worksafe.qld.gov.au/injury-prevention-safety/hazardous-manual-tasks
- WorkSafe Tasmania: https://www.worksafe.tas.gov.au/laws/codes/cop/hazardous-manual-tasks
- WorkSafe Northern Territory: https://worksafe.nt.gov.au/forms-and-resources/codes-of-practice/hazardous-manual-task
- WorkSafe Australian Capital Territory: https://www.accesscanberra.act.gov.au/app/home/workhealthandsafety/worksafeact
- Comcare: https://www.comcare.gov.au/news__and__media/features/musculoskeletal_disorders
- Safe Work Australia provides a range of information and reports on its website: https://www.safeworkaustralia.gov.au/

The following is a small sample of websites with information on tools to assist with the prevention of WMSDs. The list is not exhaustive, nor are these websites endorsed by Safe Work Australia or the authors of this report in any way.

- A Participative Hazard Identification and Risk Management Toolkit (APHIRM): http://www.aphirm.org.au/
- Participative Ergonomics for Manual Tasks – PerforM: https://www.worksafe.qld.gov.au/injury-prevention-safety/hazardous-manual-tasks/participative-ergonomics-for-manual-tasks-perform

Below is a list of other websites with information about WMSD prevention and other related activities beyond Australia.

- Institute for Work and Health Canada: https://www.iwh.on.ca/
- Health & Safety Executive UK: http://www.hse.gov.uk/msd/index.htm
- US National Institute for Occupational Safety and Health: https://www.cdc.gov/niosh/topics/ergonomics/
- Centre of Research Expertise on the Prevention of Musculoskeletal Disorders (CRE-MSD) Canada:

https://uwaterloo.ca/centre-of-research-expertise-for-the-prevention-of-musculoskeletal-disorders/

References

Aas, R. W., Tuntland, H., Holte, K. A., Re, C., Lund, T., Marklund, S. et al. (2011). Workplace interventions for neck pain in workers. *Cochrane Back Group, 2017*(4). doi:10.1002/14651858.CD008160.pub2

Afshari, D., Motamedzade, M., Salehi, R., & Soltanian, A. R. (2015). The impact of ergonomics intervention on trunk posture and cumulative compression load among carpet weavers. *Work, 50*(2), 241-248. doi:https://dx.doi.org/10.3233/WOR-131701

Aghilinejad, M., Azar, N. S., Ghasemi, M. S., Dehghan, N., & Mokamelkhah, E. K. (2016). An ergonomic intervention to reduce musculoskeletal discomfort among semiconductor assembly workers. *Work, 54*(2), 445-450.

Albers, J. T., & Hudock, S. D. (2007). Biomechanical assessment of three rebar tying techniques. *International Journal of Occupational Safety & Ergonomics, 13*(3), 279-289.

Andersen, J. H., Fallentin, N., Thomsen, J. F., & Mikkelsen, S. (2011). Risk factors for neck and upper extremity disorders among computers users and the effect of interventions: an overview of systematic reviews. *PLoS ONE [Electronic Resource], 6*(5), e19691. doi:https://dx.doi.org/10.1371/journal.pone.0019691

Armstrong, D. P., Ferron, R., Taylor, C., McLeod, B., Fletcher, S., MacPhee, R. S. et al. (2017). Implementing powered stretcher and load systems was a cost effective intervention to reduce the incidence rates of stretcher related injuries in a paramedic service. *Applied Ergonomics, 62*, 34-42. doi:https://dx.doi.org/10.1016/j.apergo.2017.02.009

Attorney-General's Department. (2010). *Australia to 2050: future challenges*. Retrieved from http://archive.treasury.gov.au/igr/

Australian Bureau of Statistics. (2018a). *6102.0.55.001 Labour Statistics: concepts, sources and methods, .* Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/6102.0.55.001:

Australian Bureau of Statistics. (2018b). National Health Survey: First Results. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4364.0.55.001~2017-18~Main%20Features~Arthritis%20and%20osteoporosis~30

Australian Institute of Health and Welfare. (2017). *The burden of musculoskeletal conditions in Australia: a detailed analysis of the Australian Burden of Disease Study 2011. Retrieved from Australian Burden of Disease Study*. Canberra, Australia Retrieved from https://www.aihw.gov.au/reports/burden-of-disease/burden-of-musculoskeletal-conditions-in-austra/contents/table-of-contents

Australian Safety and Compensation Council. (2006). *Work-related Musculoskeletal Disease in Australia*. Retrieved from https://www.safeworkaustralia.gov.au/system/files/documents/1702/workrelatedmusculoskeltaldisorders_2006australia_2006_archivepdf.pdf:

Australian Safety and Compensation Council. (2008). *Type of Occurrence Classification System, Third edition (revision one), May 2008*. Canberra

Azaroff, L. S., Levenstein, C., & Wegman, D. H. (2002). Occupational injury and illness surveillance: conceptual filters explain underreporting. *American journal of public health, 92*(9), 1421-1429.

