Human Factors & Ergonomics Society of Australia Inc.

Work-related Musculoskeletal Disorders (WMSDs) in Australia
HFESA Position Statement on Risk Factors and Workplace Prevention (June 16, 2020)
Interim version – Additional graphics to be included pending copyright approvals.

INTRODUCTION

The Human Factors and Ergonomics Society Australia (HFESA) promotes the application of sound human factors and ergonomics (HFE) principles in the workplace.

This position statement is about a substantial problem facing the Australian business sector and its workforce - Work-related Musculoskeletal Disorders (WMSDs).

WMSDs may affect any worker and can result in debilitating life-changing consequences along with significant cost impacts on businesses and the Australian economy, costing billions of dollars annually.

The model Work Health and Safety Regulations 2011 define a musculoskeletal disorder as 'an injury to, or disease of, the musculoskeletal system, whether occurring suddenly or over time, but does not include an injury caused by crushing, entrapment or cutting resulting principally from the mechanical operation of plant'. (Safe Work Australia, 2019). WMSDs may include disorders such as 'repetitive strain injuries', 'occupational overuse syndrome', 'back injury', 'osteoarthritis', 'backache', 'sciatica', 'slipped disc', 'carpal tunnel syndrome', 'tendinitis', and others (Oakman, Clune & Stuckey, 2019 pp.11).

The kinds of symptoms that occur with WMSDs are varied and can include aches and pains and general discomfort, change in the ability to detect sensations of touch and heat, loss of muscle strength and endurance, loss of ability to perform controlled movements, reduction in muscle bulk and loss of joint range of motion or stability (Punnett & Wegman 2004, cited in Oakman, Clune & Stuckey, 2019 pp. 12).

The overall effect of this type of injury can be a significant loss in physical capacity to live a healthy lifestyle and perform activities of daily living that we often take for granted.

Other disorders may also include 'cumulative trauma disorder' and 'occupational cervicobrachial disease' (Hagberg et al, 1995 pp.5) or 'body stressing', a term used to describe the mechanism of injury classification in Australian workers' compensation statistics (Safe Work Australia, 2018).

Prevention and intervention in any part of the cycle of injury and recovery can make a significant difference to the overall outcome. Primary prevention (eliminating or reducing risks to health or well-being) is the most important, but is the most difficult. It requires education; willingness and ability to intervene and commitment often with limited evidence that there is a problem.

This position statement provides contemporary evidence on some of the key areas of concern facing the Australian workforce and includes an overview of the current evidence base on the impact, causation and intervention.

The HFESA hopes that this position statement will bring about a change in the knowledge state of all Australians about the impact that WMSDs have and is a call to action for sustainable change in the way in which the prevention of WMSDs in Australia is delivered.

HFESA Position Statement

Work-related Musculoskeletal Disorders (WMSDs) may affect any worker and can result in debilitating life-changing consequences along with significant cost impacts on businesses and the Australian economy, costing billions of dollars annually.

WMSDs are a significant workplace problem, representing the highest category of serious workers' compensation claims for Australian workers.

Factors that are known to influence the development of Work-related Musculoskeletal Disorders (WMSDs) involve a combination of physical as well as psychological and / or social (psychosocial) hazards. Their level of influence varies depending on the task and equipment involved, the way in which work is designed and organised, the workplace environment and the worker profile.

Physical hazards include high force, awkward postures, repetition, long duration, fatigue and vibration. Psychosocial hazards include high job demands, low job control, high job strain, low social support, low job satisfaction and low job security. Personal characteristics such as age, pre-existing physical and psychological conditions may impact personal WMSD risk.

The HFESA recommends that a holistic systems-based approach be taken to establish the workplace WMSD risk profile. In doing this, risk management strategies need to be comprehensive and include identification and then control of physical and psychosocial hazards. Participation of workers and managers in the process is fundamental to ensure the process accurately captures the most relevant hazards and the controls are appropriate for the work. A suitably qualified professional such as a Certified Professional Ergonomist can provide assistance to implement a comprehensive risk management process.

The HFESA has prepared this position statement to clarify some key issues related to WMSD management which takes into account contemporary evidence how to address this complex workplace problem and as a call to action to achieve practicable and sustainable outcomes to prevent WMSDs.

A more extensive statement provides further information and is available at https://www.ergonomics.org.au/.

1 WMSD prevention is achieved through Human Factors and Ergonomics intervention

For a workplace, Human Factors and Ergonomics (HFE) is about design of work and the work environment to improve the health and safety, performance and productivity of the workplace (see Figure 1).

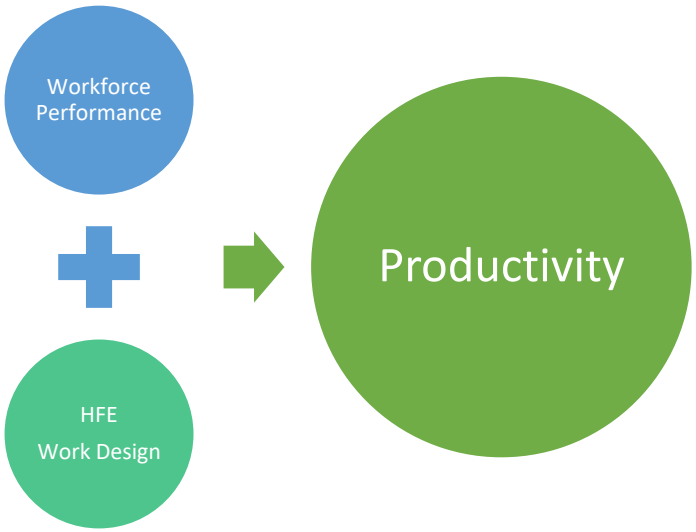


Figure 1: Relationship between performance of workers, good work design and benefits to workplace productivity

As a discipline it uses a holistic, systems approach to apply theory, principles, and data from many relevant disciplines to the design and evaluation of tasks, jobs, products, environments, and systems. HFE takes into account physical, cognitive, sociotechnical, organisational, environmental and other relevant factors, as well as the complex interactions between the human and other humans, the environment, tools, products, equipment, and technology.

Figure 2 summarises the three broad domains of specialisation with HFE.

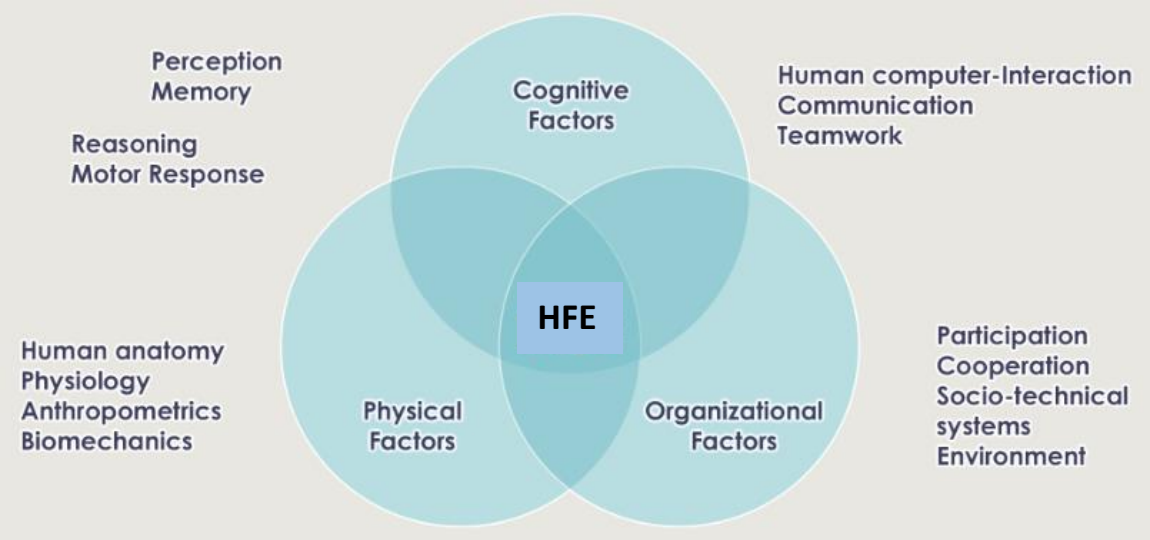


Figure 2: The three domains of HFE (physical, cognitive and organisational). Source: IEA 2020.

Physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. Relevant topics include working postures, materials handling, repetitive movements, heavy work, work-related musculoskeletal disorders, workplace layout, noise, thermal conditions and vibration, safety and health, as these relate to work.

Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning and motor response, as they affect interactions among humans and other elements of a system. Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human error, work stress and training as these may relate to the way humans work in systems.

Organisational ergonomics is concerned with the optimisation of socio-technical systems, including their organisational structures, policies and processes. Relevant topics include human system considerations in communication, human resource management, work design, design of work schedules, teamwork, participatory design, community ergonomics, cooperative work, new work models, virtual organisations, tele-work and quality management.

