RESEARCH REPORT

Review of hazardous manual task risk assessments

THE SELECTION PROCESS AND RECOMMENDED TOOLS FOR USE IN AOTEAROA NEW ZEALAND

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Te Kāwanatanga o Aotearoa
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WORKSAFE
Mahi Haumaru Aotearoa

AUTHORSHIP

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PERMISSIONS

WorkSafe would like to thank the following organisations for providing permission to use images of their risk assessment tools within this report:

- Health and Safety Executive (United Kingdom) – developed the 'Simple risk filters', 'MAC', 'RAPP', 'ART', and the 'full risk assessments' and funded the research into the 'QEC' tool. We have used images of these tools that contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence. Images of the tools are on pages 57–62, and 73. For more information refer to: Musculoskeletal disorders – HSE
- TNO (Netherlands) – developed the 'Checklist Physical Load', 'DUTCH', 'HARM', and 'WRAP'. Images of these tools are on pages 63–66. For more information on the tools offered refer to: Further information on physical load – TNO Fysieke Belasting
- BAuA (Germany) – developed and published the Key Indicator Method (KIM) series of tools. Images of these tools are on pages 67–70. For more information refer to: BAuA – Risk Assessment with Key Indicator Methods – Federal Institute for Occupational Safety and Health
- KTH (Sweden) – developed the 'RAMP' tools (Rose *et.al*., 2020). Images of these tools are on pages 71-72. For more information refer to: RAMP – Risk management Assessment tool for Manual handling Proactively | KTH
- WorkSafe Queensland – use the PErforM tool and developed the PErforM Handbook for general industry. Images of this tool are on page 74. This information was developed by the Queensland Government and is being used with permission. For more information refer to: Participative ergonomics for manual tasks (PErforM) guidance for high-risk industries | WorkSafe.qld.gov.au
- The QEC tool was originally developed by David *et al*. (2005) at the Robens Centre for Health Ergonomics, University of Surrey for the Health and Safety Executive. The Robens Centre for Health Ergonomics no longer exists so direct permissions could not be obtained. However, the tool is free to download on the internet www.msdprevention.com/resource-library/view/quick-exposure-checklist-qec-.htm

EXECUTIVE SUMMARY

Background and introduction

Harm from work-related musculoskeletal disorders (WRMSDs) represents around 30–40% of workplace harm worldwide. They are therefore a significant workplace health and safety issue. The Health and Safety at Work Act (2015) requires businesses to manage the risks they create. This includes the musculoskeletal health risks associated with the hazardous manual tasks that contribute to WRMSDs. Effective risk assessment will support businesses to identify and control musculoskeletal health risks.

Current musculoskeletal risk assessment tools from WorkSafe, New Zealand's primary work health and safety regulator, have limited application range, are difficult to use in the context of risk control, and are outdated. The reduction of musculoskeletal harm to New Zealand kaimahi (workers) requires the adoption of contemporary risk assessment tools that identify effective controls. These tools must be appropriate for use with a wide range of hazardous manual tasks. Adequate numbers of people must be trained to use the tools for effective outcomes.

WorkSafe's Human Factors/Ergonomics (HFE) team leads the programme that targets the reduction of musculoskeletal harm to New Zealand workers. This report describes the selection of musculoskeletal risk assessment tools that WorkSafe will promote for use in Aotearoa New Zealand to reduce work-related harm. This includes the process used to identify potential WRMSD risk assessments; the findings from this research; and the recommendations for preferred risk assessment tools.

The selection criteria for the risk assessment tools were scientific robustness; quick, easy, and intuitive to use and interpret; well established/familiar; immediately available and with good supporting resources. The tools must suit a diverse range of users including work health and safety professionals and WorkSafe inspectors and must suit use in small businesses.

Findings

41 hazardous manual task risk assessment tools were reviewed based on previous work completed by Boocock *et al* 2018. The tools were compared against our selection criteria to develop a shortlist of 24 tools from 4 organisations and 3 standalone tools. The shortlist of tools was from TNO (Netherlands), HSE (United Kingdom), BAuA (Germany), KTH (Sweden). The independent screening tools were from WorkSafe New South Wales/WorkSafe Queensland (Australia) and Surrey University (United Kingdom). There was one risk assessment and management tool from La Trobe University (Australia).

The shortlisted tools were reviewed in greater detail. This involved reviewing published literature on the methods, the usability of the tools, the breadth of WRMSDs risk factor coverage, and consultation with the WorkSafe Human Factors/Ergonomics (HFE) team. Following these steps, the tools from HSE, TNO, and KTH were the front runners. The pros and cons of these tools were reviewed in greater detail and there was further consultation with the WorkSafe HFE team where it was concluded:

- The KTH set of tools (RAMP) provide comprehensive coverage of hazardous manual task risk factors and offers implementation plans. However, the tool is quite new, it is an Excel-based document that could be difficult to use compared to an app or website. The screening tool could be too complex for many small or medium businesses.

- The TNO (Netherlands) tools have reasonable coverage of risk factors, although refers the assessor to use the NIOSH lifting equation for lifting tasks and KIM-LHC for carrying tasks (which this report has discounted as being too complex for most users). They have an easy-to-use website but there are some translation issues. The user must select the correct tool for a given task so is open to error and parts of the assessments can be complex.
- The HSE (United Kingdom) suite of tools present a comprehensive approach to address all risk factors associated with hazardous manual tasks. However, the tools reference the 'Manual Handling Operations Regulations 1992' (Health and Safety Executive, 2016a) which could be confusing for a New Zealand audience. Assessors must select the correct tool for the specific task being assessed but it is clear what each tool is used for. The HSE website has numerous supporting documents, resources, and training opportunities for the range of tools and are all free to access. The MAC, RAPP, and ART tools were specifically developed for inspectors.

Recommendations and next steps

We recommend further investigation and trialling of the HSE suite of tools. These provide coverage of all the hazardous manual task risk factors and can be used by inspectors, businesses, and work health and safety professionals. The first step is to contact the HSE (UK) to determine how we might use the tools, resources and training and potentially adapt them for use in New Zealand. Following that we recommend an initial trial of the tools. Suggested groups to trial the tools with include:

- WorkSafe inspectors from Kaimahi Hauora (health inspectors) and the General Inspectorate
- small and medium-sized businesses (HSRs, supervisors, managers)
- health and safety generalists
- occupational health nurses
- occupational health physiotherapists
- vocationally specialised occupational therapists
- human factors professionals/ergonomists.

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1.0 Background

IN THIS SECTION:

1.1 Risk assessment and risk management

A person conducting a business or undertaking (PCBU) has a primary duty of care to their workers and others while they are at work under the Health and Safety at Work Act (HSWA) 2015. Businesses need to identify and understand what their work-related health and safety risks are. Risk assessments enable businesses to examine what in their work could cause harm to people. They should be part of a risk management system where the risks arising from work are identified, assessed, and managed.

Businesses need to manage health and safety risks and risk assessments can help them to understand the risks and prioritise those with the significant potential to cause harm. Under section 30 of the HSWA risks to health and safety must be eliminated as far as reasonably practicable. If a risk can't be eliminated, it must be minimised as far as reasonably practicable (Health and Safety at Work Act, 2015).

Ferreira *et al*. (2009) outlined the importance of "prevention, control and management of" work-related musculoskeletal disorders (WRMSDs) as key to improving occupational health in Great Britain. They reported that inspectors play an important part in preventing WRMSDs. Not only do they enforce health and safety law, but they also provide advice on hazardous manual task risk factors and control measures among many health and safety issues. They suggest that assessment tools support inspectors by providing a screening tool that can quickly and intuitively be used in workplaces where high-risk activities occur. Tools can help to "...raise awareness of risk factors, demonstrate the presence of risk, and recommended areas for improvement." (Ferreira *et al*., 2009)

In recent years WorkSafe has had minimal focus on musculoskeletal health risks, complicated by a change in 'ownership' of WRMSDs harm prevention from Accident Compensation Corporation (ACC) to WorkSafe. Historically, the focus has often been on managing the risks from an individual level and from a rehabilitation perspective. A commonly cited (but ineffective) risk control measure is 'refresher manual handling training' (or similar) rather than the business considering the 'hierarchy of controls' and employing work design or engineering controls as effective solutions.

Our current 'manual handling' guidance (*Code of Practice for Manual Handling*, Department of Labour *et al*., 2001) is now more than 20 years old, relates to the old Health and Safety in Employment Act (1992), and is in need of update. The online ACC 'Risk Reckoner' tool is now no longer available meaning there are no locally available tools that New Zealand businesses can use to assess hazardous manual task risks.

1.2 WRMSDs statistics – why are we doing this research?

WorkSafe have defined work-related musculoskeletal disorders as 'injuries and conditions affecting the muscles, ligaments, bones, tendons, blood vessels, and nerves. WRMSDs occur when work demands lead or contribute to pain, discomfort, or injury.' (WorkSafe New Zealand, 2022).

Worldwide statistics show that WRMSDs continue to represent approximately 30-40% of all work-related harm. This makes them one of the largest occupational health and safety problems worldwide (Oakman and Macdonald, 2019). In New Zealand statistics show that about 30% of all work-related harm is due to WRMSDs and that Māori, Pacific Island peoples, and other vulnerable workers are most at risk of harm (WorkSafe New Zealand, 2019).

Examples of international statistics:

- New Zealand (2019)
  Approximately 27–30% of all workplace harm can be attributed to musculoskeletal injuries with 13,500 disability adjusted life years (DALYs) lost annually from WRMSDs, WorkSafe New Zealand (2019).
- Australia (2019/20)
  37% of work-related injury and disease was attributed to 'body stressing', Safe Work Australia (2021).
- United Kingdom (2020/21)
  28% of new and long-standing cases of work-related ill health were attributed to MSDs.
- European Statistics (2019)
  26% of non-fatal accidents at work were related to 'dislocations, sprains and strains', Eurostat (2019).
- International Labour Organization (ILO), (2015)
  Occupational diseases such as MSDs and mental health disorders are on the rise. 40% of the global compensation costs of occupational and work-related accidents and diseases are attributed to MSDs, International Labour Organization (2015).

1.3 Risk assessment tools and WRMSDs – a New Zealand perspective

Boocock *et al*. (2018) provided a summary of manual handling hazard and risk assessment methods/tools commonly used internationally. This was part of a detailed review of international programmes for the prevention and management of musculoskeletal disorders. Their work has informed our current research and the development of this review and recommendations for risk assessment tools.

The advantage of following risk assessment tools is that they guide users through the process in a methodical way. Ideally, hazardous manual task assessments should involve the workers performing the work tasks and risk factors should be based on scientific evidence for causing harm. They also allow for a standardised approach so that multiple tasks can be compared and to aid prioritisation of implementing controls.

WorkSafe was founded in December 2013 following the 2010 Pike River mining disaster and subsequent recommendations that came out of the 'Royal Commission on the Pike River Coal Mine Tragedy (2012)'. Since its inception WorkSafe has mostly had a 'safety' focus but in the last five years has increased its focus on 'health' which is where the WRMSDs harm reduction programme sits.

There are many hazardous manual task risk assessment methods available. They vary in complexity from very simple to overly complicated. They can be very time consuming or may require users to have a detailed understanding of WRMSDs. Most only focus on physical risk factors and many have no, or limited worker participation in the process. Interpreting the assessments can be difficult and few provide guidance on how to prioritise tasks to implement controls.

Within New Zealand there have been several factors that have led to a lack of focus on WRMSDs prevention in recent years. An Accimap (Appendix 7) shows many potential factors and interactions that may contribute to the burden of harm from WRMSDs in New Zealand.

Some of the factors are outlined below:

- **Outdated guidance**: New Zealand's current primary resource associated with hazardous manual tasks is the *Code of Practice for Manual Handling* (Department of Labour *et al*., 2001). This guidance is now over 20 years old, is outdated, and only considers manual handling tasks. It is hazard versus risk based, so does not fit current legislation (for example, HSWA, 2015). However, the code of practice does identify the key strategies for controlling manual handling hazards following a cycle of:
  - identifying hazards: there is a 'hazard identification checklist' that acts as an initial screening tool
  - assessing hazards: more detailed assessments of the contributory factors are considered
  - planning and implementing controls: follows a 'hierarchy of controls' approach and offers suggestions for possible controls for each of the contributory factors, and
  - reviewing controls: the importance of reviewing the effects of the controls to make sure new hazards haven't been introduced and offers suggestions for how to evaluate controls.
- **Lack of recent investment in WRMSDs**: In 2005/2006 a 'Workplace injury prevention technical advisory group for workplace musculoskeletal conditions' was established by the ACC. Multiple activities occurred during this time including the development of the 'Discomfort, pain, and injury' (DPI) programme which involved training and additional resources for businesses. Resources were a combination of hard copy documents, posters, CDs, and online tools. Types of resources produced were questionnaires, checklists, risk assessment tools, stretching resources (Work Smart Tips), a digital resource/CD called 'HabitAtWork' and the 'Risk Reckoner' risk assessment. In 2007 an online version of the Risk Reckoner was launched. The Risk Reckoner tool was based on the risk assessment in the *Code of Practice for Manual Handling* (Department of Labour *et al*., 2001). In 2018 the HabitAtWork online resources were retired from the ACC website due to outdated technology and in June 2022 the online Risk Reckoner tool was also decommissioned.
- **Decline in the DPI programme:** Around 2015/2016 there was a decline in the emphasis ACC placed on the DPI programme (website and resources). This coincided with the introduction of the Health and Safety at Work Act (2015) and a slow shift in work-related musculoskeletal resourcing from ACC to WorkSafe.
- **Handover from ACC to WorkSafe**: In 2016 WorkSafe and ACC produced the *Harm Reduction Action Plan* (ACC and WorkSafe NZ, 2016). The term 'body stressing' was introduced (a term originating in Australia) to describe the mechanism of injury for some musculoskeletal conditions. This term is not preferred for use in New Zealand as it references only a limited portion of musculoskeletal harm. In 2016 ACC was identified as the lead agency for the musculoskeletal harm part of the action plan and in 2020 ACC handed work-related musculoskeletal harm prevention responsibility over to WorkSafe.

In 2021 the WorkSafe Human Factors/Ergonomics (HFE) team was established. One of the main work programmes is musculoskeletal harm reduction. Foundational work has started with the aim to provide New Zealanders with current information, guidance, and resources. This will support businesses to successfully manage the risks associated with hazardous manual tasks. The focus is to identify, understand, and control the risks that contribute to WRMSDs. Risk management from a systems perspective is sought, rather than focusing on individual worker behaviour.

Risk management is entirely separate from the ACC insurer and rehabilitation focus. 'Good Work Design' principles are a key focus in this work programme. Part of this foundational work is to review the available risk assessment tools, and to recommend the tools most suited for use in New Zealand by the WorkSafe Inspectorate and businesses.

1.4 Purpose of this research

Providing risk assessment tools that address hazardous manual tasks helps build knowledge of risk controls for inspectors, businesses, and the work health and safety disciplines. The HFE team have a work plan to improve the resources available for the WorkSafe Inspectorate and businesses in New Zealand. For businesses, these tools would ideally be used as part of a risk management system where risk to workers can be reduced by implementing high order controls.

To improve hazardous manual task risk management in New Zealand, we require resources and tools that will help the large number of small to medium businesses. The tools must be effective for businesses, inspectors, and professionals from across the work health and safety disciplines to easily identify risks and controls.

As part of the foundational work for the musculoskeletal harm reduction programme, this report will review the available risk assessment tools, and to recommend the tools most suited for use in New Zealand.

1.5 Aims and objectives

This WorkSafe report builds upon the work completed by Boocock *et al*. (2018) who reviewed international programmes for the prevention and management of musculoskeletal disorders (MSDs). Boocock *et al*. (2018) provided a summary of hazard and risk assessment methods/tools commonly used internationally.

This WorkSafe report presents the:

1. Process used to identify hazardous manual task risk assessments that may be suitable for use in New Zealand, and the findings from this research.
2. Recommendations for preferred risk assessment tools for use in New Zealand (by the regulator, businesses, and work health and safety professionals).

Outside the scope of this report are assessments focusing on prolonged sitting (for example when working with computers) and risk assessments for the moving and handling of people or animals.

2.0 Method

IN THIS SECTION:

2.1 The tool selection process – a review of existing tools

This research started by reviewing the report completed by Boocock *et al*. (2018). They presented a table that summarised MSD risk assessment methods/tools from around the world. These were grouped into either 'screening tools – Level 1', or 'more detailed assessment methods – Level 2'. The Level 2 methods were broken down further into 'manual handling methods (lifting, lowering, pushing, pulling, carrying)', 'upper limb specific methods', and 'combined hazards methods'.

The table developed by Boocock *et al*. (2018) ranked the different methods depending on the number of risk factors each method addresses. They identified 12 criteria which were used in the ranking process:

- repetition/duration
- force: grip/pinch
- force: lift/lower/carry
- force: push/pull
- posture
- vibration
- contact stress/impact
- neck/shoulder
- hand/wrist/arm
- back/trunk/hip
- leg/knee/ankle
- psychosocial/organisational.

Of these criteria we excluded 'contact stress/impact' as these would more likely occur from specific incidents or events occurring within a workplace rather than from the effects of performing hazardous manual tasks. This resulted in a total of 11 criteria that the tools were ranked by. Those that met the most criteria were prioritised for review.

The tools were categorised, with the manual handling tools split into 1) lifting/lowering, carrying, and 2) pushing/pulling. This allowed easy identification of tools that had a single purpose (for example, only for assessing pushing or pulling tasks). Table 1 shows the resulting 5 categories.

Level 1
– Screening tools
Level 2
– Manual handling risk assessments (lifting, lowering, carrying) – Manual handling risk assessments (pushing, pulling) – Upper limb specific risk assessments – Combined hazards risk assessments

TABLE 1: Categories of risk assessment methods/tools

Boocock *et al*. (2018) identified 33 tools. Our search found an extra 8 that have been included, for a total of 41 tools considered. Of these:

- 10 were classed as screening tools
- 14 were classed as manual handling tools (lift/lower, carry, team handling, push/pull)
- 9 were classed as upper limb specific risk assessment tools
- 5 were classed as combined hazards tools
- 3 additional KIM tools were also considered. These can be used in conjunction with other manual handling or upper limb KIM tools but didn't specifically meet our criteria and were not reviewed in detail.

After the review process, there was only 1 tool (QEC), in the 'combined hazards' category that was considered for potential inclusion for use in New Zealand. We thought that this tool fitted better into the 'Level 1 – Screening' category so was moved there. This reduced the number of categories to 4.

2.2 The shortlisting criteria

We established a set of criteria to identify the key features for a shortlist of risk assessment tools. Our priorities were that the tools must be:

- scientifically robust (supported by published research)
- quick and easy to use (not too complex or time consuming, needs to be intuitive). For example, this was determined by the simplicity of the design/ layout, how difficult it was to follow the process to complete the assessment, if there were any, or lots of calculations to get to the final 'score' or outcome. Consideration was also given to the level of knowledge required to complete the assessments, that is, novice versus expert, see Appendix 3
- well established or familiar (versus expert knowledge and opinion as found in research articles or methods comparison articles)
- available for use now (ideally free, and readily available); and have
- training support and resources available (but requires minimal training). This could be online user manuals, website information, and online or in-person training opportunities.

All tools were assessed against our selection criteria for a shortlist of tools to review in further detail.

We then categorised the tools as either a simple assessment method, or a more complete risk management approach. For example, did they:

- identify hazards
- assess the level of risk
- consider how to control the risks, or offer suggestions to control the risk, or provide opportunities to develop action plans, and
- were there opportunities for reviewing controls, systems, and processes?

During the shortlisting process research papers that compared different risk assessment tools were reviewed. The findings were compared against our list of tools to make sure that our reasons for recommending a tool (or not) were in line with what others found.

2.3 WorkSafe HFE team consultation and tool selection

The HFE team, excluding the author (n=4) completed an in-person 2-hour workshop to review the shortlisted tools. These were practical sessions where team members worked individually. This involved the team:

- watching two tasks on video: one involved lifting and lowering, the other was a repetitive upper limb task
- deciding which was the most appropriate tool to use of the shortlisted tools
- using the most appropriate tool to assess the tasks
- writing notes and scoring the usability of the tools.

Approximately half an hour was given to consider each set of tools and to attempt to complete an assessment. They were given one full set of tools from one organisation at a time. For example, if they were reviewing the BAuA (Key Indicator Method – KIM) tools they received all the KIM tools. Based on the videos they then had to decide which was the most appropriate tool in that set of tools to use. They then completed an assessment based on the video and additional key information to help with the assessment (for example, weight

of the loads handled, handling frequency). All team members reviewed each set of tools but were assigned these in a different order (for example, they were all working on different tools at the same time).

Following the assessments, we discussed our experience, and considered the practical pros and cons, and how the tools linked to our new WorkSafe model for WRMSDs (discomfort, pain, and injury), Appendix 2

Throughout this process at the forefront of our minds was which tools are going to be most suitable for inspectors, businesses, and work health and safety professionals to use.

The detailed review, shortlisting, and internal consultation process identified a preferred set of tools. The preferred tools will be recommended for use by inspectors, businesses and work health and safety professionals in Aotearoa New Zealand. A summary of the research process is shown in Figure 1.

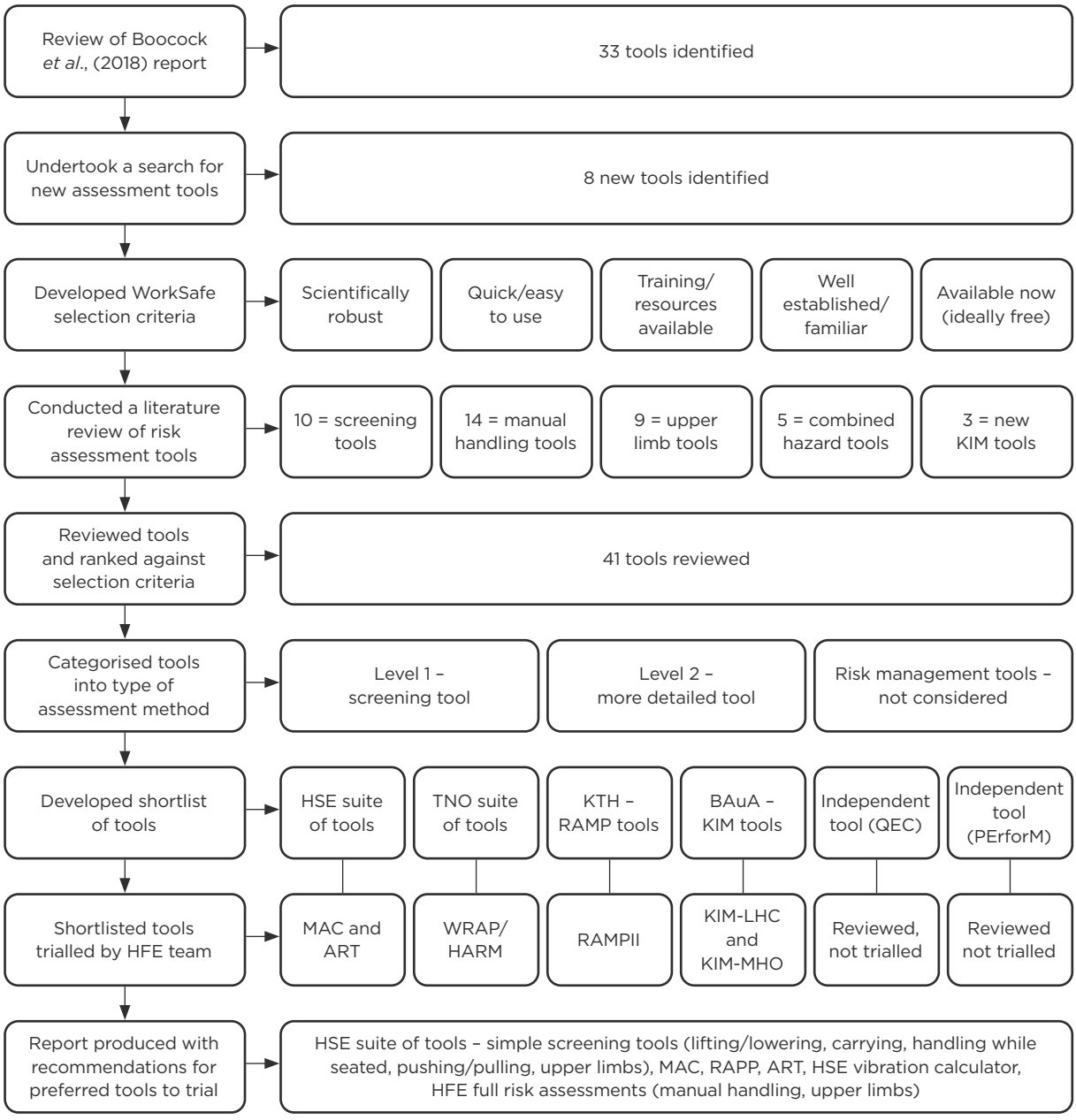


FIGURE 1: Summary of the research process

3.0 Findings from the literature review

IN THIS SECTION:

3.1 Classifying the tools

The primary focus of this current report is to identify hazardous manual task screening tools and risk assessments. A full list and summary of the assessment methods/tools reviewed is shown in Appendix 4

This research builds upon the work completed by Boocock *et al*. (2018). One of their aims and objectives that relates to our current research was to 'Evaluate the primary resources used to support international programmes (for example, best practice guides, risk assessment tools)'. They divided the risk assessment methods into two levels:

- Level 1: Screening or hazard assessment, and
- Level 2: More detailed assessment methods.