Badii, M., Keen, D., Yu, S., & Yassi, A. (2006). Evaluation of a comprehensive integrated workplace-based program to reduce occupational musculoskeletal injury and its associated morbidity in a large hospital. *Journal of Occupational & Environmental Medicine, 48*(11), 1159-1165.

Bakker, A. B., Van Veldhoven, M., & Xanthopoulou, D. (2010). Beyond the demand-control model. *Journal of Personnel Psychology*.

Barrero, L. H., Katz, J. N., & Dennerlein, J. T. (2009). Validity of self-reported mechanical demands for occupational epidemiologic research of musculoskeletal disorders. *Scandinavian journal of work, environment & health* (4), 245-260. doi:10.5271/sjweh.1335

Berecki-Gisolf, J., Clay, F. J., Collie, A., & McClure, R. J. (2012). The Impact of Aging on Work Disability and Return to Work: Insights From Workers' Compensation Claim Records. *Journal of Occupational and Environmental Medicine, 54*(3), 318-327. doi:10.1097/JOM.0b013e31823fdf9d

Bevan, S. (2015). Economic impact of musculoskeletal disorders (MSDs) on work in Europe. *Best Practice & Research Clinical Rheumatology, 29*(3), 356-373. doi:10.1016/j.berh.2015.08.002

Bongers, P. M., de Winter, C. R., Kompier, M. A. J., & Hildebrandt, V. H. (1993). Psychosocial factors at work and musculoskeletal disease. *Scandinavian journal of work, environment & health*, 297-312.

Broom, D. H., D'souza, R. M., Strazdins, L., Butterworth, P., Parslow, R., & Rodgers, B. (2006). The lesser evil: Bad jobs or unemployment? A survey of mid-aged Australians. *Social Science & Medicine, 63*(3), 575-586. doi:10.1016/j.socscimed.2006.02.003

Brown, O. (2005). Participatroy Ergonomics. In N. Stanton, A. N. Hedge, K. Brookhuis, E. Salas, & H. Hendrick (Eds.), *Handbook of Human Factors and Ergonomics, Methods*. Boca Raton: CRC Press.

Buchbinder, R., Blyth, F. M., March, L. M., Brooks, P., Woolf, A. D., & Hoy, D. G. (2013). Placing the global burden of low back pain in context. *Best Practice & Research Clinical Rheumatology, 27*(5), 575-589. doi:https://doi.org/10.1016/j.berh.2013.10.007

Burdorf, A., Koppelaar, E., & Evanoff, B. (2013). Assessment of the impact of lifting device use on low back pain and musculoskeletal injury claims among nurses. *Occupational & Environmental Medicine, 70*(7), 491-497. doi:https://dx.doi.org/10.1136/oemed-2012-101210

Burdorf, A., & van der Beek, A. J. (2016). To RCT or not to RCT: evidence on effectiveness of return-to-work interventions. *Scandinavian journal of work, environment & health, 42*(4), 257-259.

Burgess-Limerick, R. (2018). Participatory ergonomics: Evidence and implementation lessons. *Applied Ergonomics, 68*, 289-293. doi:10.1016/j.apergo.2017.12.009

Cantley, L. F., Taiwo, O. A., Galusha, D., Barbour, R., Slade, M. D., Tessier-Sherman, B. et al. (2014). Effect of systematic ergonomic hazard identification and control implementation on musculoskeletal disorder and injury risk. *Scandinavian Journal of Work Environment and Health, 40.*, 57–65.

Carayon, P., Smith, M. J., & Haims, M. C. (1999). Work organization, job stress, and work-related musculoskeletal disorders. *Human Factors, 41*(4), 644-663.