In practical terms HFE is concerned with user characteristics, technology, skills and knowledge, tasks required to be performed and their performance level, and an understanding of the environmental and psychosocial conditions in the workplace related to the design of the human-machine-environment system (HMES) of work.

Figure 3 provides a model of the relationship between different elements of HFE, which looks at the fit between workers, the work job task design, the workplace and equipment design, and work organisation factors and takes a holistic systems-based approach to determine the causes of WMSDs.

From the risk assessment perspective, although each section can be evaluated on its own, it is the combination of all four elements which is the key issue. It is therefore necessary to assess the inter-dependence of all interacting sub-sections within the overall situation.

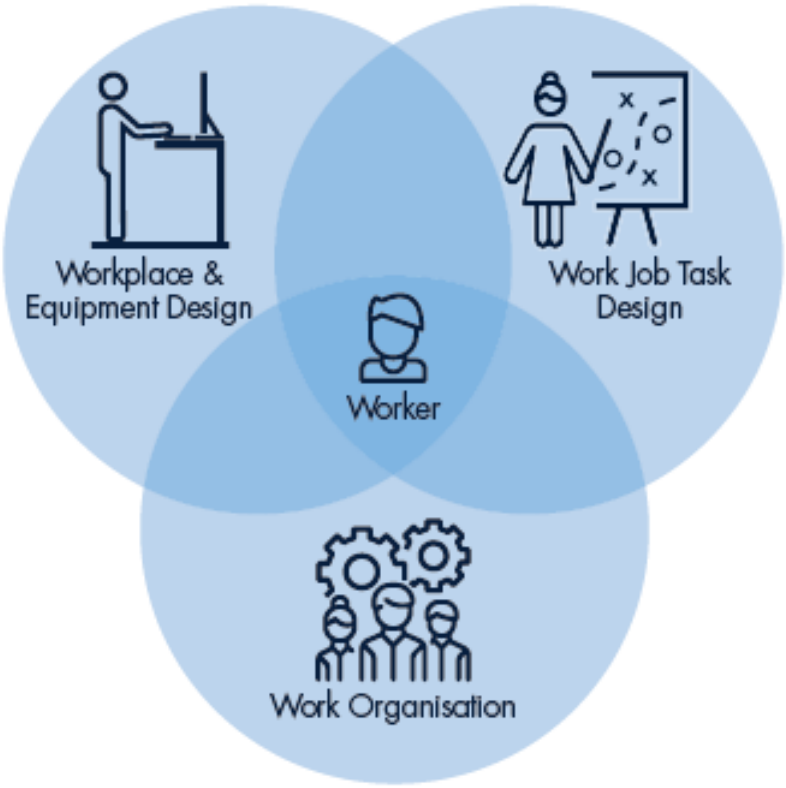
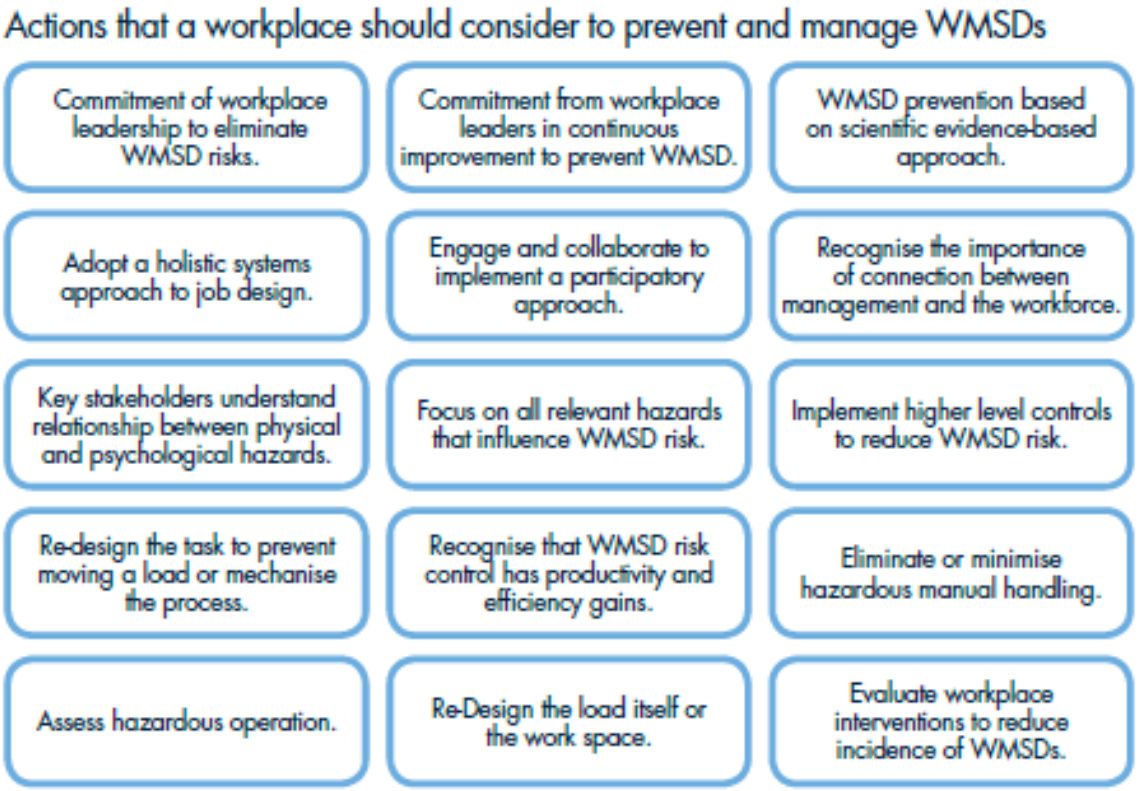


Figure 3: Model of the relationship between different elements of HFE. Adapted from Koji, K., McPhee, B. and Scott, P. (2010) pp23.

Understanding the inter-relationship between the three domains assists further in understating the need for a systems-based approach when analysing work and exploring ways it can be improved from an HFE perspective. Note that the considerations listed provide a general indication and by no means is the list exhaustive.

Table 1: Basic elements that need to be addressed when analysing work.



The table above provides examples of actions that a workplace should consider to reduce the risk of WMSDs.
Note: The actions are not presented in any particular order.

In the context of WMSDs, the design of work tasks should consider for example, the level of physical exertion required, how the work is organised, a worker's physical and mental capacity and tolerance to fatigue, ability to cope with prolonged stress associated with a 'poor fit'. This is a simplistic view and there are many other components within each of the factors to be considered.

Professionally qualified ergonomists bring knowledge and experience of the capabilities and limitations of humans to systems so both the system & people work effectively. This is particularly important from the perspective of workplace hazards that influence the risk of WMSDs.

The importance of the application of HFE principles in the design of a task is recognised in the Hazardous manual tasks Code of Practice (SWA 2018, pp. 51) and states ''*a manual task should be designed to fit the people doing the task, not the opposite where the worker has to make adjustments to fit the task. Ergonomics involves consideration of the variability in human capability and an understanding of how people interact with the work environment, tools and equipment.''*

To manage and prevent WMSDs a CPE works to:

- Analyse the interaction between the human operator and other components within the system to identify incompatibilities in the system of work and to address any “mismatch” between the worker and the task by adjusting the task to suit the capabilities of the worker.
- Apply a holistic approach, design and evaluate tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people.
- Apply the Hierarchy of Control (see Figure 11) to provide a range of system-based, practical and evidence-based WMSD risk controls that consider technology as it relates to people, place and procedures.
- Adopt a systems approach to managing WMSD risk so that interrelationships between physical and psychosocial factors are identified.
- Simplify complex workplace problems that have led to or could develop into a WMSD by applying the appropriate methods and tools to assist with identification of all relevant physical and psychosocial hazards.
- Work collaboratively with workplace key stakeholders to enhance their awareness and knowledge of WMSD risk factors using a participatory ergonomics approach with positive influence on workplace agility to solve future influencers of WMSD risk.

