June 2020

Musculoskeletal injury (MSI) prevention: a practical implementation resource for Newfoundland and Labrador (NL)

Institute for Work & Health
Research Excellence Advancing Employee Health

If you have questions about this report, please contact us at:

Institute for Work & Health

481 University Avenue, Suite 800

Toronto, Ontario M5G 2E9

info@iwh.on.ca

www.iwh.on.ca

Institute for Work & Health

Musculoskeletal injury (MSI) prevention: a practical implementation resource for Newfoundland and Labrador (NL)

Authors: Van Eerd D, Irvin E, Le Pouesard M, Butt A, Nasir K.

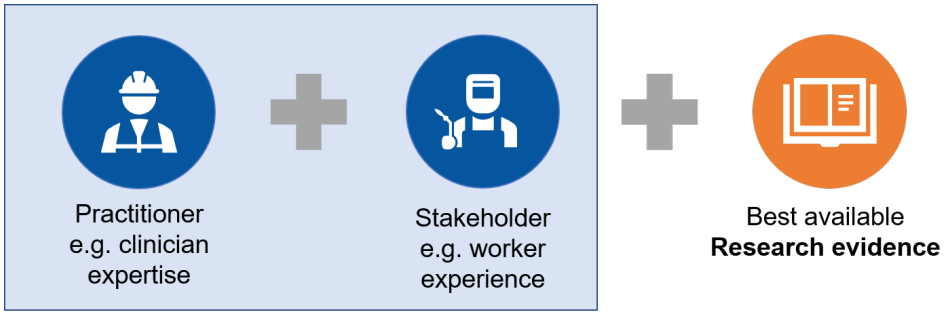
Date: June 2020

Executive summary

This report presents the findings of a research project about MSI in Newfoundland and Labrador. The objective of the project was to collect data about current musculoskeletal injury (MSI) practices (practice evidence) and synthesize it with evidence from the scientific literature (research evidence). Furthermore, we sought to close the gap in the literature between MSI prevention practices and implementation in workplaces. The resulting resource aims to support the implementation of effective and creative MSI prevention programs/practices in Newfoundland and Labrador (NL).

MSIs such as low back pain or pain and symptoms in the neck, shoulder, arm, wrist and/or hand can have an impact on workers in any sector. MSIs result in a substantial burden on workers and workplaces, often accounting for between 40 and 70% of lost time claims along with indirect costs or absenteeism or presenteeism.

The project has two components: i) gathering and describing current MSI practices, and ii) reviewing the MSI research literature. To determine current MSI practices in NL we conducted a survey of workers, managers and OHS practitioners. The research team engaged with NL stakeholders who provided input on our research process (e.g. ensuring we were using the correct language and asking meaningful questions) and provided feedback on the preliminary results. The stakeholder input ensures the messages from this project will be relevant to NL workplace audiences broadly.



There were 645 survey respondents and 16 interview participants representing workers as well as manager/OHS practitioners with experience with MSI. The

respondents represented a broad variety of sectors and job types within NL. The systematic review of reviews process identified a total of 58 relevant systematic reviews on MSI prevention, of which 21 provided evidence of sufficient quality for synthesis.

Key findings:

Practice evidence

Survey respondents noted that NL workplaces are engaged in many traditional MSI prevention practices related to hazard reduction (such as using PPE, proper tools, ergonomics and rest breaks). Survey results also revealed general agreement that traditional health and safety organizational policies and practices were in place in NL workplaces. However, they showed that exercise programs were not generally available, and that existing MSI programs and practices were not considered to be well implemented in general.

Findings from interview data supported the survey results and provided more details about existing practices and their implementation. The main themes that emerged from the thematic analysis of the interviews were:

- The need for knowledge and recognition in the workplace about MSI prevention
- MSI prevention should be proactive
- MSI prevention practices should be customized and responsive to individual needs

Key themes related to barriers and facilitators to MSI prevention included resources, implementation, and communication – and each was reported to have an impact on the success of MSI prevention practices.

The practice evidence for MSI prevention can be summarized in three categories: 1) Awareness programs and practices, both formal and informal, 2) Training programs and practices, and 3) MSI hazard identification/solutions. Programs and practices in all three categories were supported by interview participants and were consistent with the survey results.

Research evidence

The synthesis of scientific or research literature from studies conducted in a variety of jurisdictions and sectors showed that there are a number of MSI prevention

practices that are effective. Considering the categories from the practice evidence (above), most of the research evidence was on hazard solutions (such as modified equipment, adjustable workstation elements, work breaks, stress management programs, or multi-faceted programs that covered a number of hazards).

There has been some research on training for MSI prevention but the evidence of effectiveness for training programs/practice is not consistent and often reveals a lack of effect. There was no available research on awareness programs or practices for MSI prevention from this review. It is also important to note the emerging evidence on the effectiveness of exercise programs on MSI prevention in the research literature. However, there was little mention of exercises for MSI prevention practices from respondents in this study.

Summarizing and synthesizing the practice and research evidence:

The synthesis of practice and research evidence from this project indicates that there is:

1) *practice evidence* that awareness programs and practices for MSI prevention are often employed and considered effective. However, there is a lack of research evidence for these types of programs and practices.
2) *practice evidence* that training programs and activities are considered a key element for MSI prevention in workplaces. The research evidence for training is not strong, with most research finding no evidence of effect for MSI prevention outcomes.
3) *practice evidence* that hazard identification/solutions are often employed and felt to be effective for MSI prevention. There is also *research evidence* that shows that hazard prevention solutions are effective for MSI prevention outcomes.

When considering the evidence to add or adapt MSI prevention programs in their context, workplaces should also consider *how* they are implemented or put in place. The research findings suggest that good levels of knowledge and recognition about MSI prevention aid in the impact of MSI prevention programs and practices. The current research also shows that MSI prevention programs and practices that are proactive, customized, and updated regularly were found to be more effective. The findings of this project showed that barriers related to a lack of resources and knowledge about MSI prevention as well as poor implementation should be addressed in order for programs and practice to be successful in the workplace. In

contrast, good levels of communication in workplaces and attention to implementing tailored and responsive solutions were noted as key facilitators to effective MSI prevention.

Taking an evidence-based approach to MSI prevention should consider both practice evidence from practitioner expertise and worker experience along with the best available evidence from the research, which can be found in an increasing number of systematic reviews in publication. This project synthesized these types of evidence and developed a plain language summary, a slide deck, a full detailed report of methods and findings, practical resources (an 8-page booklet that provides more detail and case examples and a one-page summary) to guide the implementation of MSI prevention programs and practices in NL workplaces.

Plain language summary of findings

Using a survey and interviews we collected practice evidence (OHS practitioner expertise and worker experiences) and through a systematic review of reviews we collected the best available research evidence. Guided by an evidence-based practice approach, we synthesized this evidence.

Practice evidence (i.e, OHS practitioner expertise and worker experience) was provided by 645 survey respondents and 16 interview participants from Newfoundland and Labrador (NL) workplaces who had experience with MSI. Research evidence from 21 systematic reviews on MSI prevention was evaluated and synthesized. Together, practice and research evidence from this project were synthesized to produce a resource to support an evidence-based approach to MSI prevention programs and practices in NL workplaces.

Key findings*:*

Evidence source	**Key findings**
Practice evidence (survey – current programs)	• Traditional MSI prevention practices were in place in NL workplaces (such as using PPE, proper tools, ergonomics and rest breaks) • General health and safety organizational policies and practices were in place at NL workplaces • Exercise programs were not generally available
Practice evidence (survey – barriers)	• MSI programs and practices were not considered to be well implemented
Practice evidence (Interviews - current programs and supports)	• Awareness programs and practices (formal and informal) • Training programs and practices • MSI hazard identification/ solutions

	• There is a need for knowledge and recognition in the workplace about MSI prevention • MSI prevention programs and practices should be proactive • MSI prevention programs and practices should be customized and responsive to individual needs
Practice evidence (Interviews – barriers and facilitators)	• A lack of resources • A lack of knowledge about MSI policies • Poor implementation of MSI prevention programs and practices • Good levels of communication in the workplace • Providing tailored and responsive MSI solutions/accommodations
Research evidence (program/practice categories)	• A variety of MSI hazard solutions • Exercise programs • Early intervention • Multi-faceted approaches (e.g. combining exercise, rehabilitation, and accommodations.)

Taking the practice and research evidence together:

1) There is practice evidence that awareness programs and practices for MSI prevention are often in place and considered effective. There is a lack of research evidence on awareness programs and practices.
2) There is practice evidence that training programs and activities are considered a key element for MSI prevention in workplaces. Current research evidence does not consistently report that training is effective on MSI prevention outcomes.
3) There is practice evidence that hazard identification/solutions are often employed and felt to be effective for MSI prevention. Research evidence also shows hazard prevention solutions are effective for MSI prevention outcomes.

To create optimal conditions for developing and putting in place MSI prevention programs and practices, workplaces should:

- Increase the levels of knowledge and recognition about MSI prevention among workers and managers.
- Move from reactive to more proactive programs and practices.
- Customize MSI prevention programs and practices to the context and update them regularly.
- Devote sufficient resources to implementing MSI prevention programs and practices.
- Foster communication and tailor the MSI prevention programs and practices in the workplace.

Taking an evidence-based approach to MSI prevention should consider both practice evidence from practitioner expertise and worker experience, along with the best available evidence from the research. The resource developed from this research can support an evidence-based approach to MSI prevention programs and practices in NL workplaces.

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Background

Workers from all industrial sectors experience low back pain and/or symptoms such as numbness and tingling in the neck, shoulder, arm, wrist and/or hand. Such symptoms may be warning signs of current or impending upper extremity musculoskeletal disorders, such as peripheral nerve entrapments (e.g. carpal tunnel syndrome, ulnar tunnel syndrome), peripheral enthesopathies (e.g. shoulder tendinitis, lateral epicondylitis, hand-wrist tendinitis) and many other non-specific musculoskeletal pain disorders(Hagberg et al., 1995; Silverstein & Evanoff, 2011; Wells, Van Eerd, & Hägg, 2004) . Collectively, these conditions are often referred to as musculoskeletal injuries (MSI). MSI are a substantial burden to society and to workplaces worldwide because of lost productivity, reduced performance and lost time claims among affected workers (Fulton-Kehoe, Franklin, Weaver, & Cheadle, 2000; Hashemi, Webster, Clancy, & Courtney, 1998; Tate, 1992).

Previous estimates indicate that 40% of the world's occupational and work-related health care costs are attributable to MSI (Takala, 1999). More recently, it was estimated that costs related to MSI are between 0.5% and 2% of the EU's Gross National Product (GNP) (Schneider & Irastorza, 2010). Work-related musculoskeletal injuries are also a consistent and sizeable problem for many Canadian provinces. In Newfoundland and Labrador (NL), MSI account for 68% of all lost time claims (from 2012 to 2016) and cost an estimated $87 million annually. In Manitoba, it is estimated that 60% of all time-loss injuries are musculoskeletal injuries (Workers

Compensation Board of Manitoba, 2014). Also, in Ontario, MSI represent 40% to 50% of lost-time claims since the year 2000 (Workplace Safety and Insurance Board (WSIB), 2013). The rates are similar in Nova Scotia and British Columbia (Workers Compensation Board of Nova Scotia, 2013; WorkSafeBC, 2013).

The magnitude of the impact of MSI on workers, employers, health care systems, and society is staggering. Difficulties in the classification and assignment of work-relatedness of musculoskeletal disorders suggest that the reported rates of MSI are likely underestimated (Van Eerd et al., 2003). Additionally, workers with MSI symptoms and suffering pain at work may not report their condition. This “iceberg” of suffering was demonstrated in an investigation in a newspaper worker population where only approximately 1/3 of those with pain during the last year reported it to the workplace (Sullivan & Cole, 2002). Thus, the burden of disabling musculoskeletal pain and injuries arising from work-related causes in many NL workplaces remains substantial.

There are many known occupational risk factors for MSI including: physical (heavy physical load, awkward postures, working with arms above shoulder level, repetitive movements, same activity for prolonged periods, vibration); psychosocial (psychological demands at work, control at work, social support at work, job satisfaction); and personal (years of employment) factors (Bongers, Ijmker, van den Heuvel, & Blatter, 2006; van der Windt et al., 2000). A multi-causal problem, such as MSI, requires creative solutions. Current practices in the management of MSI are

diverse. These include various interventions in the workplace (ergonomics training, workstation adjustments, work redesign), in the clinical setting (physiotherapy clinic at the worksite), and in disability management programs (implemented by employers, insurers and jurisdictions). Despite the frequency, high costs and the range of MSI prevention approaches, little is known about the most effective occupational health and safety (OHS) interventions and even less about how to implement them.

One way to address MSI in workplaces is to consider an evidence-based practice (EBP) approach. EBP evolved from the evidence-based medicine model which first emerged in the mid-1980s and was clarified by David Sackett in 1996, with the following definition: “the…use of current best evidence in making decisions...means integrating individual expertise with the best available external evidence from systematic research." (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). Sackett (1996) also noted that patient values and experiences should be considered in an evidence-based approach. Evidence-based approaches help identify and implement more effective solutions. Optimal EBP employs the knowledge and experience of practitioners along with the most up-to-date evidence from the scientific literature contextualized to the situation of the client (worker, etc.) in order to determine prevention solutions. Using an approach adapted from the Public Health Agency of Canada’s (PHAC) best practices portal (http://cbpp-pcpe.phacaspc.gc.ca/resources/planning-public-health-programs/), we have been successful in synthesizing these forms of evidence for work-related disorders in other

jurisdictions in Canada (https://www.iwh.on.ca/tools-and-guides/evidence-informed-guide-to-supporting-people-withdepression-in-workplace).