Carroll, C., Rick, J., Pilgrim, H., Cameron, J., & Hillage, J. (2010). Workplace involvement improves return to work rates among employees with back pain on long-term sick leave: a systematic review of the effectiveness and cost-effectiveness of interventions. *Disability and Rehabilitation, 32*(8), 607-621. doi:10.3109/09638280903186301

Chaffin, D. B. (1997). Biomechanical Aspects of Workplace Design. In G. Salvendy (Ed.), *Handbook of Human Factors and Ergonomics* (pp. 772-789): John Wiley & Sons, Inc.

Coenen, P., Kingma, I., Boot, C. R., Bongers, P. M., & van Dieën, J. H. (2014). Cumulative mechanical low-back load at work is a determinant of low-back pain. *Occup Environ Med, 71*(5), 332-337.

Cole, D., Rivilis, I., Van Eerd, D., Cullen, K. L., Irvin, E., & Kramer, D. (2005). *Effectiveness of participatory ergonomic interventions: a systematic review*. Institute for Work & Health

Comper, M. L. C., Dennerlein, J. T., Evangelista, G. D. S., Rodrigues da Silva, P., & Padula, R. S. (2017). Effectiveness of job rotation for preventing work-related musculoskeletal diseases: a cluster randomised controlled trial. *Occupational & Environmental Medicine, 74*(8), 545-552. doi:https://dx.doi.org/10.1136/oemed-2016-104077

Costa, B., Gibson, K., & Collie, A. (2017). *Return to work, ISCRR Evidence Review No. 176.* Retrieved from http://www.tac.vic.gov.au/__data/assets/pdf_file/0014/270230/176_REP_ER_Return-to-work_FINAL.PDF

Côté, P., van der Velde, G., David Cassidy, J., Carroll, L. J., Hogg-Johnson, S., Holm, L. W. et al. (2008). The Burden and Determinants of Neck Pain in Workers. *European Spine Journal, 17*(1), 60-74. doi:10.1007/s00586-008-0626-9

Cox, T. (1978). *Stress*. London: Macmillan.

Cullen, K. L., Irvin, E., Collie, A., Clay, F., Gensby, U., Jennings, P. A. et al. (2018). Effectiveness of Workplace Interventions in Return-to-Work for Musculoskeletal, Pain-Related and Mental Health Conditions: An Update of the Evidence and Messages for Practitioners. *Journal of Occupational Rehabilitation, 28*(1), 1-15. doi:10.1007/s10926-016-9690-x

da Costa, B. R., & Vieira, E. R. (2010). Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. *American journal of industrial medicine, 53*(3), 285-323.

Dale, A. M., Miller, K., Gardner, B. T., Hwang, C. T., Evanoff, B., & Welch, L. (2016). Observed use of voluntary controls to reduce physical exposures among sheet metal workers of the mechanical trade. *Applied Ergonomics, 52*, 69-76. doi:https://dx.doi.org/10.1016/j.apergo.2015.06.026

de Jong, A., & Vink, P. (2000). The adoption of technological innovations for glaziers: evaluation of a participatory ergonomics approach. *International Journal of Industrial Ergonomics, 26*, 39–46.

de Jonge, J., van Vegchel, N., Shimazu, A., Schaufeli, W., & Dormann, C. (2010). A Longitudinal Test of the Demand–Control Model Using Specific Job Demands and Specific Job Control. *International Journal of Behavioral Medicine, 17*(2), 125-133. doi:10.1007/s12529-010-9081-1

Dormohammadi, A., Amjad Sardrudi, H., Motamedzade, M., Dormohammadi, R., & Musavi, S. (2012). Ergonomics intervention in a tile industry- case of manual material handling. *Journal of Research in Health Sciences, 12*(2), 109-113.

Eatough, E. M., Way, J. D., & Chang, C.-H. (2012). Understanding the link between psychosocial work stressors and work-related musculoskeletal complaints. *Applied Ergonomics, 43*(3), 554-563. doi:https://doi.org/10.1016/j.apergo.2011.08.009

Ferguson, S. A., Marras, W. S., Allread, W. G., Knapik, G. G., & Splittstoesser, R. E. (2012). Musculoskeletal disorder risk during automotive assembly: current vs. seated. *Applied Ergonomics, 43*(4), 671-678. doi:https://dx.doi.org/10.1016/j.apergo.2011.10.001

Fingerhut, M., Driscoll, T., Nelson, D. I., Concha-Barrientos, M., Punnett, L., Pruss-Ustin, A. et al. (2005). Contribution of occupational risk factors to the global burden of disease - a summary of findings. *Scandinavian Journal of Work Environment and Health Supplements, 1*, 58-61.