Malchaire *et al*. (2011) used a similar classification system for their comparison of MSD risk assessments but also used a third level. The differences in how the two authors have defined their classification levels are shown in Table 2. An example of these differences is how the KIM tools, MAC, and ART were classified as 'Level 2 Analysis tools' by Boocock *et al*. (2018) compared to a 'Level 1 Screening tool' by Malchaire *et al*. (2011). The differences may also be subject to personal experience and familiarity with the tools.

LEVEL	BOOCOCK *et al*. (2018)	MALCHAIRE *et al*. (2011)
Level 1	Screening or hazard assessment checklists that identify hazards or risks and potential controls Suitable for: – 'Non-expert' users, ranging from those with limited-moderate subject knowledge (for example, health and safety reps, some supervisors, workers, subject matter experts)	Screening – simple methods that don't require a detailed knowledge of the work situation and do not involve a quantitative assessment of postures or forces Suitable for: – The work group 'shop floor' operators, workers, supervisors.
Level 2	More detailed assessments that select hazards, tasks, or body areas and identify potential controls Suitable for: – some 'non-experts' (for example, health and safety professionals, occupational health professionals), but typically those with moderate to extensive subject knowledge or those with relevant transferable skills – 'Expert' users (for example, trained occupational health consultants or occupational hygienists, professional ergonomists	Analysis – methods take longer and take more factors into account (about 1 hour) – Any prevention advisor (for example, health and safety officers, specialists, people with relevant knowledge
Level 3	– Not identified	Expertise – complex methods, take longer to use and mostly require video-recordings and specific skills in methodology and biomechanics – Specialist knowledge or ergonomist

TABLE 2: Comparison of risk assessment level categories

Boocock *et al*. (2018) outlined that it is important to differentiate between Level 1 and Level 2 tools in terms of ease-of-use, cost, and differences in levels of awareness, knowledge, and resources. These factors are particularly important within New Zealand when considering different business sizes, particularly for small and medium sized businesses. Appendix 3 shows the model they created to identify different stages of the risk management process, with associated tools, resources, and user groups likely to be involved at the different stages.

In this report we have used the simpler two-level approach outlined by Boocock *et al*. (2018). Their assessments aligned with our own opinions and experience using some of the tools, and their review of tasks was more comprehensive and recent than Malchaire *et al*. (2011).

3.2 New Zealand guidance and tools

The *Code of Practice for Manual Handling* (Department of Labour *et al*., 2001) and the ACC Risk Reckoner tool (hardcopy and website) have historically been used within New Zealand. We found one published paper reporting on the evaluation of the draft code of practice (Ashby *et al*., 2004), but there is no evidence of how the ACC Risk Reckoner was developed. Looking at the Risk Reckoner categories it is assumed that for lifting tasks this information has come straight from the *Code of Practice for Manual Handling*. However, it is unclear where the:

- criteria for 'holding' loads and 'carrying' loads came from, and
- how the risk scores were developed.

Anecdotal evidence obtained from colleagues who were working in this area at the time suggest that the Risk Reckoner was based on the *Code of Practice for Manual Handling*. In turn the 'Code of Practice' was based on research of other international tools and knowledge of contributory factors for WRMSDs (discomfort, pain, and injury). However, observations of the online Risk Reckoner tool before it was disestablished by ACC found discrepancies between the original hardcopy tool and the online version (which had several inaccuracies within it). Anecdotal reports suggest that some modifications were made to the Risk Reckoner over time, but no documented evidence of what these were or why, was found. This resource is therefore currently not suitable for use in New Zealand.

From the evaluation of the 'Draft Code of Practice Manual Handling' the risk assessment was found to be consistent in identifying the contributory risk factors for injury (Ashby *et al*., 2004). Comparisons of the company assessments and 'experts' found that the risk assessments were broadly consistent but produced different levels of risk compared to other postural tools such as Rapid Entire Body Assessment (REBA) or Rapid Upper Limb Assessment (RULA).

Ashby *et al*., (2004) reported the limitations with the evaluation were:

- the small sample size – 8 companies participated in the review/assessment process
- this only provided a 'snapshot' assessment of the task
- companies didn't outline detailed analysis of controls
- varied understanding of the research process and contents of the 'Draft Code' may have affected how the assessments were completed and the feedback received.

There were several recommendations that resulted from the evaluation, and it is assumed they were made before the final document was produced.

Overall, the risk assessment that is in the *Code of Practice for Manual Handling* is thorough but is 5 pages long. This is supported by a further 24 pages of explanatory text about the risk factors. In its current paper-based format it is not suitable for use by inspectors or potentially by businesses.

More recently, in 2017, SafePlus was launched and was jointly developed by WorkSafe, ACC, and the Ministry of Business, Innovation and Employment (MBIE). It was designed for businesses and enables in-depth conversations with people at all levels of the organisation. The conversations can help to reveal for organisations what might help or hinder how they work.

The SafePlus toolkit is designed to aid businesses develop a culture where everyone can speak up and build collective ownership of health and safety in the workplace. It is a survey tool and has two sets of questions, one for the business owners and one for workers. There are three key areas the tool focuses on:

- leadership
- risk management
- worker engagement.

Within each of these areas are 10 performance requirements. Instead of a compliance focus the assessment identifies the level of health and safety maturity, either developing, performing, or leading. Under the 'risk management' section there is one question about 'manual handling' in both the business owner and workers sections:

- Business owner question: 'I'm certain the organisation manages the risks from manual handling the best we possibly can.'
- Worker question: 'My organisation manages the risks to me from manual handling the best it possibly can.'

In the assessment 'manual handling' was defined as "lifting, carrying, pulling, pushing load, repetitive actions" (SafePlus, 2017).

The limitation to 'manual handling' in the focus question is likely to result in businesses overlooking other work activities that may introduce musculoskeletal health risks. This type of questioning will provide the organisation with only a basic indication of how well they are performing in this area and if there are any gaps that they might want to investigate further. Therefore, it is important that more detailed risk tools are available to support businesses complete the next steps in identifying, assessing, and controlling hazardous manual tasks.

Of these three tools available or recently available in New Zealand, none of them are currently fit-for-purpose for use by businesses or the Inspectorate.

3.3 Hazardous manual tasks – Australia

A different approach is used by Safe Work Australia (2016) when considering WRMSDs. They have coined the term 'hazardous manual tasks'. This refers to a task that 'requires a person to lift, lower, push, pull, carry or otherwise move, hold or restrain any person, animal or thing'. It identifies five criteria:

- repetitive or sustained force
- high or sudden force
- repetitive movement
- sustained or awkward posture
- exposure to vibration.

One weakness identified is that these characteristics of hazardous manual tasks only focus on physical risk factors associated with WRMSDs. There is no consideration of 'individual', 'organisational', 'environmental' or 'psychosocial' risk factors. There is clear and strong evidence there are many causes of WRMSDs that work in combination to contribute towards harm.

From a brief internet search, it seems that Australia is the only country that uses the term 'hazardous manual tasks'. Other countries typically have separated different types of manual activities into different categories depending on what is involved. For tasks where the whole body is largely involved, and objects are being handled the term 'manual handling' or 'manual material handling' is most commonly and widely used (for example, UK, Sweden, USA). It describes lifting, lowering, carrying, pushing, and pulling activities.

Smaller body movements involving repetitive use of the upper limbs and light forces are typically considered as 'repetitive activities of the upper limbs'. In many countries, the term 'upper limb disorders' is used to describe discomfort, pain, or injury that is specific to the upper limbs (for example, UK, Scandinavia, USA).

3.4 Other jurisdictions – websites

Other jurisdictions, such as Canada were found to have useful information available on their websites. Of particular interest was the 'Centre of Research Expertise for the prevention of Musculoskeletal Disorders' website: CRE-MSD

They have a 'tool picker' function that allows users to enter certain criteria to pick the most suitable tool for the task they are assessing. This produces a list of tools that users can select from.

We believe this is a useful approach for businesses who have dedicated work health and safety professionals with experience in selecting and using the most appropriate tools for a given task. However, in New Zealand, due to the large number of assessment tools and low maturity in this field, it could be confusing and overwhelming for businesses. Further, when reviewing what tools are suggested for use, a lot of these were discounted within this report for several reasons as outlined in Appendix 4

The European Agency for Safety and Health at Work (EU-OSHA) have free and readily available 'Online interactive Risk Assessment' (OiRA) tools in many European languages. Of the English language tools there is one generic risk assessment and 19 sector specific tools. These tools would be particularly useful for small businesses who have a basic knowledge of health and safety and need a tool to assess all risks. The generic tool covers 15 different risks and worker engagement is encouraged. Relevant sections that relate to WRMSDs include psychosocial risks, work organisation, and risks of musculoskeletal disorders. If the user objectively considers that their current control measures aren't sufficient then the user has the option to select additional 'standard' control measures or add in their own. There are three outputs once the assessment is completed:

1. a very detailed report
2. an Excel spreadsheet 'Action plan' that automatically imports the control measures that were selected, and
3. an overview of the risks by section.

These could be helpful tools for micro and small businesses to assess the range of their health and safety risks, as they offer a risk management approach. However, they don't provide detailed insights into WRMSDs risks and will not be considered further in this report.

3.5 The problems with current risk assessment tools

Many authors have reported that there are limitations with some of the existing risk assessment tools. Oakman and Macdonald (2019) suggest that '...current workplace risk management practices fail to meet some important evidence-based requirements for effective reduction of MSD risk'. They have identified three gaps in current risk management process:

- Gap 1: Narrow focus on 'physical' risk factors and a general failure to address risks arising from psychosocial hazards.
- Gap 2: Insufficient worker participation in the MSD risk management process. There is a reliance on observation-based methods with minimal worker input, making it difficult to understand the psychosocial risks.
- Gap 3: There is often a failure to control risk at its source, and in accordance with the hierarchy of controls, rather than relying on lower order controls such as training.

Macdonald and Oakman (2015) identified that "more effective workplace management of MSD risks requires a systems-based management framework and more holistic assessment and control procedures to address risk from all relevant hazards together rather than in isolation..." To address the identified gaps Oakman and Macdonald (2019) proposed a risk management toolkit: 'A Participative Hazard Identification and Risk Management toolkit (APHIRM)'.

Rose *et al*. (2020) echo the above statement by Oakman and Macdonald (2019) and reported that current risk assessment methods have typically focused on physical factors which do not support the whole risk management process. This includes '...systemic support of developing risk reducing measures and follow-up audits as described in ISO 31000 (2009).' Other limitations that Rose *et al*. (2020) identified were that tools:

- often only target a single body region (for example, the upper limbs – Revised Strain Index)
- only apply to certain type of work operations (for example, lifting – Revised NIOSH Lifting Equation)
- generally, lack a comprehensive assessment of the risks for developing MSDs and several tools might need to be completed for a comprehensive assessment. This could produce incompatible results
- that target manual handling either do not or only partially address organisational factors, psychosocial factors, and individual factors
- may sometimes lack scientific rationale or have low reliability and others such as the Jack software system (Siemens, 2019) have expensive licence costs and require users to be technically competent.

Rose *et al*. (2020) summarised that there is a gap between user needs and accessibility and usability provided by currently available tools. European Union (EU) Directives require employers to avoid manual handling and if not, the risks need to be assessed and reduced as much as possible. To address some of the above limitations Rose *et al*. (2020) developed the 'Risk Assessment and Management tool for manual handling Proactively' (RAMP). The aim of the RAMP Package is to systematically manage MSD risks. The resources are free to download and training courses are available. The RAMP Package has four parts:

- RAMP I: Checklist-based screening
- RAMP II: In depth risk analysis
- Results Module: Shows the results at various levels of detail and scope
- Action Module: Provides supporting risk management suggestions.

Malchaire *et al*. (2011) identified that in the European Union the current legislative framework is not 'fit for purpose' and the focus is on manual handling and working with computers. They identified that a 'holistic approach is essential'. Evidence is well established that shows MSDs are linked to biomechanical, work organisation, and psychosocial risk factors. These factors determine a workers' quality of life and should not be viewed in isolation. Most MSD risk assessment tools or prevention methods are based on dose-response relationships that have looked at the relationships between work stressors and the prevalence of MSDs rather than solving a problem of a specific work situation.

However, they reported there is still a need for businesses to tackle MSDs at the source by observation and analysis. The focus should then be on eliminating risks at the source where possible. One identified problem is that often businesses 'contract out' the risk management process. They argue that the term 'risk management' is inaccurate because:

- management techniques are not suited to eliminating risk factors at source
- risk management doesn't consider re-design or re-engineering that should follow on from when design flaws or lack of forward planning in the work systems are identified

- risk management doesn't lead to a process of continuous improvement which consider known or experienced flaws identified by workers. This is because there is a lack of feedback loops and little worker participation in prevention techniques.

The aim of the study completed by Malchaire *et al*. (2011) was to find tools:

- of a high standard
- that performed efficiently in investigating the overall characteristics of work likely to cause MSDs
- that rely on the active participation of the workers concerned
- that lead to the elimination of risk factors
- that allow for monitoring progress.

Malchaire *et al*. (2011) reviewed 15 different MSD risk assessment tools and found that most were concerned with quantifying risks with some such as MAC, KIM, and ART that could easily have questions added to them that lead to solutions (for example, Why is the work done this way? How can the work situation be changed?) They found that the more complex a method the more likely that the user's attention is diverted away from the work situation to focus on individual factors such as the subject, position or force exerted.

Malchaire *et al*. (2011) identified that preventing MSDs is all about workers and the tasks they do in the workplace. Prevention relies on a participatory, cross-disciplinary, across-the-board intervention. In conclusion, they suggest that we no longer need to be told about the risks of poor work postures, mainly due to the multiple risk factors and how they relate to how the work is done. They suggest what we need are tools to identify and avoid risk postures with the aim not only to prevent worker suffering but to promote wellbeing. A 'participatory risk screening' system that sets out to give an overview, assign importance, and improve knowledge of the risks is important. Equally, aiding well-being so that workers have a useful prevention policy is needed. They also stated that prevention is an ongoing process. Age, gender, and other personal characteristics require a specific health surveillance programme to assess the physiological response to work stressors. Malchaire *et al*. (2011) also suggest that more effort is needed in the design of work, particularly in the early design stages, by involving end-users and considering all types of risk factors, including MSDs.

We agree with Malchaire *et al*. (2011) that a holistic risk management approach is optimal and needed. However, given the current lack of locally promoted and fit for purpose tools, we need to start with simple observation-based techniques to identify WRMSD risks. These can be built on as knowledge and expertise expands. WRMSDs have multiple causes, and no one risk factor can be looked at in isolation. Involving workers is a critical step in understanding tasks and job risks. Managing the risks by implementing the hierarchy of controls promoting and incorporating good work design to eliminate or minimise WRMSDs risks will be of key importance.

4.0 Results – the shortlisted tools

IN THIS SECTION:

4.1 A summary of the shortlisted tools

Tools were ranked according to how many risk factors they scored and were assessed against our selection criteria (outlined in Section 2.2). This process eliminated many tools, resulting in the shortlist that is presented in Table 3.

The shortlisted tools are from four organisations that have developed a suite of tools for the range of hazardous manual tasks, plus three standalone screening tools. Appendix 5 presents detailed information on each of the shortlisted tools. Tools were compared in the categories as defined by Boocock *et al*. (2018):

- Level 1: Initial screening tools: to identify if risks are present and a more detailed assessment is needed
- Level 2: Manual handling: lifting, carrying, team handling, pushing/pulling activities
- Level 2: Upper limb assessments: activities involving highly repetitive use of the upper limbs
- Level 2: Combined assessments: covers a range of risk factors (including vibration).

All the tools are observation-based, requiring some form of subjective assessment by the user while observing the task. They may involve worker participation, and consider other factors such as individual, organisational, environmental, or psychosocial factors. An additional tool (APHIRM) was shortlisted which represents a risk management tool. This was not in the Boocock *et al*. (2018) report as it was published after the review was completed.

APHIRM is based on a participatory approach where individual workers are surveyed. It has a strong emphasis on psychosocial risks and broadly covers a range of physical risk factors. It will likely be a useful tool for medium to large organisations. These are businesses that will have dedicated health and safety professionals and are more likely to have a good understanding of the physical risk factors associated with WRMSDs. However, it is unlikely to be suitable for the around 500,000 small businesses (with less than 20 employees) within New Zealand.

It is this large group of employers who may only have a basic understanding of WRMSD risks. They would most likely benefit from easy-to-use risk assessment tools to help identify, assess, and control risks associated with hazardous manual tasks.

APHIRM will therefore not be specifically considered within this report. A future review of risk assessments using participative, survey approaches to benefit medium to large employers is planned.

ORGANISATION AND COUNTRY OF ORIGIN	LEVEL 1 SCREENING TOOLS	LEVEL 2 RISK ASSESSMENTS
The Health and Safety Executive (HSE) **United Kingdom**	Manual handling: – Simple risk filters for manual handling: - lift/lower - carry - handling when seated - push/pull Upper limbs: – Simple risk filter for upper limb tasks	Manual handling: – Manual handling assessment charts (MAC) – Risk Assessment for pushing and pulling (RAPP) – Full risk assessments (lifting and carrying, and pushing and pulling) Upper limbs: – Assessment of the repetitive use of the upper limbs tool (ART) – Full risk assessment for upper limbs
Netherlands Organisation for Applied Scientific Research (TNO) **Netherlands**	– Checklist physical load	Manual handling: – Lifting and carrying – no tool available, recommend using NIOSH (lifting) and KIM-LHC (carrying) – Push/pull check risk assessment (DUTCH) Upper limbs: – Hand arm risk assessment method (HARM) Working postures: – Working posture risk assessment tool (WRAP)
KTH Royal Institute of Technology **Sweden**	– Risk assessment and management tool for manual handling proactively (RAMP I)	– Risk assessment and management tool for manual handling proactively (RAMP II)
BAuA **Germany**	None	Manual handling: – Key indicator method for lifting, handling, carrying (KIM-LHC) – Key indicator method for pushing and pulling (KIM-PP) Upper limbs: – Key indicator method for manual handling operations (KIM-MHO) Other KIM tools: – Key indicator method for whole-body forces (KIM-BF) – Key indicator method for body movements (KIM-BM) – Key indicator method for awkward body postures (KIM-ABP) – Key indicator method for workload type-specific assessments (KIM-Multi-E)
WorkSafe QLD **Australia**	– Participative ergonomics for manual tasks (PErforM) Handbook	
Surrey University **United Kingdom**	– Quick Exposure Check (QEC)	– Quick Exposure Check (QEC)
La Trobe University **Australia**		– A participative hazard identification and risk management toolkit (APHIRM)

TABLE 3: Summary of shortlisted assessment tools

4.2 A visual summary of tool coverage of WRMSDs risk factors

We prepared a visual summary of the shortlisted sets of tools from the four organisations, and the two independent screening tools (Figure 2). This shows how well each tool covered the range of risk factors.

First, contributory risk factors from Australia and New Zealand sources were identified. From New Zealand, information on contributory risk factors for WRMSDs (WorkSafe New Zealand, 2023) shown in Appendix 2 has risk factors grouped into:

- biomechanical and physical factors
- work organisation factors
- environmental factors
- individual factors
- psychosocial factors.

The risk factors identified by Safe Work Australia (2016) when considering hazardous manual tasks have been modified slightly by combining the two 'force' categories into one. We have summarised these factors as:

- forces – repetitive, sustained, high, sudden
- repetitive movements
- postures – sustained, awkward
- vibration – exposure to whole body or hand-arm.

Then the most common international risk assessment terms or categories were identified:

- manual handling: lifting, lowering, carrying
- manual handling: pushing, pulling
- upper limb: specific tools: to assess repetitive actions of the upper limbs
- posture specific tools: where awkward postures are assessed but are not classed as 'manual handling' tasks. Noting that all the tools assess postures
- vibration: may be mentioned in a tool, particularly those that assess upper limbs, or some of the screening tools. Typically, they refer the user to more detailed risk assessment tools that are outside the scope of this report.

Mapping all these elements on one page allows understanding of the tools with best risk factor coverage. The results are shown in Figure 2. This overview shows that most of the tools assess physical risk factors only. When the full range of risk factors are considered only the suite of tools offered by HSE and the RAMP tools (KTH) cover them all.

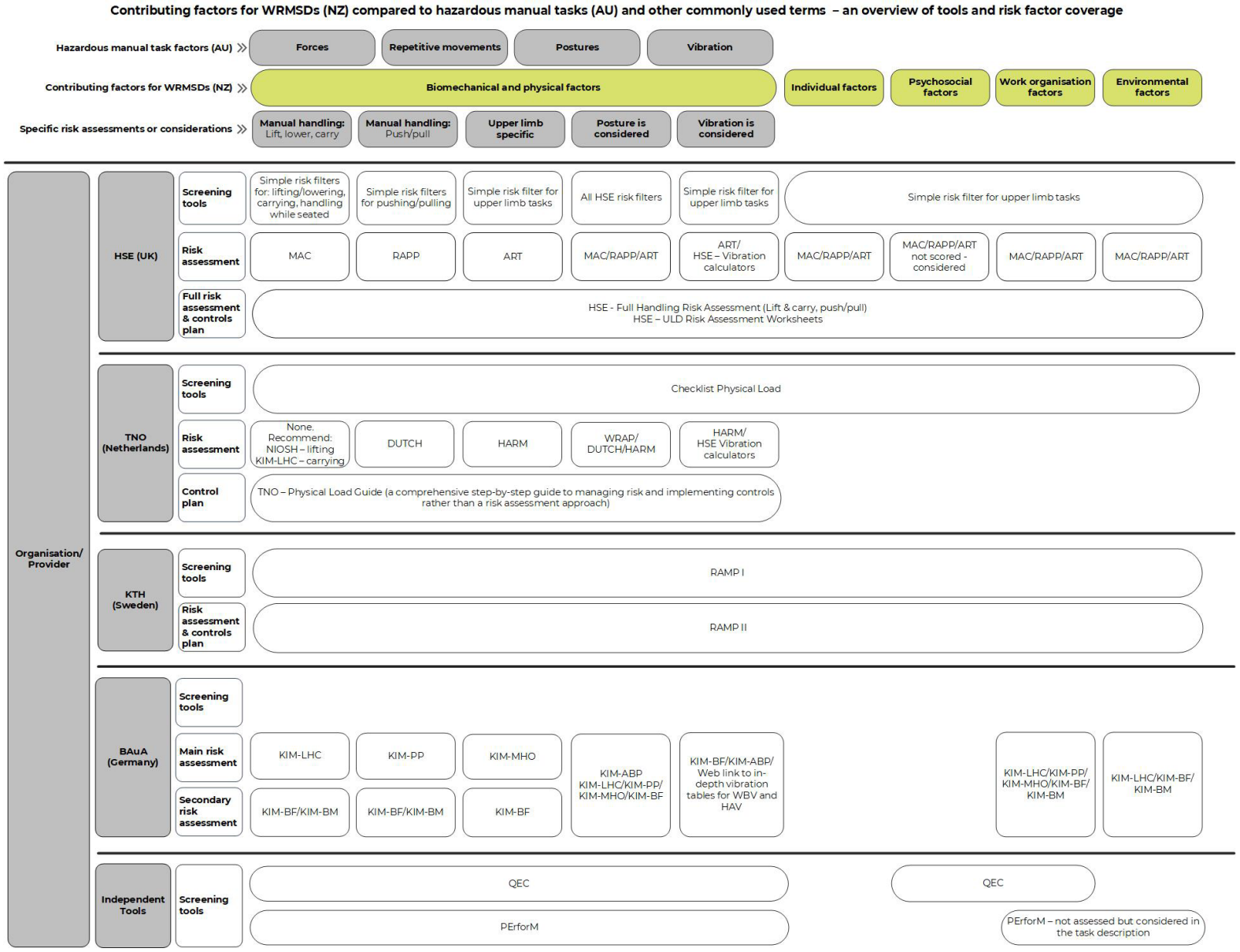


FIGURE 2:
Comparison of shortlisted risk assessment tools against WRMSDs risk factors

5.0
Internal consultation and pros and cons of the tools

IN THIS SECTION:

5.1 Internal consultation – HFE team

The HFE team excluding the author (n=4) completed an in-person 2-hour workshop to review some of the shortlisted tools. Below are the comments from the initial trial of the tools.