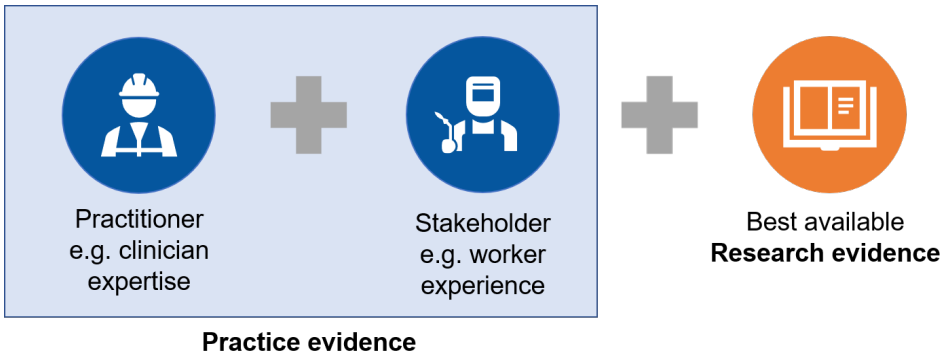

Figure 1: Evidence-based practice (EBP), adapted from Sackett et al. (1996)
Evidence based medicine: what is it and what isn't it.

Over the past decade, the Institute for Work & Health (IWH) has conducted a series of systematic reviews, which has contributed to a substantial body of evidence addressing the management and prevention of MSI. Across the IWH reviews there were over 50 different workplace-based prevention interventions studied. Overall, we found evidence that: 1) strengthening programs can help to address MSI symptoms, 2) participatory ergonomics (PE) is effective in improving MSI symptoms; 3) alternative pointing devices have a positive effect on musculoskeletal outcomes in office workers; 4) both multi-component patient handling interventions and exercise training interventions are effective in improving MSI health; and 5) there is a positive effect of arm supports in the prevention of upper extremity disorders. While a number of articles have provided an outline of the "ideal" processes for implementing

MSI prevention programs (Berg Rice, Pekarek, Connolly, King, & Mickelson, 2002; de Jong & Vink, 2002), and one narrative review has synthesized the “elements” of the process (Haines & Wilson, 1998), to our knowledge there has not been a systematic review of the literature specifically focused on the successful implementation of effective MSI interventions in workplaces (with the exception of one focused on Participatory Ergonomics by Van Eerd et al, (2010)). This research project sought to remediate this gap.

Simply producing systematic reviews, however, does not solve OHS problems. Review findings need to be effectively communicated to stakeholders in workplace environments and to knowledge users in the OHS field. One way to do this is to develop a practical, easy-to-use resource for the implementation of MSI prevention programs in workplaces. Such a resource can assist OHS practitioners to make decisions, that is, the resource does not dictate but rather aids in the decision process. Importantly, resources and tools can be helpful even when there is little scientific evidence available (Fervers et al., 2005; Knaapen, 2013).

Resource production and dissemination is a knowledge transfer and exchange (KTE) activity. KTE is a field that focuses on closing the gap between research evidence and practice decision-making (Graham et al., 2006). Its goal is to provide relevant stakeholders with appropriate evidence to assist them in making judgements within their daily work roles (McWilliam, 2007). A review of the literature noted that the most important factors for effective KTE were based on relationships (Mitton, Adair,

McKenzie, Patten, & Waye Perry, 2007). The quality of the relationship and the trust developed between the research partners were critical components, as were interactive meetings and face-to-face contact (Mitton et al., 2007). Mitton (2007) also noted the importance of clearly summarizing findings, including recommendations for action.

Additional ways to facilitate research use are to involve stakeholders in the review process and in the development of resources or tools that emerge from the review. According to the literature on KTE activities, it is important to engage stakeholders in the research itself in order to increase the utilization of research findings. Such inclusion helps to ensure that the findings are accessible and relevant to these audiences (Innvaer, Vist, Trommald, & Oxman, 2002; Lavis, Robertson, Woodside, McLeod, & Abelson, 2003; Lomas, 2000). Also, according to Mitton (2007), a frequently recommended facilitator to research uptake is the inclusion of key individuals, either decision-makers or opinion leaders, in the research planning and design stages. Involving relevant stakeholders in the development of a resource will lead to increased uptake and use of the resource.

Thus, stakeholder engagement in the research process is an important aspect of the systematic reviews conducted at the IWH (Figure 1) (Keown, Van Eerd, & Irvin, 2008). In this project, in addition to collecting data from stakeholders, we also engaged them in the development of the practical resource, as well as to help disseminate it more broadly.

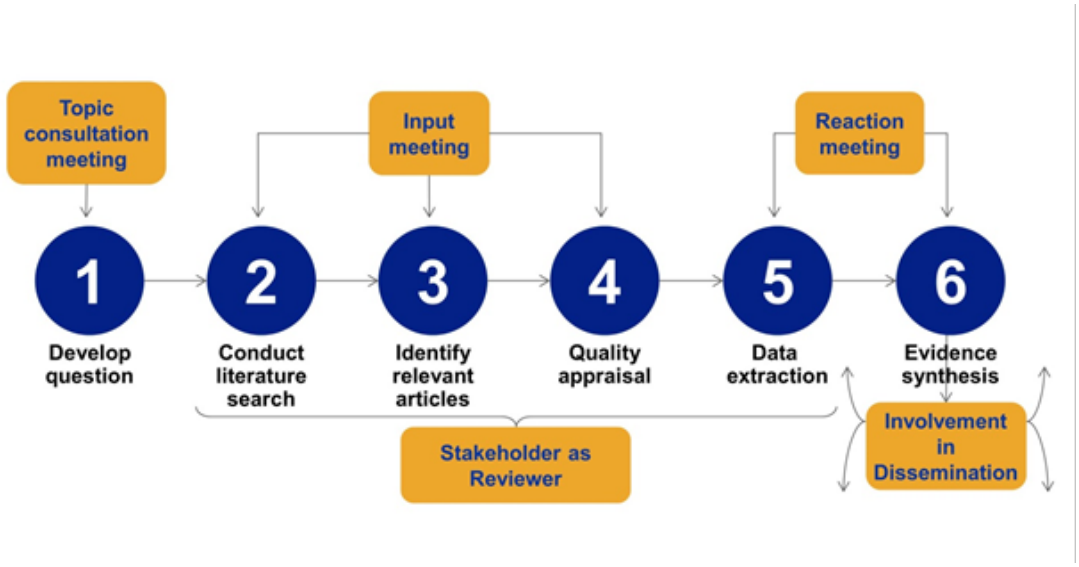

Figure 2: IWH Systematic Review Steps (Irvin, Van Eerd et al. 2010, Keown, Van Eerd & Irvin, 2008)

Objectives

The objectives for this research project were to: **1) collect and synthesize current MSI practices along with evidence from the scientific literature and 2) create a practical resource to support the implementation of effective and innovative MSI prevention programs/practices in Newfoundland and Labrador.** To meet these objectives, the team of researchers worked together with stakeholders in NL using a model of evidence-based practice (EBP) to create the resource. As aforementioned, EBP is the integration of I) practitioner expertise, ii) worker experiences, values, and preferences, and iii) the best research evidence into the decision-making process. The research evidence, by itself, does not make the

decision, but it can help inform practice and implementation process. The full integration of these three components into the creation of the resource enhances the opportunity for optimal workplace outcomes and worker health and safety (Sackett et al., 1996).

Methods

Evidence-based practice entails making decisions about how to promote health and safety behaviours by integrating the best available evidence with practitioner expertise and other resources, and with the characteristics, state, needs, values and preferences of those who will be affected. This is done in a manner that is compatible with the environmental and organizational context (EBBP.org, 2018). These principles are readily transferable from the clinical setting to a workplace-based occupational health and safety setting. For this research project, we operationalized this using two methodological stages. In stage 1, we gathered current “best practices” and workplace expertise and experiences via an online survey and in-depth interviews and, in stage 2, we completed a synthesis of current practices with evidence from the scientific literature. The research protocol was approved by the University of Toronto Research Ethics Board.

Stage 1: Gathering information on current practices and workplace experiences

Study sample and recruitment

Our study sample for both surveys and individual interviews targeted OHS practitioners (such as ergonomists, OHS professionals) and workplace personnel (JHSC members, workers and supervisors) in NL workplaces who had first-hand experience with MSI in the workplace, or had experiences with managing or providing support to employees or workplaces with MSI or MSI risks.

Participants were primarily recruited via email with the aid of the stakeholder advisory committee (described below) formed for this project who assisted in identifying the appropriate and varied workplace and OHS stakeholders to contact for participation. Additional participants were also recruited through the snowballing method; participants invited to complete the web-based surveys were asked to share the survey link with others who might be interested in participating in the project. The IWH's internal database of contacts (those of whom had previously identified as having OHS roles, were willing to be contacted for research studies and were located in NL) was also used. Finally, in cases where no pre-existing contacts existed, the research team contacted NL workplaces directly using publicly available information on the internet.

The recruitment period was between July 2019 to February 2020; a total of 762 people responded to the survey. There were 645 participants that completed at least

30% of the web-based survey (30% was chosen as it corresponds to the point in the survey where respondents identify as either worker, manager, or OHS professional; responses could then be categorized according to respondents' roles) and were used in the analysis. Seventeen participants completed an in-depth interview (1 interview was excluded from analysis due to incomplete data), leaving 16 in the qualitative analysis.

Data collection

Our data collection approach was guided by the Public Health Agency of Canada's (PHAC) best practices portal (http://cbpp-pcpe.phac-aspc.gc.ca/resources/planning-public-health-programs/.) The PHAC lists six stages for evidence-based decision making. We specifically adapted the first three stages (relevant to gathering data) to assist us in structuring our dialogue with stakeholders to gather contextual information, current practices and experiences:

1) **Clarify context, assumptions and overall public health framework for planning**
2) **Collect evidence to support program plan**
3) **Design program based on evidence**
4) Establish indicators of success
5) Develop an evaluation plan
6) Manage the project

We undertook the following methods to gather evidence for Stage 1 of this project:

Web-based survey. All potential participants were sent an email inviting them to participate in a web-based survey and were asked to provide consent before participating. Participants were encouraged to contact the research team directly with any questions. Email reminders at 2, 4 and 8 weeks were used to increase the response rate (Dillman, 1991). Guided by the PHAC approach, the survey included a brief section on context and demographics (including: sector, company size, respondent job title, job tenure), a section on MSI concerns at the workplace and previous (or ongoing) interventions (including: who is responsible for implementation, implementation steps, best practices and policy), and finally a section on implementation experiences (including: facilitators and barriers to implementation, program sustainability).

Interviews. To better understand how workplaces in NL experience and implemented MSI prevention programs/practices, we interviewed 16 participants. Interview participants were recruited by researchers from a self-identified sample of OHS practitioners and workplace personnel. The IWH team attempted to target experiences from a variety of industries and sectors in NL. Those who agreed and provided informed consent participated in a 45-60-minute semi-structured interview to discuss their organizations' use and development of best practices. The semi-structured interview explored and focused on participants' implementation experiences, gaps in programs, and aspects in need of improvement. All interviews were conducted by telephone.

Analysis

The data collected from the web-based survey and interviews were analyzed in a descriptive way.

Survey data were analyzed using counts and frequencies indicating endorsement of items along with simple descriptive statistics when applicable. Data analysis was performed using SAS v9.3 (SAS Institute, Cary, NC, USA).

The interviews were transcribed and coded using a preliminary coding list developed by the research team to capture MSI prevention practices, and key barriers and facilitators in accordance with the research objectives. Following an iterative coding process, each interview transcript was coded in multiple rounds by different research team members and analysed according to themes as they emerged. Team members met when needed to discuss any differences in their coding, and to refine emerging themes. Analyzed content was anonymized, summarized and presented to the stakeholder advisory committee for review and feedback.

Data from interviews were reviewed, analyzed for content, and organized into intermediary matrices (Guest, MacQueen, & Namey, 2012). This allowed the researchers to descriptively analyze the content that emerged from the qualitative data collection. Both the interviews and survey data underwent separate analysis but the results were considered together to support/or contrast findings across our respondent groups. The descriptive analysis was useful in understanding

stakeholder views of intervention implementation, workplace experiences, and perceived barriers and facilitators to implementation. Results from this analysis, along with the expertise and experience of the stakeholder advisory committee, formed the basis of the material presented to the stakeholders to discuss the optimal design of the resource and dissemination strategies.

Stage 2 – Examination of Peer Reviewed Literature

A systematic review of reviews (SRR) is a literature review focused on examining systematic reviews published on a research question(s) by identifying, appraising, selecting and synthesizing all medium and high-quality systematic reviews relevant to that question. The SRR process at IWH was adapted by the IWH SR program (Irvin, Van Eerd, Amick, & Brewer, 2010) and based on the process developed by the Cochrane Collaboration (Higgins & Thomas, 2019). The basic steps of this SRR process include: Step 1: Develop question; Step 2: Conduct literature search; Step 3: Identify relevant studies; Step 4: Quality appraisal; Step 5: Data extraction; and Step 6: Evidence synthesis.