Fujishiro, K., Weaver, J. L., Heaney, C. A., Hamrick, C. A., & Marras, W. S. (2005). The effect of ergonomic interventions in healthcare facilities on musculoskeletal disorders.[Erratum appears in Am J Ind Med. 2006 Jan;49(1):65]. *American journal of industrial medicine, 48*(5), 338-347.

Gerr, F., Fethke, N. B., Anton, D., Merlino, L., Rosecrance, J., Marcus, M. et al. (2014). A prospective study of musculoskeletal outcomes among manufacturing workers: II. Effects of psychosocial stress and work organization factors. *Human Factors, 56*(1), 178-190.

Guyatt, G. H., Sackett, D. L., Sinclair, J. C., Hayward, R., Cook, D. J., Cook, R. J. et al. (1995). Users' guides to the medical literature: IX. A method for grading health care recommendations. *Jama, 274*(22), 1800-1804.

Haddon Jr, W. (1973). Energy damage and the ten countermeasure strategies. *Human Factors, 15*(4), 355-366.

Hagberg, M., Silverstein, B., Wells, R., Smith, M. J., Hendrick, H. W., Carayon, P. et al. (1995). Work-related Musculoskeletal Disorders (WMSDs). A Reference Book for Prevention. In I. Kuorinka & L. Forcier (Eds.): Taylor & Francis.

Haims, M., & Carayon, P. (1998). Theory and practice for the implementation of in-house', continuous improvement participatory ergonomics programs. *Applied Ergonomics, 29*, 461–472.

Haslam, C., Clemes, S. A., McDermott, H., Shaw, K., Williams, C., & Haslam, R. (2007). Manual handling training: investigation of current practices and development of guidelines. Retrieved from http://www.hse.gov.uk/research/rrhtm/rr583.htm

Haslam, R. (2002). Targeting ergonomics interventions—learning from health promotion. *Applied Ergonomics, 33*(3), 241-249.

Hauke, A., Flintrop, J., Brun, E., & Rugulies, R. (2011). The impact of work-related psychosocial stressors on the onset of musculoskeletal disorders in specific body regions: A review and meta-analysis of 54 longitudinal studies. *Work & Stress, 25*(3), 243-256. doi:10.1080/02678373.2011.614069

Hayes, M. J., Osmotherly, P. G., Taylor, J. A., Smith, D. R., & Ho, A. (2014). The effect of wearing loupes on upper extremity musculoskeletal disorders among dental hygienists. *International Journal of Dental Hygiene, 12*(3), 174-179. doi:https://dx.doi.org/10.1111/idh.12048

Hendrick, H. W., & Kleiner, B. (Eds.). (2002). *Macroergonomics: theory, methods, and applications*. Boca Raton: CRC Press.

Hoefsmit, N., Houkes, I., & Nijhuis, F. J. N. (2012). Intervention Characteristics that Facilitate Return to Work After Sickness Absence: A Systematic Literature Review. *Journal of Occupational Rehabilitation, 22*(4), 462-477. doi:10.1007/s10926-012-9359-z

Hogan, D. A. M., Greiner, B. A., & O'Sullivan, L. (2014). The effect of manual handling training on achieving training transfer, employee's behaviour change and subsequent reduction of work-related musculoskeletal disorders: a systematic review. *Ergonomics, 57*(1), 93-107. doi:10.1080/00140139.2013.862307

International Organization for Standardisation. (2009). *ISO Guide 73:2009 Risk Management - Vocabulary* In. Retrieved from https://www.iso.org/standard/44651.html

Jaegers, L., Dale, A. M., Weaver, N., Buchholz, B., Welch, L., & Evanoff, B. (2014). Development of a program logic model and evaluation plan for a participatory ergonomics intervention in construction. *American Journal of Industrial Medicine, 57*, 351–361.