Some examples of task specific interventions focused on the provision of equipment or aids to reduce physical loads and WMSD risk are:

- Carousels positioned at a point of sale checkout that support customer bags for the checkout operator to fill and rotate for the customer to remove and place in their trolley, to reduce repetitive lifting movements and cumulative loading on neck, shoulder and lower back.
- A mechanical aid to hitch to a dump master waste bin to move it by a single operator rather than a team of workers eliminates exclusive reliance on manual force that is high to extreme and which accommodates a range of workplace environmental hazards to reduce load to the lower back, hand/finger entrapment trauma and enables higher efficiency gains.
- A mechanical aid to hitch to a roll cage to move it along inclines, over long distances and in restricted spaces to reduce twisting force to the lower back, excessive upper limb strain and hand related trauma.
- An auto levelling trolley to maintain optimal height for picking and placement of product to reduce bending and stooping in the lower and upper back and reduce early onset fatigue.
- A workplace participatory program to invite and encourage workers to share their ideas in the innovative and safe workplace design space to generate practical solutions by persons that are intimately involved and understand the nature of the tasks.
- A mechanical aid to move multiple nested shopping trolleys over large distances rather than rely exclusively on manual effort by a single worker to walk while applying push effort to return the trolleys to reduce worker fatigue and high upper body sustained load.
- Powered height-adjustable stretchers used by ambulance services to reduce the ergonomic risks associated with handling patients to and from stretchers and into and out of ambulances.
- A desktop accessory to positioned on the desk in front of the keyboard to replace a conventional input device (mouse) to reduce undesirable repetitive shoulder movement and local fatigue with efficiency gains.

2 WMSD prevention is critical as it is the largest occupational health problem in Australia

The Australian Work Health and Safety Strategy 2012–2022 (the Strategy) was launched on 31 October 2012 and an updated version republished in April 2018.

With its vision of 'healthy, safe and productive working lives' it is a high level, forward-looking document capable of being implemented by governments, unions, industry and other organisations across Australia.

A priority national target set by the Strategy to be achieved by 2022, was a reduction in the incidence rate of claims for musculoskeletal disorders resulting in one or more weeks off work of at least 30%.

A key national priority area of the Strategy is healthy and safe by design and two key priority work-related conditions based on the severity of consequences for workers was musculoskeletal disorders (MSDS) and mental health conditions (SWA Australian Work Health and Safety Strategy 2012-2022. March 2020).

WMSDs are the highest category of serious claims for compensation for Australian workers with 38,770 claims (36% of all claims) in 2017-18 being for 'body stressing' (SWA, 2020, pp. 21). The majority of claims (80%) are attributed to handling (including lifting, carrying or putting down) objects with most claims involving the back (38%) and shoulder (19%) (Table 2). While males incur more WMSD claims than females, WMSDs represent a slightly higher proportion of claims for females than for males (Table 3).

In 2012-13 the cost of work-related injury and disease to the Australian economy was $61.8 billion with the cost of WMSDs at ~$22 billion. Recent trends show an overall 17% reduction in claims for WMSD from 2013 to 2017 (Table 4) while in the same period the median time lost for body stressing claims has increased by 7% from 5.8 to 6.2 weeks (SWA, 2020, pp. 50), but the median cost per claim has increased by 32% to $12,900 per claim (Table 5).

Table 2: Serious claims for 'body stressing', 2017-18 (SWA 2020).

		No of serious claims*	Proportion of claims for category*
Mechanism	Muscular stress while handling objects	16,775	43%
	Muscular stress while lifting, carrying, or putting down objects	14,420	37%
	Muscular stress with no objects being handled	5075	13%
	Total	38,770	
Bodily location	Back – upper or lower	14,830	38%
	Shoulder	7175	19%
	Knee	3450	9%
	Abdomen & pelvic region	2150	6%
	Wrist	2010	5%
	Hand, fingers & thumb	1420	4%
	Elbow	1290	3%
	Neck	935	2%
	Total	38,770	

* Figures do not add to total as small categories have been omitted from SWA published summary data.
* 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 (Safe Work Australia, 2018).

Table 3: Gender breakdown for injuries to musculoskeletal and connective tissue (SWA, 2020).

		No of serious claims	Proportion of claims for gender
Musculoskeletal & connective tissue	Male	9095	13%
	Female	6230	16%
	Total	15,320	14%

Table 4: Trends in number of serious claims for 'body stressing', 2013-2017 (SWA, 2020).

	2013	2014	2015	2016	2017	% change
Muscular stress while handling objects	18,925	18,330	18,000	17,255	16,220	11%
Muscular stress while lifting, carrying, or putting down objects	19,620	18,605	16,910	15,740	15,780	20%
Muscular stress with no objects being handled	6,105	6,080	5,580	5,210	5,525	10%
Total	48,480	46,615	44,120	41,345	40,380	17%

Table 5: Trends in costs of serious claims for 'body stressing', 2013-2017 (SWA, 2020).

	2013	2014	2015	2016	2017	% change
Muscular stress while handling objects	$9,800	$10,500	$11,300	$12,000	$13,100	+34%
Muscular stress while lifting, carrying, or putting down objects	$9,000	$9,800	$10,500	$11,500	$12,100	+35%
Muscular stress with no objects being handled	$9,000	$9,300	$10,600	$11,500	$11,600	+29%
Total	$9,800	$10,400	$11,300	$12,100	$12,900	+32%

Note: The majority of injury statistics in Australia is informed by surveillance data from Safe Work Australia's National Data Set for Compensation-base Statistics (NDS).

3 WMSD prevention is not achieved through teaching workers how to lift

The distinction between task-based training and Hazardous Manual Task (HMT) training is important. Workers must be provided with information, instruction and training in the tasks they are required to perform to enable them to acquire the necessary knowledge and skill to perform tasks safely. This type of training is considered to be a part of risk control and may involve the way to use plant or equipment and would hopefully be based on good work design that had considered relevant WMSD risk factors.

HMT training on the other hand supports other solutions that have been put in place (e.g. describing what equipment is needed and how to use it, to safely perform specific HMTs). Such training also assists workers and management to identify and understand HMTs, the risk factors that cause them and solutions used to reduce the risk.

The provision of training for workers in lifting techniques or physical actions, movements or postures to perform manual work will not prevent WMSDs. An example of such an approach, would involve training a worker to manually lift material from the floor with specific instruction to the worker to adopt a full squat position and then lift the material while keeping a straight back and ensuring that the load is moved slowly without any jerking movement. Lifting training emphasising such techniques as *bend your knees and keep your back straight* is not suitable as the risk factors causing the problem are not changed. Even if workers attempt to apply lifting techniques, they may still be exposed to a serious injury risk.

A key message here is that HMT training must not be used to prevent back injuries as it does not address the cause of these injuries.

Unfortunately, while the perspective of HFE is to design tasks to make them safe, a most common approach in many industries is to train workers to lift safely and as seen in the above example, the reliance on such an approach would expose workers to physical harm and risk of WMSD.

A review of the literature over the last fifty years has yielded the same finding – that Manual Materials Handling (MMH) technique training as a risk control method for WMSD risk is not effective.

As far back as 1971, Brown suggested that despite extensive information campaigns, very few workers used the ‘straight back -bent knees’ technique’ (Hagberg et al, 1995c). In 1978 Snook compared three approaches to low back injury prevention – pre-employment selection, training in lifting techniques, and job design. The findings showed no difference in the proportion of injuries in companies that did or did not train their workers in lifting technique. Interestingly, a significant finding was there was scope for a 67% reduction in injuries through job redesign (Bridger 2018, pp 213).

In 2014 Hogan reviewed 13 studies where the effectiveness of manual handling training has been investigated, concluding that such training was ineffective in changing employees’ manual handling behaviour or at reducing back injury (Bridger 2018, pp 214).

An extensive literature review undertaken by the Cochrane Back Review Group in 2011 to determine the effectiveness of manual material handling advice and training and the provision of assistive devices (back belts) in preventing and treating back pain. The review concluded that there is moderate quality evidence that MMH advice and training with or without assistive devices does not prevent back pain or back pain-related disability when compared to no intervention or alternative interventions. Furthermore, it was also concluded that there is no evidence for the effectiveness of MMH advice and training or MMH assistive devices for treating back pain (C. Haslam et al., 2007; Verbeek et al., 2012, pp. 79-80).

The lack of evidence to support the use of back belts or abdominal belts was concurred by Burgess-Limerick (2012, pp. 12). Clearly, such assistive devices should not be deployed as a way of controlling WMSD risk.

A clear message from the research evidence is MMH technique training is not effective (C. Haslam et al., 2007; Hogan et al., 2014; Martimo et al., 2007; Verbeek et al., 2012 as cited in Oakman, Clune & Stuckey, 2019, pp. 39). Bridger confirmed that every study known to him from 1978 to 2014 had essentially the same conclusion. He provided a perspective as to why training in lifting technique was so often ineffective (Bridger 2018, pp. 214-216). A summary of reasons is:

- It is the design of the task that determines the WMSD risk
- Techniques that are taught are not necessarily safe
- So called safe techniques may not necessarily be usable
- The training may not transfer to the actual work performed by workers
- That the outcomes of the training may not necessarily yield gains in WMSD risk reduction

4 WMSD prevention cannot be achieved through reliance on physical strength training

Exercise or work hardening programs can lead to improvements in a variety of fitness and health outcomes for an individual. This is true for both workers without injury and injured workers undergoing rehabilitation and return-to-work programs. According to Hagberg et al (Hagberg et al, 1995, pp. 248), it is possible that exercise programs may prevent WMSDs such as in jobs where a high level of muscle strength is utilised, muscle strength training may prevent neck-shoulder disorders, however the results of intervention studies showing that exercise programs prevent WMSDs are not consistent. Furthermore, a further challenge with the exercise-based interventions is adherence to the intervention.