This SRR built on a series of IWH SRs including the IWH SR of the literature on workplace-based interventions to prevent work-related MSI (Van Eerd et al., 2016). In particular, the Van Eerd (2016) review informed the literature search, inclusion/exclusion criteria and data extraction for this updated review of reviews.

Step 1: Development of the Research Question

The review team and the IWH Librarian participated in a meeting to discuss the review update, the research question, and proposed search terms. The review question and search terms from the Van Eerd (2016) review were used as a starting point. To ensure that the SRR examining MSI was as comprehensive as possible, two SRRs were conducted. The research questions we examined were; what the evidence on the effectiveness of workplace-based interventions focused on upper extremity musculoskeletal disorders is and what is the evidence on the effectiveness of workplace-based interventions focused on low back pain.

Step 2: Conduct literature search

Search terms were identified for three broad areas: population terms for workers and for injury/ conditions, intervention terms, and outcome terms. Both database-specific controlled vocabulary terms and keywords were included. The terms within each category were combined using a Boolean OR operator and then terms across the three main categories were combined using a Boolean AND operator. The complete list of terms used in our search is reported in the appendices. The following electronic databases were searched; Medline (OVID), EMBASE(OVID), CINAHL (EBSCO) and COCHRANE Library from [2013] to [August 2019]. As the controlled vocabulary and the ability to handle complicated multi-term searches differ across the databases searched, search terms were customized for each database as required. All peer-reviewed literature was included, with no language restrictions.

References were loaded into a commercially available systematic review software (DistillerSR®), which was also used for all remaining review steps. DistillerSR® is an online application designed specifically for the screening, quality appraisal and data extraction phases of a systematic review.

Step 3: Identify relevant studies

The research team created a standard set of inclusion/exclusion criteria, based on the research question. Eligibility criteria were as follows:

- *Was the study a systematic review?*
- *Did the review examine the evidence of OHS intervention(s) in a workplace-based setting and;*
- *Is the outcome an upper extremity musculoskeletal symptom, sign, disorder, injury, claim or lost time? Or is the outcome low back pain symptoms, signs, disorders, injuries, claims or lost time?*

To ensure that the criteria were uniformly applied, standardized relevance screening forms with instructions were prepared and the team undertook a pilot test of the relevance screening process. The selection of relevant studies took place in two stages. In the first stage, the titles and abstracts of identified references were screened based on our inclusion/exclusion criteria to exclude studies of obvious irrelevance. In the second stage, full-text articles that met the criteria or with insufficient information to determine relevance were retrieved. At this stage, two reviewers independently screened articles in full for relevance. Where reviewers were not in agreement on relevance, disagreements were discussed until consensus

was obtained. If agreement could not be reached, a third reviewer was consulted. Team members did not review studies they consulted on, authored, or co-authored.

Step 4: Quality Appraisal

Relevant articles were appraised for methodological quality using the AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews) quality appraisal tool. AMSTAR 2 was developed to adapt the AMSTAR to evaluate systematic reviews that not only include randomised but also non-randomised studies of healthcare interventions, or both. The AMSTAR 2 is not intended to generate an overall score; users should consider the potential impact of an inadequate rating for each item. The AMSTAR 2 authors propose a scheme for interpreting weaknesses detected in critical and non-critical items (Shea et al., 2017).

For this review, each article was independently assessed by two reviewers, who reached consensus on all criteria. If consensus could not be achieved, a third reviewer was consulted. Team members did not review articles they had consulted on, authored or co-authored. We a priori decided that data extraction and evidence synthesis were only to be completed on high-quality and medium-quality studies.

Step 5: Data Extraction

Data were extracted on, the study design & setting, research question/objective, sector, review inclusion/exclusion criteria (according to PICO), outcomes and statistical analysis, intervention characteristics and a summary of the findings. The extracted data were used to create summary tables sorted by intervention category and outcomes in order to synthesize the evidence from the reviews. Data were extracted independently by pairs of reviewers. Again, reviewer pairs were rotated to reduce bias. Team members did not review articles they consulted on, authored or co-authored. Any conflicts between reviewers were resolved by discussion.

Step 6: Evidence Synthesis

In order to ensure the synthesis of the SRRs were as practical as possible we chose to synthesize the evidence from individual reviews using the following algorithm INTERVENTION “was/were found to have” X EFFECT “on” OUTCOME “for” POPULATION (to the extent that all of this information was presented in the individual reviews).

Synthesis of practices and literature evidence

We synthesized the evidence from all literature sources with the information we gathered from study participants via the survey and interviews. In completing the overall synthesis, we were guided by the categories available in the scientific literature and key themes that emerged from the analysis of stage 1 (described

above) to frame the various MSI prevention findings using concepts and terminology familiar to stakeholders. In this way, we are able provide important information about effective MSI prevention programs/practices along with information about facilitators and barriers related to implementation at the workplace.

Stakeholder advisory committee and workshop

We established a stakeholder advisory committee comprising of key leaders in the public and private sectors with expertise in occupational health and safety in Newfoundland and Labrador (NL), including ergonomists, physiotherapists and allied health professionals focusing on rehabilitation, policy advisors and industry leaders.

The stakeholder advisory panel were consulted by the research team for feedback and guidance on their respective areas of expertise. In the early stages of the project, the committee aided us in developing the survey and interview guides and in recruiting survey participants, by forwarding our recruitment email to members of their respective networks. In the later stages of the project we held a workshop to receive advisory committee feedback on resource development and dissemination. We believe this integrated research-to-practice approach will lead to improved approaches to implement MSI prevention practices and better support individuals with MSI in the workplace.

Resource development and dissemination plan

Guided by the IWH stakeholder engagement model (Keown et al., 2008), a stakeholder workshop was held on April, 27, 2020 with representatives from Newfoundland and Labrador Employers' Council, WorkplaceNL, Health care clinics (across the province), Newfoundland and Labrador Construction Safety Association and the Government of Newfoundland. The workshop provided stakeholders with the results of the synthesis and an opportunity to participate in the development of key messages, content, and format of the resource of practices and policies.

The workshop was structured to 1) share the synthesis results and gather specifications from stakeholders on what the resource would contain based on stakeholder needs and wants; 2) determine a useful layout for the information in the resource; and, 3) discuss dissemination and consider alternative communication formats for the information.

IWH is dedicated to making research evidence available, understandable and usable for decision-makers to assist in creating safer and healthier workplaces. Ongoing relationships with key stakeholders help us to identify research priorities, frame research questions and communicate findings in ways that are useful for policy and practice.

The dissemination plan for this project includes engaging with the project funder and stakeholder advisory committee to encourage broad dissemination through website

postings, inclusion in email and online news alerts, and regular communications to networks. In addition to the dissemination strategies identified by stakeholders, we will publish a lay version of the project in our quarterly newsletter, *At Work***.** Over 6000 people get *At Work* and/or IWH news via our quarterly and monthly e-alerts, which summarizes the articles and points people to the website for the full versions. We will also present our findings to external stakeholders at one of the weekly *"IWH Speaker Series"* sessions. These sessions are recorded and made available as presentation slide casts on our YouTube channel, with links from our website. Our website (www.iwh.on.ca) contains direct links and downloadable versions of our research content, including: research summaries, full reports, media releases, and the aforementioned *At Work* articles and plenary slide casts. The website averages approximately 65,000 users (new and returning) per month. Our tools and guides have been downloaded over 5,000 times in 2020 so far. We will actively pursue the feasibility of web links to our research findings and resource on project partner websites. In addition, we will use our partner organizations to help disseminate the tool via their communication vehicles and network contacts.

Findings

Survey Results

There were 792 survey respondents in total. Of these, 645 (85%) completed 30% or more of the survey answering key questions about their role (workers or

managers/supervisors/OHS personnel) and experience with MSI and/or MSI prevention strategies at the workplace. We report on the survey findings from these 645 respondents.

Respondent characteristics

Considering the entire sample (n=645), respondents were predominantly from NL (96%), with the remaining respondents from other Canadian provinces. A majority of respondents (60%) were in the 45 years or above age range, and most worked in workplaces with 50-100 staff (42%) or workplaces with 1-5 staff (40%). Most respondents reported they had worked at the workplace for more than 10 years (47%) with the greatest proportion having permanent full-time jobs (39%). Many respondents reported their job tenure was more than 10 years (39%) or from 1-5 years (29%). Various sectors were represented in this sample with the largest proportion of respondents coming from construction, forestry, and healthcare.

As table 1 shows, sixty-one percent of respondents identified as a worker with experience with MSI, the remaining 39% identified as a manager or OHS practitioner that had experience managing or providing support to others with MSI. Details on survey respondent characteristics can be found in Table 1 broken down by whether they were workers or managers/OHS practitioners. There were no differences in participant characteristics between respondents who identified as workers when compared to those who identified as manager/OHS personnel.

Table 1: Survey respondent characteristics

Variable	Response category	% worker respondents (n=395, 61%)	% mgr/OHS respondents (n=250, 39%)
Age category	18-34	17.0	14.8
	35-44	23.3	25.2
	45 or above	59.2	60.0
Sex	Male	59.2	49.6
	Female	40.2	50.4
Tenure in organization	< 1 year	14.2	12.8
	1-5 years	30.6	26.4
	6-10 years	18.0	18.0
	>10 years	36.5	42.8
Organization size	1-5 staff	40.0	39.6
	6-50 staff	8.9	9.6
	50-100 staff	42.5	40.8
	100+ staff	7.6	10.0
Employment status	Contract PT	6.1	2.0
	Contract FT	10.4	9.6
	Perm PT	8.1	7.6
	Perm FT	66.8	76.8
	Other	7.8	4.0
Employment role	Staff/employee	33.2	12.4
	Manager/supervisor/HR	5.8	37.2
	OHS personnel/Disability Management	5.1	20.8
	Union/Labour Rep	27.3	12.8
	Other	2.0	1.2
Tenure in role	< 1 year	13.7	13.1
	1-5 years	36.2	30.8
	6-10 years	18.5	24.4
	>10 years	30.6	31.2
Sector	Construction	19.2	13.2

Variable	Response category	% worker respondents (n=395, 61%)	% mgr/OHS respondents (n=250, 39%)
	Forestry	10.1	9.6
	Health care and social assistance	8.4	11.6
	Professional, scientific and technical services	6.6	4.8
	Finance/ insurance/real estate	5.8	6.8
	Educational services	4.8	6.0
	Utilities	3.8	5.2
	Transportation and warehousing	3.3	3.2
	Retail	3.0	2.8
	Manufacturing	1.8	4.0
	Food/accommodation	2.5	1.2
	Other*	17.7	18.4
Province**	NL	95.2	96.4
	Other provinces	4.8	3.6

*Includes responses entered as “other” and combines sectors where the size was too small to report

**The survey was targeted to NL workplaces but there were also respondents from other provinces as they may live in NL but work outside of the province.

MSI training and knowledge

Fifty-five percent of workers who experienced an MSI indicated they received some training about MSI. The largest proportions of worker respondents reported receiving training that was half a day or less (15.7%) or training that was one day long (11.4%). Training for workers was most often delivered in-person by their own

organization (24.6%) with a smaller number from an external source (16%). Seventeen percent of those who reported having received some training also received a certificate. Also, 87.1% of worker respondents felt they were “somewhat” or “very knowledgeable” about MSI.

Two thirds (67.6%) of manager/OHS respondents reported they had some training to support workers with MSI. Many manager/OHS respondents received either MSI training that was a full day (29%) with the rest of the respondents evenly distributed across less than half-day, half day, 2-3 days or training that was more than five days response options. The MSI training was most often delivered in-person from an external organization (43.2%). Forty-one percent of those who reported having received some training also received a certificate. Over 90% of manager/OHS respondents indicated they were somewhat or very knowledgeable about MSI.

Who is responsible to support workers with MSI?

Figure 1 shows who, according to workers and managers/OHS, was responsible for MSI prevention at the workplace. Worker respondents reported most often turning for help to their direct manager (65.3%) or OHS professional (59.2%) or senior management (including Owner/CEO/President) (55.9%). However, between 20 and 30% of workers consulted others either within or external to their organization (see Figure 1). Manager/OHS respondents mirrored the worker responses with most endorsing a direct manager (76.8%), senior management (including Owner/CEO/President) (71.2%) and OHS professional (70.0%), among others. Few

worker or managers/OHS respondents (6.1% and 4.4% respectively) indicated that they did not know who was responsible.