Karsh, B. T. (2006). Theories of work-related musculoskeletal disorders: Implications for ergonomic interventions. *Theoretical Issues in Ergonomics Science, 7*(1), 71-88. doi:10.1080/14639220512331335160

King, T. K., Severin, C. N., Van Eerd, D., Ibrahim, S., Cole, D., Amick, B., 3rd, et al. (2013). A pilot randomised control trial of the effectiveness of a biofeedback mouse in reducing self-reported pain among office workers. *Ergonomics, 56*(1), 59-68. doi:https://dx.doi.org/10.1080/00140139.2012.733735

Kop, J.-L., Althaus, V., Formet-Robert, N., & Grosjean, V. (2016). Systematic comparative content analysis of 17 psychosocial work environment questionnaires using a new taxonomy. *International Journal of Occupational and Environmental Health, 22*(2), 128-141. doi:10.1080/10773525.2016.1185214

Kotowski, S. E., Davis, K. G., & Waters, T. R. (2009). Investigation of select ergonomic interventions for farm youth. Part 2: wheelbarrows. *Journal of Agromedicine, 14*(1), 44-57. doi:https://dx.doi.org/10.1080/10599240802612653

Kuorinka, I., & Forcier, L. (1995). *Work related musculoskeletal disorders (WMSDs) : a reference book for prevention*. London: Taylor and Francis.

Lahelma, E., Laaksonen, M., Lallukka, T., Martikainen, P., Pietiläinen, O., Saastamoinen, P. et al. (2012). Working conditions as risk factors for disability retirement: a longitudinal register linkage study. *BMC Public Health, 12*(1), 309. doi:10.1186/1471-2458-12-309

Lang, J., Ochsmann, E., Kraus, T., & Lang, J. W. (2012a). Psychosocial work stressors as antecedents of musculoskeletal problems: a systematic review and meta-analysis of stability-adjusted longitudinal studies. *Social Science & Medicine, 75*(7), 1163-1174.

Lang, J., Ochsmann, E., Kraus, T., & Lang, J. W. B. (2012b). Psychosocial work stressors as antecedents of musculoskeletal problems: A systematic review and meta-analysis of stability-adjusted longitudinal studies. *Social Science & Medicine, 75*(7), 1163-1174. doi:https://doi.org/10.1016/j.socscimed.2012.04.015

Leka, S., & Cox, T. (Eds.). (2008). *PRIMA-EF: Guidance on the European Framework for Psychosocial Risk Management*. Geneva: Institute of Work, Health and Organisations.

Leyshon, R., Chalova, K., Gerson, L., Savtchenko, A., Zakrzewski, R., Howie, A. et al. (2010). Ergonomic interventions for office workers with musculoskeletal disorders: a systematic review. *Work, 35*(3), 335-348. doi:https://dx.doi.org/10.3233/WOR-2010-0994

Lowe, D., Taylor, M., & Hill, S. (2016). Changing definitions altered multimorbidity prevalence, but not burden associations, in a musculoskeletal population. *Journal of Clinical Epidemiology, 78*(C), 116-126. doi:10.1016/j.jclinepi.2016.03.016

Luijsterburg, P. A., Bongers, P. M., & de Vroome, E. M. (2005). A new bricklayers' method for use in the construction industry. *Scandinavian journal of work, environment & health, 31*(5), 394-400.

Macdonald, W. (2006). Managing workloads to optimise performance, health and wellbeing. In K. W (Ed.), *International Encyclopedia of Ergonomics and Human Factors* (pp. 2170–2174). London: Taylor and Francis.

Macdonald, W., & Evans, O. (2006). *Reaserch on the prevention of work-related musculoskeletal disorders: Stage 1 - Literature review. 2006*. Canberra: Australian Safety and Compensation Council.

Macdonald, W., & Oakman, J. (2015). Requirements for more effective prevention of work-related musculoskeletal disorders. *BMC musculoskeletal disorders, 16*(1), 293. doi:10.1186/s12891-015-0750-8

Macfarlane, G. J., Pallewatte, N., Paudyal, P., Blyth, F. M., Coggon, D., Crombez, G. et al. (2009). Evaluation of work-related psychosocial factors and regional musculoskeletal pain: results from a EULAR Task Force. *Annals of the Rheumatic Diseases, 68*(6), 885.

Marras, W. S. (2008). *The working back a systems view*. Hoboken: Wiley-Interscience.

Marras, W. S., Cutlip, R. G., Burt, S. E., & Waters, T. R. (2009). National occupational research agenda (NORA) future directions in occupational musculoskeletal disorder health research. *Applied Ergonomics, 40*(1), 15-22. doi:https://doi.org/10.1016/j.apergo.2008.01.018

Martimo, K. P., Verbeek, J. H., Karppinen, J., Furlan, A. D., Kuijer, P. P. F., Viikari-Juntura, E. et al. (2007). Manual material handling advice and assistive devices for preventing and treating back pain in workers. *Cochrane Database of Systematic Reviews*(3).