ORGANISATION/ TOOLS REVIEWED	SUMMARY OF COMMENTS
BAuA (KIM-LHC and KIM-MHO)	– Too complex, difficult to understand, very 'wordy', complicated calculations – PCBUs, inspectors, health and safety professionals would find it difficult to use
HSE (MAC and ART)	– Quick and easy to use and reasonably self-explanatory – Some descriptions could do with some more examples – It could be easy to incorrectly calculate the risk scores for ART if completing the paper-based assessment (not a problem for the online version) – Although not scored, it was useful that psychosocial factors were considered so the assessor could make notes – Some further explanation could be needed around the final risk score – HSE tools are most likely to identify high risk tasks and aspects of the tasks without assessors needing to complete lengthy training courses – These tools are risk-control based which is best suited for use by the Regulator – MAC and ART were by far the easiest tools to use for specific tasks
KTH (RAMPII)	– Too complicated/complex to use, calculating times was difficult – Manual scoring is difficult and not well explained, unsure how to make the calculations or what the scores mean as it totals the number of risks in each category (for example, high, moderate, low) – Actions aren't clear on the manual form – Overall, it's a bit hard and users are likely to misuse the tool or not use it at all
TNO (WRAP and HARM)	– The online assessment was user friendly, task focused, and linked the harm with potential interventions – Some aspects were helpful, but others required the assessor to work out calculations of a percentage of time which could be easy to get wrong – The results were presented using a 'traffic light' system which was helpful, but would have been useful to also describe these in terms of the hierarchy of controls – Some of the translations to English had been missed – Was a bit tricky, but easier than KIM and RAMPII

TABLE 4: Summary of the feedback from the internal HFE team when trialling each of the tools

General comments from the participants were:

- any tools that require the user to complete complex calculations, particularly to work out percentage of time for activities is too difficult and time consuming. This could lead to the risk being underestimated. A straightforward process is best. Of the tools reviewed the easiest to use in terms of time calculations were the HSE tools (MAC, ART)
- one participant thought that inspectors would be unlikely to use any of the tools, but Health and Safety professionals within PCBUs might
- inspectors and others may need to start with more 'simple' screening tools before progressing with more complex risk assessment methods
- the HSE tools (MAC and ART) were the preferred assessment tools because they were quick and relatively easy to use and understand.

Two of the team attempted to complete the KIM-LHC or KIM-MHO assessments but they found it too difficult and stopped half-way through. At this point it was decided that to make the best use of time the other two team members would not review the KIM tools.

Limitations of this review process were:

- the limited time available to spend on each tool (approximately 30 minutes per tool)
- participants were provided with a limited introduction to the tools, but no training was provided
- the RAMPII tool was assessed by three of the four participants using the paper version and not the Excel spreadsheet
- two participants used the online tools for WRAP and HARM, one used the paper version, and one did not complete WRAP or HARM
- only the paper versions of MAC and ART were used, and two of the participants only assessed the ART tool (not MAC).

At the end of the session, the four participants were asked to score the tools they assessed. Table 5 shows the questions that were asked and the participant ratings. There is some variation in the ratings, but the findings suggest that of the four organisations only two (HSE, TNO) were consistently scored as 'easy' or 'useful'.

TOOLS ASSESSED	HOW EASY WAS IT TO SELECT THE RIGHT TOOL?	HOW EASY WAS IT TO USE THE TOOL?	HOW EASY WAS IT TO INTERPRET THE RESULTS?	DO YOU THINK PCBUs, HEALTH AND SAFETY PROFESSIONALS, INSPECTORS, WOULD FIND THE TOOL USEFUL?
BAuA (KIM)	Moderately difficult – very difficult	Moderately difficult – very difficult	Easy – very difficult	Not very useful – not at all useful
HSE (MAC/ART)	Easy	Easy	Easy	Very useful – moderately useful
KTH (RAMPII)	Difficult	Difficult – very difficult	Moderate-Difficult	Not very useful
TNO (WRAP/ HARM)	Very easy	Moderately easy	Easy	Useful – not at all useful

TABLE 5: Participant ratings of the shortlisted tools assessed

What this shows is that even a group of HFE professionals struggled with using some of the assessment tools. We can conclude that other users (novices and non-experts) would find using some of the tools (for example, KIM and RAMPII) very difficult. This was only a small sample size, and the participants received no training on how to use the tools. This shows that some of the tools were not very intuitive to use and that all tools will require some level of training.

In reviewing the different tools, the author had found some of the tools (for example, KIM) difficult to use. The findings from this small user trial support the authors suspicions. Malchaire *et al*. (2011) reviewed some of the HSE and KIM tools. Their summaries of the tools are shown in Appendix 6 and their findings align with our summary of the shortlisted tools.

5.2 Pros and cons of the shortlisted tools

Table 6 shows all the shortlisted tools and the pros and cons for each. These were developed from the literature, HFE team consultation, and previous experience.

TOOLS	PROS	CONS
HSE (UK) – Risk filters – MAC – RAPP – ART – Full risk assessments for manual handling and upper limbs	– Have a range of simple screening and assessment tools that covers all the risk categories – MAC/RAPP/ART designed specifically for inspectors – MAC/RAPP/ART similar format/layout aids familiarity for users – All tools are intuitive and require little training – Assessors are encouraged to engage with workers – Free and easily available online resources and supporting information – Tools are scientifically robust, with easily accessible validity and usability reports available – Paper-based and online tools are available – Uses a traffic-light system to prioritise what aspects need to be considered first – We have preliminary approval to use these tools in New Zealand	– Refers to UK Regulations – MAC/RAPP/ART mainly cover physical risk factors, users are encouraged to record psychosocial risk factors, but these are not scored – MAC/RAPP/ART used for reviewing specific tasks. For complex tasks several different assessments may need to be completed – The full risk assessments are in pdf versions only
TNO (Netherlands) – Checklist Physical Load – WRAP – DUTCH – HARM – Physical load guide	– Free and easily accessible online risk assessments and associated information – Evidence of scientific robustness – Reasonably simple and easy to use – Also have an online risk assessment tool for working with computers – Uses a traffic-light system to prioritise what aspects need to be considered first	– Within the online tools some translations haven't been made from Dutch to English – No 'manual handling' specific risk assessment – refers the user to NIOSH for lifting or KIM-LHC for carrying – Psychosocial risk factors not considered – Screening tool is too detailed
KTH (Sweden) – RAMP I – RAMP II	– Free and easily accessible tools – Mainly focuses on physical risk factors but does score psychosocial risk factors – Uses a traffic-light system to prioritise risks – Integrates the risk scores into an action plan sheet (factor-by-factor) – Very comprehensive – Involves workers – Online training courses available	– The main video introducing the 'RAMP' tools is in Swedish with English subtitles – Was developed for the manufacturing industry and is quite a new tool, so there is no evidence that the tools will cross over well into other industries – Uses an Excel spreadsheet or pen-and-paper – There is a user manual and information available online – Screening tool is too complex and time consuming
BAuA (Germany) – KIM-LHC – KIM-PP – KIM-MHO – KIM-ABP – KIM-BF – KIM-BM	– Freely accessible with information on how to use the tools – Scientifically robust	– No screening tools available – Too many tools to select from could be confusing to select the correct one – Tools are quite complex, better suited to 'expert' users – There is no plan for how to deal with identified risk factors – Doesn't help to prioritise tasks – Paper-based only, no online version available

TOOLS	PROS	CONS
Independent tools		
QEC	– Scientifically robust – Quick and easy to use – Involves workers	– Is a standalone tool with no 'organisation' support – Pen-and-paper based tool only – Could be too complex for some
PErforM	– Covers a range of physical risk factors using hazardous manual tasks risk factors – Is participative, asking workers directly to rate their experiences – Relatively simple to use – Can be used as part of a health and safety management system	– Freely available but only accessible on WorkSafe NSW or WorkSafe QLD websites (e-Tool not currently working) – No help for the user to prioritise a plan of action to reduce risk – Only suitable for small employers – Only addresses physical risk factors, not psychosocial factors – Assesses individuals and not the tasks

TABLE 6: Pros and cons of the screening and risk assessment tools

5.3 Summary

Considering the literature, pros and cons of the tools, and the consultation feedback some of the tools were no longer considered as options for use in New Zealand. These were the:

- BAuA – KIM tools from Germany. Mainly because they are too complicated, there is no screening tool, and they don't cover the full range of risk factors
- PErforM tool from Australia. Discounted mainly because it only considers physical risk factors. While it is the tool of choice for New South Wales and Queensland Regulators, there are limited supporting resources available
- QEC – tool from the United Kingdom. It could be a useful quick screening tool but isn't part of a suite of tools from a single organisation, and there is limited supporting resources available.

The top three tools that were looked at in greater detail were:

- The KTH set of tools (RAMP). Provides comprehensive coverage of WRMSDs risk factors and offers implementation plans. However, the tool is quite new, it is an Excel-based document that could be difficult to use compared to an app or website. The screening tool could be too complex for many small or medium businesses.
- The TNO (Netherlands) tools. These have reasonable coverage of risk factors, although refers the assessor to use the NIOSH lifting equation for lifting tasks (which didn't make our shortlist as it was considered too complex) and KIM-LHC for carrying tasks (which this report has discounted as being too complex for most users). They have an easy-to-use website but there are some translation issues. The user must select the correct tool for a given task so is open to error and parts of the assessments can be slightly complex.
- The HSE (United Kingdom) suite of tools presents a comprehensive approach to address all WRMSDs risk factors associated with hazardous manual tasks. However, the tools reference the 'Manual Handling Operations Regulations 1992' (Health and Safety Executive, 2016a) which could be confusing for a New Zealand audience and assessors must select the correct tool for the specific task being assessed but is quite clear what each tool is used for. The HSE website has numerous supporting documents, resources, and training opportunities for the range of tools and are all free to access. The MAC, RAPP, and ART tools were specifically developed for inspectors.

From these top three tools the HSE (United Kingdom) suite of tools is the preferred choice. While there are several tools, it is easy to select the correct tool for the task being assessed and different users will benefit from different tools. For example, inspectors could use the simple risk filters to identify risks, or for a slightly more detailed approach could use MAC, RAPP, or ART. These tools were specifically designed for inspectors. Businesses on the other hand could use all three types of tools, simple risk filters to determine if a more detailed assessment such as MAC/RAPP/ART is needed, or the more detailed risk assessments and implementation plans as part of their risk management systems. If this suite of tools were promoted and used in New Zealand, then a common language could develop between inspectors and businesses when focusing on WRMSDs. Of key importance is that these tools meet all our selection criteria, they are scientifically robust, quick, and easy to use, available now, with plenty of resources available. Most importantly they target the key users – inspectors, and small to medium-sized businesses, helping them to clearly identify, assess, control, and monitor WRMSDs risks. Additionally, there is anecdotal evidence that some New Zealand work health and safety professionals have already discovered and are using these tools.

6.0 Discussion

IN THIS SECTION:

6.1 Reliance on observation tools

This review of WRMSD risk assessment methods has shown the wide variety of tools that are available. Most of them are classed as observation tools, meaning the assessor observes the work being done to complete the assessment. The tools vary in terms of how much they require the assessor to engage with the workers while completing the assessment. Worker engagement is a key factor in successful risk assessment and management. This can be achieved by having conversations with workers about the problems they experience, and if they have any ideas for solutions, as the worker should be considered the 'expert'.

Observation-based tools are subjective and rely on the assessor, potentially (and ideally) with the input of the worker, to decide on the level of risk for certain risk factors. This process identifies factors that present the greatest potential for harm to workers.

Common findings from this review:

- the tools are not designed to assess people or animal handling, or computer workstation assessments (outside the scope of this research)
- most of the tools focus on assessing physical risk factors or include limited scope for recording or assessing psychosocial or individual factors
- some tools assess the tasks (for example, RAMP, MAC, KIM) and others assess individuals (for example, PErforM)
- scoring methods can be very simple or complex and how the findings are presented varies (for example, traffic light systems to indicate risk level)
- some tools identify factors or tasks that should be prioritised while others don't
- some tools are 'standalone' methods while others are supported by organisations and additional training structures
- some tools can be integrated into a wider health and safety management system. For example, where risk factors have been identified, control measures can be implemented to reduce the risk workers are exposed to. Risk assessments can be repeated to ensure the risk has been reduced and no new risks have been introduced.

It is also important to remember that risk assessments only offer a 'snapshot in time' perspective. They don't consider the cumulative nature of risk exposure over days, weeks, months, or years, or the accumulated risk from several hazardous manual tasks.

6.2 Beyond observation-based approaches

Authors such as Lind *et al*. (2014), Macdonald and Oakman (2015), and Oakman *et al*. (2022) suggest that current risk assessment methods aren't working well in preventing injuries. They have recommended a more holistic, risk management approach is required for harm reduction. Oakman *et al*. (2022) identify that one problem is the lack of comprehensive tools that include identification and control of both physical and psychosocial hazards. They proposed that simple tools that take a hazard-by-hazard approach are not sufficient. As a result of their research these authors developed participatory risk assessment tools that have more of a risk management focus instead of the traditional observation-based tools. The two tools that are considered to offer a risk management approach are, APHIRM (Macdonald & Oakman, 2015), and RAMP (Lind *et al*., 2014).

Oakman *et al*. (2022) identified that one of the main barriers to tool implementation are at an organisational level. They found that for WRMSDs where there is separate management of physical and psychosocial hazards that this doesn't allow for a comprehensive approach. They recommend that both hazard groups are considered simultaneously, providing a holistic, multifactorial approach.

This approach makes sense – evidence is clear that a range of risk factors, including psychosocial risk factors, play a significant role in the cause of WRMSDs. Boocock *et al*. (2018) also recommended that emphasis needs to be placed on evaluating a range of hazards together rather than in isolation. For example, assessments that cover physical, psychosocial, organisational, individual, and environmental factors. Ensuring workers are involved is a critical aspect of any risk assessment and risk management process. These factors have been included in the WorkSafe 'Risk factors associated with the development of WRMSDs' model Appendix 2

While both APHIRM and RAMP are participatory there are differences between them:

- APHIRM is a worker survey tool that includes psychosoial risk factors
- RAMP relies on assessor observations combined with worker input especially on the 'work organisation and psychosocial factors' section
- RAMP is more focused on physical risk factors and engaging with workers during the assessment.

While these approaches are considered 'participatory' and provide a 'risk management approach' so do the range of tools offered by some of the organisations identified in this report. For example:

- TNO (Netherlands) offer a range of tools – an initial screening tool, more detailed assessment methods (WRAP, DUTCH, HARM) and implementation plans. Focus is on physical risk factors, but does not explicitly advise the assessor to involve workers during the assessment process. While these tools might not be considered 'participatory' the range of tools cover a variety of phsycial risk factors, but not the full range of WRMSDs risk factors. The range of tools provided by this organisation could be considered as a 'risk management approach'.
- HSE (UK) – the focus is more inclined toward physical risk factors but a range of risk factors are assessed. The HSE tools offer screening tools, the more detailed MAC, RAPP, and ART assessments, and full risk assessments and implementation plans. While psychosocial factors aren't scored they are mentioned in the assessment and space is given to record them. These tools aren't classed as 'participatory' but all the HSE tools outline that the assessments should involve the workers. This essentially provides organisations with a suite of tools to select from and offers a risk management approach.

Boocock *et al*. (2018) identified that comprehensive programmes provide a 'toolkit' of assessment methods. These vary in complexity, recognising different levels of awareness, knowledge, expertise, and resources of organisations, particularly those of small and medium-sized businesses. The holistic approach that Lind *et al*. (2014) and Macdonald and Oakman (2015) recommend is present when you consider the range of tools offered by organisations. For example, a variety of tools that are offered by an organisation (for example, a suite of tools or a 'toolkit') rather than by looking at individual tools in isolation. Figure 2 shows that the HSE suite of tools and RAMP tools provide the most holistic approach, covering the full range of WRMSDs risk factors and systems to implement controls compared to the other tools reviewed.

Lind *et al*. (2014) and Macdonald and Oakman (2015) make valid points about the need to move on from the traditional purely observation-based approaches to more of a participatory approach. This was one of the reasons why many tools within this review were discounted. For example, the NIOSH lifting equation, Mital, and Snook Tables are based on observations and complicated calculations to determine risk and aren't particularly user friendly.

However, Malchaire *et al*. (2011) suggest that observation techniques still have their place, particularly if completed while engaging with workers. The shortlisted tools within this report mostly encourage assessments to be completed with workers (for example, MAC, RAPP, ART). Further, to be effective it is essential that workers participate in the risk assessment process. This provides an opportunity for businesses to meet their duties under the Health and Safety at Work Act 2015 (HSWA) for worker engagement and participation. This should involve assessors and workers working together to identify, quantify, prioritise, and control WRMSDs risk factors associated with hazardous manual tasks. What this research has found is that most, if not all the shortlisted observation-based risk assessment tools recommend a participatory approach but have not necessarily been identified as 'participatory tools'.

6.3 Managing WRMSDs risks in New Zealand

It is our view that in New Zealand work health and safety knowledge regarding work-related musculoskeletal disorders risk management is in its infancy. This is particularly true for small to medium employers who represent the largest proportion (99.5%) of businesses in New Zealand. There are approximately 500,000 small businesses, with 71% of these considered to be a micro-business which are sole-traders and have no other employees. Medium-sized businesses typically have more than 20 but less than 100 employees and make up 2% of all businesses, around 10,000 in New Zealand (MYOB, 2022).

Many issues have been identified as contributing to the lack of, or outdated WRMSDs knowledge and focus from the regulator. These factors are shown in Appendix 7

Some of the main factors are a lack of:

- 'ownership' of WRMSD management – possibly from the decline in WRMSD prevention priority from around 2015 and then the handover from ACC to WorkSafe
- up-to-date resources – manual handling guidance material is over 20 years old, and ACC resources (HabitAtWork and Risk Reckoner) are now inaccessible, and
- focused WRMSD expertise in WorkSafe – the HFE team having only recently been established (2021).

The WorkSafe Human Factors/Ergonomics team have a clear roadmap to address the above gaps (and others), and have made progress completing key foundational work. For this aspect of our work programme, we have identified that there is a need for risk assessment tools that address hazardous manual tasks. Historically we have had the ACC Risk Reckoner tool (now unavailable) and the 'Code of Practice for Manual Handling' (Department of Labour *et al*., 2001), which is over 20 years old, refers to the old Health and Safety in Employment Act (1992), and is in need of update.

Other tools such as APHIRM (Macdonald & Oakman, 2015) may be better suited to large organisations, typically those with more than 100 employees, who are more likely to have a mature health and safety culture and have good systems in place to manage WRMSDs risks. There are approximately 2,500 large businesses which represents 0.5% of all New Zealand businesses (MYOB, 2022), with 149 of those listed on the ACC Accredited Employers Programme (AEP). These are businesses who manage their own workplace injury claims process. Participatory risk management approaches such as APHIRM might be the next step for these businesses to better understand and manage the combined effects of physical, psychosocial, and organisational risk factors to further reduce harm from WRMSDs.

It is our opinion that to build and grow WRMSD knowledge in New Zealand, we need to start with some basic resources and tools that will help the largest numbers of businesses. Often resources are limited in small and medium-sized businesses, so tools need to be quick and easy to use, free and readily available, require little training, and be suitable for a range of users, including novices.

This research has shown that the most suitable tools for use in New Zealand, by businesses, health and safety professionals, health providers, and the WorkSafe Inspectorate are the suite of tools offered by the HSE (UK). They provide a systematic, holistic approach that covers the range of WRMSDs risk factors and encourage worker participation in the process. They provide tools for implementing control measures that take a 'risk management' approach to controlling the risks associated with hazardous manual tasks. While they refer to Regulations in the United Kingdom, they met our selection criteria and MAC, RAPP, and ART were specifically designed for inspectors. Compared to the other tools there are no translation issues and training, and additional resources are easily accessible. This includes other tools that are outside the scope of this report such as the hand-arm vibration exposure calculators.

7.0
Conclusions

There are many screening and risk assessment tools available. We have identified and selected those that are most suitable for use in New Zealand at this time.

The *New Zealand Code of Practice – Manual handling* (Department of Labour *et al*., 2001) is over 20 years old and in need of update, and the ACC 'Risk Reckoner' tool is now unavailable. Currently there are no preferred tools for New Zealand businesses, and health and safety professionals to use to identify and assess hazardous manual task risks. WorkSafe has up until recently placed little emphasis on addressing musculoskeletal harm and the Inspectorate have no tools to help them identify and assess WRMSDs risks.

It is clear from this review that there is no perfect tool, each has limitations and constraints for use. It is well known that the development of WRMSDs can be cumulative in nature and multifactorial in origin making their development complex. Many tools reviewed only, or mostly, consider physical risk factors, with no, or little consideration of environmental, organisational, or psychosocial factors. Recommendations to move beyond observation-based assessments that have a focus on physical risk factors is advocated by some who have proposed alternative risk assessment methods.

Of the shortlisted tools apart from the RAMP tool there is currently no single risk assessment that assesses all WRMSDs risk factors. We propose that the most logical approach is to have a range of tools from the same provider. This will help users to build familiarity with the tools and understand what tool to use and when. This should allow for a holistic approach to WRMSDs risk management.

Tools such as APHIRM and RAMP are considered to offer a 'risk management system' approach. They provide a holistic method to address WRMSDs from identifying risk factors to implementing and reviewing controls. However, we believe that other observation-based methods also achieve this if tools provided by organisations are looked at collectively rather than in isolation. The suite of tools offered by the HSE (United Kingdom) cover a range of assessments to address hazardous manual tasks. If used as intended, they offer opportunities:

- for worker participation and engagement
- to record or assess environmental, organisational, individual, and psychosocial risk factors
- to be incorporated into a safety management system allowing assessors to record controls and assign delegations to make sure the controls are implemented
- to allow for a review process to be completed.

Tools such as APHIRM are more suited to the small proportion of large employers. They may already have a good understanding of the physical risk factors their workers are exposed to and are likely to have a higher level of health and safety maturity. For these businesses, better understanding of psychosocial risk factors could be a beneficial next step in managing their hazardous manual tasks risks. We propose to investigate such tools in greater detail in the future.

In New Zealand the greatest proportion of businesses (99.5%) are classed as either small or medium. This is our target audience to engage with and educate. We have identified that there is a need to provide quick, easy to use, simple to understand, scientifically robust tools that are currently available. We propose the HSE (UK) suite of tools meet these criteria and are best suited for use in New Zealand.

The HSE tools provide a simple, consistent approach to hazardous manual tasks risk assessment. This is a critical first step in building knowledge. Introducing tools that will help businesses to identify, assess, and control the risks associated with WRMSDs and ultimately reduce exposure is important. This key work needs to involve providing guidance, advice, and information; promoting and supporting research, education, and training; and promoting and sharing information. These functions are directly linked to the WorkSafe New Zealand Act 2013, s 10, (f), (g), and (i). At the same time, it is important that we engage with, and upskill our Inspectorate so they too can better identify and understand the risks associated with WRMSDs and how they can be managed. Understanding and reducing risks ‘as far as is reasonably practicable’ is critical for businesses to meet their obligations under the HSWA, namely under Section 36, ‘Primary Duty of Care’.

8.0 Recommendations and next steps

IN THIS SECTION:

We recommend using the tools from the Health and Safety Executive (United Kingdom) in New Zealand. They are simple and easy to use and provide an holistic approach when assessing hazardous manual tasks.

Due to time restrictions and limited resourcing, we are currently unable to develop our own assessment tools.

To provide guidance most quickly and efficiently we need to select existing tools that would be suitable for both PCBUs and the WorkSafe Inspectorate.

We acknowledge that there is not a one size fits all risk assessment approach and PCBUs might decide to use or are already using other methods to assess hazardous manual tasks. This report shows there are many similarities between some of the tools reviewed.