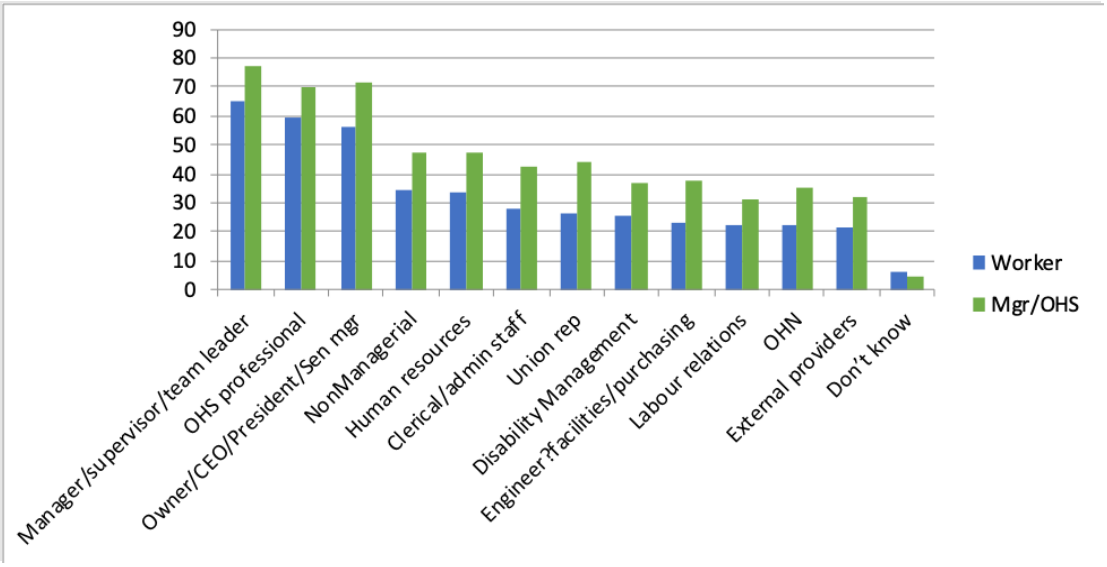

Figure 3: Percentage of workers and manager/OHS that endorsed who is responsible for MSI prevention at their workplace.

MSI policies

Over 40% of workers and over 50% of managers/OHS replied that their workplace had formal MSI policies when asked (see Figure 2). Furthermore, around a third of workers and nearly half of managers/OHS indicated that MSI policies and MSI

processes were reviewed and updated regularly.

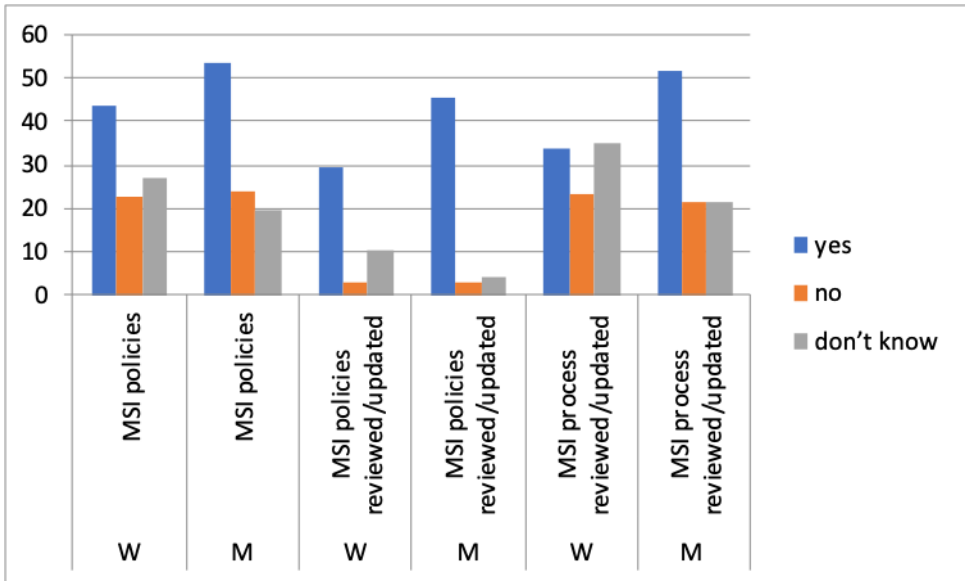

Figure 4: Percentage of workers (W) and manager/OHS (M) that endorsed MSI policy existence and details.

Practices for preventing MSI

Table 2 shows examples of MSI practices for preventing MSI and the proportion of workers and managers/OHS that agreed or disagreed that these practices were available in their workplaces. Both workers and managers/OHS respondents generally agreed that many of the practices listed were available in their workplaces. However, a consistently higher proportion of managers/OHS respondents agreed that the practices listed were available than did workers. Workers and managers/OHS respondents disagreed on the availability of two MSI prevention practices: flexible work hours/location and exercise. In addition, there were discrepancies in worker and manager/OHS responses on the availability of MSI

prevention practices related to “task flexibility”, “adequate staffing”, whether “workers were heard”, and if “timely information was provided”. A higher number of workers “disagreed” or “did not know” if these practices were available than managers/OHS respondents.

Overall, while many worker respondents reported that their workplace’s MSI prevention strategy was good (18.2%), or very good (18.2%), the highest proportion indicated the strategy was poor (23.5%) with a mean rating of 3.0 (SD=1.13). In contrast, managers/OHS respondents mostly responded with very good (25.6%) but many also rated their workplaces as poor (22.0%) with a mean rating of 3.2 (SD=1.15).

Table 2: Survey respondent agreement about available MSI practices.

MSI Practice	Respondent	Response (%)			
		Agree	Disagree	N/A	Don’t know
safe tools	worker	67.6	12.4	1.3	3.3
	manager/OHS	75.6	3.6	4.4	0.4
rest breaks	worker	63.3	16.5	2.5	2.8
	manager/OHS	72.8	8.0	2.4	0.8
force	worker	61.0	17.7	2.8	3.5
	manager/OHS	74.0	5.6	3.2	1.2
PPE	worker	58.0	12.7	9.1	4.8
	manager/OHS	68.4	6.4	8.8	0.4
modified tools	worker	52.4	19.7	4.1	8.1
	manager/OHS	63.6	8.8	8.0	3.2
ergonomics	worker	49.1	21.3	5.3	8.9
	manager/OHS	66.4	12.4	2.4	2.4
task flexibility	worker	48.9	25.1	3.0	7.3
	manager/OHS	54.4	19.6	6.0	4.0

feedback	worker	48.4	20.3	3.3	13.2
	manager/OHS	63.6	12.0	2.8	4.8
temperature	worker	46.8	18.2	15.7	4.3
	manager/OHS	58.0	3.2	21.2	1.2
staffing	worker	45.8	32.2	3.8	3.0
	manager/OHS	68.0	12.0	2.0	2.0
worker heard/involved	worker	42.0	15.7	3.5	23.5
	manager/OHS	74.0	2.8	5.2	2.4
timely information given	worker	41.5	13.2	4.3	26.1
	manager/OHS	76.0	4.4	1.6	2.0
vibration	worker	37.2	16.7	22.8	7.8
	manager/OHS	46.4	5.2	26.8	5.6
flex hours/work location	worker	19.7	35.2	24.8	4.8
	manager/OHS	24.0	30.8	24.8	4.4
exercise	worker	16.7	48.1	9.1	10.6
	manager/OHS	25.2	40.0	11.6	6.8
no programs	worker	19.5	34.2	7.1	21.8
	manager/OHS	11.2	48.0	11.6	10.0

Implementation of MSI prevention

When asked about how well MSI prevention practices were implemented in the workplace, between 30 and 40% of managers/OHS respondents indicated that there was a clear implementation plan, enough resources, and that the prevention strategies are evaluated (see Figure 3). While 30% of workers said that their workplaces had an MSI prevention implementation plan, between 30 and 34% of workers answered that they did not know if their workplace had enough resources or MSI implementation plans were evaluated.

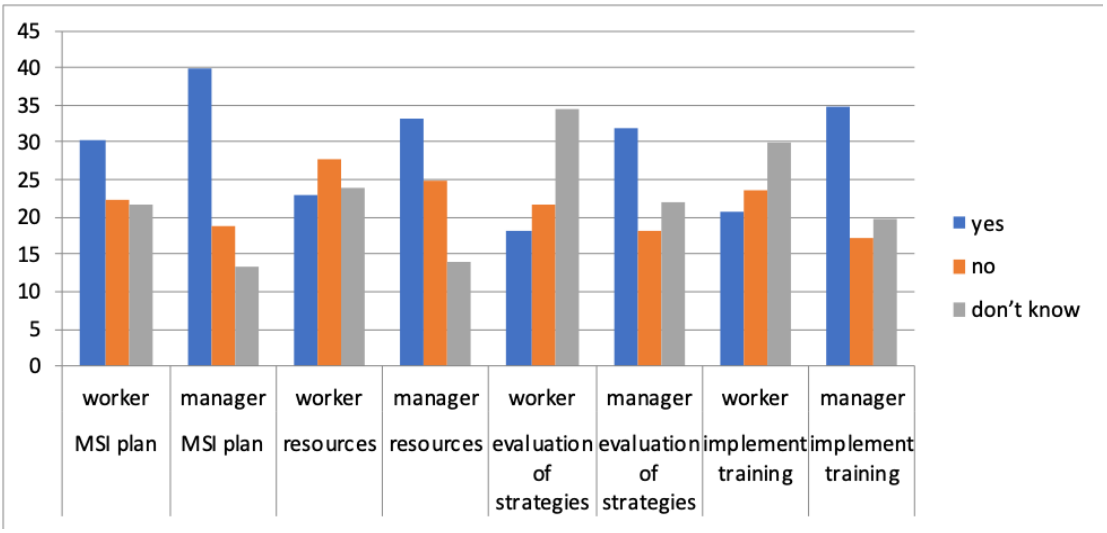

Figure 5: Percentage of worker and manager/OHS endorsement of MSI implementation details

Table 3 displays the results relating to organizational policies and practices as they relate to MSI prevention. In general, both workers and managers/OHS agreed that these practices happen between 60 and 100% of the time at their workplace. However, managers/OHS consistently had a higher proportion of endorsement than workers. The practices related to employees being involved in safety decisions and receiving positive recognition for acting safely were less positively endorsed than the other practices.

Table 3: Survey respondent report of time that organizational policies and practices take place as they relate to MSI prevention

Organizational performance practice	Respondent	Percentage of time each practice takes place				
		0-20%	20-40%	40-60%	60-80%	80-100%
Workers and supervisors have information needed to work safely	worker	4.6	4.8	11.4	17.7	36.5
	manager	1.6	3.6	4.8	19.2	42.8
Workplace considers safety at least as important as production and quality	worker	5.6	6.8	12.2	19.0	31.4
	manager	3.2	6.8	9.2	18.0	34.8
Formal safety audits occur regularly	worker	11.6	7.3	10.1	13.7	31.4
	manager	8.0	6.4	6.4	12.8	38.0
Everyone at this workplace values safety improvement	worker	3.8	6.6	10.6	22.3	32.2
	manager	3.2	6.0	9.2	24.4	28.8
Those in charge of safety have the authority to make changes	worker	8.9	6.6	9.9	18.7	30.9
	manager	6.0	5.6	7.2	18.4	34.8
Everyone has the tools/equipment needed to work safely	worker	6.3	7.6	12.9	19.2	28.6
	manager	2.8	3.6	6.8	20.0	38.4
Employees are always involved in health and safety decisions	worker	10.1	9.4	11.6	19.7	24.1
	manager	4.8	6.8	13.2	23.2	24.0
	worker	16.2	9.4	14.2	13.7	21.5

Those who act safely receive positive recognition	manager	11.2	7.6	12.8	18.0	22.4

Barriers to MSI prevention

When asked about barriers to MSI prevention, both worker and manager/OHS respondents most often reported that there was little knowledge about MSI in their workplace. Workers reported that they were not sure who was responsible for MSI prevention in the workplace. Only a small number of respondents reported not having any/or few supports for MSI, that the direct manager/supervisor was not supportive, or that the workplace did not consider health and safety a priority.

In this section of the survey we asked some specific questions of workers that were not relevant to ask managers/OHS respondents and vice versa. The survey included an item for managers/OHS about employee compliance, and a third of the managers/OHS respondents endorsed the response that employees were not often compliant. We asked workers about fear of reprisal which was endorsed by a fifth of workers. We also asked workers if they had access to treatment for MSI and about ten percent of workers selected that they have no access to treatments.

Qualitative Results

Interviews were conducted with participants who identified as having experience with MSI, either as workers, managers or OHS practitioners. The interviews consistently provided rich descriptions of the experiences related to MSI. The overarching themes

that emerged are listed and described below with accompanying quotes. In addition, we describe the MSI practice sub-themes that emerged from these interview data. The MSI practice sub-themes will be synthesized with the evidence from the scientific literature in a section below.

Theme: Knowledge and recognition

Participants consistently mentioned that MSI prevention required that all individuals in the workplace have knowledge about MSI, as well as recognition of their impact. Often participants reported that there was a need for knowledge about MSI risk factors as well as the nature of the injury and what effective measures could be taken to reduce the risk. There were many comments about the lack of recognition of MSI and the problems they cause in the workplace. When speaking about knowledge of MSI risk factors, participants often remarked that additional training and awareness for both workers and managers were required in their workplace. However, participants also acknowledged that they had seen improvements in the level of knowledge about MSI.

> Quote: *"Everyone always thinks that to address MSIs, employees should change their seat or their desk. But how many construction employees sit at a desk?* ***There is an ignorance towards ergonomics and MSIs****. All they understand is carpal tunnel syndrome and change your desk.* ***I feel like that's where we failed them.*** *There is no recognition in understanding, for example, that the hammer a carpenter is using needs to be held at the right*

> *grip, or a drill should not be held in a certain way. That little bit of extra knowledge or recognition would be helpful in preventing MSIs..."* **OHS01**
>
> Quote: *"People are getting better – attitudes to safety, including MSI, are becoming more open and understanding, they are looking for information about prevention education."* **OHS14**

Both worker and manager/OHS interviewees considered that sharing knowledge and information about MSI was very important. In fact, many participants noted that reminders and updates should be provided to workers as well as managers on a regular basis. Many workers reflected on their own experiences with MSI and shared their knowledge with co-workers. This type of informal sharing of knowledge was considered an important way to increase the recognition of MSI risk factors as well as the potential solutions. These informal ways of sharing knowledge and increasing awareness extended to "round-table" meetings, toolbox talks, "buddy systems", and leading by example, where supervisors play a role in exhibiting safe practices. In addition, participants spoke of posters and bulletin boards that provided important reminders, although these methods required regular updating to be most effective.