May, J., Hawkes, L., Jones, A., Burdick, P., Ginley, B., Santiago, B. et al. (2008). Evaluation of a community-based effort to reduce blueberry harvesting injury. *American journal of industrial medicine, 51*(4), 307-315. doi:https://dx.doi.org/10.1002/ajim.20554

Miranda, H., Kaila-Kangas, L., Heliövaara, M., Leino-Arjas, P., Haukka, E., Liira, J., & Viikari-Juntura, E. (2010). Musculoskeletal pain at multiple sites and its effects on work ability in a general working population. *Occupational and Environmental Medicine, 67*(7), 449. doi:10.1136/oem.2009.048249

Morse, T., Dillon, C., Warren, N., Hall, C., & Hovey, D. J. A. j. o. i. m. (2001). Capture–recapture estimation of unreported work-related musculoskeletal disorders in Connecticut. *39*(6), 636-642.

Myck, M. (2015). Living longer, working longer: the need for a comprehensive approach to labour market reform in response to demographic changes. *European Journal of Ageing, 12*(1), 3-5. doi:10.1007/s10433-014-0332-x

National Institute for Occupational Safety and Health. (1997). *Musculoskeletal Disorders (MSDs) and Workplace Factors. A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back*. U.S. Department of Health and Human Services. National Institute for Occupational Safety and Health Retrieved from https://www.cdc.gov/niosh/docs/97-141/

National Research Council. (2001). *Musculoskeletal disorders and the workplace: low back and upper extremities*: National Academies Press.

Nicholas, M. K., Linton, S. J., Watson, P. J., & Main, C. J. (2011). Early Identification and Management of Psychological Risk Factors (“Yellow Flags”) in Patients With Low Back Pain: A Reappraisal. *Physical Therapy, 91*(5), 737-753. doi:10.2522/ptj.20100224

Nielsen, K. (2013). How can we make organizational interventions work? Employees and line managers as actively crafting interventions. *Human Relations, 66*(8), 1029-1050.

Nielsen, K. (2017). Organizational occupational health interventions: what works for whom in which circumstances? *Occupational Medicine, 67*(6), 410-412. doi:10.1093/occmed/kqx058

Norlund, A., Ropponen, A., & Alexanderson, K. (2009). Multidisciplinary interventions: Review od studies of return to work after rehabilitation for low back pain. *Journa of Rehabilitation Medicine, 41*, 115-121.

O’Neill, S., Martinov-Bennie, N., Cheung, A., & Wolfe, K. (2013). Issues in the measurement and reporting of work health and safety performance: A review. *Safe Work Australia, Safety Institute of Australia, CPA Australia*.

Oakman, J., & Chan, S. (2015). Risk management: Where should we target strategies to reduce work-related musculoskeletal disorders? *Safety science, 73*, 99-105.

Oakman, J., Macdonald, W., & Kinsman, N. (2019). Barriers to more effective prevention of work-related musculoskeletal and mental health disorders. *Applied Ergonomics, 75*, 184-192.

Oakman, J., Macdonald, W., & Wells, Y. (2014). Developing a comprehensive approach to risk management of musculoskeletal disorders in non-nursing health care sector employees. *Applied Ergonomics, 45*(6), 1634-1640.

Oakman, J., Rothmore, P., & Tappin, D. (2016). Intervention development to reduce musculoskeletal disorders: Is the process on target? *Applied Ergonomics, 56*, 179-186.

Oakman, J., & Wells, Y. (2016). Working longer: What is the relationship between person-environment fit and retirement intentions? *Asia Pacific Journal of Human Resources, 54*(2), 207. doi:10.1111/1744-7941.12075

Olishifski, J. B. (1976). General Methods of Control. In J. B. Olishifski & F. E. mcElroy (Eds.), *Fundamentals of Industrial Hygiene* Chicago: National Safety Council.

Punnett, L., & Wegman, D. H. (2004). Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *Journal of Electromyography and Kinesiology, 14*(1), 13-23. doi:10.1016/j.jelekin.2003.09.015

Rasmussen, C. D. N., Holtermann, A., Bay, H., Søgaard, K., & Jørgensen, M. B. (2015). A multifaceted workplace intervention for low back pain in nurses' aides: a pragmatic stepped wedge cluster randomised controlled trial. *Pain, 156*, 1786–1794.