While a strength training program aimed to increase an individual's core strength, absolute upper body strength or strength-endurance of leg muscles will produce possible strength gains, there is no guarantee that this gain will prevent injury as there are many factors which influence WMSD risk.

For example, if a worker is required to perform an MMH task that is inherently hazardous because it requires the worker to twist their trunk while they support or lift a load their core strength may not be sufficient to withstand the postural stress involved. Taking this further, if the task is performed in a restricted space and while seated the added mechanical stress may well exceed any strength training effect gained by the individual as a result of a resistance training program.

Bridger (Bridger 2018, pp. 311) identified that to be effective, a work hardening program must be of greater intensity than that experienced on the job, be structured and graded and take a progressive approach, use exercises that closely resemble the movements made on the job and be evaluated using tests and simulate the activities carried out during training. This suggests therefore that key training factors of progressive overload and specificity are important and if the program does not align with the tasks required it may not be effective. Strength is only one aspect of a work hardening program and any program must also include other key components such as flexibility and endurance.

5 WMSD prevention interventions work when considering all of the relevant factors

Fundamental to the management and prevention of WMSDs is to design work that is inherently safe and which considers all relevant known and foreseeable hazards. To do this, there are many aspects required to be considered such as taking a holistic systems-based approach, application of the risk control hierarchy along with an evidence-based approach.

Failure of the workplace to espouse, practise and evaluate workplace actions to strengthen its capacity to actively prevent WMSDs would likely see an increase in WMSDs and / or little if any, improvement in its WMSD performance metrics. Examples of actions that a workplace should consider to prevent and manage WMSDs are:

- Ensure that the workplace leadership fully understand and are committed to change when implementing a change in the system of work to tackle poor performance in workplace WMSD risk reduction indicators.
- Focus on individual hazards and not adopting a holistic systems approach to job design and identification of all relevant workplace hazards that influence WMSD risk.
- Adopt the general and specific guidelines about prevention of WMSDs that are usually based on scientific knowledge and general experience such as the work envelope, environmental risk factors such as working in the cold, posture, high force, static load and lack of variability in postures and movements inclusive of repetition and duration, cognitive demands, organisational and psychosocial aspects of work.
- Avoid hazardous manual handling as much as possible.
- Assess hazardous operations.
- Re-design tasks to obviate the need to move the load or automate or mechanise the process.
- Implement risk mitigation by provision of mechanical assistance, redesigning the load itself or redesigning the work space.
- Deploy a co-ordinated intervention with consideration and implementation of different types and combinations of levels of the hierarchy of risk controls, with a focus on implementation of higher order controls rather than attempts to modify worker behaviours.
- Demonstrate commitment from workplace leaders in adopting a continuous improvement approach to prevention of WMSD risk.
- Recognise the benefits of implementing systems of work that control WMSD risk including productivity and efficiency gains.
- Realise a disconnect between the values espoused by management within the workplace and those practiced and the effect that this has on levels of trust between management and workers.
- Engage and collaborate with workers to implement a genuine participatory approach where workers have an opportunity to be actively included in WMSD risk management programs and risk control interventions.
- Implement higher-level controls to reduce WMSD risk such as safety in design or re-design for existing job roles rather than over rely on administrative controls (Figure 11) such as manual handling technique training.
- Ensure key stakeholders have a good understanding of the multiple workplace hazards that may lead to the onset of WMSDs including the interrelationship between physical and psychosocial hazards.
- Actively pursue a process of evaluation of workplace interventions to improve strategies to reduce the incidence of WMSDs inclusive of the process of overall change in WMSD risk lead indicators.

6 WMSD prevention requires a risk management approach

A risk management strategy for the prevention of WMSDs involves identifying work hazards related to poor work design or work processes, assessing them to decide how important each one is and then controlling them by the best means available i.e. finding an 'optimum' solution. It also involves monitoring to ensure that the improvement continues and is successful.

This is a proactive process that helps respond to change and facilitate continuous improvement in a workplace. It should be planned, systematic and cover all reasonably foreseeable hazards and associated risks.

Figure 4 provides a process flow model for the ergonomics risk management process.

There are many ways to identify potential hazards within the workplace. The common approach in HFE is through hazard identification, risk assessment and risk control, followed by monitoring and evaluation of applied solutions.

Note the importance of training and consultation throughout all 3 stages of the HFE risk management process.

From Figure 2 the three broad domains of specialisation within HFE are illustrated. The emphasis of any HFE investigation may be more in one domain than another. However, it should be noted that no thorough evaluation of a workplace should ever be exclusively in one area.

For each of the four-key phases of the process, a fundamental question should be asked:

- *Hazard identification*
  What hazards can I identify arising from this job?
- *Risk assessment*
  How can I measure or assess the risks on this job?
- Risk control
  What do I do to reduce the risks of injury and illness?
- *Monitoring and evaluation of controls*
  Have the interventions/controls worked?

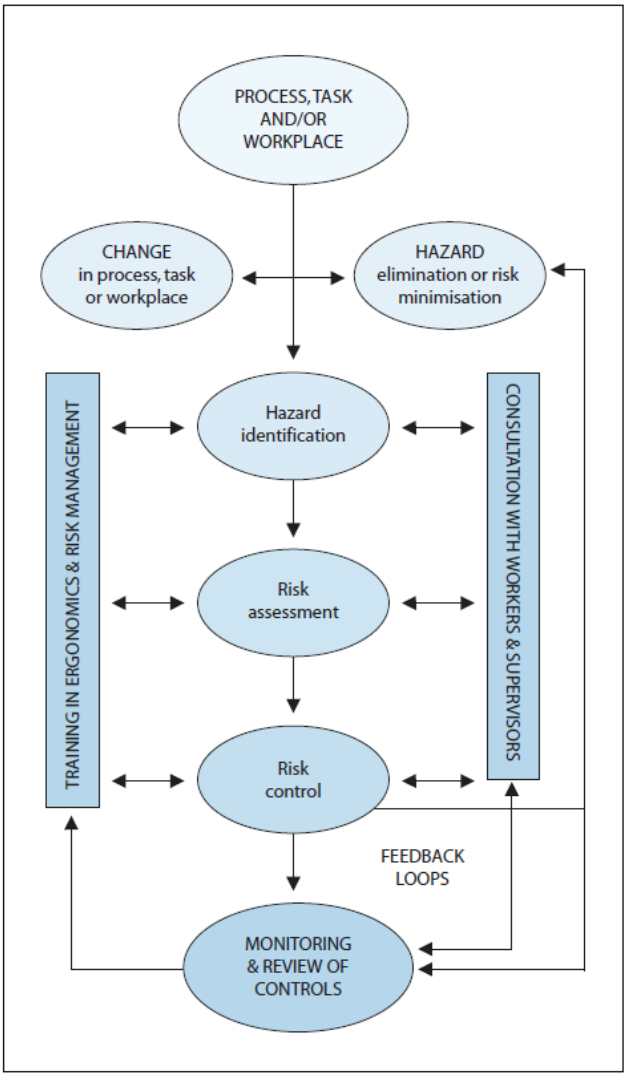


Figure 4: Human Factors and Ergonomics Risk Management process. McPhee, B. (2005) pp25.

7 WMSD prevention is not just about the physical act of handling objects; there are other organisational factors that are just as important

Numerous attempts have been made to model WMSDs with most models assuming a dose-response relationship between the amount of strain on a person and the resulting level of WMSD (Hagberg et al, 1995, pp. 7-9). It is important to note that not all manual tasks may be hazardous in nature; it is manual tasks that may involve hazardous elements such as poor posture, an unsafe level of force, high repetition and psychosocial risk factors that must be assessed to reduce overall risk as they are most likely to cause injury.

There is substantial evidence from around the world which supports that there are many factors that contribute to the development of WMSDs. Exposure to physical, psychological and / or social workplace hazards may result in the onset of musculoskeletal disorders either in a single event or more commonly from exposure to one or more workplace hazards over time. The link between these workplace hazards and symptoms is complex and can be difficult to recognise for what they are. If there is no intervention, the condition can become chronic and lead to further disability.

The concept of an optimal arousal or stress level to maximise an individual's performance is not new. Exceeding a certain intensity of stress means that performance will decrease.

In Australia WMSDs are categorised into two main groups: 'Traumatic joint/ligament and muscle/tendon injuries' (usually acute and traumatic events) and 'Musculoskeletal and connective tissue diseases' (typically gradual onset or cumulative disorder).