The main priorities of any tools should be to:

- identify hazards and risks from hazardous manual tasks
- assess the hazards and risks
- plan and implement controls, based on the hierarchy of controls, and
- review and monitor those controls.

Applying a holistic risk management approach and ensuring worker participation in the assessment process is key to successfully identifying and controlling the risks and reducing harm. Risk assessment is only the first step in understanding the risk so that suitable controls can be implemented.

8.1 Tool selection recommendations and reasoning

We recommend that the simplest and most logical approach is to suggest a range of tools from the same organisation. This will provide the most holistic approach to assess hazardous manual tasks.

Considering the pros and cons of each of the shortlisted tools we recommend that WorkSafe use and promote the suite of tools from the HSE (UK) to assess hazardous manual tasks. The main reasons being:

- between the risk filters, MAC, RAPP, ART, and the full risk assessments all the hazardous manual task risks, plus individual, environmental, work organisation, and psychosocial risks are addressed
- MAC, RAPP, and ART were designed specifically for inspectors
- MAC, RAPP, and ART are similar in layout and how you use them. Once the user is familiar with one tool, they can quickly learn how to use the others
- the tools are scientifically robust with supporting literature easily accessible
- all the tools are quick, easy, and intuitive to use and understand
- they require very little training to use
- a traffic light system is used that easily identifies high, moderate, or low risk. This system allows risk factors and tasks to be prioritised to help focus attention on where to implement changes first
- there are paper-based and online versions and supporting resources available now, that are free to access
- there are paper-based PDF versions of the full risk assessments which could be made into an online resource.

8.2 Short-term recommendations: Introduce selected risk assessment tools

- In the short-term we need to contact the Health and Safety Executive to determine:
  - how we could use their online resources, apps, and training material
  - if we are able to modify the tools to suit the New Zealand context.
- We propose that we introduce the tools to a small group of people who are interested in being involved. For example:
  - Kaimahi Hauora (health) inspectors
  - a small group of general inspectors
  - a small number of New Zealand businesses
  - a small number of health and safety professionals, such as occupational health nurses, ergonomists, occupational health physiotherapists, occupational health nurses.

As part of this introduction, we would:

- develop and provide these groups with relevant resources and training on how to use the tools
- request feedback from participants at the introductory workshops
- continue to modify and develop the tools and training material as part of an iterative development process
- be reliant on other WorkSafe teams to work with us to help support the workshops and engage with relevant businesses or industries if needed
- produce a report summarising the processes, findings, and recommendations from the workshops.

8.3 Medium-term recommendations: Launch selected risk assessment tools

- Following the introductory workshops, we plan to publicly launch the selected risk assessment tools for use in New Zealand. Ideally this would align with the release of the updated/or new hazardous manual tasks good practice guide to replace the existing Code of Practice – Manual handling.
- From a WorkSafe perspective a critical first step is to provide inspectors with the knowledge and skills to be able to identify WRMSDs risk factors associated with hazardous manual tasks We can do this by:
  - providing education and training on how to use the tools (screening tools, MAC, RAPP, and ART, and full risk assessments)
  - developing other resources and guidance to support inspectors.
- Inspectors are not expected to be experts. These tools would give them the basic skills to identify the risks, have conversations with PCBUs, and to identify when they might need additional support.
- We need to develop a coordinated plan to promote and share this information widely within New Zealand. Those with an interest in these tools are likely to include:
  - PCBUs
  - work health and safety professionals (for example, occupational health physiotherapists, occupational health nurses, ergonomists/human factors professionals, occupational therapists, occupational hygienists, health and safety generalists)
  - industry groups.
- Providing inspectors and others with this information and supporting guidance will help to develop a common language to talk about managing the WRMSDs risks associated with hazardous manual tasks.

Appendices

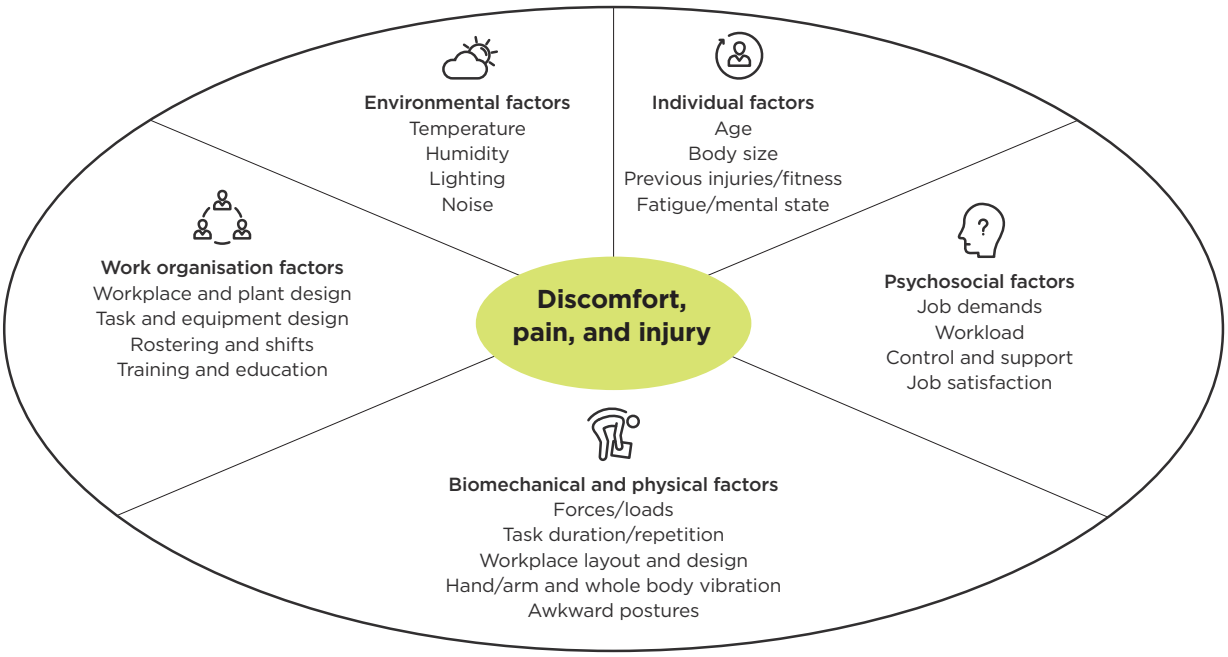
IN THIS SECTION:

Appendix 1: Glossary

TERM	MEANING
ACC	Accident Compensation Corporation
APHIRM	A participative hazard identification and risk management toolkit
ART	Assessment of repetitive tasks of the upper limbs
BAuA	Federal Institute for Occupational Safety and Health (Germany)
DUTCH	Push/pull assessment from TNO (Netherlands)
DPI	Discomfort, pain, and injury
HAW	HabitAtWork
HARM	Hand arm risk assessment method
HSE	Health and Safety Executive (United Kingdom)
HSWA	Health and Safety and Work Act
HFE	Human Factors/Ergonomics (team)
Kaimahi	Workers
KIM	Key indicator method – German risk assessment tools
KTH	Royal Institute of Technology (Sweden)
MAC	Manual handling assessment charts
MSDs	Musculoskeletal disorders
NSW	New South Wales, Australia
PCBUs	Persons conducting business or undertakings
PErforM	Participative ergonomics for manual tasks
QLD	Queensland, Australia
RAMP	Risk management assessment tool for manual handling proactively
RAPP	Risk assessment for pushing and pulling
REBA	Rapid entire body assessment
RULA	Rapid upper limb assessment
TNO	Dutch organisation
UK	United Kingdom
WEPR	Worker engagement, participation, and representation
WRAP	Working postures risk assessment tool
WRMSDs	Work-related musculoskeletal disorders

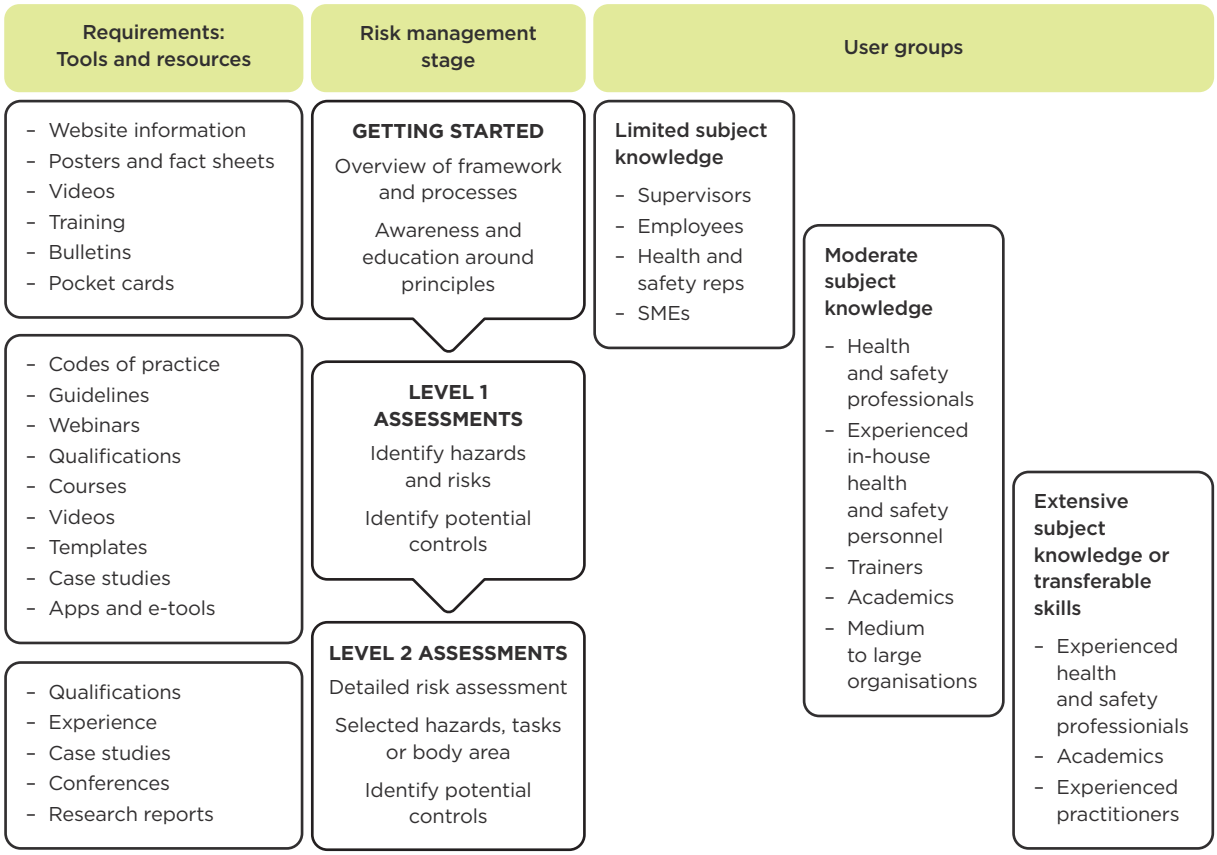
Appendix 2: WorkSafe model – risk factors associated with the development of work-related musculoskeletal disorders

This model shows the risk factors associated with the development of WRMSDs, commonly referred to as discomfort, pain, and injury. It also provides examples for each of the risk factor groups. Please note, these are examples and not an exhaustive list.



Appendix 3: Assessment methods and user groups

Boocock *et al*. (2018) developed a model to show the different stages of the risk management process and the associated tools, resources, and likely user groups for the different assessment stages. A representation for their model, 'Toolkit of hierarchical assessment methods and the potential user groups' is shown below.



Appendix 4: Summary tables of risk assessment methods reviewed

Screening tools – methods that allow for generalised screening of hazardous manual tasks

These methods were classed as Level 1 by Boocock *et al*. (2018), meaning they are considered to be generalised screening tools with a low level of complexity. A screening tool could be completed initially and then a more detailed risk assessment completed depending on the findings of the screening process. These tools are presented in the order that we ranked them in.

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
MSD hazard risk assessment checklist (Canada) (Ranked first equal)	Probably – known risk factors for WRMSDs are considered	Easy/moderate – some tables could be difficult to interpret	Not sure, probably in Canada but maybe not elsewhere	Yes – printable checklist	No – just access to the checklist and referral to the Ontario MSD Prevention Guideline	No – this is a detailed screening tool and could be too complex to use as an initial screening tool
Washington State industry specific checklists (America) (Ranked first equal)	Probably – known risk factors for WRMSDs are considered	Easy	Well established tool in America and Canada, probably well known by HFE professions, but probably not well known in New Zealand	Yes – printable checklist	No training needed quite self-explanatory, with some website resources	No – there are several checklists which might be confusing and could be a little too complex for a screening tool, only physical risk factors considered
Risk management assessment tool for manual handling proactively (RAMP I) (Sweden) (Ranked first equal) Shortlisted	Yes – this is the screening tool that is used before the full assessment method	Easy – designed for manual handling tasks in manufacturing	Quite a new tool, probably known by some HFE professionals but not by health and safety generalists in New Zealand	Yes – online	Yes – there is a good website with lots of information and resources. There are pdf and excel versions of the tool, which is freely available, but you must request access. Online courses are available	Potentially – it is a well-balanced, easy to use screening tool. The focus is on physical risk factors, but there are questions on psychosocial risk factors, and involves workers. This screening tool is part of a system considered to be a 'risk management system'
Checklist physical load (TNO) (Netherlands) (Ranked second) Shortlisted	Yes – online paper outlines development process	Easy	Probably known by some HFE professionals but not by health and safety generalists in New Zealand	Yes – online	Yes – online information on how to complete is available	Potentially – could be used as part of a risk management system, only considers physical risk factors

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
ISO 'key questions' and 'quick assessments' (International Organization of Standardization) (Ranked third)	Not sure	Not sure	Not sure, is an international standard but not freely available	Yes – if the standard is purchased, presumably a paper-based assessment	Presumably no training needed to complete the basic questions. Information is not freely available; the standard must be purchased	No – not freely available
Participative ergonomics for manual tasks (PErforM) (Australia) (Ranked fourth) Shortlisted	Probably – developed from ManTRA (but there is no evidence of validity or reliability)	Easy/moderate	Used by Regulators in New South Wales and Queensland (Australia)	Yes – paper-based form and online (currently not working)	Yes – there is a lot of information on the SafeWork NSW and WorkSafe QLD websites	Possibly as a screening tool, only assesses physical risk factors. There needs to be an online tool available. It is participative, but it is only suited to small businesses
Checklists for prevention of manual handling risks (2008) e-fact 44 (European Agency for Safety and Health at Work – EUOSHA) (Ranked fifth equal)	Probably – known risk factors for WRMSDs are considered and from reliable sources (NIOSH, HSE)	Easy	Probably in Europe but not in New Zealand	Yes – paper-based, no online version	No training needed, is straight forward and all information is in the fact sheet	No – is paper-based, and parts that refer to the NIOSH lifting equation might be too complicated, mainly focused on physical risks and has one psychosocial risk factor question
HSE Simple Risk Filters (United Kingdom) (Ranked fifth equal) Shortlisted	Yes – based on well-known WRMSD risk factors	Easy – (recently updated) the assessor looks at an image and bullet-pointed list to determine if a full risk assessment is needed	Well established in the UK and linked to the Manual handling Operations Regulations 1992 (UK), probably somewhat familiar in New Zealand	Yes – online at HSE (UK) or can be printed, freely available	HSE website has a large variety of resources. The Manual handling Operations Regulations 1992 have information on the risk filters and more detailed risk assessments. Simple to use, no training required	Potentially – the filters are quick and easy to use, with supporting resources and guidance material freely available

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
Risk Reckoner (New Zealand) (Ranked sixth)	Probably, but not sure – no evidence of how it was developed. Understood to have been developed from the Code of Practice for Manual Handling (NZ)	Both the paper-based version and the online version were easy to use	In New Zealand it was well known and linked to the DPI programme	No – online version has been withdrawn so only those with a paper-based version could use it	No – this assessment method is currently not being promoted or supported within New Zealand. Inaccuracies were found when the information was transferred from the paper-based to online version	Not at this stage – there is no reported evidence of how the tool was developed, and psychosocial risk factors not considered. Could potentially be reviewed and re-developed but would take resources and time so not a valid short-term solution
A participative hazard identification and risk management toolkit (APHIRM)[1] (Australia)	Yes – based on the Copenhagen Psychosocial Questionnaire (COPSOQ) categories and WOAC and discomfort/pain	Easy – but quite long to complete the survey (54 questions). Could be difficult for those who don't have English as their first language	Quite new – probably needs more evidence from use in the 'real world' to see if it is effective. Seems to be gaining in popularity	Yes – freely available online via La Trobe University (Australia)	Yes – information is available online but in person training is recommended	Potentially – this is the only survey tool that relies on direct input from workers (not on observations). It is long (54 questions), could be hard to interpret for some (for example, for those who have English as a second language), can only by used by larger organisations (more than 12 people). This is more in the category of a 'risk management system' rather than a simple screening or risk assessment tool. May be better suited to larger organisations who have more mature health and safety cultures

[1] RAMPI, RAMP II, and APHIRM are methods that offer a more complete 'risk management' approach.

Manual handling assessment methods reviewed: Lift, carry, team handling

These methods were classed as Level 2 by Boocock *et al*. (2018), meaning they represent a more detailed risk assessment method compared to a screening tool (Level 1) and are perceived to be more complex to perform. These tools are presented in their initial ranked order.

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
Risk management assessment tool for manual handling proactively (RAMP II)[2] (Sweden) (Ranked first equal) Shortlisted	Yes	Moderate – uses excel so might not be good for using on a phone	No – quite new. Introduction video is spoken in Swedish with English subtitles	Yes	Yes – there is a good website with lots of information and resources. There are pdf and excel versions of the tool, which is freely available, but you must request access. Online training courses are available	Potentially – offers a risk management systems approach to manual handling tasks. Was designed specifically for the manufacturing industry so unsure if it is crosses over well to other industries
Hazard identification checklist (NZ – Code of Practice for Manual Handling) (New Zealand) (Ranked first equal)	Probably – no evidence of how it was developed but does consider well-known WRMSD risk factors – thought to be based on the KIM tools	Moderate	Should be widely known in New Zealand as it is in the current Code of Practice for Manual Handling	Yes – only paper based	No training needed but would need to be updated and online resources developed	Not at this stage – there is no reported evidence of how the tool was developed, psychosocial risk factors not considered. Could potentially be reviewed and re-developed but would take resources and time so not a valid short-term solution
HSE Full manual handling risk assessment: (lifting and carrying, and pushing/pulling) (United Kingdom) (Ranked second) Shortlisted	Yes – based on well-known WRMSD risk factors	Easy – tick box assessment with room for notes	Well established in the UK and linked to the Manual handling Operations Regulations 1992 (UK), probably not overly familiar in New Zealand	Yes – paper-based version freely available to download as a pdf	HSE website has a large variety of resources. The Manual handling Operations Regulations 1992 have information on the full assessments which would usually be used after MAC or RAPP if a more detailed assessment is required. Simple to use, no training required	Potentially – the assessment is quick and easy to use to gain greater understanding of the risk following the use of MAC or RAPP and includes questions on psychosocial risks. Provides an action plan template to control risks. Supporting resources exist and is freely available

[2] RAMPI, RAMP II, and APHIRM are methods that offer a more complete 'risk management' approach.

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
Mital tables (America) (Ranked third equal)	Yes	Moderate	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – there is software, but would need to be purchased	Not really	No – too time consuming, lots of tables and needs exact measurements – not practical for PCBUs
Snook tables (America) (Ranked third equal)	Yes	Moderate – needs training to understand how to collect data	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – online version that must be purchased	Yes – when purchased	No – too time consuming and complicated
Working postures risk assessment tool (WRAP) (Netherlands) (Ranked third equal) Shortlisted	Yes – based on high risk working postures, but validity remains unknown	Easy – online tool that you click the relevant criteria, six-step process, and provides results based on a 'traffic light' approach	Probably well-known in the Netherlands, and possibly known by New Zealand HFE professionals but probably not by health and safety generalists	Yes – online version freely available	Yes – online information/ risk assessment website is self-explanatory, no formal training needed	Potentially – if used with other tools. It doesn't consider force/ load, assessing postures rather than manual handling tasks. Is quite quick to complete, about 20 minutes
Key indicator method (KIM-LHC) (lifting, holding, carrying) (Germany) (Ranked fourth equal) Shortlisted	Yes – several papers available on how it was developed	Moderate – some training needed. Somewhat complex and multiple tools might need to be used if there are multiple factors to assess	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – risk assessments can be printed off from the internet, no online version	Yes – pdf sheets with information on how to use them – looks to be more of a pen and paper-based assessment	Potentially – looks reasonably complicated to complete and is paper based. There are many tools which users could find difficult to select the correct one for the task. Doesn't consider psychosocial risk factors

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
Manual handling assessment charts (MAC) (United Kingdom) (Ranked fourth equal) Shortlisted	Yes – several reports on reliability and validity of the tool	Moderate/ Easy – with basic training/ knowledge uses a traffic light system	Well known by HFE professionals and already being used by some health and safety generalists/PCBUs in New Zealand	Yes – pen and paper-based or app/online version freely available (or more detailed access at a cost)	Yes – online resources and training form HSE (UK) available	Yes – it was designed specifically for Health and Safety inspectors, is quick and intuitive to use. Scores physical risk factors, but psychosocial risks can be recorded but not scored. Worker participation is encouraged when completing the assessment
ACGIH – Lifting threshold limit values (TLV) (America) (Ranked fourth equal)	Yes	Moderate – lots of tables not really designed for inexperienced users	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes	Not really	No – too time consuming, complicated, and intrusive
Revised NIOSH lifting equation (RNLE) (America) (Ranked fourth equal)	Yes	Moderate/ Difficult – measurements need to be quite accurate. Recommended for experienced users only	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – there is an app	Yes – manuals available online	No – too time consuming, complicated, and intrusive. Needs a lot of exact measurements and uses technical terminology, not practical for PCBUs in New Zealand
NIOSH Variable Lifting Index (VLI) (America) (Ranked fourth equal)	Yes	Difficult – for experienced users only	Known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes	Not really	No – as above, too complex

Manual handling assessment methods reviewed: Push/pull

These methods were classed as Level 2 by Boocock *et al*. (2018), meaning they represent a more detailed risk assessment method compared to a screening tool (Level 1) and are perceived to be more complex to perform. These tools are presented in their initial ranked order.

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
Risk management assessment tool for manual handling proactively (RAMP II)[3] (Sweden) (Ranked first) Shortlisted	Yes	Moderate – uses excel so might not be good for using on a phone	No – quite new. Introduction video is spoken in Swedish with English subtitles	Yes	Yes – there is a good website with lots of information and resources. There are pdf and excel versions of the tool, which is freely available, but you must request access. Online training courses are available	Potentially – offers a risk management systems approach to manual handling tasks. Was designed specifically for the manufacturing industry so unsure if it is crosses over well to other industries
HSE Full manual handling risk assessment: (lifting and carrying, and pushing/pulling) (United Kingdom) (Ranked second equal) Shortlisted	Yes – based on well-known WRMSD risk factors	Easy – tick box assessment with room for notes	Well established in the UK and linked to the Manual handling Operations Regulations 1992 (UK), probably not overly familiar in New Zealand	Yes – paper-based version freely available to download as a pdf	HSE website has a large variety of resources. The Manual handling Operations Regulations 1992 have information on the full assessments which would usually be used after MAC or RAPP if a more detailed assessment is required. Simple to use, no training required	Potentially – the assessment is quick and easy to use to gain greater understanding of the risk following the use of MAC or RAPP and includes questions on psychosocial risks. Provides an action plan template to control risks. Supporting resources exist and is freely available
Mital tables (America) (Ranked second equal)	Yes	Moderate	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – there is software, but would need to be purchased	Not really	No – too time consuming, lots of tables and needs exact measurements – not practical for PCBUs
Snook tables (America) (Ranked second equal)	Yes	Moderate – needs training to understand how to collect data	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – online version that must be purchased	Yes – when purchased	No – too time consuming and complicated

[3] RAMPI, RAMP II, and APHIRM are methods that offer a more complete 'risk management' approach.