Rempel, D., Star, D., Barr, A., Blanco, M. M., & Janowitz, I. (2010). Field evaluation of a modified intervention for overhead drilling. *Journal of Occupational & Environmental Hygiene, 7*(4), 194-202. doi:https://dx.doi.org/10.1080/15459620903558491

Richardson, K. M., & Rothstein, H. R. (2008). Effects of occupational stress management intervention programs: a meta-analysis. *Journal of occupational health psychology, 13*(1), 69.

Rivière, S., Penven, E., Cadéac-Birman, H., Roquelaure, Y., & Valenty, M. (2014). Underreporting of musculoskeletal disorders in 10 regions in France in 2009. *American journal of industrial medicine, 57*(10), 1174-1180.

Rivilis, I., Van Eerd, D., Cullen, K., Cole, D. C., Irvin, E., Tyson, J. et al. (2008). Effectiveness of participatory ergonomic interventions on health outcomes: A systematic review. *Applied Ergonomics, 39*(3), 342-358. doi:https://doi.org/10.1016/j.apergo.2007.08.006

Roman-Liu, D. (2014). Comparison of concepts in easy-to-use methods for MSD risk assessment. *Applied Ergonomics*, 45(3), 420-427.

Rosenman, K. D., Gardiner, J. C., Wang, J., Biddle, J., Hogan, A., Reilly, M. et al. (2000). Why most workers with occupational repetitive trauma do not file for workers' compensation. *Journal of Occupational Environmental Medicine, 42*(1), 25.

Rothmore, P., Aylward, P., Gray, J., & Karnon, J. (2017). A long-term evaluation of the stage of change approach and compensable injury outcomes–a cluster-randomised trial. *Ergonomics, 60*(5), 628-635.

Ruschena, L. (2017). Prevention and Intervention In Safety Institute of Australia (SIA) (Ed.), *The Core Body of Knowledge for Generalist OHS Professionals*. Tullamarine, VIC.: Safety Institute of Australia.

Safe Work Australia. (2010). *Compendium of Workers' Compensation Statistics Australia 2007-2008*. Retrieved from https://www.safeworkaustralia.gov.au/doc/compendium-workers-compensation-statistics-2007-08:

Safe Work Australia. (2015a). *The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012–13*. Canberra, Australia

Safe Work Australia. (2015b). Good Work Design.

Safe Work Australia. (2016a). *Guide to the Model Work Health and Safety Act*. Retrieved from https://www.safeworkaustralia.gov.au/doc/guide-model-work-health-and-safety-act:

Safe Work Australia. (2016b). *Statistics on work-related musculoskeletal disorders*. Canberra, Australia

Safe Work Australia. (2018a). *Australian Workers' Compensation Statistics 2015-2016*. Retrieved from https://www.safeworkaustralia.gov.au/doc/australian-workers-compensation-statistics-2015-16:

Safe Work Australia. (2018b). Compensation schemes and workers aged over 65. Retrieved from https://www.safeworkaustralia.gov.au/media-centre/news/compensation-schemes-and-workers-aged-over-65

Safe Work Australia. (2018c). *Hazardous Manual Tasks - Code of Pracice*. Retrieved from https://www.safeworkaustralia.gov.au/doc/model-code-practice-hazardous-manual-tasks:

Safe Work Australia. (2018d). *Comparison of workers' compensation arrangements in Australia and New Zealand* Retrieved from https://www.safeworkaustralia.gov.au/doc/comparison-workers-compensation-arrangements-australia-and-new-zealand-2018

Sauter, S., & Moon, S. D. (1996). *Beyond biomechanics: psychosocial aspects of musculoskeletal disorders in office work*: CRC Press.

Schoenfisch, A. L., & Lipscomb, H. J. (2009). Job characteristics and work organization factors associated with patient-handling injury among nursing personnel. *Work (Reading, Mass.), 33*(1), 117. doi:10.3233/WOR-2009-0847

Schofield, D. J., Callander, E. J., Shrestha, R. N., Passey, M. E., Percival, R., & Kelly, S. J. (2013). Multiple chronic health conditions and their link with labour force participation and economic status. *PloS one, 8*(11), e79108.

Silverwood, S., & Haddock, M. (2006). Reduction of musculoskeletal injuries in intensive care nurses using ceiling-mounted patient lifts. *Dynamics (Pembroke, Ont.), 17*(3), 19-21.