Models for development of WMSD include a pathophysiological process in which it is recognised that if a risk factor exceeds an individual's capacity a pathological process will result or the individual will adapt, get stronger and resist breakdown.

Such risk factors may involve biomechanical hazards (Burgess-Limerick 2012, pp. 4), which may compromise hard (bone) and soft (muscle, tendon, ligaments, articular cartilage and other connective tissues, nerves and blood vessels) tissues resulting in a biomechanical injury. Such tissue damage can normally repair before injury occurs, however, if the load on a body tissue such as tendon or ligament exceeds the tissue strength and the rate of tissue damage is greater than the rate at which repair of that tissue can occur, a WMSD may result.

In 1993, Armstrong et al developed a model that identified several key elements for the development of WMSDs to the upper body. The model included 4 key elements including: Exposure, Dose, Capacity and Response.

Exposure refers to work demands such as posture, force and repetition rate which have an effect (dose) on the internal body parts, physical, work organisation and psychosocial demands

Dose refers to the mechanical stretching of tendons / ligaments, compression of articular surfaces of joints) and physiological changes (accumulation of waste products) within the soft tissues as well as psychological factors such as anxiety,

Capacity which refers to the individual worker's ability to cope with various doses to which their musculoskeletal system is exposed. Note that an individual's capacity is not fixed and may change over time as the individual ages or acquires a higher level of skill

Response refers to both primary and secondary responses (pain or a loss of coordination), the physiological and physical changes that occur within the body tissue such as accumulation of waste products, and psychological which includes the onset of pain.

(Bridger 2018, pp. 160).

If the task performed is designed well to accommodate the capacity of a body tissue such as tendon or ligament, then tissue adaptation can occur, get stronger and injury may be avoided.

It is therefore critical for the management of WMSD risk to understand the hazardous nature of a manual material handling (MMH) task and where there is the potential for failure. As an added benefit designing an MMH task with consideration of key WMSD risk factors can result in the task characteristics interacting with the worker to enhance health and wellbeing. For example, tasks that incorporate dynamic and varied body movements with low to moderate levels of force, comfortable and varied postures, no exposure to whole body or peripheral vibration, provide for adequate recovery and are performed in a safe work environment can assist an individual to maintain their general fitness, muscle endurance and a healthy weight range.

Since the early 1990s, researchers have been proposing multiple factors in the development of WMSDs. Following extensive literature reviews, it is evident that an imbalance between, workplace factors, individual factors and an individual's personal state will result in increased WMSD risk (Macdonald and Oakman, 2015).

The ergonomics systems model shown in Figure 5 provides a summary of the range of the five factors known to influence WMSD risk.

Of the five factors described in the model, the two factors of workers' personal characteristics and external factors are largely beyond the control of the workplace. However, a workplace can reasonably ensure that work is matched to workers' capacities and skill levels to mitigate risk.

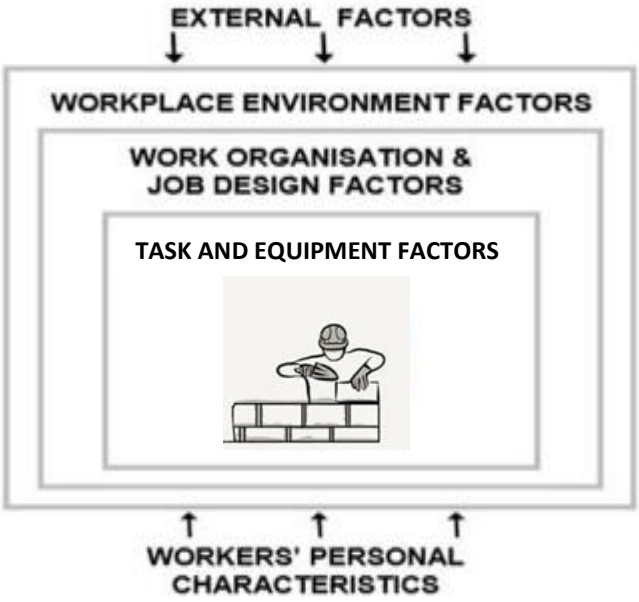


Figure 5: The ergonomics systems model (Source: Macdonald, W. & Oakman, J. (2015). *Cited in* Oakman, Clune & Stuckey, 2019, pp. 29. Note – image modified).

Table 6 below provides a profile of hazards within each of the factors. Note that this only provides a few examples.

Table 6: Examples of workplace hazards that influence WMSD risk (Source: Oakman, Clune & Stuckey, 2019, pp.29).

Factor	Hazard Profile	Examples of specific hazards leading to WMSD risk
External factors	External	Economic factors such as pay levels, regulatory standards, WHS legislation, regulatory drivers such as equity and work arrangements
Workers' personal characteristics	Worker profile	Physical and psychological capacities, non-work personal issues, hazardous personal states of stress attributable to factors such as fatigue and rushing, pre-existing injury, age
Task and equipment factors	Task specific	MMH tasks that involve awkward postures, heavy physical work, static loads, excessive emotional demands, lifting, time pressure demand
Work organisation and job design factors	Job demands	Excessive amounts of work, long work shifts, inadequate rest breaks, time pressures, low rewards for personal effort invested
	Psychosocial hazards	Inadequate personal control and task variety, inadequate opportunities for skill utilisation and inadequate job security
Workplace environment factors	Coping resources	Physical such as cold / heat, air quality Psychosocial such as low-level workplace support, poor supervisor support, low morale, inadequate training, low level perception of workplace culture or climate
Combination	Fatigue	Specific body location or whole-body system

Many of the WMSD risk factors in Table 6 have also been identified as sources of risk in the Hazardous Manual Tasks Code of Practice ('the Code') (Safe Work Australia 2018, pp. 27). Task factors include postures, movements and high force.

The Code also makes reference to the aspect of the physiological responses brought on by WMSD factors mentioned previously, in regards to the way in which work is organised or the 'system of work' (Safe Work Australia 2018, pp. 29) and its influence on the demands both physically and mentally on a worker.

Figure 6 shows how physical and psychosocial factors interact with individual factors that may bring on a stress response in a worker and as a result of this poor match, lead on to a hazardous personal state which increase WMSD risk.

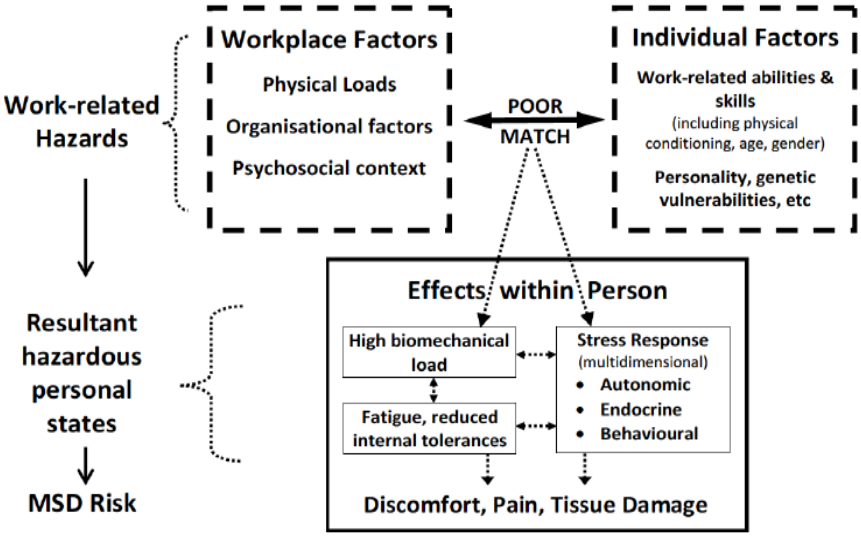


Figure 6: Poor fit between workplace tasks and workers' individual characteristics can increase risk of a WMSD. Macdonald, W. & Oakman, J. (2015). *Cited in* Oakman, J., Clune, S. & Stuckey, R. (2019) pps. 26-27.

Psychosocial hazards are recognised as important workplace risk factors in terms of direct and indirect costs and contribution to poor health outcomes. The regulatory space includes psychosocial hazards within the Work Health and Safety Act, which specifies a definition of 'health' that means physical and psychological health (Safe Work Australia 2016, pp. 5).

A key international policy document – *PRIMA-EF Guidance on the European Framework for Psychosocial Risk Management* (part of the World Health Organisation's *Protecting Workers' Health Series*) states:

> Work-related psychosocial risks [*sic*] concern aspects of the design and management of work and its social and organisational contexts that have the potential for causing psychological or physical harm (cited in Way 2012, pp. 1).

Psychosocial hazards are those aspects of work design and the organisation and management of work and the social and environmental context that have the potential for causing social or physical harm (Bridger 2018, pp. 290). They include the ability for workers to influence workload or work methods and changes in the workplace and performance requirements or processes for dealing with conflicts, inadequate workplace training for work organisation and work environment factors, respectively.