> Quote: "[The posters] *have not been changed in a long time. Most people just read them once and forget about it. If you ask them what's on them, they probably can't tell you. But it does give you a visual and if you take a minute to read it, it gives you a kick in the pants"* **EMP07**

The importance of communication was consistently and strongly noted by participants as they spoke about the need for knowledge and recognition. Workers

often felt they required updated information and looked to get this via formal means such as training. Managers/OHS interviewees also emphasized the need for training to increase knowledge, but many also felt that informal communication was useful. Many participants remarked that having written MSI policies was important but that it was also important to communicate information to the workplace broadly.

> Quote? *"… once a document is written, [the] employer will spend some time letting everyone know it exists, e.g. putting up posters across the workplace."* **OSH04**

Theme: Importance of being proactive

Workers and manager/OHS interviewees both spoke of the need to be proactive for MSI prevention, often noting that the concept of prevention requires proactivity. Both manager/OHS and worker participants felt that worker engagement and involvement with MSI prevention was necessary. Engagement and input were considered important in making MSI prevention more proactive. Manager/OHS interviewees marked that practices related to early reporting of injuries as well as near misses, and hazards are key to the prevention of injuries.

> Quote: "*We stress early reporting. Having dealt with lots of injured employees, if you catch it early enough, you can make the appropriate changes. So we stress early reporting as an organization. If there's something even minor – tell your supervisor and then it gets dealt with from that level on. Internally, that's been a bit of a change we've made 6.5 years*

> *ago. I brought this in early on because of what I have seen and dealt with. If you have even the slightest issue, lets deal with it early on because it becomes a major issue … I don't think we've had a single person who has gone off with any MSI issue in the company.*" **OHS01**

Workers often felt that their workplace was reactive and that hazards were not being identified, resulting in MSI injuries and claims. They remarked that regular equipment, worksite, and workstation checks by OHS professionals were very helpful in MSI prevention, but that this was not happening, though it did in the past. Workers noted that there were policies in place but that there was little follow-up to ensure that actions related to prevention were in place.

> Quote: *We have written guidelines for work practices. We have many policies, "policies galore." But the onus is on the employee to read it. Nobody goes around to make sure people are actually following safe ergonomic practices, the onus is on the employee*. **EMP02**

Worker involvement was seen as an important element of being proactive by both manager/OHS and worker participants. Manager/OHS interviewees commented about their need to be responsive to worker feedback and reports. This was linked to early reporting but extended to regular observations or assessments as well. Workers considered their feedback was useful only in supportive and communication-rich environments. Workers reported that 'open-door' policies were most helpful and often considered these a part of a positive workplace culture. Manager/OHS interviewees supported this view and described situations in which

senior management support was key in moving MSI prevention from ‘reactive’ to ‘proactive’, with positive results.

> Quote: “*Communication. It is very important for every workplace to communicate to their employees how important it is for them to work safe because they (employees) are an investment the company is making*.” **EMP07**

> Quote: *“Workplaces are redesigned, new systems and processes but NOT getting the input from the people who have to use it beyond training on the equipment. The engineers and designers put their expertise into design, but human factors are not taken into consideration. The people themselves [who then work with it] then go, ‘hey, we didn’t have any input into this. We didn’t say put that desk there and even the process, we didn’t have a say’ Then they are dealing with issues after the fact. Individuals should be involved in the planning and design process [during construction or renovation], not just supervisors and designers. Even just asking for their ideas at the design stage.”* **OHS17**

Theme: Customized and updated

Workers strongly endorsed the need for customized/individualized assessments and solutions (adjustments or equipment) for effective MSI prevention. They raised concerns about generic approaches potentially causing or exacerbating MSI injuries.

> Quote: *“[My] station was set up and [I] was supplied with the standard prevention tools but they actually contributed to the injury. But, there are*

> *going to be individual differences that have to be acknowledged. An ergonomic keyboard does not mean that there will not be an MSI."* **EMP10**

Alternatively, once solutions were identified, workers at times remarked that it took a long time to receive the individualized solution that worked best for them. Oftentimes workers mentioned trying a number of solutions along the way to one that they considered helpful.

> Quote: "*Proper workstations are very important…I finally received my new chair in [late] 2018 and I'm starting to reap the benefits, feeling better, but not my best – it took 5-6 years too long."* **EMP12**

Workers who received customized accommodations related to equipment, workstation adjustments or modified duties felt their workplaces were responsive and noted they felt better quickly once the solution was implemented.

Manager/OHS interviewees did not emphasize the need for individualized approaches but often spoke about customizing what they provided as a matter of course. They noted that workplaces often had generic MSI prevention programs/practices in place and that they would go beyond that approach to solve a problem. Manager/OHS participants spoke about customizing their training, awareness activities, and MSI prevention programs to the recipients within their environments.

> Quote: *"Programming consists of including employee-centered MSI prevention in supervisor-led Toolbox Talks and watching for potential MSI*

hazards during OHS Committee inspections (under hazard assessments), sometime WorkplaceNL posters hung up …." **OHS16**

Quote: *"If not geared to the environment, the uptake is not as good."* **OHS03**

Some Manager/OHS interviewees also felt the need to address individual workers' concerns within generic policy environments. They felt this responsiveness to worker concerns was important to avoid situations where workers would potentially stop reporting hazards.

Quote: "*Workplaces have policies in place and have feedback BUT have to follow through and deal with it. Action is required. You can't take no action. Otherwise, the employee feels like, 'I brought it up a million times, nothing's ever gonna' be done about that' and they stop reporting."* **OHS17**

Facilitators and Barriers

Facilitators and barriers to MSI prevention were identified by both workers and Manager/OHS interviewees. As is common, facilitators and barriers can be described as either-or depending on the language used. For example, resources can be seen as a barrier if they are too few, or a facilitator if they are sufficient. We present the predominant characterization as described by participants below.

Theme: Facilitator - Communication

Two themes emerged when we asked about facilitators for MSI prevention.

Communication was consistently noted as a key element in MSI prevention. Both workers and Manager/OHS interviewees discussed the benefits of clear and open communication in all aspects of hazard identification, training, and awareness activities. Communication was also noted as important to convey policy and program information to workers, as well as for workers to provide feedback and for reporting of hazards and injuries.

> Quote: *"Clear communication with employees without repercussions" as key facilitator (in terms of the ability of employees to be able to report); "Just open communications. We make sure workers' voices are heard."* **OHS16**

> Quote: *"Communication. It is very important for every workplace to communicate to their employees how important it is for them to work safe because they (employees) are an investment the company is making."* **EMP07**

Workers reported that when the workplace had good levels of communication, they felt valued and that their employers exhibited genuine concerns for workers' health status as well as concern for the hazards in the workplace. Manager/OHS interviewees noted that communication between all parties was necessary for MSI prevention. They considered communication as necessary specifically to convey important information regarding MSI prevention via awareness activities or training. They often described overall good levels of communication as a facilitator in itself.

> Quote: *"Communication. It is very important for every workplace to communicate to their employees how important it is for them to work safe*

because they (employees) are an investment the company is making."

EMP07

Quote: *"Clear communication with employees without repercussions" [is a key facilitator]; "Just open communications. We make sure workers' voices are heard."* **OHS16**

Theme: Facilitator - Tailored / Responsive

Another identified theme centered on providing tailored information and solutions to addressing MSI. This concept is linked to the overarching theme of MSI programs being customized and regularly updated. For example, both worker and Manager/OHS interviewees described how tailoring MSI information and practices enhanced prevention of MSI.

Quote: *"[There are] regular safety inspections that include workstation set up [etc] 'But it doesn't take into account the individual needs."* **EMP10**

Manager/OHS interviewees felt that MSI prevention was more successful when they were responsive to individual worker needs. The success was characterized not only by a decrease in hazard exposure but also in that the worker felt heard and was aware that the workplace was concerned and willing to adapt. Providing support in this way was perceived to facilitate early reporting and collaborative resolution of MSI issues.

Quote: *"[There is an] opportunity for employees to share concerns individually. Management goes around table and asks if employees have concerns. They note concerns and discuss how corporate can address them.*

> *At next roundtable meeting, they talk about how concerns were addressed and what they are doing about it if not yet addressed + timelines for changes. Also discuss new safety initiatives coming up that they would like staff to be ready for."* **EMP07**

Theme: Barrier - Lack of resources

Most participants commented on lack of resources as a barrier. Workers described a lack of resources in terms of their experiences with MSI, describing a lack of new or appropriate equipment as well as trained staff to address adjustments or workflow. Often, workers noted that it took too long to make the changes they needed to avoid an MSI injury. There were times when workers would compare current situations with times past when they felt there were more resources available. This again was concerning because they felt that change took too long to happen.

> Quote: "*It is the job of the OHS manager to oversee all this and make sure risks for MSIs are recognized and people are made aware, but he is not doing it. One person can't deal with a staff of [hundreds], get the information and reminders out to everyone and do his job full-time. He needs to collaborate with HR and see if they can do something together."* **EMP02**

Manager/OHS interviewees also often commented on the lack of resources as a barrier to MSI prevention. They often reflected on their own situation, usually noting they were a single individual that had to address a large number of workers concerns/hazards. There were some manager/OHS participants that took a broader

view and felt the workplace was not devoting enough resources the problem of MSI prevention overall.

> Quote: *"OHS/Managers do not have enough resources, and have too much on their plate, to successfully manage staff. Not enough support from upper level management or from employees you are managing in order to close that gap."* **OHS05**

Theme: Barrier - Lack of Knowledge

Lack of knowledge was also considered a barrier to MSI prevention by both worker and manager/OHS interviewees. Participants often indicated that workers did not have adequate awareness or knowledge about the workplace MSI policies. The challenge reported was a combination of the workplace not providing the information required and the amount of time it required to fully understand the MSI policies.

> Quote: *"More awareness/education could have helped prevent it. Everyone needs the education. You have to take care of yourself. … We need to be aware of what could become an MSI over time, I never thought I would get one."* **EMP02**

> Quote: *"Employees are not always aware of the MSI prevention policy at work, may not even know what MSIs are, or what ergonomics is. The issue with MSIs is that people don't always realize that even if an unhealthy behaviour does not impact you right away, it takes its toll after time."* **OHS04**

There were a few participants who felt that the lack of knowledge was due to the workplace not providing sufficient information to workers. This is linked to MSI

program subthemes about awareness and training (see section below). These participants remarked that improved training and awareness programs would be a solution.

> *Quote: "Workplaces can provide more education about MSI injuries to staff, especially after someone has had an MSI injury and need supports at work, nothing like this has ever been done at [t]his workplace. Employers can raise awareness about MSI by providing literature to staff, e.g. letting employees know about the proper ways of lifting."* ***EMP08***

> *Quote: "Management has no understanding about how to prevent MSIs at their workplaces. It is a case of workers themselves having no understanding of what MSI injuries are, they just don't know the difference and then management also don't understand. Management can be restricted as well because they have to report to someone above them …"* ***OHS14***

Theme: Barrier - Poor implementation

Some manager/OHS interviewees raised concerns about how well MSI prevention programs were implemented in workplaces. Poor MSI program implementation was considered to result in more retroactive approaches in which prevention was not accomplished. Some also noted that the lack of proper implementation meant that the full potential of expensive equipment solutions was not being realized. This vocal minority often mentioned that the MSI policies were only on paper and that they were not put into practice.

Quote: *MSI program is largely theoretic and prescriptive in nature, these 'best practices' are recommendations - but not implemented effectively, or at all. It is a checklist. All ingredients are there but the MSI program is a "sinking ship in terms of practice, it's just not being implemented. It's a checkbox for people to say that it's done, but that doesn't mean it is successfully done."* **OHS05**

MSI program categories and sub-themes

When asked about MSI prevention programs and practises in place at their workplaces, participants described a variety of different activities. Participants focused on the prevention activities based on their experiences and what they found most useful in their circumstances. There were three broad categories of MSI prevention practices described: 1) prevention activities related to awareness; 2) training; and, 3) hazard identification and solutions. We explore the sub-themes that emerged within these broader categories and synthesize these MSI practice-based subtheme findings with the evidence from scientific literature (research evidence).

Awareness programs and practices

Awareness of MSI was considered a key element of MSI prevention for many workers and manager/OHS participants. They spoke of both formal and informal ways of increasing awareness of MSI in the workplace. Most often activities were directed to increasing MSI awareness among workers, but OHS participants noted that managers could often benefit from increased awareness as well.