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
Key indicator method (KIM-PP) – Push/pull (Germany) (Ranked third) Shortlisted	Yes – several papers report on the development process	Moderate – some training needed as the assessment is somewhat complex	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – risk assessments can be printed off from the internet (pen-and-paper based)	Yes – pdf sheets with information on how to use them – looks to be more of a pen and paper-based assessment, no specific training is available	Potentially – looks reasonably complicated to complete, is only paper-based, doesn't consider psychosocial factors
Risk assessment for pushing and pulling (RAPP) (United Kingdom) (Ranked fourth equal) Shortlisted	Yes – based on well-known risk factors and linked to UK Regulations	Easy – same format used in MAC and ART, traffic light system	Probably known by HFE professionals but probably not by many health and safety generalists in New Zealand	Yes – online tool freely available	Yes – online resources and training from HSE (UK) available	Yes – it was designed specifically for Health and Safety inspectors, is quick and intuitive to use. Scores physical risk factors. Psychosocial risks can be recorded but are not scored. Worker participation is encouraged. May underestimate certain risk factors
Push/pull check risk assessment (DUTCH) (Netherlands) (Ranked fourth equal) Shortlisted	Yes – tool development is presented on their website and linked to research papers	Easy/Moderate – online tool that you click the relevant criteria, six-step process, and provides results based on a 'traffic light' approach	Probably known in Europe but probably not by health and safety generalists or HFE specialists in New Zealand	Yes – online tool freely available	Yes – online information/ risk assessment website is self-explanatory, no formal training needed	Potentially – easy to use online tool, quite quick to complete – about 20 minutes

Upper limb specific risk assessment methods reviewed

These methods were classed as Level 2 by Boocock *et al*. (2018), meaning they represent a more detailed risk assessment method compared to a screening tool (Level 1) and are perceived to be more complex to perform. These tools are presented in their initial ranked order.

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
HSE Risk assessment worksheets: for upper limbs (United Kingdom) (Ranked first) Shortlisted	Yes – based on well-known WRMSD risk factors	Easy – tick box assessment with room for notes	Well established in the UK and linked to the guidance: 'Upper limb disorders in the workplace' (HSG60), (UK), probably not too familiar in New Zealand	Yes – paper-based version freely available to download as a pdf	HSE website has a large variety of resources. The guidance document has information on the assessment which would usually be used after ART if a more detailed assessment is required. Simple to use, no training required	Potentially – the assessment is quite detailed but is easy to use to gain greater understanding of the risk of upper limb disorders following the use of ART, it includes questions on psychosocial risks. Supporting resources exist and is freely available
Assessment of repetitive tasks of the upper limbs tool (ART) (United Kingdom) (Ranked second equal) Shortlisted	Yes – papers available on development process	Easy/Moderate – slightly more complex than MAC due to the nature of the tasks assessed. Uses the traffic light system and same format as MAC and RAPP	Well known by HFE professionals and others in the UK but probably not by many health and safety generalists in New Zealand	Yes – pen and paper-based or app available online	Yes – online resources and training form HSE (UK) available	Yes – it was designed specifically for Health and Safety inspectors, is quick and intuitive to use (based on the same format as MAC). Mainly addresses physical risk factors (scored) and gets the user to record psychosocial risk factors (unscored)
Occupational repetitive actions methods (OCRA) – Checklist (initial screening tool) and an Index (detailed assessment) (Italy) (Ranked second equal)	Yes	Moderate/Difficult – recommended for use by 'experts' only	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes	Yes – needs several days of training in MSDs	No – too complex and time consuming
Revised strain index (SI) (America) (Ranked third equal)	Yes	Moderate – recommended for experienced users or those with some HFE training	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes	Not really – none that could be found easily	No – too complex with lots of calculations, time consuming

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
Hand arm risk assessment method (HARM) (Netherlands) (Ranked third equal) Shortlisted	Yes – information on development is available online and linked to papers	Moderate – online tool is easy to use by entering or clicking on the relevant criteria but is more technical than other tools in the TNO series. Six-step process, and provides results based on a 'traffic light' approach and gives a total risk score	Probably known in Europe by HFE professionals and others but not by health and safety generalists or HFE professionals in New Zealand	Yes – online version is freely available (force measurements haven't been translated into English)	Yes – online user manual, information, demonstration, and risk assessments are available. They are self-explanatory and require no formal training.	Potentially – like ART, easy to use online tool, but is quite technical with body segment degrees/observations needed. Has a detailed section on vibration, particularly if vibration intensities are known. Estimated to take 30–60 minutes per assessment
Rapid upper limb assessment (RULA) (United Kingdom) (Ranked fourth)	Yes	Moderate – recommended for use by 'experts'	Very well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – pen and paper-based or online tools available – free to use	Yes – there are several online/YouTube videos available – but not necessarily from the assessment authors	No – too time consuming and complex. Only recommended for HFE professionals doing more detailed task analysis
Key indicator method manual handling operations (KIM-MHO) – upper limbs (Germany) (Ranked fifth equal) Shortlisted	Yes – papers available on development	Moderate – the scoring system can be complicated	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – risk assessments can be printed off from the internet, but no online version	Yes – pdf sheets with information on how to use them – looks to be more of a pen and paper-based assessment	Potentially – looks reasonably complicated to complete, is only paper-based, and doesn't consider psychosocial factors. Could be confused and used incorrectly (for example, for manual handling tasks – lifting, carrying etc, rather than for assessing upper limb tasks)
Postural loading on the upper body assessment (LUBA) (America) (Ranked fifth equal)	No – physiological discomfort scores from 20 male participants only. No evidence of reliability or validity	Not sure – couldn't find the assessment. Considered for use by researchers and possibly health and safety professionals and ergonomists	No – established in 2001 (America)	Yes – but couldn't find the assessment or website so not easily findable	No – could only find some presentations people had created but didn't show how to use the tool and no supporting information available	No – only focuses on static work, and questions around the validity and reliability of the tool
ACGIH – Hand arm limit (HAL) (America) (Ranked sixth)	Yes	Moderate/Difficult – recommended for use by 'experts'	Known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – pen and paper-based available	Not really – none that could be found easily	No – too complex

Combined hazards methods reviewed

These methods were classed as Level 2 by Boocock *et al*. (2018), meaning they represent a more detailed risk assessment method compared to a screening tool (Level 1) and are perceived to be more complex to perform. These tools are presented in their initial ranked order.

LIST OF SCREENING TOOLS REVIEWED	WORKSAFE REQUIREMENTS					RECOMMENDED FOR USE IN NEW ZEALAND
	Scientifically robust	Easy to use	Well established/familiar	Available now	Training/resources available	
Manual tasks risk assessment tool (ManTRA) (Australia)	Probably – based on Strain Index and QEC but no evidence of how cumulative scores are calculated	Moderate	Used by New South Wales and Queensland Regulators	Yes – there is an online calculator (WorkSafe QLD)	No	No – PErforM was developed from ManTRA as it is a participative tool. No supporting training or resources and ManTRA could be too complicated to use
Quick exposure check (QEC) (United Kingdom) Shortlisted	Yes – based on well known risk factors associated with WRMSDs	Easy/Moderate – tick box	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – paper-based only	Reference guide freely available online – no detailed training required, no online tool	Potentially – as a quick screening tool to see if a more detailed assessment is needed
The European Assembly worksheet (Europe)	Yes	Moderate	Possibly known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes – but not easily available	Not really – difficult to find	No – looks too complicated
Rapid entire body assessment (REBA) United Kingdom	Yes	Moderate – recommended for 'expert' users	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes	Yes – online guides and tools are available but not necessarily from the assessment authors	No – only for HFE professionals doing detailed postural analysis
Ovako working posture assessment system (OWAS) (Finland)	Yes	Moderate	Well known by HFE professionals but probably not by health and safety generalists in New Zealand	Yes	Not really – requires training to use the tool properly	No – too time consuming and complex

Risk management methods

These approaches are considered as 'risk management' tools and there are several similarities using participatory approaches. The biggest difference is that the RAMP tools are heavily focused on physical risk factors whereas APHIRM focuses on psychosocial risk factors. APHIRM is a survey completed by workers, RAMP is largely observation-based.

	WORKSAFE REQUIREMENTS					
List of combined assessment tools reviewed	**Scientifically robust**	**Easy to use**	**Well established/familiar**	**Available now**	**Training/resources available**	**Recommended for use in New Zealand**
RAMP I and RAMP II (Sweden) Shortlisted	Yes	Moderate – uses excel so might not be good for using on a phone	No – quite new. Introduction video is spoken in Swedish with English subtitles	Yes	Yes – there is a good website with lots of information and resources. There are pdf and excel versions of the tool, which is freely available, but you must request access. Online training courses are available	Potentially – offers a risk management systems approach to manual handling tasks. Was designed specifically for the manufacturing industry and focuses on physical risk factors, unsure if it is crosses over well to other industries
APHIRM (Australia)	Yes – based on the Copenhagen Psychosocial Questionnaire (COPSOQ) categories and WOAC and discomfort/pain	Easy – but quite long to complete the survey (54 questions). Could be difficult for those who don't have English as their first language	Quite new – probably needs more evidence from use in the 'real world' to see if it is effective. Seems to be gaining in popularity	Yes – freely available online via La Trobe University (Australia)	Yes – information is available online but in person training is recommended	Potentially – this is the only survey tool (not an observation tool), relying on direct input from workers. It is long, could be hard to understand (for example, for those who have English as a second language), is only designed for larger businesses with more than 12 people. The holistic approach of the tool means it is more of a 'risk management system' rather than a simple screening or risk assessment tool. May be better suited to larger organisations who have more mature health and safety cultures

Appendix 5: Detailed summaries of shortlisted tools

HSE (UK) Tools

The The tools from the Health and Safety Executive (HSE) offer three different levels or risk assessment:

- very basic risk filters
- focused assessments (MAC/RAPP/ART)
- full risk assessments (manual handling – lift, carrying, push/pull, and upper limbs).

By using a combination of all three methods this enables users to easily:

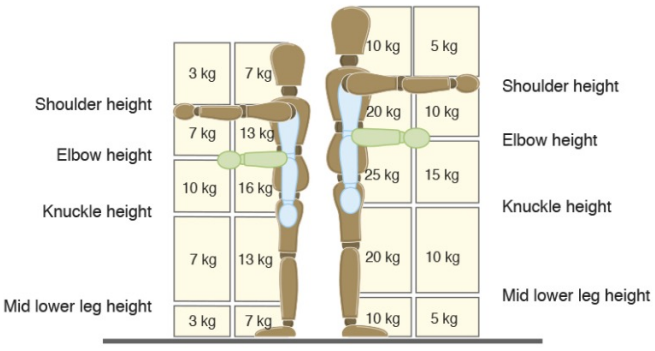
- identify risks (of the tasks not individuals)
- engage with workers to better understand the problems and help identify solutions
- prioritise areas for risk reduction (traffic light system), and
- develop an action plan and plan for review as part of a holistic risk management approach (full risk assessments only).

While the HSE methods, particularly the MAC, RAPP, and ART tools are focused on physical risk factors, there is space to record psychosocial factors, and these can be looked at in greater detail if a full risk assessment. Each of the tools and the full risk assessments requires worker engagement and the assessor discussing issues with workers.

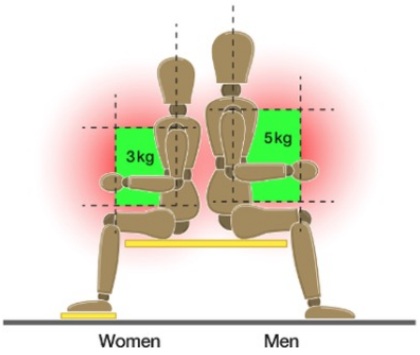
SIMPLE RISK FILTERS

On the HSE website there are four simple manual handling risk filters that can initially be used to help users identify low-risk manual handling and decide if more a detailed risk assessment needs to be carried out. These risk filters are supported by HSE guidance 'Manual handling – Manual Handling Operations Regulations 1992 – Guidance on Regulations' (Health and Safety Executive, 2016a):

- **Lifting and lowering risk filter**: Can be applied by observing the work task and assessing which zones the hands pass through when moving the load. The filter does not represent 'safe handling limits'. If weights handled are above those specified in the filter for certain zones, it is recommended that a more detailed risk assessment is completed.
- **Carrying risk filter**: Specifies criteria above which would trigger a full risk assessment. For example, if the load is carried more than 10m without resting, prevents the person from walking normally, obstructs the persons view when carrying, and the person must adopt awkward postures (above shoulder height, or below knee height).
- **Pushing and pulling risk filter**: Requires the user to observe the worker's posture during the pushing or pulling task and has a set of criteria which if exceeded a detailed risk assessment should occur. For example, the force is applied with the body not the hands, poor pushing postures, hands above shoulder height or below hip height, and large pushing or pulling distances (greater than 20m).
- **Handling while seated risk filter**: This filter can be applied for handling operations that are performed while seated. If loads handled by females are greater than 3kg and for men, greater than 5kg or loads are handled beyond the 'green' zone then a more detailed assessment should be completed.



Lifting and lowering risk filter



Handling while seated risk filter

Pushing and pulling risk filter

MAC AND VMAC – MANUAL HANDLING ASSESSMENT CHARTS AND VARIABLE MANUAL HANDLING ASSESSMENT CHARTS

The *Manual Handling Assessment Charts (MAC)* was the first tool developed by the HSE (Health and Safety Executive, 2019). There are several reports outlining the need for the tool, the development process, usability, reliability, and validity studies. One of the key drivers for the development of the tool was to provide health and safety inspectors a relevant tool to quickly identify high risk activities. The main criteria for the tool were that it should be:

- very quick and easy to use
- linked to scientific studies and guidance
- intuitive and indicate good practice, and
- able to identify high risk manual handling tasks.

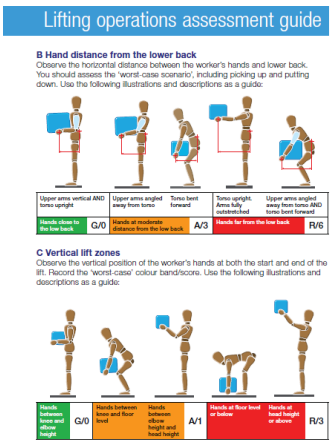
Initial research of some other methods (QEC, NIOSH lifting equations, Psychophysical lifting and carrying table (Snook), Job Severity Index (JSI), and Ovako Working posture Analysis System (OWAS)) found that they were restricted for use in an inspection setting and didn't meet the four key criteria. The research also found that none of the tools reviewed had been validated as predictors of injury risks (Monnington *et al*., 2002).

MAC works best when the same loads are handled over the course of the workday/shift. But if load weights vary significantly (for example, in an order-picking/warehouse job) then the Variable manual handling assessment chart (V-MAC) tool should be used to assess the load/weight frequency risk factor. The V-MAC is slightly more complex and needs information on the range of product weights handled (Pinder, 2011; Pinder *et al*., 2014). The VMAC is an Excel spreadsheet that uses actual loads handled to calculate the level of risk. It is only used instead of the standard table for 'Load weight/frequency' in the MAC tool. Once that factor has been assessed the rest of the risk factors in the MAC tool are followed.

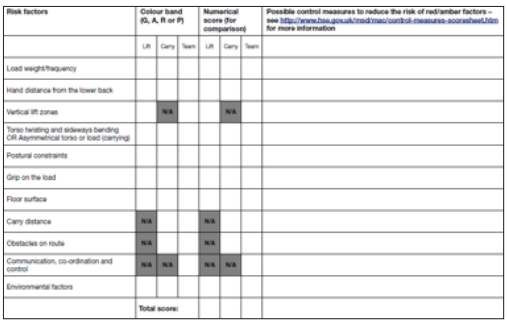
A traffic light system helps the user to prioritise risk control measures for each risk factor assessed. When multiple tasks are assessed, the total scores help to prioritise which order to review tasks. The tool mainly assesses physical risk factors, but environmental factors are considered, and psychosocial risk factors can be recorded on the score sheet but are not scored.

The MAC tool is supported by HSE guidance 'Manual handling – Manual Handling Operations Regulations 1992 – Guidance on Regulations' (Health and Safety Executive, 2016a).

Flowchart



Assessment criteria example



Score sheet

RAPP – RISK ASSESSMENT OF PUSHING AND PULLING TOOL

The Risk Assessment of Pushing and Pulling (RAPP) tool is aimed at those responsible for health and safety in workplaces – employers, managers, and safety representatives (Health and Safety Executive, 2016b). The tool:

- will help users identify high-risk pushing and pulling operations and check the effectiveness of risk reduction measures
- assesses two types of pushing and pulling operations
  - moving loads on wheeled equipment
  - moving loads without wheels.

Like MAC, for the two types of assessments there is a flowchart, assessment guide and score sheet. The flowcharts provide an overview of the risk factors and assessment process. The assessment guides provide information so the user can determine the level of risk for each of the risk factors.

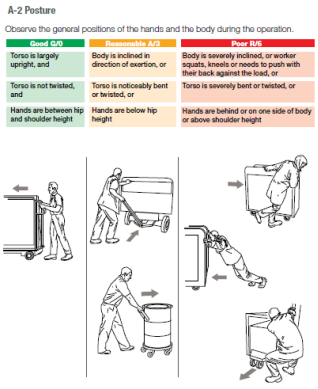
The tool should not be used to assess pushing/pulling tasks that involve just the upper limbs (for example, pulling levers), just the lower limbs (for example, operating pedals), or for powered handling equipment.

As with MAC and ART the traffic light system helps the user to prioritise risk control measures and psychosocial risk factors can be recorded on the score sheet but are not scored.

This is the newest tool from the HSE compared to MAC and ART, and is supported by HSE guidance 'Manual handling – Manual Handling Operations Regulations 1992 – Guidance on Regulations' (Health and Safety Executive, 2016a).

Research suggests that for some risk factors or parts of a task the tool may underestimate the level of risk. For example, moving loads with hand pallet trucks or similar equipment with small wheels. This is due to how the factors, floor surface and obstacles along the route are assessed. If they are low risk but there are small irregularities or debris on the floor surface or there is a small gradient then this could have a significant effect on the manual forces needed to push or pull the equipment, that may not be captured by RAPP. HSE recommends in cases where there are varying floor and environmental conditions (for example, outdoor yards, delivery areas) that a full push/pull risk assessment is completed (Health and Safety Executive, 2016b).

Flowchart



Assessment criteria example

Score sheet

ART – ASSESSMENT OF REPETITIVE TASKS OF THE UPPER LIMBS

The Assessment of Repetitive Tasks of the upper limbs (ART) tool was the second tool developed and assesses repetitive tasks involving the upper limbs (excluding computer workstation assessments) (Health and Safety Executive, 2010). It is most suited to tasks that involve actions of the upper limbs, repeated every few minutes (or more frequently), and occur for at least 1–2 hours per day or shift.

The ART tool is based on the format of the MAC tool to aid user familiarity. It was based on the technical content of OCRA checklist rather than the OCRA index as it was a more suitable initial screening tool for repetitive tasks (Ferreira *et al*., 2009). The OCRA checklist statements were carefully considered to ensure they linked to existing HSE guidance of upper limb disorders in the workplace. Elements of QEC were also considered to be useful to include following the early peer-review process.

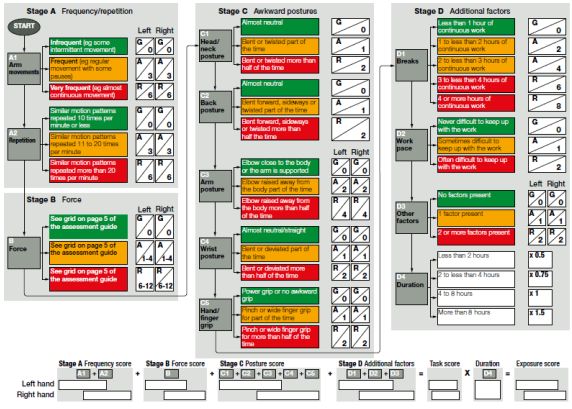
There is one question on work pace that relates to psychosocial risk factors, but users are encouraged to write down any other factors, though these are not scored.

ART was developed for inspectors to:

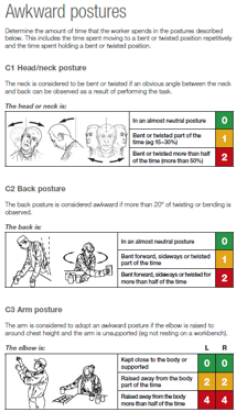
- screen repetitive tasks of the upper limbs for common physical risk factors that contribute to the development of upper limb disorders
- raise duty holders' awareness and understanding of the risks of repetitive tasks
- demonstrate the presence of risk to duty holders
- give a broad indication of the level of risk
- recommend areas for improvement.

Limitations: scored reasonably well when compared to Strain Index, OCRA and QEC – but difficult to judge due to different scoring systems. Observation-based assessments of quick hand and arm movements is inherently difficult. It can be useful to record workers performing the tasks for improved task analysis and risk assessment.

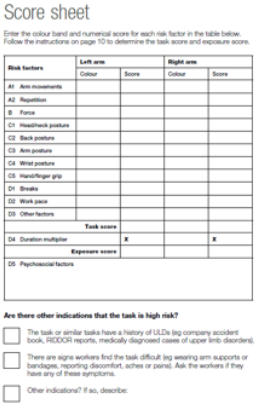
The usability of ART was perceived as favourable. It may require more training compared to the MAC due to the difficulty of completing upper limb assessments but, it was deemed sufficiently credible with training (Ferreira *et al*., 2009).



Flowchart and score recording



Assessment criteria example



Score sheet

HSE FULL RISK ASSESSMENTS

If the MAC, RAPP, or ART tools have been used and the assessor feels that a more detailed assessment is needed then the HFE full risk assessment tools can be used. These assessments are more detailed and provide the user with a risk management approach where the risks can be identified, assessed, and an action plan developed to implement and re-evaluate controls. There is one assessment for 'manual handling' tasks and a separate one for 'upper limb tasks':

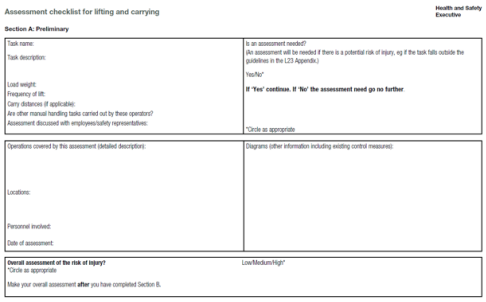
– Full manual handling risk assessment

The full risk assessments allow users to systematically consider risk factors associated with a task, and highly recommends involving workers in the process. The risk assessments are linked to the 'Manual handling – Manual Handling Operations Regulations 1992 – Guidance on Regulations' (Health and Safety Executive, 2016a).

Each risk factor can be scored on a scale, low, medium, or high. Physical and psychosocial risk factors are assessed.

Within the assessment there are two separate risk assessments: 1. Lifting and carrying, 2. Pushing and pulling. The risk assessments are divided into three sections:

- Preliminary section: where basic information about the task being assessed is entered.
- Detailed assessment: a list of risk factors that users tick if they are present.
- Remedial action section: a prioritised action list to summarise the remedial steps that need to be taken, who is responsible for completing them, and when they need to be completed. There is also space to enter a date for a follow up assessment if needed.



Assessment checklist for lifting and carrying

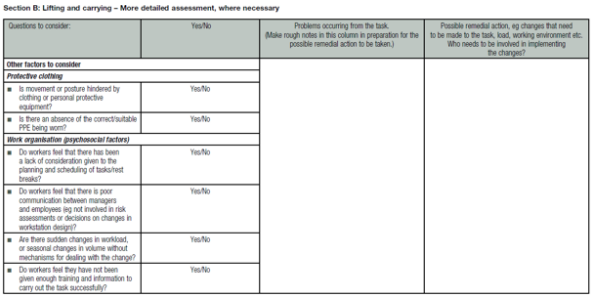
Health and Safety Executive

Section A: Preliminary

Task name: Task description: Load weight: Frequency of lift: Carry distances (if applicable): Are other manual handling tasks carried out by these operators? Assessment discussed with employees/safety representatives:	Is an assessment needed? (An assessment will be needed if there is a potential risk of injury, eg if the task falls outside the guidelines in the L23 Appendix.) Yes/No* **If 'Yes' continue. If 'No' the assessment need go no further** *Circle as appropriate
Operations covered by this assessment (detailed description): Locations: Personnel involved: Date of assessment:	Diagrams (other information including existing control measures):

Overall assessment of the risk of injury? Low/Medium/High*
*Circle as appropriate
Make your overall assessment **after** you have completed Section B.