There is a framework that illustrates the relationship between work demands that may be seen as work stressors that can have a negative effect on both physiological and psychological health and work resources that can create a buffer against the negative effects of job strain (cited in Way 2012, pp. 10).

The risk factors of work resources and work demands represent ways that workplaces can influence the level of balance at the worker-demands interface and thereby positively influence the management of worker exposure to occupational stress.

Work demands and the degree of control a worker has over how that work will be done is an important consideration in the design of a successful system of work. Figure 7 illustrates how workers who have high demands placed on them and have little work control are the most likely of to be at risk of developing psychological or physical disorders. On the other hand, workers who have high demands and high degree of job control over how they meet those demands more actively contribute to higher levels of motivation, learning and new behaviours and therefore are exposed to lower risk.

The workplace provides a potent stage on which our anxieties can be played out writes Bright (Bright, J. 2020). A worker who suffers anxiety typically feels worried and irritable and may experience symptoms of muscle pain such as in their shoulders and jaw. Social anxiety in the workplace involves a worker experiencing fear of being judged or rejected in social situations or in performance evaluations. This reduces their capacity to process information which can lead to performance problems and greater exposure to WMSD risk.

Clearly, it is imperative that successful work system design has to take into account work demands and provide workers with the opportunity to have a say over how work is to be done and this balanced approach should be done at the design stage of a task.

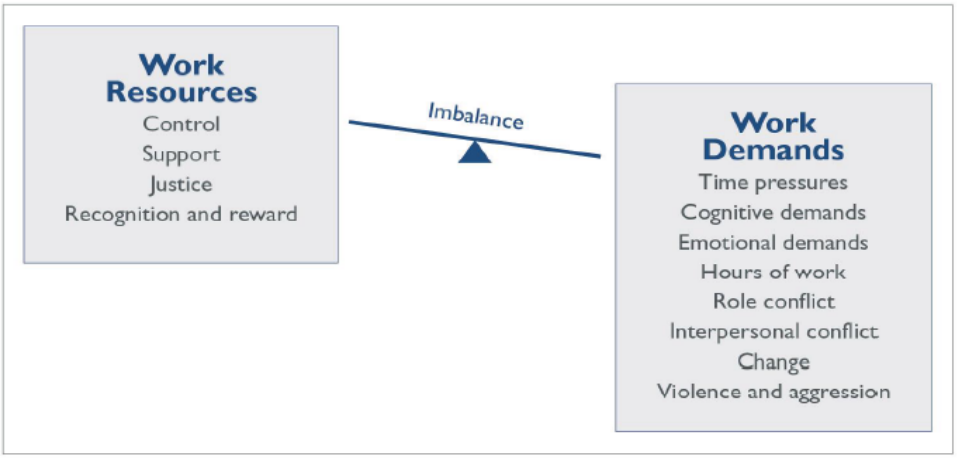


Figure 7: Psychosocial risk factors/work stressors illustrative framework – potential imbalance between work demands and work resources contributing to worker experience of strain (Source: Way 2012, pp. 10).

An important point to emphasise here is that the WMSD hazard profile is typically generated from a variety of work organisation and job design factors, such as working hours and overall job design, which is why an HFE approach provides an effective way to identify and control WMSD hazards and their risk factors across the whole workplace and perhaps to some extent outside of the workplace.

Gardell (cited in Bridger 2018. pp. 624) summarised the key points for human-centred job design as:

- Allow workers to influence their own working situation
- Provide the worker an overview and understanding of the whole process
- Give the worker the chance to use and develop his / her human resources
- Allow for human contact and cooperation
- Allow the worker to satisfy other demands on his / her time

The key message here is the importance of taking a risk assessment approach to managing an imbalance between work resources and work demands through identifying workplace psychosocial hazards.

8 WMSD prevention must include a participatory approach to solving workplace problems

Given the widespread nature of potential hazards that influence WMSD risk, there are a variety of methods to be considered when attempting to identify relevant workplace hazards. It is important to ensure that the impact of interaction between hazards is also considered particularly as combinations of physical factors and psychosocial hazards often occur.

Consultative feedback from regulators, WHS consultants and industry association representatives from across Australia indicated that worker participation and management was an essential part of ensuring success of WMSD interventions (Oakman, Clune & Stuckey, 2019, pp. 42). The idea of worker participation in the development of effective interventions to reduce WMSDs is widely reported. The success of this participatory approach is likely to be as a result of the recognition that workers have valuable insights in the tasks that they perform and have intimate knowledge of hazards and how they interact with other hazards. They can also provide valuable perspectives about the “user-friendliness” and unintended consequences of proposed risk controls to ensure workers accept and use the proposed changes. An example of this is the introduction of a mechanical lifting aid without consulting workers who subsequently find it too cumbersome or too slow to use. As a result, the mechanical lifting aid is never used.

Management considers the future plans for the workplace that include immediate and future operations as well as resources and other commercial based decisions. Management involvement is therefore integral to WMSD prevention given their insights into what is practicable from a cost perspective, and therefore the implementation of immediate and long term WMSD risk controls.

The term used to describe this approach is ‘participatory ergonomics’ and it appears that this was first proposed in around 1983. Noro made the point about the importance of the connection between people and technology in a workplace and why the complexity in the human-machine-environment working relationship must consider input from a range of people, including experts and non-experts. He termed this concept as ‘fusion’ (Noro and Imada 1991, pp. vii).

Burgess-Limerick stated that "Participatory ergonomics means actively involving workers in developing and implementing workplace changes which will improve productivity and reduce risks to safety and health” pp. 289. (Burgess-Limerick 2018, pp. 289). This is particularly important with regard to WMSDs because some the risk factors may be hard to identify, quantify and change, such as worker behaviours and workers’ personal characteristics (see Table 6).

Worker participation in different forms can contribute substantially to the success of different work systems and workplaces. However, successful participation in decision-making and consultation takes time and skill, and there must be time in the planning process to allow for it. It must also start early as sometimes decisions are made at the outset that cannot be reversed by the people who ultimately have to make the system work.

Participative processes are an excellent way of involving workers and training them in the practical aspects or ergonomics application.

The participative approach may take longer and it may be more difficult, but it is more likely to lead to the desired outcomes in the short- and long-term. Worker participation in the planning or redesign of their work and/or workplaces does not cost more than the cost of getting it wrong.

The requirements for effective participation include workers having to acknowledge the need for participation, having trust in their participation that it will not have negative effects and that they perceive that changes are being introduced in a legitimate way (Bridger 2018, pp13).

9 WMSD prevention is available through readily available solutions for workplaces

Workplaces need to be aware of and manage workplace hazards that lead to WMSDs.

Below are several examples of proactive steps that workplaces can take to tackle and control the range of factors known to influence WMSD risk as indicated in the ergonomics systems model (Figure 7).

External factors

- Maintain vigilance in new information about managing workplace hazards and WMSD risk.
- Use the WHS legislation and associated codes, regulatory standards and related guidance information to assist with development of workplace solutions to prevent WMSDs.

Workers' personal characteristics

- Ensure work to be performed is matched to workers' capacities and skill levels with elimination or mitigation of workplace hazards that influence WMSD risk.
- Explore ways to identify workers at risk or error states such as fatigue, frustration, rushing and complacency.

Task and equipment factors

- Use the principle of Hierarchy of Control (Figure 8) with a determined effort to utilise the highest order level of risk control which is to eliminate the risk. If it is not reasonably practicable to eliminate the risk, then you must minimise it so far as is reasonably practicable.
- Ensure that the hierarchy of control is applied to the procurement and purchasing stage to prevent bringing hazards into the workplace.
- Design the nature of workplace tasks that change the interaction of the task factors so that they have positive health benefits.
- Provide appropriate methods and tools to assist with identification of all relevant physical and psychosocial hazards, and assess the level of risk by determining / measuring the level of exposure to the hazards (dose) and the level of severity of those hazards.
    - For physical hazards, use guidelines from a reputable source to assist with identification of WMSD hazards which include repetitive movement, sustained or awkward postures, or repetitive or sustained forces. Note as a general guideline, 'repetitive' means a movement or force is performed more than twice a minute; 'sustained' means a posture or force is held for more than 30 seconds at a time and long duration means the task is done for more than a total of 2 hours over a whole shift or continuously for more than 30 minutes at a time (Safe Work Australia 2018, pp. 62-66).
- Provide appropriate reassessment tools and processes to determine the effectiveness of WMSD risk controls.
- Do not rely on MMH technique training to reduce WMSD risk.
- Use a participatory ergonomics approach and get worker's acceptance of risk controls to be implemented.
- Adopt a system of early intervention to proactively manage the onset of WMSD symptoms as early as possible for healthy workers as well as workers who are on an RTW / rehabilitation program.
- Design new work tasks and re-design existing work tasks that reduce biomechanical / postural stress by:
    - Minimising the reach distance to grasp or hold load.
    - Eliminating the need to twist the truck while supporting or lifting a load.
    - Limiting the height at which an object is lifted or lowered to between knee and shoulders.
    - Minimising the time to hold or carry loads.
    - Minimising the number of times to lift or carry loads.
    - Eliminating the need to lift objects while seated.
    - Minimise the weight to be handled.
    - Increase the time available for lifting.
    - Minimise static work.
    - Use mechanical aids and powered plant.
    - Maintain mechanical aids such as trolleys.
    - Use PPE such as protective footwear, kneepads, aprons, gloves and do not use back belts or abdominal belts.