> Quote: "*I do think workplaces are all trying to prevent MSIs, but if employees don't know enough about them, they cannot know what to do to prevent them*." (EMP02)

Awareness practices included informal communication between manager/OHS and worker participants as well as more formal communication often referred to as Toolbox Talks. Toolbox Talks were frequently mentioned by participants. They could be considered quite formal with planned regular occurrences or somewhat informal in which case they were referred to as toolbox chats or worker safety huddles. In all cases they were considered an effective way to increase awareness. Posters and other communication methods were not always noted as effective but when mentioned methods such as posters did play a role in prevention practice:

> Quote: *"[toolbox talks are] To communicate new ideas and make safety a priority in the workplace." [*Weekly, usually during Friday lunches provided by company. Usually on a health & safety topic related to the work they are currently doing*]. "They are full of information for them [*owners*] and our employees. I can't tell you how much I take back to employees through Toolbox Talks. They keep issues fresh in mind among workers."* MGR06

> Quote: *"[the posters] have not been changed in a long time. Most people just read them once and forget about it. If you ask them what's on them, they probably can't tell you. But it does give you a visual and if you take a minute to read it, it does give a kick in the pants."* EMP07

These findings suggest the following evidence statement: Awareness programs and practice were considered important and effective for MSI prevention when information was presented (formally or informally) and regularly updated. “Toolbox Talks” were an MSI prevention practice often noted as effective.

Training

Training was consistently considered a key element of MSI prevention by both worker and manager/OHS participants. Formal and informal types of training from full courses, online sessions, and webinars, to one-on-one training for specific tasks such as manual materials handling were described. Participants noted that training should be engaging and “user-friendly” but also cover MSI prevention topics in-depth. Many participants noted that training should not just occur at “orientation” but that it should be repeated and refreshed regularly. Manager/OHS participants felt that the training should be evidence-based and up to date so that workers could best work safely.

> Quote: *“Training courses need to be user-friendly, packaged in a way so learners fully understand what MSIs are and how to identify risks in the workplace – it all comes back to the education and training. A lot of people just don’t have the knowledge.”* OHS14

> Quote: *“They [supervisors/managers] would show you in training the proper methods for lifting. There were videos and in-person training, you would have to show them you could do it. There were 5 days of training, and on the first*

> *few weeks on the floor, you wear a vest and they show you how to load pallets on the carts. There is 3 months of probation after that*. EMP09

Based on the findings about training, we suggest the following evidence statement: Training programs were considered effective and a key element of MSI prevention.

Implementation tips for training: Manager/OHS participants often delivered training and noted the need to regularly review and update content based on up-to-date information. Workers noted that training should be up-to-date and delivered regularly (not just at orientation). High engagement training was considered more effective by both workers and manager/OHS interviewees. Engaging trainees with hands on, practical examples relevant to their work and tasks noted as an important element of effective training.

MSI Hazard identification/solutions

The most common type of MSI prevention programs and practices mentioned by participants were those that considered the *identification* of MSI hazards or the *solutions* to MSI hazards. Workers often described the hazards they faced which led to MSI over time. They also described the types of solutions that they felt were effective for them. Manager/OHS interviewees tended to reflect on hazards across multiple jobs or tasks as well as task-specific hazards. Both mentioned that hazards changed over time and that identifying them early was a priority.

Participants spoke about physical hazards in their jobs and workplaces and often noted these hazards were addressed through ergonomics programs of some sort.

Both worker and manager/OHS interviewees spoke at length about the physical hazards in their workplaces. They were often able to provide details about the solutions required as well as the workplace processes required to bring about change or hazards solutions.

Ergonomics programs were sometimes noted as synonymous with MSI prevention.

> Quote: *"Very few people from an employee standpoint would understand the term MSI. But if I use the term ergonomics, that term is probably used enough now that people have at least heard it. They might not fully understand what the science is, but at least they have heard it, and they know it means adjusting their workstation or chair, they at least know some sort of adjustment is being made or needs to be made."* OHS01

Workload was another concern which was perceived as a cause of MSI. Some workers remarked that 'ergonomics' were not always an issue or concern for their job but that the workload or pace of work often led to MSI. Workers often described their concerns about the influence of workload as imposed by their workplace / work environment. In contrast, manager/OHS interviewees described workload as an issue more often in terms of the workers being too rushed and/or not in control as a result of their own decisions.

> Quote: *"Workload contributes and is a barrier to preventing MSIs. [The only thing that prevents prevention is the high workload. Work through poor practices to get the work done.]* EMP10

> Quote: “Even though there are different programs and approaches in place to make people aware of the potential for injury, at the end of the day it’s the workers themselves in trying to get the job done that may influence if they get hurt or not. *Sometimes human nature is to do what you can to save time but it can come back and nip them in the butt*.” (OHS16)

When describing hazard solutions, participants consistently noted that individualized solutions were more effective than generic or one-size-fits-all solutions. Workers tended to focus on the need for individualized solutions more than manager/OHS interviewees. However, manager/OHS interviewees often described the need for individual assessments to better address and be responsive to workers MSI prevention needs.

> Quote: *“They don’t live in my world. They don’t do my work.“* EMP13

> Quote: “*We have done workstation reviews for people that work in the desk jobs and provide education and knowledge. I get many emails from colleagues about adjusting their workstations and I do that when I go to the [other] office. Some people here think that … we shouldn’t have to hire someone to come in and do that.*” OHS01

There was a great deal of focus on MSI hazards, and the findings suggest the following evidence statement: MSI prevention programs that addressed MSI hazards (identification and/or solutions) were considered effective.

Specifically, ergonomics programs were considered necessary and effective for MSI prevention. In addition, participants noted that workload issues played a role in MSI and should be addressed. Workers often considered workload issues as a key cause of MSI.

Regardless of the type of hazards addressed, individualized solutions were felt to be more effective than general/generic or one-size-fits-all programs for MSI prevention.

Systematic review of reviews results

The results of Steps 1-6 of the two systematic review of reviews (SRR) may be found in Figure 6.

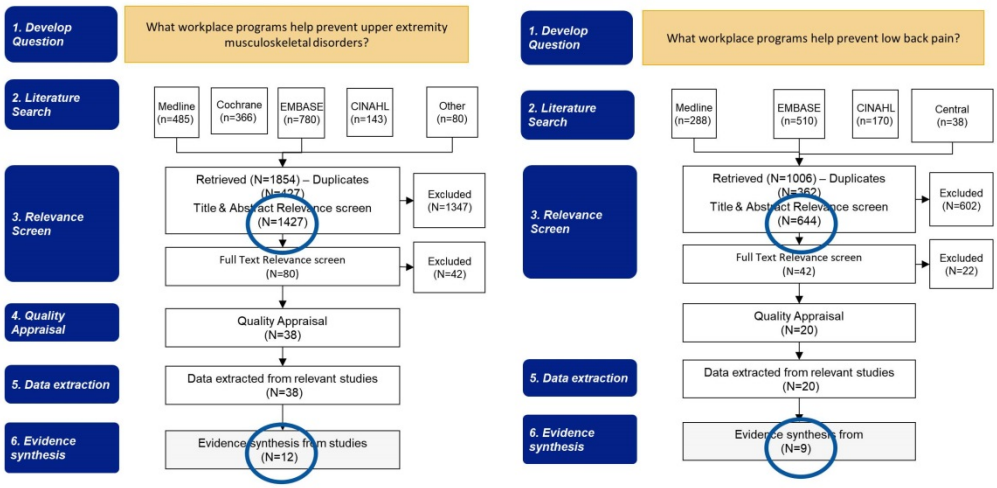

Figure 6: Flowcharts of the SRR

Across the two reviews, the team reviewed and assessed 2,071 titles and abstracts resulting in the full review of 122 full articles. From these, the team appraised the quality of 58 systematic reviews, extracted data from all 58 systematic reviews, and summarized the evidence from 21 extracted systematic reviews.

Review characteristics

We reviewed systematic reviews of multiple studies. Since sample sizes, sectors, job titles or countries were not consistently included in each of the reviews, it is not

possible to obtain an accurate count of these characteristics in the systematic reviews. Therefore, characteristics will be presented, where possible, in aggregate.

Figure 7 shows the countries of the review leads. The greatest number of reviews were from Canada, the USA, Germany, and Australia. There is also representation from other nations around the world.

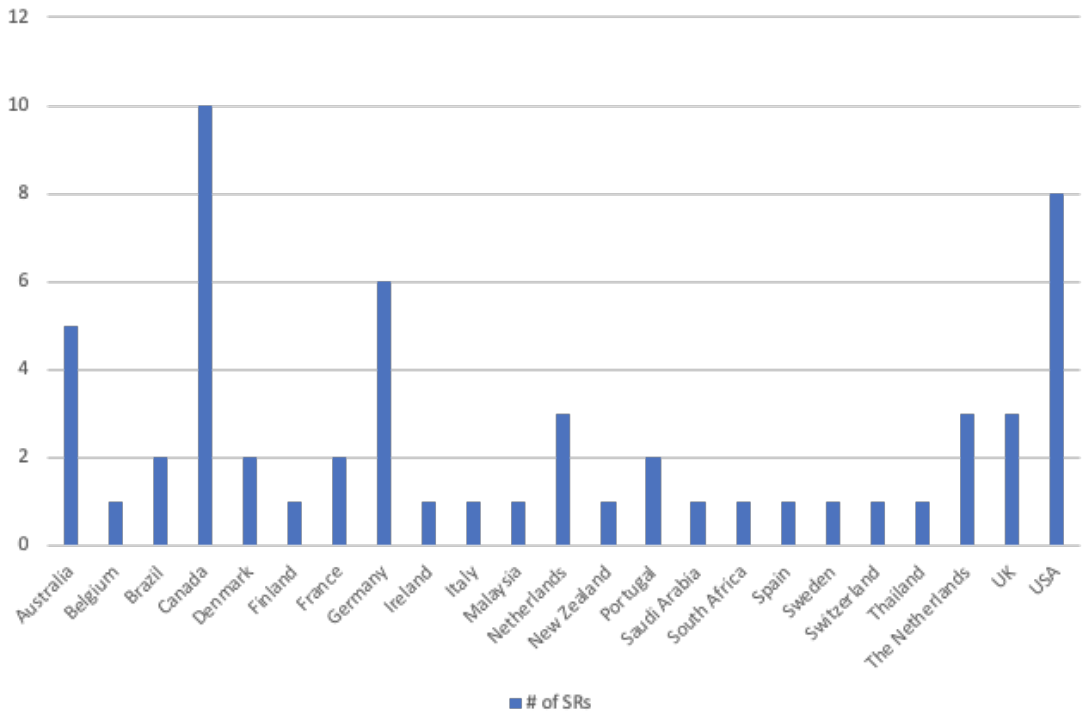

Figure 7: Number of reviews in countries they were conducted.

The following sectors were described and represented in the reviews: Agriculture, Armed services, Educational services, Health care & social assistance, Hospitality, Manufacturing, Municipality, Professional, Scientific or Technical Services, Public Administration and Retail. Within these sectors, a majority of the studies examined a working age population in general. A few specifically examined office workers, nurses and one examined agricultural workers.

Evidence Synthesis of research

Where possible, our evidence was synthesized first by the intervention, then the outcome and finally by the population examined.

Training Programs

There were four systematic reviews that looked at various training interventions for manual handling, biofeedback, and stress management across multiple low back pain and musculoskeletal outcomes. The manual handling training interventions were applied in a population of low back pain workers and showed mixed results. The biofeedback training intervention was examining the effect on musculoskeletal outcomes and found to have no effect. Three of the interventions included an examination of stress management - one in a low back pain population in nurses, one in workers with a focus on musculoskeletal outcomes, and one in workers with upper limb conditions. All three interventions were found to have no significant effect. The synthesis statements from each of the systematic reviews are in Table 4.

The synthesis statement from this body of evidence is: Overall, there is a mixed level of evidence on the effectiveness of training on MSI outcomes in different jobs and sectors?

MSI Hazard Prevention/ Solutions

There were nine systematic reviews that examined MSI hazard prevention and solutions.

One review included the broad examination of the role(s) of equipment, work design and organisation (including working relationships), working conditions or work environment, and occupational (case) management with active stakeholder involvement of (at least) the worker and the employer across multiple outcomes in workers with musculoskeletal disorders, and found positive results (1396U).

Two reviews looked at types of work accommodation and job rotation in workers with musculoskeletal outcomes and found that work accommodation decreased lost time whereas job rotation was found to have a mixed effect (430U, 436U).

Seven reviews examined modifications to workstations. One review resulted in the determination that sit-stand desks bring about a slight reduction in discomfort from low back pain (483 U). Another review determined that workstation adjustments with minimal worker engagement had no effect on musculoskeletal outcomes. The same review found that adding forearm supports to workstations and providing a mouse with vibration feedback had a positive effect on musculoskeletal outcomes (431U). In contrast, a review that examined arm support or an alternative mouse had

inconclusive findings when examining these interventions in terms of their effect on the incidence of neck or shoulder musculoskeletal disorders (468U). Another review examined the impact of either an adapted mouse or adjustable keyboard-mouse tray on pain, muscle strength, endurance, work ability, function and work disability in workers with upper limb conditions and found that they had positive results across all of the outcomes (1392U). Finally, two reviews that examined the impact of different types of breaks, active, standing and supplementary, on low back pain and discomfort in office workers and symptom intensity of workers with musculoskeletal disorders had generally positive results. Specifically, active breaks with postural change were found to reduce low back pain and discomfort in office workers whereas, without postural change, active breaks had no effect on pain but did have a positive effect on discomfort duration. Standing breaks (while performing computer work) were found to reduce discomfort from low back pain in the same population. Supplementary breaks versus a conventional break schedule were found to decrease symptom intensity of workers with musculoskeletal disorders (565L,159U). Table 4 shows the synthesis statements from each of the systematic reviews.

The synthesis statement from this body of evidence is: Overall, there is evidence of effectiveness for many MSI hazard prevention/solutions. While many of the studies were completed among office workers form various sectors, the MSI prevention principles can be applied to different types of jobs.