Singh, S., Sinwal, N., & Rathore, H. (2012). Gender involvement in manual material handling (mmh) tasks in agriculture and technology intervention to mitigate the resulting musculoskeletal disorders. *Work, 41 Suppl 1*, 4333-4341. doi:https://dx.doi.org/10.3233/WOR-2012-0728-4333

Smith, M. L., Pickens, A. W., Ahn, S., Ory, M. G., DeJoy, D. M., Young, K. et al. (2015). Typing performance and body discomfort among overweight and obese office workers: A pilot study of keyboard modification. *Applied Ergonomics, 46 Pt A*, 30-37. doi:https://dx.doi.org/10.1016/j.apergo.2014.06.004

Steenkamer, B. M., Drewes, H. W., Heijink, R., Baan, C. A., & Struijs, J. N. (2017). Defining population health management: a scoping review of the literature. *Population health management, 20*(1), 74-85.

Stock, S. R., Nicolakakis, N., Vezina, N., Vezina, M., Gilbert, L., Turcot, A. et al. (2018). Are work organization interventions effective in preventing or reducing work-related musculoskeletal disorders? A systematic review of the literature. *Scandinavian Journal of Work, Environment and Health, Supplement, 44*(2), 113-133. doi:http://dx.doi.org/10.5271/sjweh.3696

Stuckey, R., & Lamontagne, A. D. (2005). Occupational light-vehicle use and OHS legislative frameworks: an Australian example. *International Journal of Occupational and Environmental Health, 11*(2), 167-179.

Stuckey, R., LaMontagne, A. D., & Sim, M. (2007). Working in light vehicles—a review and conceptual model for occupational health and safety. *Accident Analysis Prevention, 39*(5), 1006-1014.

Sudiajeng, L., Adiputra, N., & Leibbrandt, R. (2012). Ergonomics work stations decreases the health impairment and saves electrical energy at the woodworking workshop in Bali, Indonesia. *Journal of Human Ergology, 41*(1-2), 41-54.

van Eerd, D., Cole, D., Irvin, E., Mahood, Q., Keown, K., Theberge, N. et al. (2010). Process and implementation of participatory ergonomic interventions: a systematic review. *Ergonomics, 53*(10), 1153-1166. doi:10.1080/00140139.2010.513452

van Rijn, R. M., Robroek, S. J., Brouwer, S., & Burdorf, A. (2014). Influence of poor health on exit from paid employment: a systematic review. *Occup Environ Med, 71*(4), 295-301.

Verbeek, J., Martimo, K., Karppinen, J., Kuijer, P., Takala, E., & Viikari-Juntura, E. (2012). Manual material handling advice and assistive devices for preventing and treating back pain in workers: a Cochrane Systematic Review. *J Occup Environ Med, 69*(1), 79-80.

Vieira, E. R., & Brunt, D. (2016). Does wearing unstable shoes reduce low back pain and disability in nurses? A randomized controlled pilot study. *Clinical Rehabilitation, 30*(2), 167-173. doi:https://dx.doi.org/10.1177/0269215515576812

Viner, D. (1991). *Accident analysis and risk control*: VRJ Delphi.

Waddell, G. (2006). Preventing incapacity in people with musculoskeletal disorders. *British Medical Bulletin, 77*(1), 55-69.

Way, K. (2012). Psychosocial hazards and occupational stress. In *HaSPA (Health and Safety Professionals Alliance), The Core Body of Knowledge for Generalist OHS Professionals*. Tullamarine, Vic: Safety Institute of Australia.

Webb, G., Redman, S., Wilkinson, C., & Sanson-Fisher, R. (1989). Filtering effects in reporting work injuries∗. *Journal of Accident Analysis, 21*(2), 115-123.

Wells, R. (2009). Why have we not solved the MSD problem? *Work, 34*(1), 117-121.

Wilson, J.R. (2014). Fundamentals of systems ergonomics/human factors. *Appl. Ergon., 45(1),* 5–13.

WorkSafe Victoria. (2016). *Manual Handling: Review and revision of risk control measures. Guidance for employers on how to review and revise risk control measures for manual handling.* Retrieved from http://www.worksafe.vic.gov.au/data/assets/pdf_file/0005/191219/ISBN-manual-handling-review-revison-risk-control-measures-2016-05.pdf

Zakaria, D., Robertson, J., MacDermid, J., Hartford, K., & Koval, J. (2002). Work-related cumulative trauma disorders of the upper extremity: Navigating the epidemioligic literature. *J American Journal of Industrial Medicine, 42*(3),258–269.