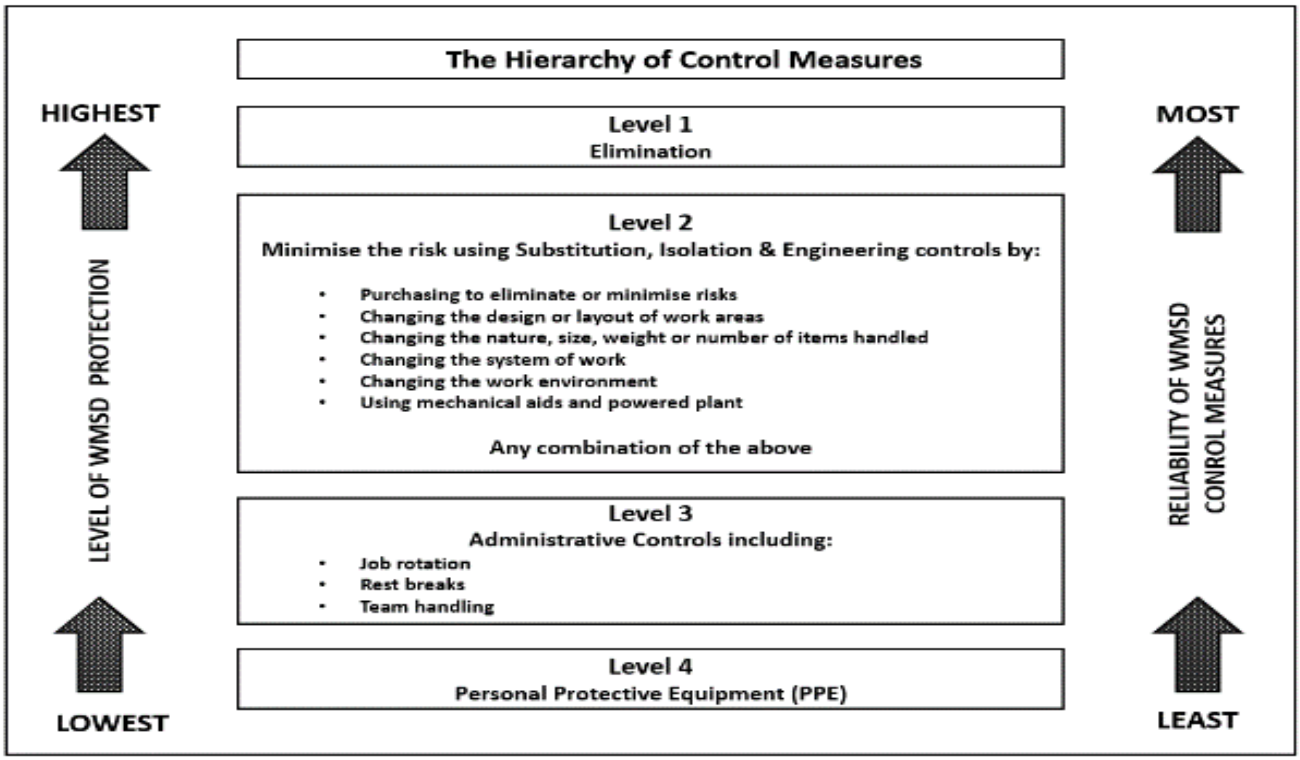


Figure 8: Effectiveness and reliability of risk control measures to reduce risk of WMSDs (Adapted from Oakman, Clune & Stuckey, 2019 pp. 35 and the Hazardous Manual Tasks Code of Practice Safe Work Australia 2018 pp.31-47.

Work organisation and job design factors

- Ensure there is structured management support and organisational leadership commitment to the management of WMSD risk is in place and periodically reviewed as part of a workplace system of continuous improvement.
- Adopt a systems approach to managing WMSD risk so that interrelationships between physical and psychosocial factors are identified; this requires not only inspection and analysis of job tasks, but also how the work is organised and structured, how the job tasks are supervised and how organisational policies and procedures are developed to support those job tasks.
    - For psychosocial hazards, follow the same principles as risk assessment for any other WHS hazards. Six factors fundamental to successful risk assessment of psychosocial factors are organisational and management commitment, organisational communication, worker participation, definition of areas / work groups for assessment, use reliable methods for risk assessment and realistic timeframes (Way 2012, pp. 15-19).
- An appreciation of the multiple WMSD risk factors involved as illustrated in the ergonomics systems model shown in Figure 6 that provides a summary of the range of factors known to influence WMSD risk. This illustrates that a multifactorial preventive strategy is required as there is no one single action that alone would be sufficient to eliminate WMSDs.
- Given that the system of work will naturally comprise interrelated parts it is important to note that changing an aspect of the system of work is likely to affect other system elements with such ripple effects having adverse impact on workers and the overall system of work (Hagberg et al, 1995, pp. 337).
- Build values of trust and respect between workplace management and workers through demonstrative positive change in WMSD risk reduction to quash scepticism and tokenism in relation to WMSD prevention strategies.
- Ensure risk control interventions are evidence-based, practical and used by workers.
- Design work tasks that reduce psychosocial stressors by design of:
    - Job content and demands that have reasonable physical, mental and emotional demands.
    - Workload balance with reduced pressure caused by time pressures and deadlines.
    - Provision of work schedules that are flexible, predictable and consider sociable hours.
    - Enabling higher participation is worker decision making and higher control over workload.
    - Well-designed plant and equipment and good work environment conditions.
    - Good communication systems, scope for personal development and provision of clear objectives.
    - Good social support structures enabling social interaction, good supervision and social support.
    - Job roles that are clear and do not conflict with other roles.
    - Opportunities for career development, good security and job promotion opportunities.

- Work that considers individual differences in coping style and work conditioning of workers.
- Work that is adaptable to external work-home conflict and low support at home.

Workplace environment factors

- Ensure relevant workplace data involving accurate hazard identification sourced holistically is collected and evaluated to address the unique workplace WMSD risk.

The following summary graphic represents the position of the HFESA for the prevention of WMSDs:

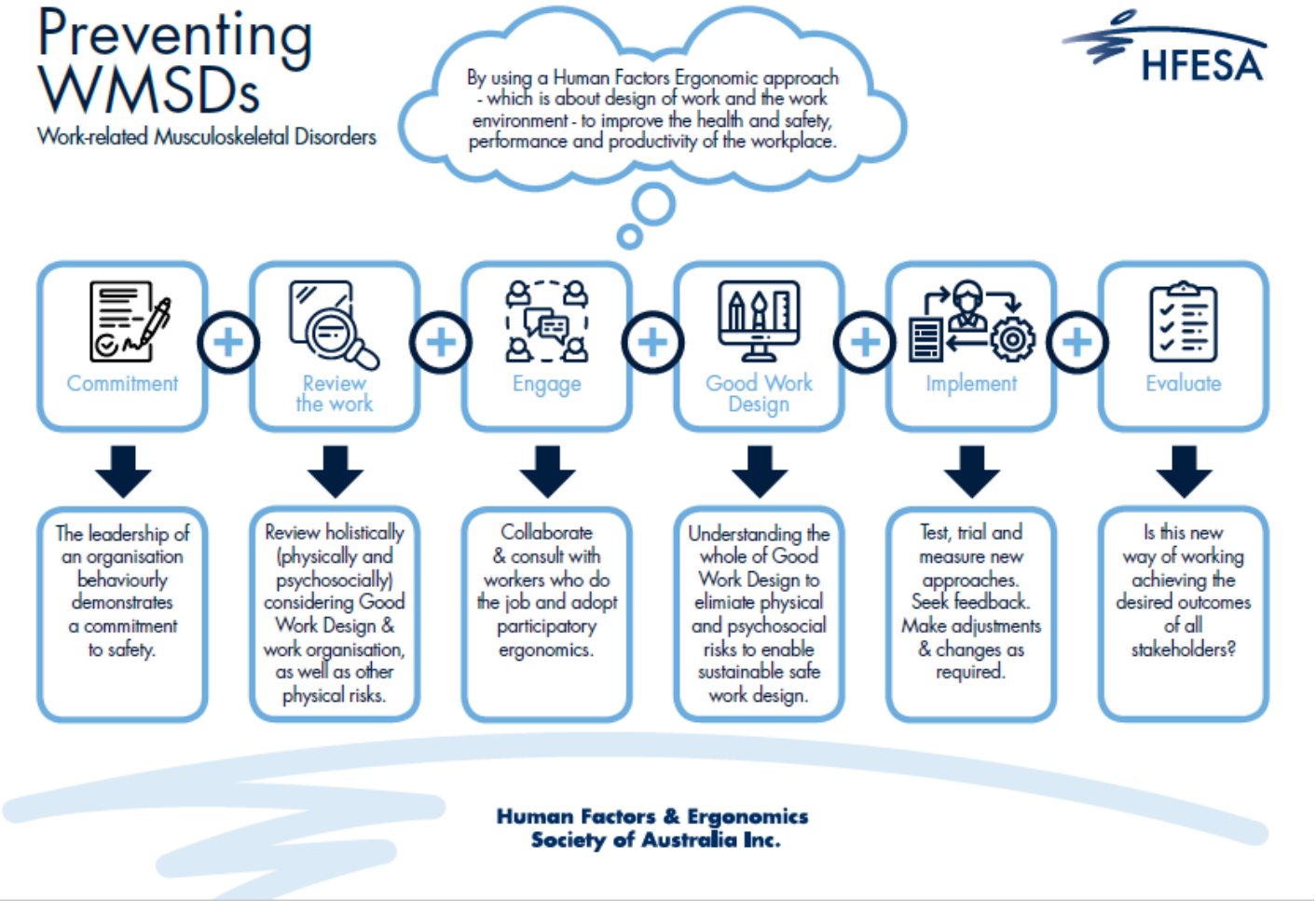


Figure 9: HFESA Position on the steps and process required to prevent WMSDs.

10 WMSD prevention starts with good work design as it optimises work health and safety, human performance, job satisfaction, and business success

'Good work' is healthy and safe work where the hazards and risks are eliminated or minimised so far as is reasonably practicable. Good work is also where the work design optimises human performance, job satisfaction and productivity.

Good work design (GWD) is work which has had hazards designed-out, effective risk control measures have been incorporated and efficiencies have been designed-in. This is inclusive of the system of work which looks at the fit between the elements of HFE - workers, the work job task design, the workplace and equipment design and work organisation factors.

(Further details on GWD will be provided in the HFESA position paper on the topic to be released mid July 2018. It will be available on www.ergonomics.org.au).

The most effective design process begins at the earliest opportunity during the conceptual and planning phases involving for example, an innovation such as a new plant or a change to the way a job is to be performed and should involve collaboration between key stakeholders. A stakeholder is a person, a group or an organisation that has an interest in, concern for, and/or involvement in preventing and managing WMSDs. Stakeholders include workers, managers, PCBUs, trade unions, WHS practitioners and professionals, equipment manufacturers, designers, clients and customers.

The wider community might also be a stakeholder in the sense that it benefits from good occupational health and safety practice and it may pay for failures through higher costs of goods and services, insurance premiums, taxes and other imposts.

At this early stage it is important to consider the lifecycle factors of the innovation or change.

The Commonwealth of Australia Australian Safety and Compensation Council (2006) in their publication titled "GUIDANCE ON THE PRINCIPLES OF SAFE DESIGN FOR WORK" show the main lifecycle factors and is a key concept of sustainable and safe design (Page 9) that provides a framework for eliminating the hazards at the design stage and/or controlling the risk as the product is constructed or manufactured, imported, supplied or installed, commissioned, used or operated, maintained, repaired, cleaned, and/or modified, de-commissioned, demolished and/or dismantled, and disposed of or recycled.

Effective design of good work considers:

The workers:

- physical, emotional and mental capacities and needs.

The work:

- how work is performed, including the physical, mental and emotional demands of the tasks and activities
- the task duration, frequency, and complexity, and
- the context and systems of work.

The physical working environment:

- the plant, equipment, materials and substances used, and
- the vehicles, buildings, structures that are workplaces.

Failure to consider how work is designed can result in poor risk management and lost opportunities to innovate and improve the effectiveness and efficiency of work.

Safe Work Australia provide guidance on what they define as Ten principles of good work design (SWA 2015 pp.4)

Their ten principles demonstrate how to achieve good design of work and work processes. Each is general in nature so they can be successfully applied to any workplace, business or industry.

The ten principles for good work design are structured into three sections:

1. Why good work design is important
2. What should be considered in good work design; and
3. How good work is designed.

CALL TO ACTION

ALL WORKPLACES NEED TO ACTIVELY MANAGE AND PREVENT WMSD RISK

A workplace should ensure that these actions are followed to manage and prevent WMSD risk and to effectively manage persistent problems of WMSDs using a strategic, informative and contemporary evidence-based methodology:

Action 1: Get key stakeholder buy-in and commitment end to end in the process.

Action 2: Identify, assess and control both physical and psychosocial hazards.

Action 3: Use a holistic systems-based approach using evidence-based tools and worker and management participation.

Action 4: Use a suitably qualified ergonomics professional such as a Certified Professional Ergonomist.

Action 5: Use the Hierarchy of Control Measures that target all levels of the workplace.

Action 6: Tasks to be performed are matched to workers' capacities and skills.

Action 7: Design of work considers HFE inputs and review.

Action 8: Evaluate effectiveness of workplace interventions to ensure effective change.

Action 9: Use WHS legislation and associated codes, regulatory standards and related guidance information to keep informed.

Action 10: Contact HFESA for further information and help.

ENDORSEMENT

This position statement was endorsed by the Board of the Human Factors and Ergonomics Society of Australia based on the recommendation of the society's committee for Work-related Musculoskeletal Disorders in Australia: HFESA Position on Risk Factors & Workplace Prevention on May 23 2020.

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WHERE TO GO FOR FURTHER INFORMATION

HFESA

https://www.ergonomics.org.au/

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Worker Representation and Participation Guide

https://www.safeworkaustralia.gov.au/doc/worker-representation-and-participation-guide

Guides for whole body vibration and hand-arm vibration

https://www.safeworkaustralia.gov.au/doc/guide-managing-risks-exposure-whole-body-vibration

https://www.safeworkaustralia.gov.au/doc/guide-managing-risks-exposure-hand-arm-vibration

https://www.safeworkaustralia.gov.au/doc/guide-measuring-assessing-hand-arm-vibration

https://www.safeworkaustralia.gov.au/doc/guide-measuring-assessing-whole-body-vibration

https://www.safeworkaustralia.gov.au/doc/information-sheet-hand-arm-vibration

https://www.safeworkaustralia.gov.au/doc/information-sheet-whole-body-vibration

Handbook - Principles of Good Work Design

https://www.safeworkaustralia.gov.au/doc/handbook-principles-good-work-design

Guides for Fatigue at work

https://www.safeworkaustralia.gov.au/doc/guide-managing-risk-fatigue-work

https://www.safeworkaustralia.gov.au/doc/fatigue-management-workers-guide

Work-related musculoskeletal disorders in Australia

https://www.safeworkaustralia.gov.au/doc/work-related-musculoskeletal-disorders-australia

Priority Mechanisms Fact Sheet

https://www.safeworkaustralia.gov.au/doc/priority-mechanisms-fact-sheet

Statistics on work-related musculoskeletal disorders

https://www.safeworkaustralia.gov.au/doc/statistics-work-related-musculoskeletal-disorders

Model Code of Practice: Hazardous manual tasks

https://www.safeworkaustralia.gov.au/doc/model-code-practice-hazardous-manual-tasks

Lifting, pushing and pulling (manual handling)

https://www.safeworkaustralia.gov.au/manual-handling

Psychological health and safety in the workplace: a national guide

https://www.safeworkaustralia.gov.au/media-centre/psychological-health-and-safety-workplace-national-guide

Good work design and applying it to psychosocial risks

https://www.safeworkaustralia.gov.au/media-centre/good-work-design-and-applying-it-psychosocial-risks

Beyond Blue

https://www.beyondblue.org.au/the-facts/anxiety

Australian Psychological Society

www.psychology.org.au

RELATED HFESA POSITION STATEMENTS (UNDER DEVELOPMENT)

- *An historical account of the development of Human Factors and Ergonomics*
- *Human Factors and Ergonomics – workplace solutions for WMSD prevention Case Studies*
- *Definitions & Common Terminology*
- *Roles of an Ergonomist*
- *Good Work Design*
- *Working Environments*
- *Age Relatedness - Older and Younger Workers*
- *Casual and Special Needs Workforce*
- *Body Stressing Risk Factors*
- *Psychosocial Risk Factors*
- *Technology and Automation*
- *Training*
- *Workplace Social Climate and Participatory Ergonomics*
- *Evidenced Based Tools for Ergonomists*