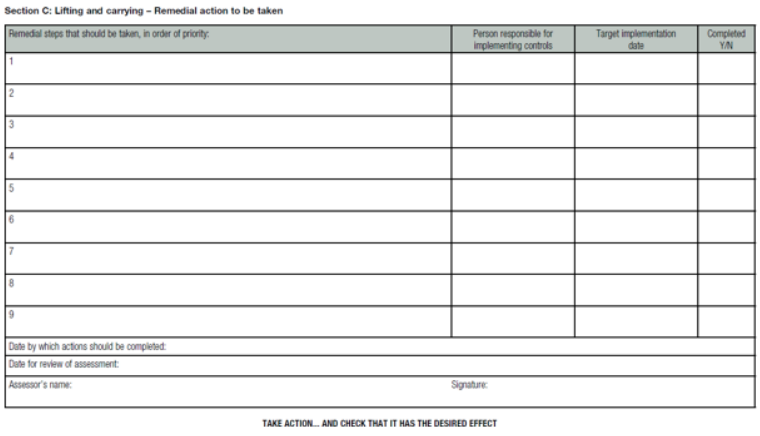
Example of the 'preliminary section' in the full manual handling risk assessment



Section B: Lifting and carrying – More detailed assessment, where necessary

Questions to consider:	Yes/No	Problems occurring from the task. (Make rough notes in this column in preparation for the possible remedial action to be taken.)	Possible remedial action, eg changes that need to be made to the task, load, working environment etc. Who needs to be involved in implementing the changes?
Other factors to consider			
Protective clothing			
■ Is movement or posture hindered by clothing or personal protective equipment?	Yes/No		
■ Is there an absence of the correct/suitable PPE being worn?	Yes/No		
Work organisation (psychosocial factors)			
■ Do workers feel that there has been a lack of consideration given to the planning and scheduling of tasks/rest breaks?	Yes/No		
■ Do workers feel that there is poor communication between managers and employees (eg not involved in risk assessments or decisions on changes in workstation design)?	Yes/No		
■ Are there sudden changes in workload, or seasonal changes in volume without mechanisms for dealing with the change?	Yes/No		
■ Do workers feel they have not been given enough training and information to carry out the task successfully?	Yes/No		

Example of the factors assessed in Section B



Section C: Lifting and carrying – Remedial action to be taken

Remedial steps that should be taken, in order of priority:	Person responsible for implementing controls	Target implementation date	Completed Y/N
1			
2			
3			
4			
5			
6			
7			
8			
9			
Date by which actions should be completed:			
Date for review of assessment:			
Assessor's name:	Signature:		

TAKE ACTION... AND CHECK THAT IT HAS THE DESIRED EFFECT

Example of the action plan in the manual handling full risk assessment

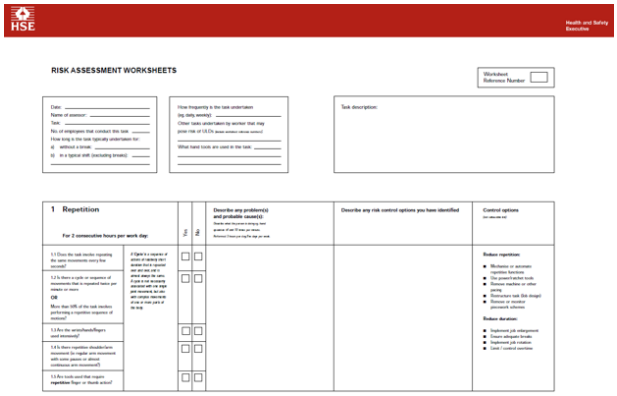
- Upper limb risk assessment worksheets

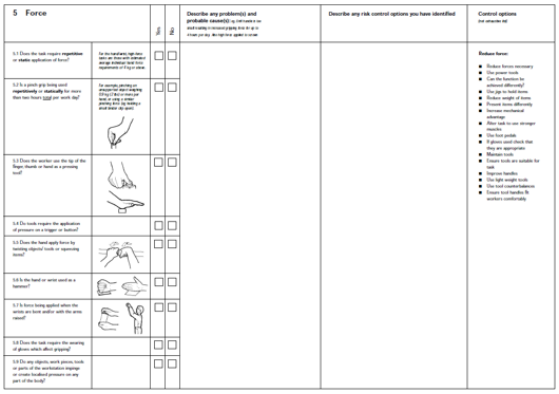
  This risk assessment is specifically for assessing tasks that mostly use the upper limbs. For example, it could be used if more information is needed following the ART assessment. The risk assessment is supported by HSE guidance 'Upper limb disorders in the workplace' (Health and Safety Executive, 2002).

  It follows the same layout as the full manual handling risk assessment (outlined above) with the three sections that users complete and strongly encourages worker involvement.

  Both physical and psychosocial risk factors are assessed, with more psychosocial questions covering a broader range of factors compared to the full manual handling risk assessment. There is room in the assessment for comments and initial ideas for control measures, and control options are provided to help the user.

  The action plan helps the user to prioritise control measures to implement, responsibilities, and dates for implementation and re-evaluation.





Examples of the upper limb full risk assessment criteria

ACTION PLAN

Worksheet reference	Controls to be implemented	Priority	Who is responsible for implementing controls?	Target implementation date	Date of re-evaluation

Example of the upper limb risk assessment action plan

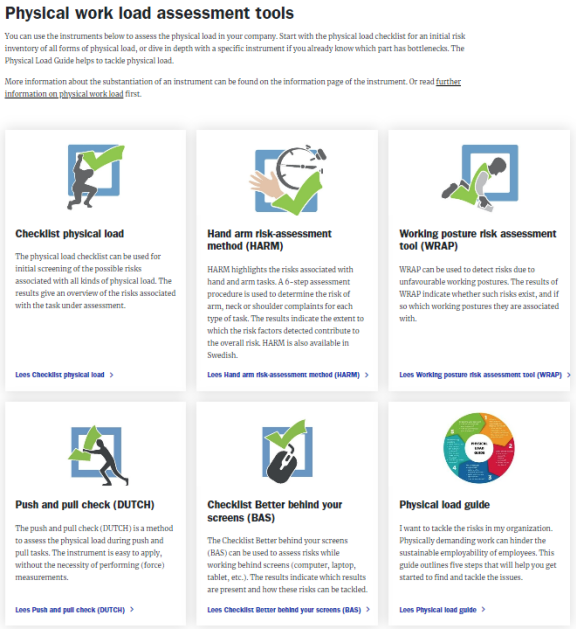
TNO tools (Netherlands)

The tools offered by TNO (TNO, 2022) are like those offered by the HSE:

- they are free, easily accessible, and reasonably intuitive to use, all following a step-by-step approach
- the pictures of various postures are helpful to make observation-based assessments for the user
- the range of tools cover specific activities (WRAP, DUTCH, HARM), except there is no clearly defined 'manual handling' tool, instead users are advised to use the NIOSH lifting equation (lifting) and KIM-LHC for carrying
- other tools such as computer workstation assessments are available.

Using the tools allows users to:

- identify risks (of the tasks not individuals)
- prioritise areas for risk reduction (traffic light system), and
- offer solutions for risk reductions.



The physical workload assessment tools offered by TNO

There is no direct worker engagement during the assessment process unless the user follows the 'Physical load guide' where businesses are encouraged to involve workers in ideas for risk reduction solutions.

Potential downsides to the suite of tools are that:

- there is no specific 'manual handling' tool
- only physical risk factors are considered
- there is little, or no worker engagement or involvement during the process (but could be easy to incorporate)
- some of the translations haven't been made from Dutch to English
- it may be unclear what the results of the assessments mean.

CHECKLIST PHYSICAL LOAD

The Checklist Physical Load is a broad screening tool (TNO, 2022). It was developed to allow users to gain a quick insight into the possible physical-workload-related risks for a given task. It is an online 9-step checklist that provides an overview of the risks for each physical task. The table below shows the physical tasks covered in the checklist and if there is a risk to health the recommendations for a more detailed risk assessment is recommended.

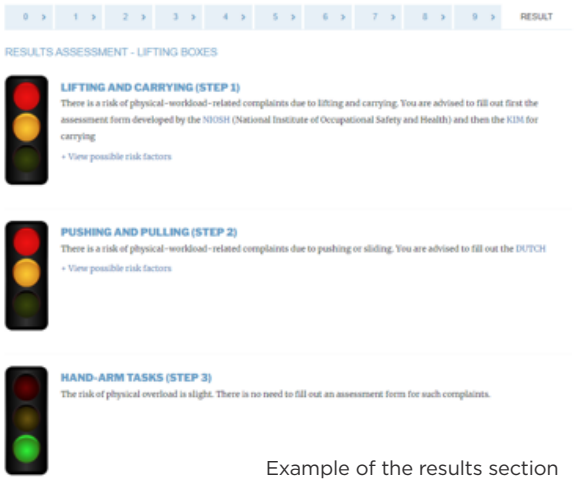
CHECKLIST PHYSICAL LOAD RISK FACTORS	RECOMMENDATIONS FOR DETAILED RISK ASSESSMENT
Lifting and carrying	NIOSH first assessment tool for lifting, and then KIM-LHC
Pushing and pulling	DUTCH
Hard-arm tasks	HARM
Working postures	WRAP
Computer-related work	BAS
Hand-arm vibration	Hand-arm vibration exposure calculator (HSE)
Whole body vibration	Whole body vibration calculator (HSE)
Energetic overload	No specific assessment identified
Energetic underload	No assessment identified but advice is provided
The existence of task-related complaints	Advice is to try and discover the cause of the complaints – no risk assessment identified

Summary of checklist physical load risk factors

The results are presented in a traffic light system with a brief outline about the level of risk:

- green – risk is slight, no need to perform a detailed risk assessment
- amber and red – there is a risk of health complaints, or physical-workload-related complaints (depending on what risk factor is being assessed). The advice is to complete a detailed risk assessment

The checklist was designed for Health and Safety Managers, Health and Safety Professionals and Officers (even in smaller businesses), directors, and ergonomists.



Example of the results section from the 'Checklist Physical Load'

WRAP – WORKING POSTURE RISK ASSESSMENT TOOL

The Working Posture Risk Assessment (WRAP) tool can be used to determine the risk of developing WRMSDs due to unfavourable working postures. Insights can be made into:

- health risks due to unfavourable postures
- identifying high-risk postures.

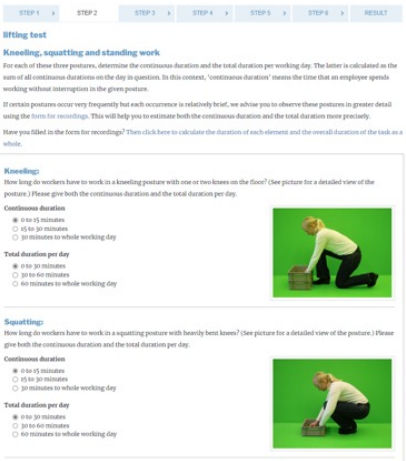
WRAP is considered a first step towards risk reduction and prevention for tasks, not individuals. It is a 6-step assessment and uses the traffic light system to identify at risk activities. Unlike the Checklist Physical Load screening tool there are different categories for amber and red:

- green – the task is not considered to pose a risk of complaints affecting muscles, ligaments, bones, or joints in the majority of employees
- amber – the task poses a risk of symptoms affecting muscles, ligaments, bones, or joints in the majority of employees
- red – the task poses a significant risk of complaints affecting muscles, ligaments, bones, or joints in most employees.

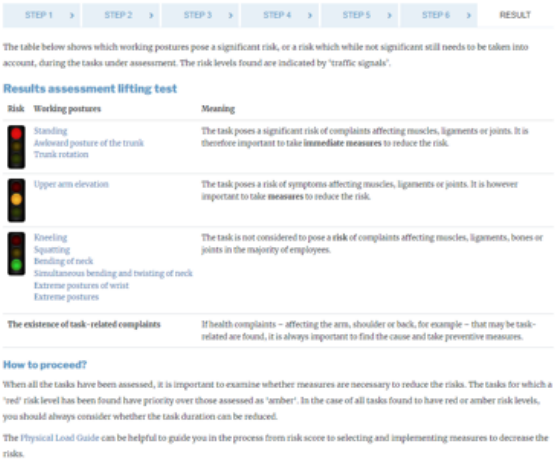
If 'red' risk levels have been identified these should be addressed first before 'amber' factors. Following this assessment, the Physical Load Guide can be used to guide users to select and implement control measures to reduce risk.

The WRAP tool is unvalidated but is based on scientific knowledge concerning high-risk working postures and expert opinion.

Assessment criteria example



Summary from the risk assessment



Examples from the WRAP tool

DUTCH – PUSH PULL TOOL

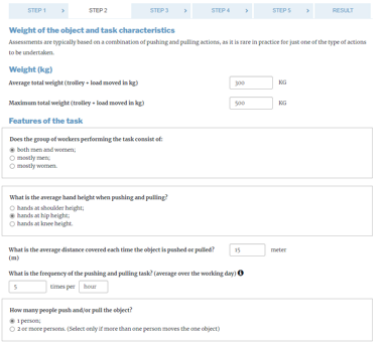
DUTCH is a simple push/pull risk assessment method used to determine the likelihood of injury, without the need to take force measurements. Using DUTCH, you can check:

- if pushing or pulling tasks are likely to lead to musculoskeletal complaints
- which risk factors contribute to the risk of musculoskeletal complaints. This information can then be used to identify steps for risk reduction.

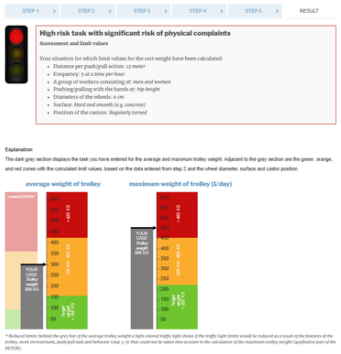
This is a 5-step tool that assesses the task and not individuals and requires some information on load weights moved prior to the assessment. It uses the traffic light system (as outlined in WRAP) to identify the overall level of risk for the task and provides more detailed information on the high-risk areas that were identified. The assessment provides recommendations for risk reduction.

The DUTCH tool is based on scientific evidence from the literature on the most important risk factors associated with pushing and pulling (shoulder complaints), supplemented with experts' judgements. Based on a validation study the method was improved in September 2019.

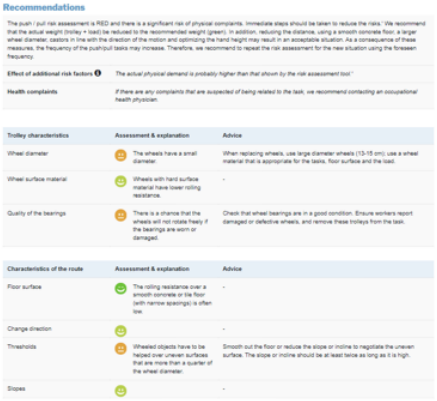
Assessment criteria example



Summary from the risk assessment



Example of recommendations provided



Example of the DUTCH tool

HARM – HAND ARM RISK-ASSESSMENT METHOD

The Hand Arm Risk Assessment (HARM) tool is a 6-step risk assessment designed to determine the risk of arm, neck, or shoulder complaints when performing tasks that mainly use the upper limbs (hands or arms). This method will help to:

- gain insights into what health risks the work might entail
- identify the most important risk factors associated with the work
- determine which intervention measures are likely to have the most benefit (to reduce risk of injury).

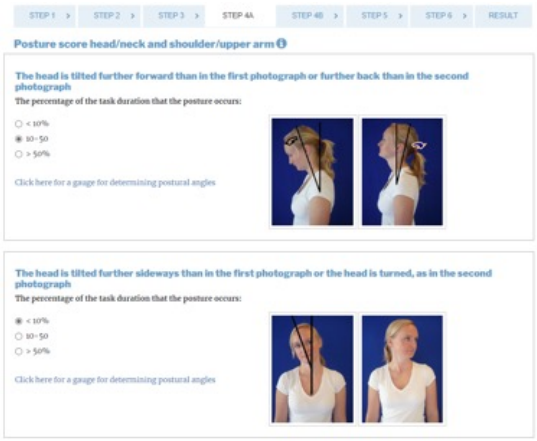
The results provide a 'total risk score' and the traffic light system is based on the values of the score:

- green – <30 = no risk of arm, neck, or shoulder complaints
- amber – 30–50 = increased risk of arm, neck, or shoulder complaints for some employees. To protect all employees, preventative measures to lower the risk should be taken
- red – >50 = high risk of arm, neck, and shoulder complaints. Preventative measures should be taken immediately.

The results are then broken down into each of the six risk areas and shows the risk scores for each. The higher the score meaning the greater contribution of that risk factor. These scores help the user to prioritise possible intervention measures. Additional support is provided in the 'Physical Load Guide'.

The HARM tool is validated and is based on knowledge of risk factors reported in the literature and supplemented by expert opinion.

Assessment criteria example



Summary from the risk assessment

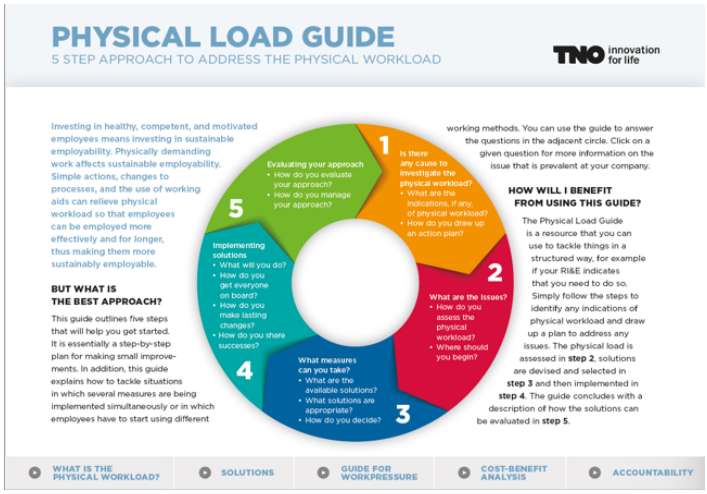
Examples from the HARM tool

PHYSICAL LOAD GUIDE

The 'Physical Load Guide' is a 5-step approach that can help employers to tackle the physical workload risk reduction strategies in a structured way. The five stages are:

1. **Is there any cause to investigate the physical workload?** For example, what are the indications and how to draw up and action plan?
2. **What are the issues?** For example how do you assess physical workload and where to begin?
3. **What measures can you take?** For example, what solutions are available, appropriate, and how do you decide?
4. **Implementing solutions.** For example, what will you do, how do you get everyone on board and make long-lasting changes, and share success?
5. **Evaluating your approach.** For example, how to evaluate and manage the approach?

By following this approach employers can better understand the risk assessments and how to implement changes to reduce the risk of WRMSDs. The guide also offers advice on how to calculate the cost-benefit of interventions. It encourages a participative approach so that workers are involved in developing solutions, alongside designers, managers, and other relevant people.



Five stages in the 'Physical Load Guide'

BAuA tools (Germany)

There are 6 different types of Key Indicator Method (KIM) tools that BAuA consider to be screening tools (BAuA, 2022). These can be used to assess physical workloads that cover a wide range of hazardous manual tasks:

- manual lifting, holding, and carrying of loads (KIM-LHC)
- manual pushing and pulling of loads (KIM-PP)
- manual handling operations (KIM-MHO – assesses upper limb tasks)
- whole-body forces (KIM-BF)
- awkward body postures (KIM-ABP)
- body movement (KIM-BM).

The various tools have undergone comprehensive investigation of the criteria, they have been tested by many businesses and have been 'approved' for use. There are also more advanced extension tools, labelled KIM-E that have more complex algorithms that are applied for the "interpolation of rating points and the aggregation of the results of the risk assessment" (BAuA, 2022). The results have been published but the report is written in German.

Interactive forms with integrated calculations are available but currently only in German. The website mentions a screening tool that should be used first to understand if there is physical workload to be assessed in the workplace, however this is only offered in German.

The tools are designed for workplace practitioners such as managers, those responsible for work design, employee representatives, occupational health and safety specialists, and company doctors.

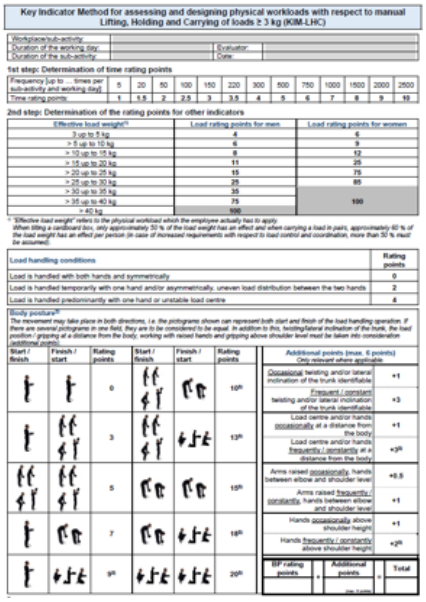
KIM-LHC – KEY INDICATOR METHOD-LIFTING HOLDING CARRYING

This 4-step tool is used to assess loads that are handled or carried and weigh more than 3kg. Loads can be objects, people, or animals. Typical activities include loading activities, palletising good, childcare in preschools, and transporting patients.

It is important to make sure that the correct tool is selected depending on the task. For example, if the load is changed then KIM-BF or KIM-MHO might need to be considered instead of KIM-LHC. If the load is carried over distances longer than 10m then KIM-BM should also be considered.

The evaluation and assessment record (Step 3) is the same for all the KIM tools.

Example of Step 1 and 2


Key Indicator Method for assessing and designing physical workloads with respect to manual Lifting, Holding and Carrying of loads ≥ 3 kg (KIM-LHC)

Workplace/sub-activity:
Duration of the working day:
Duration of the sub-activity:
Evaluator:
Date:

1st step: Determination of time rating points

Frequency [up to ... times per sub-activity and working day]	5	20	50	100	150	220	300	500	750	1000	1500	2000	2500
Time rating points	1	1.5	2	2.5	3	3.5	4	5	6	7	8	9	10

2nd step: Determination of the rating points for other indicators

Effective load weight*	Load rating points for men	Load rating points for women
3 up to 5 kg	4	6
> 5 up to 10 kg	6	9
> 10 up to 15 kg	8	12
> 15 up to 20 kg	11	25
> 20 up to 25 kg	15	75
> 25 up to 30 kg	25	85
> 30 up to 35 kg	35	100
> 35 up to 40 kg	75	
> 40 kg	100	

* "Effective load weight" refers to the physical workload which the employee actually has to apply. When lifting a cardboard box, only approximately 50 % of the load weight has an effect and when carrying a load in pairs, approximately 60 % of the load weight has an effect per person (in case of increased requirements with respect to load control and coordination, more than 50 % must be assumed).

Load handling conditions	Rating points
Load is handled with both hands and symmetrically	0
Load is handled temporarily with one hand and/or asymmetrically, uneven load distribution between the two hands	2
Load is handled predominantly with one hand or unstable load centre	4

Body posture*

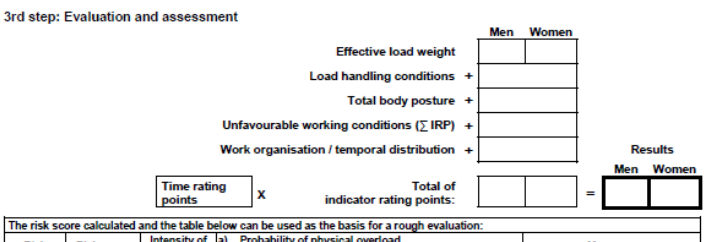
The movement may take place in both directions, i.e. the pictograms shown can represent both start and finish of the load handling operation. If there are several pictograms in one field, they are to be considered to be equal. In addition to this, twisting/lateral inclination of the trunk, the load position / gripping at a distance from the body, working with raised hands and gripping above shoulder level must be taken into consideration (additional points).

Start / finish	Finish / start	Rating points	Start / finish	Finish / start	Rating points
		0			10*
		3			13*
		5			15*
		7			18*
		9*			20*

Additional points (max. 6 points) Only relevant where applicable	
Occasional twisting and/or lateral inclination of the trunk identifiable	+1
Frequent / constant twisting and/or lateral inclination of the trunk identifiable	+3
Load centre and/or hands occasionally at a distance from the body	+1
Load centre and/or hands frequently / constantly at a distance from the body	+3*
Arms raised occasionally, hands between elbow and shoulder level	+0.5
Arms raised frequently / constantly, hands between elbow and shoulder level	+1
Hands occasionally above shoulder height	+1
Hands frequently / constantly above shoulder height	+2*

IRP rating points	+	Additional points	=	Total

Example of Step 3, Evaluation and assessment


3rd step: Evaluation and assessment

	Men	Women
Effective load weight		
Load handling conditions +		
Total body posture +		
Unfavourable working conditions (∑ IRP) +		
Work organisation / temporal distribution +		

Time rating points x Total of indicator rating points: = Results (Men / Women)

The risk score calculated and the table below can be used as the basis for a rough evaluation:

Risk		Risk range	Intensity of load[1]		Probability of physical overload / Possible health consequences	Measures
	1	< 20 points	low	a) b)	Physical overload is unlikely. No health risk is to be expected.	None
	2	20 - < 50 points	slightly increased	a) b)	Physical overload is possible for less resilient persons. Fatigue, low-grade adaptation problems which can be compensated for during leisure time	For less resilient persons, workplace redesign and other prevention measures may be helpful.
	3	50 - < 100 points	substantially increased	a) b)	Physical overload is also possible for normally resilient persons. Disorders (pain), possibly including dysfunctions, reversible in most cases, without morphological manifestation	Workplace redesign and other prevention measures should be considered.
	4	≥ 100 points	high	a) b)	Physical overload is likely. More pronounced disorders and/or dysfunctions, structural damage with pathological significance	Workplace redesign measures are necessary. Other prevention measures should be considered.