Multi-faceted Programs

Eight reviews examined different types of multi-faceted programs, for example: multidisciplinary rehabilitation; multiple types of physical interventions; or, different workplace adjustments across the multiple outcomes such as pain, disability, lost time, muscle strength, endurance, work ability, function, in low back pain and musculoskeletal disorders. In one of the eight reviews, multidisciplinary rehabilitation versus usual care was found to reduce pain and disability in patients with low back pain but had no impact on the odds of being at work. However, when compared to physical treatments, it was found to increase the odds of being at work one year later in patients with low back pain returned to work(357L). One review found that multidimensional interventions were found to have no effect on low back pain in nurses (571L). Physical activity or integrated health care at the workplace was found to decrease pain and symptoms of workers with chronic musculoskeletal disorders (468U) in another review. Two reviews reported that multi-domain interventions (encompassing at least two of health-focused interventions, service coordination interventions, work modification interventions) or graded activity programs decrease lost time for workers with musculoskeletal disorders (430U, 1396 U). At the broader workplace level, workplace adjustments, ergonomic training and work style behaviour counselling were found to reduce pain, increase muscle strength and endurance, maintain work ability, improve upper limb function and reduce work disability in workers with upper limb conditions (1392U). One review examined the effect of physical interventions (including exercise, body mechanics, modalities, and pre-task priming activities) in agricultural workers and found they prevented injury

and positively assisted in the management of chronic low back pain (294L). Finally, the effectiveness of work disability prevention (WDP) interventions for managing neck pain, whiplash-associated disorders (WAD), and upper extremity disorders was found to be inconclusive (158U). Table 4 shows the individual synthesis statements from each of the systematic reviews.

The synthesis statement from this body of evidence is: Overall there is evidence of effectiveness for multi-faceted interventions for MSI prevention (and MSI disability prevention) across various sectors.

Early intervention

One study examined what happens if a workplace intervenes early with part time sick leave in conjunction with appropriate job modifications. Study results suggest that if intervention occurs during the first two weeks of sickness absence, both interventions reduced the duration and recurrence of sickness absence for workers with musculoskeletal disorders (428U). The synthesis statements from each of the systematic reviews are in Table 4.

The synthesis statement from this body of evidence is: Overall early interventions for MSI are effective for MSI disability prevention

Exercise

Six reviews examined different forms of exercise programs, some at the workplace level and some at the individual level. Workplace-based exercise programs (e.g. work hardening and training, physical activity and strengthening) that acknowledged the role of pain, muscle strength, endurance, work ability, function and disability on MSIs were found to be effective (1392, 1391U, 468U). One review determined that intense physical conditioning as compared to usual care reduced sickness absence for workers with chronic low back pain (413L). Two reviews that examined stretching exercises, one in nurses and one in workers in general, found them to be effective in low back pain and musculoskeletal outcomes (571L, 431U). Table 4 shows the individual synthesis statements from each of the systematic reviews.

The synthesis statement from this body of evidence is: There is consistent emerging evidence that exercise is effective for MSI prevention

Table 4: Synthesis statements from the included systematic reviews according to intervention type

Intervention type	Evidence statements from the included systematic reviews Positive=bold, no effect=plain, mixed-italics
Training	• *Manual handling training was found to have mixed results on workers with low back pain. (551 U,571 L)* • Biofeedback training was found to have no effect on musculoskeletal outcomes. (431 U)

	• Stress management was found to have no effect on reducing low back pain intensity in nurses. (571L) • Job stress management training was found to have no effect on musculoskeletal outcomes. (431 U) • Job stress management training was found to have no significant additional effect on pain, muscle strength, endurance, workability, upper limb function or work disability in workers with upper limb conditions. (1392 U)
MSI Hazard prevention/ solutions	**• Equipment, work design and organisation (including working relationships), working conditions or work environment, and occupational (case) management with active stakeholder involvement of (at least) the worker and the employer were found to reduce time to RTW and improve pain and functional status in workers with musculoskeletal disorders. (1396U)** **• Work accommodation was found to decrease lost time for workers with musculoskeletal outcomes. (430 U)** **• Sit-stand desks were found to bring about a slight reduction in low back pain discomfort in office workers. (483 L)** **• Forearm supports added to workstations were found to have a positive effect on musculoskeletal outcomes in office workers. (431 U)** **• Vibration feedback on mouse was found to have a positive effect on musculoskeletal outcomes in office workers. (431 U)** **• Adapted mouse using more neutral forearm and wrist positions was found to reduce pain, increase muscle strength and endurance, maintain work ability, improve upper limb function and reduce work disability in workers with upper limb conditions in office workers. (1392 U)** **• Adjustable keyboard-mouse tray with touch pad in the non-dominant hand when compared with Microsoft Naturals keyboards and reduced force keyboards were found to reduce pain, increase muscle strength and endurance, maintain work ability, improve upper limb**

	function and reduce work disability in workers with upper limb conditions in office workers. (1392 U) **• Active breaks with postural change were found to reduce low back pain and discomfort in office workers. (565L)** **• Standing breaks (while performing computer work) were found to reduce discomfort from low back pain in office workers. (565L)** **• Supplementary breaks versus a conventional break schedule were found to decrease symptom intensity of workers with musculoskeletal disorders. (159U)** *• Job rotation was found to have a mixed effect on musculoskeletal outcomes. (436 U)* *• Arm support or an alternative mouse may or may not have been found to reduce the incidence of neck or shoulder musculoskeletal disorders in office workers. (468U)* • Workstation adjustment alone with minimal worker engagement was found to have no effect on musculoskeletal outcomes in office workers. (431 U) • Active breaks without postural change were found to have no effect on pain but a positive effect on discomfort duration in office workers. (565L)
Multi-faceted programs	**• Multidisciplinary rehabilitation versus usual care was found to reduce pain and disability in patients with low back pain. (357L)** **• Multidisciplinary rehabilitation versus usual care was found to have no impact on odds of being at work, but when compared to physical treatments it was found to increase the odds of being at work one year later in patients with low back pain. (357L)** **• Physical activity or integrated health care at the workplace was found to decrease pain and symptoms of workers with chronic musculoskeletal disorders. (468U)** **• Multi-domain interventions (encompassing at least two of Health-focused interventions, Service**

	coordination interventions, Work modification interventions) were found to decrease lost time for workers with musculoskeletal disorders. (1396 U) **• Graded activity programs were found to decrease lost time for workers with musculoskeletal disorders. (430U)** **• Workplace adjustments, ergonomic training and work style behaviour counselling were found to reduce pain, increase muscle strength and endurance, maintain work ability, improve upper limb function and reduce work disability in workers with upper limb conditions. (1392U)** **• Physical interventions (including exercise, body mechanics, modalities, and pre-task priming activities) were found to prevent injury and positively assist in the management of chronic low back pain in agricultural workers. (294L)** • *Effectiveness of work disability prevention (WDP) interventions for managing neck pain, whiplash-associated disorders (WAD), and upper extremity disorders was found to be inconclusive. (158U)* • Multidimensional interventions were found to have no effect on low back pain in nurses. (571L)
Early interventions	**• Early part-time sick leave together with appropriate job modifications was found to lead to a reduction in the duration and recurrence of sickness absence for workers with musculoskeletal disorders. (428U)** **• Intervening during the first two weeks of sickness absence was found to reduce the duration of sickness absence for workers with musculoskeletal disorders. (428U)**
Exercise	**• Workplace exercise programs were found to reduce pain, increase muscle strength and endurance, maintain work ability, improve upper limb function and reduce work disability for workers with upper limb conditions. (1392U)**

	• Workplace-based work hardening, and training were found to reduce pain, increase muscle strength and endurance, maintain work ability, improve upper limb function and reduce work disability in workers with upper limb conditions. (1392U) **• Workplace-based strengthening exercises were found to be effective in reducing neck pain in office workers who were symptomatic, and the effect size was larger when the exercises were targeted to the neck/shoulder. (1391U)** **• Interventions to improve workplace physical activity were found to be moderately effective in reducing musculoskeletal pain among employees. (468U)** **• Intense physical conditioning compared to usual care was found to reduce sickness absence for workers with chronic low back pain. (413L)** **• Stretching exercises were found to reduce low back pain intensity in nurses, (571L)** **• Stretching exercise programs (including Yoga) with an upper extremity component were found to have a positive effect on musculoskeletal outcomes, (431U)** **• Resistance exercise was found to have a positive effect on musculoskeletal outcomes. (431U)**

Discussion: synthesis of practice and research evidence

Guided by the original definition of evidence-based practice (Sackett et al., 1996) and an evidence-based approach described by the Public Health Agency of Canada best practices portal (PHAC, http://cbpp-pcpe.phac-aspc.gc.ca/resources/planning-public-health-programs/), we set out to collect and synthesize evidence from current practice and from the scientific research literature. We conducted a survey and in-

depth interviews to collect practice evidence on how to prevent MSI in the workplace. In addition, we conducted a systematic review of reviews of the literature on MSI prevention. We then synthesized the evidence from these sources to provide practical guidance for workplaces on MSI prevention programs and practices, including their implementation. Note the resource we produced from this project is presented in a different section of this final report.

Evidence from practice

Results from the survey of 645 respondents shows that workplaces are reported to be engaged in many traditional MSI prevention practices related to hazard reduction including personal protective equipment (PPE), proper tools, ergonomics, and rest breaks. There was less agreement that flexible work hours/locations or exercise programs were available, despite the growing evidence from research about the effectiveness of exercise programs for MSI prevention (Chen et al., 2018; Hoosain, de Klerk, & Burger, 2019; Moreira-Silva et al., 2016; Schaafsma et al., 2013; Skamagki, King, Duncan, & Wahlin, 2018; Van Eerd et al., 2016). There was general agreement that traditional organizational policies and practices were in place in NL workplaces. However, the survey results showed there was less agreement that MSI prevention programs and practices were well implemented. Our qualitative findings supported the survey results about the availability of MSI program and practices. The qualitative results also showed there were overarching concepts related to knowledge and recognition, proactive approaches, and customization around MSI

prevention programs and practices that are important for workplaces to consider. These results also revealed key barriers and facilitators related to resources, implementation, and communication which were linked to the success of MSI prevention practices.

Our synthesis of practice evidence found three categories of MSI prevention programs and practices that were considered important and effective in NL workplaces:

1) Awareness programs and practices, both formal and informal, were described as necessary and effective particularly when updated regularly. There appears to be little or no research on awareness interventions for MSI prevention in the scientific literature. While this means there is a lack of research evidence, it does not mean that awareness programs and practices are not effective.
2) Training programs and practices were consistently noted as an important element of MSI prevention in workplaces. This was noted by both workers and managers/OHS participants. The research evidence for MSI prevention training is not strong, with many studies reporting no evidence of effect from training (see below). It is possible that the training interventions studied were not well implemented or that the follow-up times were short and therefore MSI outcomes did not change.

3) MSI hazard identification/ solutions were reported as key MSI prevention programs and practices by study participants who felt they were effective. These programs and practices were felt to be particularly effective if they were individualized. MSI hazard solutions are consistently found to be effective for MSI prevention in the literature (see below).

Evidence from research

The synthesis of the scientific literature shows that there are a number of effective MSI prevention practices. The research findings are from studies conducted in a variety of jurisdictions and industrial sectors. In general most of the 'interventions' considered effective were hazard solutions (such as modified equipment, adjustable workstation elements, work breaks, stress management programs, or multi-faceted programs that covered a number of hazards) (Agarwal, Steinmaus, & Harris-Adamson, 2018; Cullen et al., 2018; Hoe, Urquhart, Kelsall, Zamri, & Sim, 2018; Hoosain et al., 2019; Van Eerd et al., 2016; Varatharajan et al., 2014; Waongenngarm, Areerak, & Janwantanakul, 2018). Most of these focused on physical hazards but included some psychosocial interventions as well. Our findings are in agreement with those of a recent overview of reviews on the broader area of occupational health and safety intervention by Teufer et al (2019). They also found some evidence for hazard solutions and ergonomics interventions, and reported that training interventions were not found to be effective. The lack of evidence of

effectiveness of training programs for MSI prevention is consistently reported in the research literature (Hogan, Greiner, & O'Sullivan, 2014; Kuijer et al., 2014; Van Hoof et al., 2018). It is possible that, despite the fact that the training programs were considered important and effective in practice, the research did not examine the same MSI prevention outcomes as our study sample. More research is necessary to determine why there is a divide between practice and research evidence. One emerging area of evidence from the research relates to the effectiveness of exercise programs such as strengthening and stretching, which we found and was also supported by Teufer (2019) and others (Chen et al., 2018; Hoosain et al., 2019; Moreira-Silva et al., 2016; Schaafsma et al., 2013; Skamagki et al., 2018; Van Eerd et al., 2016). There was little mention of exercises for MSI prevention practices in our sample of participants.

In summary, we found that current practices for MSI prevention included awareness activities, training and hazard identification and solutions. The current research literature is more focused on the effectiveness of hazard solutions and health promotion activities (e.g. strengthening exercises). Our qualitative analysis also revealed several key themes, including facilitators and barriers that were important to successful implementation of MSI prevention programs and practices. ,

Synthesis of practice and research evidence

Our synthesis of the practice and research evidence suggests there is:

- *positive and consistent evidence* for many hazard solution practices
- *mixed evidence* for MSI prevention training with practice evidence support and *mixed evidence* from research, and
- *practice evidence support but no research evidence* for awareness practices related to MSI prevention.