KIM-LHC assessment examples

KIM-PP – KEY INDICATOR METHOD-PUSH PULL

KIM-PP can be used to assess physical workloads resulting from moving transport devices (for example, wheelbarrows, trolleys), overhead conveyors or overhead cranes. There are several exceptions for when this tool should not be used. For example, if the load is pushed or pulled without using equipment, then KIM-BF should be used. KIM-BM and KIM-BF should be considered if the equipment has mechanical drives, such as stair climbing equipment.

KIM-PP-E should be used if there are several push/pull sub-activities during the workday and they must be recorded and assessed separately. The probability of physical overload can only be assessed if all physical workloads occur during the working day are assessed.

1st step: Determination of time rating points (distance, duration of the PP)

Distance[1] up to ...m[2]	40	200	400	800	1200	1800	2500	4200	6300	8400	11000	15000	20000
Duration[1] up to ...min[2]	≤ 1	≤ 5	≤ 10	≤ 20	≤ 30	≤ 45	≤ 60	≤ 100	≤ 150	≤ 210	≤ 270	≤ 360	≤ 480
Time rating points	1	1.5	2	2.5	3	3.5	4	5	6	7	8	9	10

[1] *An approximate walking speed of 0.7 m/s (2.5 km/h) when pushing and pulling loads is assumed.* [2] *Per sub-activity and working day.*

2nd step: Determination of the rating points for other indicators

Load weight to be moved including transport device [kg]	Transport device: Barrows[3] [4]			Carriages: only swivel castors		Carriages: with fixed castors or lockable swivel castors		Carriages: pedestrian-controlled	Overhead conveyors	Overhead cranes
up to 50	3	2	2.5	2.5	3	1	1	1	1	2
> 50 up to 100	5	3	4	3	4	1	1	1	1	2.5
> 100 up to 200	10	6	7	4	6	2	1.5	1.5	1.5	3.5
> 200 up to 300	50	12	50	5	8	3	2	2	2	4.5
> 300 up to 400		50		7	12	4	3	2.5	2.5	6
> 400 up to 600				12	50	6	5	4	4	10
> 600 up to 800				50		10	8	7	7	15
> 800 up to 1000	100	100	100		100	15	12	10	10	50
> 1000 up to 1300				100		50	50	50	20	100
> 1300						100	100	100	50	

Driveway conditions

Driveway conditions			Rating points:		Carriages
Driveway completely level, smooth, solid, dry, without inclinations			0	0	0
Driveway mostly smooth and level, with small damaged spots/faults, without inclinations			0	0	1
Mixture of cobbles, concrete, asphalt, slight inclinations[6], dropped kerb			0	1	2
Mixture of roughly cobbled, hard sand, slight inclinations[6], small edges/sills			1	2	3
Earth or roughly cobbled driveway, potholes, heavy soiling, slight inclinations, landings, sills			3	5	6
Additional points in case of significant inclinations or stairs	Inclinations of 2 up to 4° (4 up to 8%)	5	Rating points + additional points Total		
	Inclinations of 5 up to 10° (9 up to 18%)	10			
	Stairs[7], inclinations > 10° (18%)	25			

[6] *Slight inclination: up to 2° (4%)* [7] *only for using stair climbing carts*

Driveway conditions

Driveway conditions			Rating points:		Carriages
Driveway completely level, smooth, solid, dry, without inclinations			0	0	0
Driveway mostly smooth and level, with small damaged spots/faults, without inclinations			0	0	1
Mixture of cobbles, concrete, asphalt, slight inclinations[6], dropped kerb			0	1	2
Mixture of roughly cobbled, hard sand, slight inclinations[6], small edges/sills			1	2	3
Earth or roughly cobbled driveway, potholes, heavy soiling, slight inclinations, landings, sills			3	5	6
Additional points in case of significant inclinations or stairs	Inclinations of 2 up to 4° (4 up to 8%)	5	Rating points + additional points Total		
	Inclinations of 5 up to 10° (9 up to 18%)	10			
	Stairs[7], inclinations > 10° (18%)	25			

[6] *Slight inclination: up to 2° (4%)* [7] *only for using stair climbing carts*

Examples of Step 2 from KIM-PP

KIM-MHO – KEY INDICATOR METHOD-MANUAL HANDLING OPERATIONS

The Key Indicator Method-Manual Handling Operations (KIM-MHO) should be used to assess physical work that involves repetitive motion and force exerted by the upper extremities. For example, when using instruments, small tools, or on assembly lines. The tasks usually involve sitting or standing while largely stationary.

As with the other tools users must carefully select that this is the right tool for the task they are assessing. For example, if loads are greater than 3kg then KIM-LHC should be used.

One of the concerns with the name of this tool is that users might assume this assesses 'manual handling tasks' instead of assessing upper limb tasks. This could be confusing as most jurisdictions use the term manual handling to describe tasks involving lifting, carrying, pushing, or pulling. For lifting, holding, or carrying tasks the KIM-LHC should be used.

2nd step: Determination of the rating points for other indicators

Type of force exertion in the finger/hand area within a "standard minute"		Holding[1] average holding time [sec. per minute]			Moving average movement frequencies [number per minute]				
		31-60	16-30	≤ 15	< 5	5-15	16-30	31-60	61-90
Level	Description, typical examples	Rating points			Rating points				
low	**Very low / low forces** (up to 15% $F_{max}M$) e.g. button actuation / shifting / ordering / material guidance / insertion of small parts	5.5	3	1.5	0.5	1	2.5	5	7
	Moderate forces (up to 30% $F_{max}M$) e.g. gripping / joining small work pieces by hand or with small tools	9	4.5	2.5	0.5	2	4	7.5	11
	High forces (up to 50% $F_{max}M$) e.g. turning / winding / packaging / grasping / holding or joining parts / pressing in / cutting / working with small powered hand tools	14	7	3.5	1	3	6	12	18
	Very high forces (up to 80% $F_{max}M$) e.g. cutting involving major element of force / working with small staple guns / moving or holding parts or tools	22	11	5.5	1.5	5	10	19	
	Peak forces[2] (more than 80% $F_{max}M$) e.g. tightening, loosening bolts / separating / pressing in	100		35	8	30	100		
high	**Powerful hitting**[3] with ball of the thumb, palm of the hand or fist				8	30			
The work cycle must be observed and the rating points for the force categories marked. Added (left and right hands separately), these produce the force rating point. To calculate the total score (step 3), the higher value must be used.		Rating points of force exertion:			Left hand		Right hand		

Hand/arm position and movement[4]	
	Good: position or movements of joints in the middle (relaxed) range, only rare deviations / no continuous static arm posture / hand-arm rest possible as required
	Restricted: occasional positions or movements of the joints at the limit of the movement ranges / occasional long continuous static arm posture
	Unfavourable: frequent positions or movements of the joints at the limit of the movement ranges / frequent long continuous static arm posture
	Poor: constant positions or movements of the joints at the limit of the movement ranges / constant long continuous static arm posture

[4] *Typical positions are to be considered. Rare deviations can be ignored.*

Unfavourable working conditions (specify only where applicable)
Good: there are no unfavourable working conditions, i.e. reliable recognition of detail / no dazzle / good climatic conditions
Restricted: occasionally impaired detail recognition due to dazzle or excessively small details difficult conditions such as draught, cold, moisture and/or disturbed concentration due to noise
Unfavourable: frequently impaired detail recognition due to dazzle or excessively small details frequently difficult conditions such as draught, cold, moisture and/or disturbed concentration due to noise

Examples of Step 2 (KIM-MHO)

KIM-BF – KEY INDICATOR METHOD-BODY FORCES

The KIM whole body forces (KIM-BF) tool should be used when considerable forces are exerted. The force is usually applied through the hands but is transmitted via the shoulders, back, legs, and feet. Users are usually standing to complete the tasks due to high forces. A few examples of activities where KIM-BF would be used are working with levers or crowbars, installing windows, transferring patients, shovelling, and using pneumatic hammers.

Other tools may also need to be used in conjunction with this tool, for example if the task involves lifting, handling, or carrying then KIM-LHC should also be used to assess those aspects of the task. If several sub-activities occur, they must be assessed separately using the KIM-BF-E).

2nd step: Determination of the rating points for other indicators

Force exertion within a standard minute for continuous sub-activities and/or per sub-activity for discontinuous sub-activities		Holding[3] average holding time [seconds]			Moving average movement frequencies [number]			
Level	typical examples as classification aid for orientation purposes	31 - 45[3]	16 - 30	≤ 15	< 5	5 - 15	16 - 30	31 – 45[3]
low	**Low forces** Whole-Body Forces with low forces cannot occur by definition. Where applicable, these sub-activities must be assessed using the KIM-MHO.	-	-	-	-	-	-	-
	Moderate forces (up to 30 % F_{max}M) Work with hand-guided tools, such as angle grinders, small chainsaws, hedge trimmers or impact drills < 3 kg / moving loads on roller tracks < 20 kg	18	12	6	1.5	6	12	18
	High forces (up to 50 % F_{max}M) Work with heavy hand-guided tools, such as angle grinders, large chainsaws, hammer drills3-8 kg / operating high-pressure cleaners or sandblasters/shovelling loads < 4 kg / moving loads on roller tracks 20-50 kg / throwing loads < 3 kg up to max. 5 metres	25	17	8	2	8	17	25
	Very high forces (up to 80 % F_{max}M) Work with heavy hand-guided tools, such as pneumatic hammers (≥ 8 kg) / shovelling loads 4-8 kg / moving loads on roller tracks > 50-100 kg / throwing loads < 3 kg up to max. 10 metres or 3-5 kg max. 5 metres	100	32	15	4	15	32	100
high	**Peak forces**[4] (more than 80 % F_{max}M) Pulsed exertion of force such as when working with crowbars, sledgehammers / tipping heavy drums (> 200 kg), transporting heavy pieces of furniture / shovelling loads > 8 kg / moving loads on roller tracks > 100 kg / throwing loads < 3 kg more than 10 metres or ≥ 3 kg more than 5 metres	100		25	6	25	50	100
The sub-activity must be observed and the rating points for the force categories marked. The sum represents the total force rating point.		**Total force rating point:**						
		For women x 1.5:						

Body posture[6]		Rating points
	- Standing upright up to a position with the trunk being slightly inclined forward (< 20°) - No twisting	0
	- Standing, trunk being more severely inclined forward (20-60°) - Occasional twisting and/or lateral inclination of the trunk identifiable - - Hands occasionally above shoulder level / at a distance from the body	3
	- Standing, trunk being severely inclined forward (> 60°) or backward - Frequent twisting and/or lateral inclination of the trunk identifiable - Hands frequently above shoulder level / at a distance from the body - Work in a lying position with hands above/below the body	6
	- Combination of more severe forward or backward inclination and lateral inclination/torsion - Constant twisting and/or lateral inclination of the trunk identifiable - Work in a squatting or kneeling position - Hands constantly above shoulder level / at a distance from the body	9[7]

Examples of Step 2 assessment (KIM-BF)

KIM-ABP – KEY INDICATOR METHOD-AWKWARD BODY POSTURES

Awkward body postures are 'strenuous body postures which are required for the work process and held uninterrupted (one-time posture >1-minute, repeated posture >10 seconds)'. Awkward body postures can affect the lower and upper back, shoulders, upper arms, neck, knees joints, legs, and feet. Several body postures can be classified at the same time.

Typical activities where KIM-ABP could be used are tiling, steel fixing, ceiling mounting, working on assembly lines, and working with microscopes.

As with the other tools, careful selection is needed to make sure the right tool is used for the task. The KIM-ABP-E should be used when there are several sub-activities carried out throughout the day.

2nd step: Determination of the rating points for other indicators

A		Loads on the back – body posture when working without or with low force exertion		Amount of time as part of the sub-activity: up to 1/4 occasionally	up to 1/2 frequently	up to 3/4 predominantly	> 3/4 constantly	Points
	1	**Upright back posture** in a standing, squatting or kneeling position[1], also interrupted by walking a few steps or by body movements (trunk can be inclined forward up to 20°) e.g. sales personnel, machine operators		2	4	6	8	
	2	**Torso being moderately inclined forward** (> 20-60°) in a standing, squatting or kneeling position[1] or inclined backward e.g. sorting conveyors for baked goods		7	15	22	30	
	3	**Torso being severely inclined forward** (> 60°) in a standing, squatting or kneeling position[1] - e.g. steel fixers		10	20	30	40	
	4	**Sitting in forced postures**, torso being moderately to severely inclined forward, mostly looking permanently towards the work area - e.g. working at a microscope, driving cranes, endoscopy (medicine), also sitting on the floor		3	6	9	12	
	5	**Sitting in a variable sitting posture** e.g. office work (administration)	**Alternation to standing / walking is** not possible	2	4	6	8	
			possible	0.5	1	1.5	2	
[1] Please note: For hand/arm postures, also complete Part B where applicable! If the work is carried out in a squatting and kneeling position, Part C is also to be completed!								
				Total of risk scores	A	**Back:**		

B		Loads on shoulders and upper arms when working without or with low force exertion[2]	Amount of time as part of the sub-activity: up to 1/4	up to 1/2	up to 3/4	> 3/4	Points
	1	**Arms raised, hands above shoulder level** in a standing, squatting or kneeling position e.g. dry construction, interior design, electrical installation, installation of ventilations systems, skilled manual assembly work, servicing	10	20	30	40	
	2	**Arms raised, hands below shoulder level or at a distance from the body** in a standing, squatting or kneeling position without the arms being supported, e.g. sorting activities at sorting conveyors	6	12	18	24	
	3	**Lying on the back, arms over head**, e.g. ceiling painting, assembly work, ship's bottom, tank construction **Lying prone, arms in front of / below the body**, e.g. harvesting equipment ("flyers"), assembly work	7	14	21	28	
Remaining time		Portion of the assessment period **without posture loads of the shoulders/arms**	0	0	0	0	
[2] Please note: If there are physical workloads of the hand/arm system, this sub-activity should also be evaluated using the KIM-MHO.							
		Total of risk scores	B	**Shoulders and upper arms:**			

Examples of Step 2 KIM-ABP

KIM-BM – KEY INDICATOR METHOD-BODY MOVEMENT

The KIM Body Movement (KIM-BM) tool should be used to assess physical workload concerns and body movements to a place of work or in a work area. Typical activities where KIM-BM would be used are transporting furniture without handling aids, transporting patients, walking on construction sites, and maintenance tasks on equipment.

If the sub-activities have increased forces, then KIM-BF, KIM-LHC, or KIM-PP must also be considered. KIM-BM-E must also be used if there are several different sub-activities per working day and these must be recorded and assessed separately.

2nd step: Determination of the rating points for other indicators

A Body Movement without using equipment

Type	Description		Carried load: without / < 3 kg	3 ... 10 kg	> 10 ... 15 kg	> 15 ... 20 kg	> 20 ... 25 kg	> 25 ... 30 kg	> 30 ... 35 kg	> 35 ... 40 kg	> 40 kg
	Walking	Slowly	4	6	8	10	12	14	25	35	100 [1]
		At a moderate pace (3 ... 5 km/h)	8	10	12	14	16	18	30	40	
		Quickly	12	14	16	18	20	22	35	50	
	Climbing	Angle of inclination < 5°	10	12	14	16	18	20	35	50	
		Angle of inclination 5 - 15°	12	14	16	18	20	22	35	50	
		Angle of inclination > 15°	24	26	28	30	32	34	40	50	
	Climbing stairs	Normal stairs	18	20	22	24	26	50	100 [1]		
		Steep stairs (35 ... 50°)	24	26	28	30	50	100 [1]			
		Very steep stairs (> 50°)	30	32	34	50	100 [1]				
	Climbing ladders Angle of inclination 65 ... 75°		24	26	50	100 [1]					
	Climbing Angle of inclination > 80° Vertical movement on step irons, vertical ladders, manhole ladders		30	32	50	100 [1]					
	Crawling[2], walking with a severe stoop Predominantly horizontal movement in low-ceiling rooms, tunnels, maintenance platforms, channels		24	26	50	100 [1]					

[1] *This combination of type of movement and transport of loads leads to an increased risk even with short exposure times.*
[2] *For this type of movement, the sub-activity must also be evaluated using the KIM-ABP Part C.*

Location of the load centre for A	Carried load: 3 up to 15 kg	> 15 ... 30 kg	> 30 kg
No load or load < 3 kg or load is close to the body in a carrying frame or backpack on the shoulders	0		
Load close to the body, held in the hands or carried on one shoulder	4	8	12
Load at a distance from the body, held in the hands [3]	8	12	16

Trunk posture for A		Carried load: 0 up to 15 kg	> 15 ... 30 kg	> 30 kg
Trunk clearly inclined forward and/or twisting and/or lateral inclination of the trunk identifiable	Occasionally	2	4	6
	Frequently to constantly [3]	4	6	8

[3] *Please note: If unfavourable arm or trunk postures occur frequently to constantly, the sub-activity must also be evaluated using the KIM-LHC (for load ≥ 3 kg) or the KIM-ABP (no load or load < 3 kg).*

Unfavourable working conditions for A (Specify only where applicable. Indicators not mentioned in the tables are to be taken into account accordingly. Rare deviations can be ignored.)	Rating points
Restricted: narrow space for movement (e.g. fall protection by means of safety cage) / reduced stability due to movable or inclined standing surface / **sand / gravel path**	3
Severely restricted: freedom of movement hindered / no technical climbing aids (natural conditions) / **open country**	5
Critical: freedom of movement severely hindered due to confined spaces and danger points / restricted view / no resting platforms / mountaineering / respiratory protective equipment / **muddy ground**	15
Climate: extreme climatic influences, such as heat, wind, snow (graded as rarely/occasionally and frequently/constantly)	4 8
Total of "Restricted", "Severely restricted" or "Critical" and "Climate" (if applicable)	

Examples of Step 2 KIM-BM

KTH Tools (Sweden)

RAMP is a tool that was developed to support the assessment and management of WRMSD risks in manual handling jobs (KTH, 2022). It is research based and consists of four modules that use Microsoft Excel™:

- RAMP I: Checklist based screening tool
- RAMP II: Allows for a more in-depth analysis
- Results: presents, visualises, and communicates the results (for example, x number of 'red' or high-risk factors, x number of 'grey' factors meaning to investigate further, and x number of 'green' low risk factors assessed)
- Action: supports the development of risk reducing measures and systematic risk management.

RAMP I – RISK ASSESSMENT AND MANAGEMENT TOOL FOR MANUAL HANDLING PROACTIVELY

RAMP I is a Microsoft Excel™ checklist for screening physical risks for manual handling. It is a tick box document with room for additional comments. It mainly covers physical risks but there are questions on work organisational and psychosocial risk factors. Users are also encouraged to 'ask five people' about their levels of discomfort when performing a work task.

RAMP I includes the 'Results' and 'Action' modules. The 'results' section helps the user understand the results from the tick-box exercise by summarising the results into green/low risk, grey/investigate further, and red/high risk. Using the colour coded system means it is easy to see which risk factors should be prioritised for further investigation.

The 'Action' module provides suggestions for risk reduction, starting with elimination of the risk where possible. 'RAMP's action model' provides an overview of how changes can be achieved within a company in five key areas:

- organisation
- technology and design
- employees
- vision and strategies
- environment.

There is also an 'Action plan' which transfers the scores from the checklist into the template. This summarises on one sheet for all risk factors the colour-coded assessment with space for comments, planned actions, responsibilities, and dates.

	A	B	C	D	E
1		**RAMP I - Checklist for screening physical risks for manual handling**			
2		Note! Write an "x" (small x) in each " Yes" or "No" statement box under each question.	**Yes**	**No**	**Comment:**
3	**1. Postures**				Write your comments, if any, in the white fields below:
4	1.1 Does work occur often or for a long time* in any of the following unfavourable postures?				
5		** often = about 100 times per work day or more*			
6		** a long time = about 30 minutes per work day or more*			
7		head bent backwards		x	
8		back/upper body bent or twisted - forwards, backwards or towards the side	x		
9		arm almost or fully stretched forwards (the hand more than about 45 cm from the spine)		x	
10		hand above shoulder height or below knee height	x		
11		hand/arm brought outwards to the side (to the right or to the left)	x		
12	1.2 Does work occur in any of the following unfavourable postures about 1 hour per work day				
13	or more?				
14		head clearly twisted or bent - forwards or towards a side			
15		hand clearly bent upwards, downwards or towards a side			
16		legs or feet have insufficient space, or the surface is unstable or with a slope	x		
17	**2. Work movements and repetitive work**		**Yes**	**No**	
18	2.1 Does work occur in any of the following ways?				
19		the work cycle is shorter than 30 seconds	x		
20		the work cycle is between 30 seconds and 5 minutes			
21		similar work movements are repeated more than 1/10 up to half of the work cycle time			
22		similar work movements are repeated more than half of the work cycle time	x		
23	**If "No" on all in 2.1, go to 3. If "Yes" on any in 2.1, answer 2.2 below.**				
24	2.2 How long time of the working day does such work occur? Choose one alternative.				
25		the work or similar work tasks are carried out between 1 and 4 hours of the work day			
26		the work or similar work tasks are carried out for more than 4 hours of the work day			
27	**3. Lifting work**		**Yes**	**No**	
28	3.1 Does lifting of loads occur? If "No", go to 4.		x		
29	3.2 How heavy are the loads and how often are they lifted?				
30		less than 3 kg			
31		- more than 100 times per work day			
32		3-7 kg			
33		- more than 40 times per work day			
34		more than 7 kg - 14 kg			
35		- more than 20 times per work day			
36		more than 14 kg - 25 kg			
37		- more than 5 times per work day			
38		more than 25 kg	x		
39	3.3 Do the lifts generally occur in any of the following unfavourable postures?				
40		back/upper body clearly bent			

Example of the RAMP I screening checklist

99	**Results summary:**	
100	**Number of red assessments (high risk)**	**2**
101	**Number of grey assessments (investigate further)**	**15**
102	**Number of green assessments (low risk)**	**3**

Example of the RAMP I 'Results' tab

	A	B	C	D	E	F	G	H	I
1	**Action plan based on RAMP I assessment.** Note that for the risk factors assessed as grey, further investigation is needed to assess the risk level and form suggested actions.								
2	**Date of assessment:**			**Work/Employee load:**		**Department:**			
3	**Work/Work task:**			**Site:**		**Country:**			
4	**Ordered by:**		**Formed by:**		**Date (Action plan):**	**Note:**			
5	**Risk factor**		**Assessment**	**User comments**	**Planned actions**	**When**	**By whom**	**Ready (date)**	**Follow-up**
6	**1. Postures**								
7	**1.1 Does work occur often or for a long time?**								
8	a. Head bent backwards								
9	b. Back/upper body bent or twisted - forwards, backwards or towards the side								
10	c. Arm almost or fully stretched forwards								
11	d. Hand above shoulder height or below knee height								
12	e. Hand/arm brought outwards to the side (to the right or to the left)								
13	**1.2 Work in unfavourable postures about 1 hour or more?**								
14	a. Head clearly twisted or bent - forwards or towards a side								
15	b. Hand clearly bent upwards, downwards or towards a side								
16	c. Legs or feet have insufficient space, or the surface is unstable or with a slope								
17	**2. Work movements and repetitive work**								
18	2.1 & 2.2 Work movements and repetitive work?								
19	**3. Lifting work**								
20	**3.1 Does lifting of loads occur?**								
21	**3.2. How heavy are the loads and how often are they lifted?**								
22	a. Less than 3 kg more than 100 times per work day								
23	b. 3-7 kg more than 40 times per work day								
24	c. More than 7 kg -14 kg more than 20 times per work day								
25	d. More than 14 kg -25 kg more than 5 times per work day								
26	e. More than 25 kg								

Example of the RAMP I 'Action Plan'

RAMP II – RISK ASSESSMENT AND MANAGEMENT TOOL FOR MANUAL HANDLING PROACTIVELY

RAMP II is a more detailed assessment tool that can be used for more in-depth assessment of physical risk factors associated with manual handling and associated with an increased risk of WRMSDs. RAMP II uses the same Microsoft Excel™ format as RAMP I, but each factor has its own separate sheet which investigates each of the 7 factors assessed in greater detail:

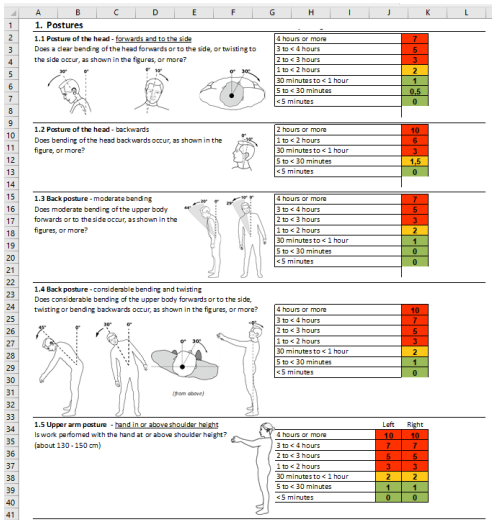
- postures
- work movements and repetitive work
- lifting work
- pushing and pulling work
- influencing factors
- reports on strenuous work
- perceived physical discomfort.

RAMP II mainly focuses on physical risk factors but includes four questions on psychosocial risk factors that are scored.

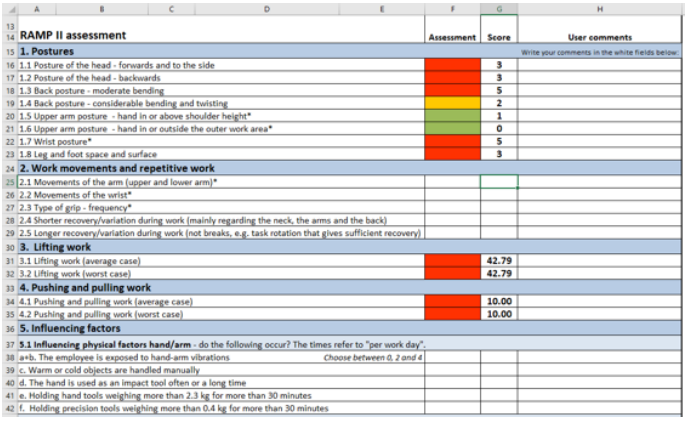
RAMP II includes the 'Results' and 'Action' modules, which support prioritisation and development of risk reduction measures. There is a slight change from RAMP I where the results are colour-coded as 'green'/low risk, 'yellow'/risk, 'red'/high risk. Depending on how the risks are scored suggestions for risk reduction are automatically populated on the 'Action Suggestions' tab.

The ‘Action plan’ is the same as RAMP I which provides an opportunity for the results to be summarised and a plan can be made for risk reduction interventions. This format supports a structured risk management approach for businesses.

Example of some questions in the ‘posture’ section of RAMP II



Example of the ‘Results’ section in RAMP II



RAMP II assessment	Assessment	Score	User comments
1. Postures			Write your comments in the white fields below
1.1 Posture of the head - forwards and to the side		3	
1.2 Posture of the head - backwards		3	
1.3 Back posture - moderate bending		5	
1.4 Back posture - considerable bending and twisting		2	
1.5 Upper arm posture - hand in or above shoulder height*		1	
1.6 Upper arm posture - hand in or outside the outer work area*		0	
1.7 Wrist posture*		5	
1.8 Leg and foot space and surface		3	
2. Work movements and repetitive work			
2.1 Movements of the arm (upper and lower arm)*			
2.2 Movements of the wrist*			
2.3 Type of grip - frequency*			
2.4 Shorter recovery/variation during work (mainly regarding the neck, the arms and the back)			
2.5 Longer recovery/variation during work (not breaks, e.g. task rotation that gives sufficient recovery)			
3. Lifting work			
3.1 Lifting work (average case)		42.79	
3.2 Lifting work (worst case)		42.79	
4. Pushing and pulling work			
4.1 Pushing and pulling work (average case)		10.00	
4.2 Pushing and pulling work (worst case)		10.00	
5. Influencing factors			
5.1 Influencing physical factors hand/arm - do the following occur? The times refer to "per work day".			
a+b. The employee is exposed to hand-arm vibrations *Choose between 0, 2 and 4*			
c. Warm or cold objects are handled manually			
d. The hand is used as an impact tool often or a long time			
e. Holding hand tools weighing more than 2.3 kg for more than 30 minutes			
f. Holding precision tools weighing more than 0.4 kg for more than 30 minutes			

Results summary:	
Total risk score	127.57
Number of red assessments (high risk)	9
Number of yellow assessments (risk)	1
Number of green assessments (low risk)	2

Examples of layout of assessment and results section (RAMP II)

Action plan based on RAMP II assessment

Date of assessment:			Work/Employee load:			Department:			
Work/Work task:			Site:			Country:			
Ordered by:	Formed by:			Date of action plan:		Note:			
Risk factor	**Assessment**	**Score**	**User comments**	**Planned actions**	**When**	**By whom**	**Ready (date)**	**Follow-up**
1. Postures								
1.1 Posture of the head - forwards and to the side		3						
1.2 Posture of the head - backwards		3						
1.3 Back posture - moderate bending		5						
1.4 Back posture - considerable bending and twisting		2						
1.5 Upper arm posture - hand in or above shoulder height*		1						
1.6 Upper arm posture - hand in or outside the outer work area*		0						
1.7 Wrist posture*		5						
1.8 Leg and foot space and surface		3						
2. Work movements and repetitive work								
2.1 Movements of the arm (upper and lower arm)*								
2.2 Movements of the wrist*								
2.3 Type of grip - frequency*								
2.4 Shorter recovery/variation during work								
2.5 Longer recovery/variation during work								
3. Lifting work								
3.1 Lifting work (average case)		42.786						
3.2 Lifting work (worst case)		42.786						
4. Pushing and pulling work								
4.1 Pushing and pulling work (average case)		10						
4.2 Pushing and pulling work (worst case)		10						
5. Influencing factors								
5.1 Influencing physical factors hand/arm								
a+b. Hand-arm vibrations								
c. Warm or cold objects are handled manually								
d. The hand is used as an impact tool often or a long time								
e. Holding hand tools weighing more than 2.3 kg for more than 30 minutes								
f. Holding precision tools weighing more than 0.4 kg for more than 30 minutes								

Example of the ‘Action Plan’ template (RAMP II)

QEC – Quick Exposure Check (United Kingdom)

QEC front page

The Quick Exposure Check (QEC) was developed by the University of Surrey for the HSE (UK) (David *et al*., 2005; David *et al*., 2008). QEC was designed as an observation-based tool for Occupational Safety and Health (OSH) practitioners to:

- assess changes in exposure to MSD risk factors of the back, shoulders and arms, hands and wrists, and neck before and after an ergonomic intervention
- involve the user completing the assessment in collaboration with workers who understand the task being assessed
- indicate changes in exposure scores following an intervention.

The tool is based on epidemiological evidence and has been tested and validated using simulated and workplace tasks. It has acceptable intra- and inter-observer reliability and validity.

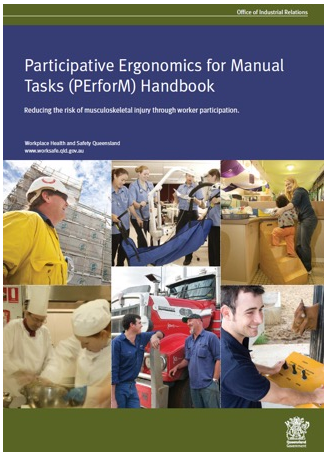
QEC mainly focuses on physical risk factors but includes a small number of psychosocial questions and is quick to use (estimated to take 10 minutes). The tool assesses the four main body areas and involves the assessor and workers completing the assessment together. It has a scoring system and exposure level provides guidance on intervention priorities. It provides a structured approach and can provide the tools for beginning conversations with workers and management on implementing controls.

QEC is a pdf document that can be printed and completed (David *et al*., 2005). This is a standalone tool and the 'Robens Centre for Health Ergonomics' based at the University of Surrey is no longer operational. As a result there is little supporting information, training or guidance available to help people use the tool, however, it is reasonably self-explanatory.

Example of the QEC assessment criteria

Example of the QEC score sheet

PErforM – Participative Ergonomics for Manual Tasks (Australia)



PErforM Handbook

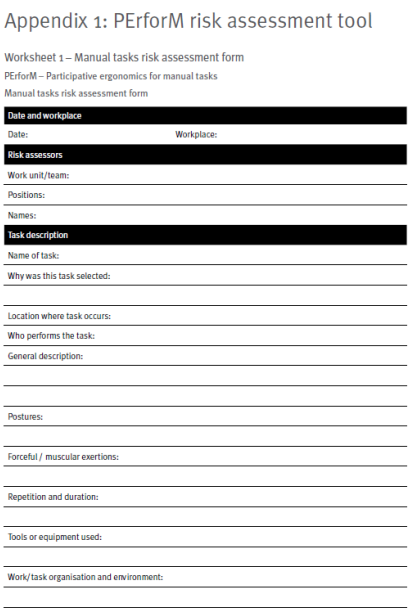
PErforM is a 'participative ergonomics program for reducing musculoskeletal injuries resulting from hazardous manual tasks'. (Workplace Health and Safety Queensland, 2013).

It is primarily used in Australia by SafeWork New South Wales and by WorkSafe Queensland. It helps users to identify, assess, and control hazardous manual tasks risk factors, and provides case study examples. In around 2019 ACC did some work to promote the tool for use in New Zealand. But work health and safety professionals did not get behind this and the development efforts excluded the work health and safety regulator (WorkSafe). We believe the tool remains little-used within New Zealand.

There is a pen-and-paper based tool or an e-Tool, which can be used by managers, health and safety professionals, and workers. As with most risk assessment methods, to be successful PErforM needs management commitment and for the tool to be integrated as part of a business's health and safety management system.

PErforM is different from other specific tools used to assess manual handling or upper limb tasks:

- a body map is used, and assessors ask workers to rate the parts of their body they feel are affected by the task
- a 5-point scale from 'no factors' present to 'most severe/extreme' factors experienced is used
- physical risk factors are categorised into those that have been associated with 'hazardous manual tasks'
  - exertion
  - awkward posture
  - vibration
  - duration
  - repetition
- design risk controls can be recorded, followed by administrative controls
- the assessment can be repeated following the introduction of controls to see if the level of risk has been reduced
- the user ratings must be coded for different body parts to show areas of risk associated with the five risk factors, but psychosocial factors aren't assessed. An example of a completed assessment is shown below
- there is no overall rating to help the assessor prioritise which tasks to address first.



Appendix 1: PErforM risk assessment tool

Worksheet 1 – Manual tasks risk assessment form

PErforM – Participative ergonomics for manual tasks

Manual tasks risk assessment form

Date and workplace

Date: Workplace:

Risk assessors

Work unit/team:

Positions:

Names:

Task description

Name of task:

Why was this task selected:

Location where task occurs:

Who performs the task:

General description:

Postures:

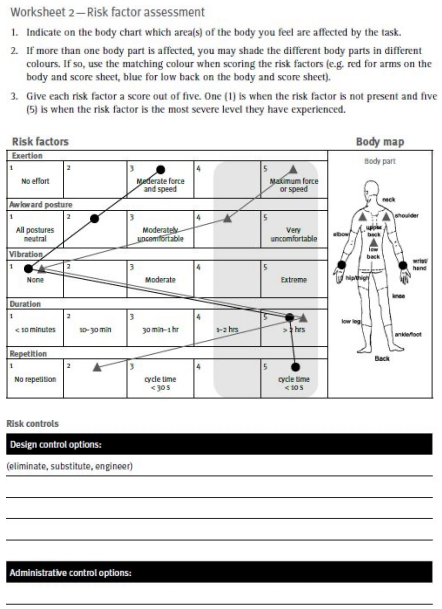
Forceful / muscular exertions:

Repetition and duration:

Tools or equipment used:

Work/task organisation and environment:

Page 1 of the PErforM tool



Worksheet 2 – Risk factor assessment

1. Indicate on the body chart which area(s) of the body you feel are affected by the task.
2. If more than one body part is affected, you may shade the different body parts in different colours. If so, use the matching colour when scoring the risk factors (e.g. red for arms on the body and score sheet, blue for low back on the body and score sheet).
3. Give each risk factor a score out of five. One (1) is when the risk factor is not present and five (5) is when the risk factor is the most severe level they have experienced.

Risk factors

	1	2	3	4	5
Exertion	No effort		Moderate force and speed		Maximum force or speed
Awkward posture	All postures neutral		Moderately uncomfortable		Very uncomfortable
Vibration	None		Moderate		Extreme
Duration	< 10 minutes	10–30 min	30 min–1 hr	1–2 hrs	> 2 hrs
Repetition	No repetition		cycle time < 30 s		cycle time < 10 s

Body map

Body part

neck, shoulder, upper back, elbow, low back, wrist/hand, hip/thigh, knee, low leg, ankle/foot, Back

Risk controls

Design control options:

(eliminate, substitute, engineer)

Administrative control options:

Worked example of the risk factor assessment

Appendix 6: Comparison of tools – a summary from the literature

Comparison of some of the shortlisted tools from the literature

	MALCHAIRE *et al.* (2011)	TAKALA *et al.* (2010)	KADIKON AND RAHMAN (2016)
MAC (HSE)	**Level** Level 1: Screening **Potential users** Anyone, employers, safety officers, safety representatives, inspectors, others. **Training** No training is needed **Time to complete** Quite quick especially when familiar with the tool **Pros** – Easy to use – Involves worker participation, especially if asking for ideas for improvements – Helps to prioritise tasks that need most urgent attention – Helps checks effectiveness of improvements – Fairly good benefit-cost ratio **Cons** Only used for standard manual handling tasks (lifting, carrying)	**Potential users** Occupational health and safety practitioners, ergonomists, workers, supervisors **Risk factors considered** Posture, force, duration, frequency **Outputs** Item profile – sum score indicating risk **Observation strategy** Selection by general knowledge of work **Recording method** Pen and paper, video **Correspondence with 'valid' reference** Insufficient information **Association with MSDs** Insufficient information **Intra-observer repeatability** Moderate – good **Inter-observer repeatability** Moderate – good **Pros** – Simple and easy to use – Well described process for assessment **Cons** – Assesses only monotonous lift/carry tasks, not jobs or compound tasks – Includes frequency but not duration of the lifting **Decision rules** Four level grading for action limits	**Objective** To aid health and safety inspectors assess the most common risk factors in lifting, carrying, and team handling tasks **Potential users** Occupational safety and health practitioners, ergonomists **Function** Assess risk associated with WRMSDs **Risk factors considered** Force, frequency, posture, coupling, environment **Development** – Identify inspection criteria tool – Review current manual materials handling assessment tools and Manual Handling Operations Regulations – Develop format tool and select the risk factor – Consideration discussion group and peer-review feedback **Rating score** Traffic light and total sum score **Concurrent validity** No formal study **Reliability trials/intra-rater reliability** Moderate – good **Inter-rater reliability** Moderate – good

	MALCHAIRE *et al.* (2011)	TAKALA *et al.* (2010)	KADIKON AND RAHMAN (2016)
L23 – Full risk assessments (lifting, carrying, pushing/pulling) (HSE)			**Objective** To guide organisations to reduce the risk of injury from manual handling **Potential users** Occupational safety and health practitioners, ergonomists, researchers **Function** Regulation for manual handling associated with MSDs **Risk factors considered** Force, Environment, Individual **Development** – Identify cause of increased number of injuries related to MSDs – Comply with the regulation and review risk assessment **Rating score** Regulation and guidance **Concurrent validity** No formal study **Reliability trials/intra-rater reliability** No formal study **Inter-rater reliability** No formal study

	MALCHAIRE *et al.* (2011)	TAKALA *et al.* (2010)	KADIKON AND RAHMAN (2016)
KIM (BAuA)	**KIM-LHC and KIM-PP** **Level** Level 1: Screening **Potential users** Health and safety practitioners (ergonomists, occupational doctors) employers, workers, workers representatives, inspectors **Training** No training is needed, but need to be know the guide well **Time to complete:** Quite quick **Pros** – Is complementary to the MAC tool as it addresses different handling operations – Can involve worker participation, especially if asking for ideas for improvements – Helps to prioritise tasks that need most urgent attention – Helps checks effectiveness of improvements – Fairly good benefit-cost ratio, if the assessment is combined with worker discussions around reasons for problems and possible improvements – Easy to use **Cons** Calculation of scores is long-winded and risks diverting attention away from prevention		**KIM-MHO** **Objective** To assess the risk of manual handling of loads on a screening level **Potential users** Researchers, occupational safety and health practitioners, ergonomists, workers **Function** Screening level on manual handling risk **Risk factors considered** Load, force, posture environment **Development** – Develop time rating point total sum – Establish risk evaluation technique – Develop risk range **Rating score** Total sum score **Concurrent validity** No formal study **Reliability trials/intra-rater reliability** No formal study **Inter-rater reliability** No formal study

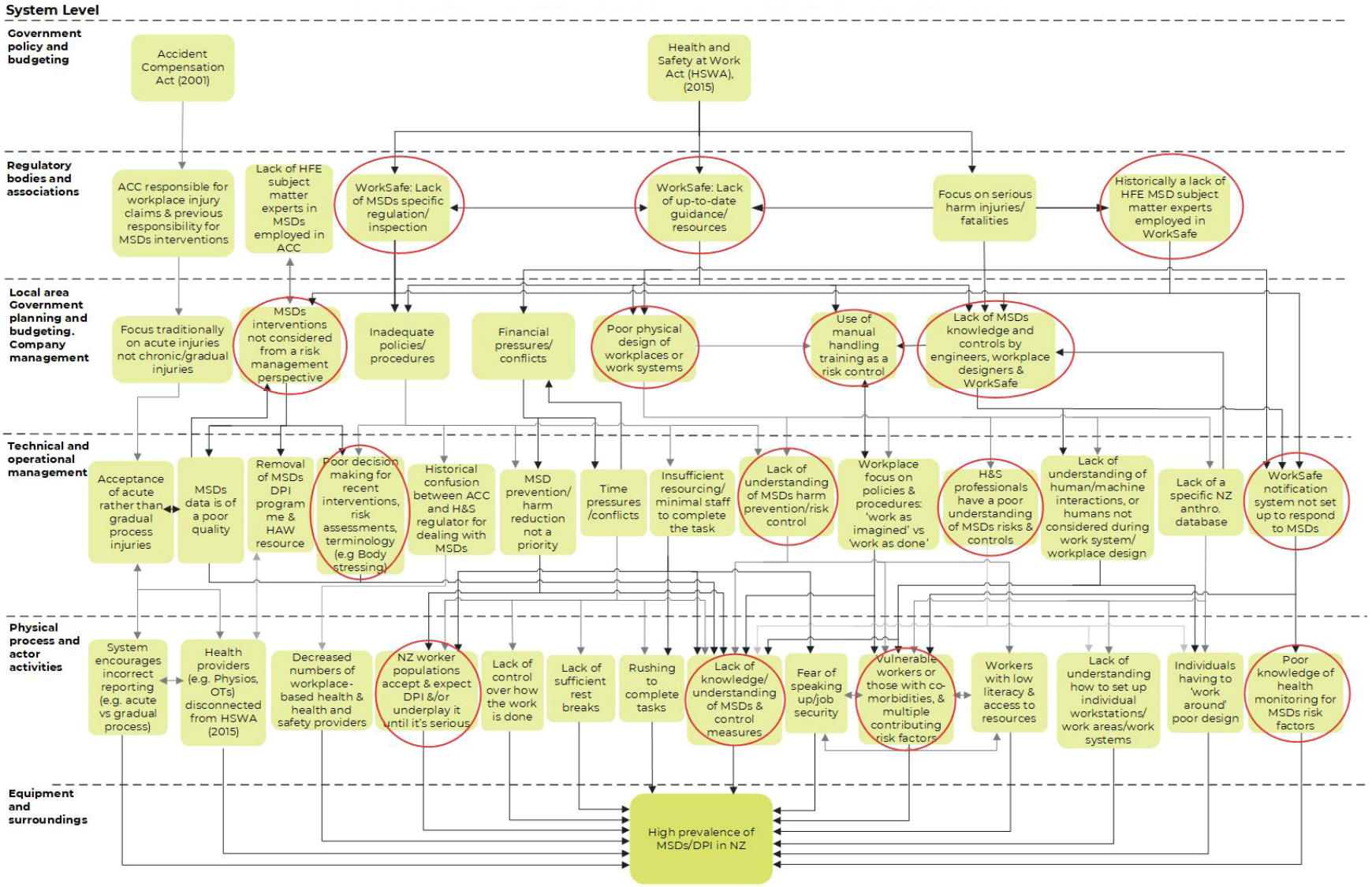
	MALCHAIRE *et al.* (2011)	TAKALA *et al.* (2010)	MONNINGTON *et al.* (2002)
QEC		**Potential users** Occupational health and safety practitioners, ergonomists, workers, supervisors, possibly researchers **Target exposures** Posture, force, duration, frequency, movements **Outputs** Sum score of weighted items **Observation strategy** 'Worst case' of the task **Recording method** Pen and paper **Correspondence with 'valid' reference** Good (video, technical measures) **Association with MSDs** Association with cross-sectional studies **Intra-observer repeatability** Moderate **Inter-observer repeatability** Moderate **Pros** – Easy to use – Applies for a wide range of tasks – Considers the interaction of risk factors **Cons** – Not suitable when tasks are highly varied – Concentrates on work tasks – The user decides which tasks are most loaded **Decision rules** Tentative limits indicating level of risk	– Posture and load exposure tool for MSD risks – Developed specifically for practitioners – Quick and easy after some familiarisation. Scoring observations done live, might be awkward. May not be quick enough where varied manual handling occurs – Emphasis on overall MSD risk, not manual handling. Less applicable to load related factors – Useful but not intuitive to a duty holder **Overall potential** Reasonable, but limited by reduced manual handling emphasis, involved observation required and need for employees to rate every operation

	MALCHAIRE *et al.* (2011)	TAKALA *et al.* (2010)	KADIKON AND RAHMAN (2016)
HSE – Upper limb risk assessment worksheets	**Level** Level 1: Screening **Potential users** Anyone, including workers and their supervisors **Training** No training is needed **Time to complete** Takes about 60 minutes as it involves discussions with the workers about their work, problems, causes, and solutions **Pros** – Aimed at prevention rather than quantifying risks – Easy to use – Involves worker participation – Ideal benefit-cost ratio **Cons** None stated	**Potential users** Occupational health and safety practitioners, ergonomists, workers, supervisors **Target exposures** Posture, force, duration, frequency, vibration **Outputs** Yes/no answers **Observation strategy** Tasks involving high repetition/low variety **Recording method** Pen and paper **Correspondence with 'valid' reference** Insufficient information **Association with MSDs** Insufficient information **Intra-observer repeatability** Insufficient information **Inter-observer repeatability** Insufficient information **Pros** – Easy to use – Straight forward questions – Offers advice for potential solutions **Cons** – Doesn't consider interaction of the risk factors – Subjective rating – definition of observed items not always clear – No metric measure to quantify the risk **Decision rules** Tasks with 'Yes' require more detailed assessment	

	MALCHAIRE *et al.* (2011)	TAKALA *et al.* (2010)	KADIKON AND RAHMAN (2016)
ART (HSE)	**Level** Level 1: Screening **Potential users** Anyone, employers, safety officers, safety representatives, inspectors, others. **Training** No training is needed **Time to complete** Quite quick especially when familiar with the tool **Pros** – Easy to use – Involves worker participation, especially if asking for ideas for improvements – Helps to prioritise tasks that need most urgent attention – Helps check effectiveness of improvements – Fairly good benefit-cost ratio – Useful if the assessment is combined with worker discussions around reasons for problems and possible improvements **Cons** None stated		

Appendix 7: Potential factors and interactions identified in the development of WRMSDs in New Zealand

The Accimap (below) shows possible factors and interactions that could potentially contribute to the development of WRMSDs in New Zealand. These factors are based on the extensive experience of the WorkSafe HFE team. The factors circled in red indicate areas where providing risk assessment tools is likely to help build knowledge on WRMSD risk factors and lead to higher order controls being implemented to reduce risk to workers.



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