Our findings suggest that these programs and practices had improved chances of success if there were good levels of **knowledge and recognition** about MSI prevention in the workplace. We also found that **proactive** approaches as well as **customized and updated** programs and practices were considered to be more beneficial for MSI prevention. In addition, the key barriers revolved around a **lack of** sufficient **resources** and **knowledge** about MSI as well as **poor implementation** of MSI programs and practices. Key facilitators, on the other hand, were linked to good levels of **communication** and having **tailored and responsive** solutions to MSI prevention.

Our approach to this evidence synthesis is unique and builds on the original definition of evidence-based practice. We recognize that, based on our experience doing systematic reviews, research evidence is lacking for MSI prevention. This is partly due to the fact that research focuses on ‘interventions’ that workplaces *can* put in place, but it is unclear how well these interventions are *actually* implemented (Kristensen, 2005; van Eerd et al., 2010). It may also be the case that programs and practices that workplaces put in place are developed more specifically for their own context, which may result in better implementation. The findings of this research

included considerations about implementation. In our qualitative analysis, we were able to highlight some important themes that support improved implementation of MSI prevention programs and practices.

Strengths and limitations

Our research has a number of strengths. We engaged with a stakeholder advisory committee to guide our research approach from the type of questions we asked, through to the framing of the practical messages from our results. This integrated knowledge transfer approach can aid in the dissemination of research to workplace knowledge users (Van Eerd & Saunders, 2017). In addition, we collected data from a sample of workers, and from those who manage others, or provide occupational health and safety expertise, who reported having experience with MSI. Our methods for collecting practice evidence were guided by the PHAC best practices approach and the original definition of evidence-based practice (Sackett et al., 1996) which provided data rich descriptions of workplace practices and experiences from study participants.

One limitation of this study was our use of a convenience sample. It would be useful to explore workplace practices in a broader sample of respondents with equal representation of sectors and organization sizes. However, reaching workers, managers, and OHS personnel in workplaces is challenging. Therefore, we recruited from known networks and through our stakeholder advisory committee (and their networks) and encouraged potential participants to forward the survey to others who

may be interested. While we were unable to determine our response rate, our sample represented those who reported experience with MSI in multiple industrial sectors in the target province in Canada. Additional research including individuals who had left the labour market due to MSI, or who are working in more precarious jobs, would complement our findings.

Conclusion

This research used a unique approach to synthesizing evidence from both practice and research. We found evidence that three categories of MSI prevention programs and practice were considered important and effective. Workplaces should consider implementing i) awareness programs/practices, ii) training programs/activities, and iii) MSI hazard identification/solution programs/practices for MSI prevention. Our findings also suggest that these programs/practices can be enhanced if they are proactive, customized and updated, and when there are good levels of knowledge and recognition about MSI prevention. In addition, good communication and solutions that are tailored and responsive are important facilitators for the implementation of MSI prevention programs/practices. The key barriers noted for effective MSI prevention are lack of resources and knowledge as well as incomplete or poor implementation of the programs/practices. While these barriers are commonly reported, they remain important to address to ensure that MSI prevention is effective in workplaces.

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Appendices

Appendix A: Medline literature searches

MEDLINE search MSDs- Low Back Pain

Database: Ovid MEDLINE: Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE® Daily and Ovid MEDLINE® <1946-Present>

Search Strategy:

---

1 dorsalgia.ti,ab.

2 exp Back Pain/

3 exp Low Back Pain/

4 (lumbar adj pain).ti,ab.

5 coccyx.ti,ab.

6 coccydynia.ti,ab.

7 sciatica.ti,ab.

8 sciatic neuropathy/

9 spondylosis.ti,ab.

10 lumbago.ti,ab.

11 back disorder$.ti,ab.

12 (backache or back pain).ti,ab.

13 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12

14 accountant?.ti,ab.

15 apprentice?.ti,ab.

16 companies.ti,ab.

17 company.ti,ab.

18 "computer user?".ti,ab.

19 contractor?.ti,ab.

20 employee?.ti,ab.
21 employer?.ti,ab.
22 Employment/
23 factories.ti,ab.
24 factory.ti,ab.
25 firm?.ti,ab.
26 "Delivery of Health Care"/
27 health care.ti,ab.
28 healthcare.ti,ab.
29 exp industry/
30 job?.ti,ab.
31 laborer?.ti,ab.
32 labourer?.ti,ab.
33 manufacturing.ti,ab.
34 material? handler?.ti,ab.
35 material? handl$.ti,ab.
36 millwright?.ti,ab.
37 Occupations/
38 occupation$.mp.
39 office?.ti,ab.
40 operator?.ti,ab.
41 personnel.ti,ab.
42 plant?.ti,ab.
43 retail$.ti,ab.
44 supervisor?.ti,ab.
45 (task? adj10 (work$ or occupation$ or job$)).ti,ab.

46 Labor Unions/

47 visual display terminal?.ti,ab.

48 VDT.ti,ab.

49 warehous$.ti,ab.

50 Work/

51 work$ environment.ti,ab.

52 Workload/

53 work pace.ti,ab.

54 work site?.ti,ab.

55 worksite?.ti,ab.

56 worker?.ti,ab.

57 Workplace/

58 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57

59 13 and 58

60 systematic review.tw.

61 meta-analysis.pt.

62 intervention$.ti.

63 60 or 61 or 62

64 59 and 63

65 limit 59 to "reviews (maximizes specificity)"

66 64 or 65

67 limit 66 to yr="2013-current"

MEDLINE search MSDs- Upper Extremities

Database: Ovid MEDLINE: Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE® Daily and Ovid MEDLINE® <1946-Present>

Search Strategy:

---

1 accountant?.ti,ab.

2 apprentice?.ti,ab.

3 companies.ti,ab.

4 company.ti,ab.

5 "computer user?".ti,ab.

6 contractor?.ti,ab.

7 employee?.ti,ab.

8 employer?.ti,ab.

9 Employment/

10 factories.ti,ab.

11 factory.ti,ab.

12 firm?.ti,ab.

13 "Delivery of Health Care"/

14 health care.ti,ab.

15 healthcare.ti,ab.

16 exp industry/

17 job?.ti,ab.

18 laborer?.ti,ab.

19 labourer?.ti,ab.

20 manufacturing.ti,ab.

21 material? handler?.ti,ab.

22 material? handl$.ti,ab.

23 millwright?.ti,ab.

24 Occupations/

25 occupation$.mp.

26 office?.ti,ab.

27 operator?.ti,ab.

28 personnel.ti,ab.

29 plant?.ti,ab.

30 retail$.ti,ab.

31 supervisor?.ti,ab.

32 (task? adj10 (work$ or occupation$ or job$)).ti,ab.

33 Labor Unions/

34 visual display terminal?.ti,ab.

35 VDT.ti,ab.

36 warehous$.ti,ab.

37 Work/

38 work$ environment.ti,ab.

39 Workload/

40 work pace.ti,ab.

41 work site?.ti,ab.

42 worksite?.ti,ab.

43 worker?.ti,ab.

44 Workplace/

45 or/1-44

46 Accident Prevention/

47 administrative control?.ti,ab.

48 alternat$ point$ device?.ti,ab.

49 anti-fatigue mat?.ti,ab.

50 antifatigue mat?.ti,ab.

51 anti-vibration.ti,ab.

52 antivibration.ti,ab.

53 arm support?.ti,ab.

54 exp Self-Help Devices/

55 assistive equipment.ti,ab.

56 back belt?.ti,ab.

57 back school?.ti,ab.

58 backschool?.ti,ab.

59 behavio?r based.ti,ab.

60 Practice Guidelines as Topic/

61 best practice?.ti,ab.

62 best practice?.mp.

63 chair?.ti,ab.

64 cleaning regime?.ti,ab.

65 disability management.ti,ab.

66 education/

67 Occupational Health Services/

68 engineering control$.ti,ab.

69 Human Engineering/

70 ergonomic?.ti,ab.

71 exp Exercise/

72 Physical Fitness/

73 foot stool?.ti,ab.

74 footstool?.ti,ab.

75 Genetic Testing/

76 Gloves, Protective/

77 Health Promotion/

78 (health adj3 safety).ti,ab.

79 (injur$ adj2 accommodat$).ti,ab.

80 (injur$ adj2 assess$).ti,ab.

81 injury control$.ti,ab.

82 (injur$ adj2 prevent$).ti,ab.

83 intervention studies/

84 intervention?.ti,ab.

85 job control.ti,ab.

86 job control$.ti,ab.

87 job control?.ti,ab.

88 job enlargement.ti,ab.

89 job expansion?.ti,ab.

90 job rotation?.ti,ab.

91 keyboard?.ti,ab.

92 lift$ assist$.ti,ab.

93 lift$ device?.ti,ab.

94 Lighting/

95 machine guard?.ti,ab.

96 manual lift$.ti,ab.

97 micro-break?.ti,ab.

98 microbreak?.ti,ab.

99 (modif$ adj2 job?).ti,ab.

100 (modif$ adj2 task?).ti,ab.
101 (modif$ adj2 work$).ti,ab.
102 nerve conduction test$.ti,ab.
103 Accidents, Occupational/
104 office support?.ti,ab.
105 "occupational health and safety program$".ti,ab.
106 OHS program$.ti,ab.
107 onsite treatment?.ti,ab.
108 organizational policy/
109 organisational practice?.ti,ab.
110 organizational practice?.ti,ab.
111 "occupational safety and health program$".ti,ab.
112 OSH program$.ti,ab.
113 participatory process$.ti,ab.
114 "Moving and Lifting Patients"/
115 people based safety.ti,ab.
116 people-oriented culture?.ti,ab.
117 personal protective equipment.ti,ab.
118 Posture/
119 postur$.ti,ab.
120 pre-employment screen$.ti,ab.
121 pre-placement screen$.ti,ab.
122 prevention?.ti,ab.
123 Primary Prevention/
124 protection.ti,ab.
125 Protective Clothing/

126 Protective Devices/

127 Ear Protective Devices/

128 Eye Protective Devices/

129 Head Protective Devices/

130 Masks/

131 protective equipment.ti,ab.

132 radiographic screen$.ti,ab.

133 re-design$.ti,ab.

134 redesign$.ti,ab.

135 rest break?.ti,ab.

136 Return to Work/

137 (return$ adj3 work$).ti,ab.

138 Safety/

139 safety climate?.ti,ab.

140 safety culture?.ti,ab.

141 safety incentive?.ti,ab.

142 safety training.ti,ab.

143 Muscle Stretching Exercises/

144 supervisor training.ti,ab.

145 training.ti,ab.

146 Vibration/

147 vibration dampen$.ti,ab.

148 violence prevention?.ti,ab.

149 work accommodation?.ti,ab.

150 work hardening.ti,ab.

151 workplace organisation.ti,ab.

152 workplace organization.ti,ab.
153 workplace surveillanc$.ti,ab.
154 work-place surveillanc$.ti,ab.
155 workstation adjust$.ti,ab.
156 work-station adjust$.ti,ab.
157 wrist guard?.ti,ab.
158 or/46-157
159 Arm/
160 Cervical Vertebrae/
161 Elbow/
162 exp Fingers/
163 Forearm/
164 Hand/
165 Metacarpus/
166 Neck/
167 Rotator Cuff/
168 exp Musculoskeletal System/
169 Shoulder/
170 thumb/
171 Upper Extremity/
172 Wrist/
173 or/159-172
174 Pain/
175 Soft Tissue Injuries/
176 "Sprains and Strains"/
177 "Wounds and Injuries"/

178 or/174-177

179 173 and 178

180 exp Aging/

181 exp Arm Injuries/

182 Arthralgia/

183 Arthritis/

184 Brachial Plexus Neuritis/

185 exp Bursitis/

186 Carpal Tunnel Syndrome/

187 Causalgia/

188 "complaint? of the arm neck and shoulder?".ti,ab.

189 Cubital Tunnel Syndrome/

190 Cumulative Trauma Disorders/

191 CTD.ti,ab.

192 De Quervain Disease/

193 (elbow? adj2 injur$).ti,ab.

194 epicondylitis.ti,ab.

195 exp Forearm Injuries/

196 Ganglion Cysts/

197 "golfer$ elbow".ti,ab.

198 Hand Injuries/

199 Hand-Arm Vibration Syndrome/

200 hernia$.mp.

201 exp Musculoskeletal Diseases/

202 musculoskeletal disorder?.ti,ab.

203 MSD?.ti,ab.

204 (musculoskeletal adj2 injur$).ti,ab.
205 exp Myofascial Pain Syndromes/
206 exp Neck Injuries/
207 Neck Pain/
208 exp Neuralgia/
209 Neuritis/
210 Osteoarthritis/
211 Osteoarthritis, Spine/
212 prolapse/
213 Radiculopathy/
214 Raynaud Disease/
215 repetitive strain injur$.ti,ab.
216 RSI?.ti,ab.
217 Shoulder Dislocation/
218 Shoulder Impingement Syndrome/
219 (shoulder? adj2 injur$).ti,ab.
220 Shoulder Pain/
221 synovitis/
222 Tendinopathy/
223 exp Tendon Injuries/
224 tendonitis.ti,ab.
225 Tennis Elbow/
226 Tenosynovitis/
227 tenovaginitis.ti,ab.
228 tension neck syndrome?.ti,ab.
229 Thoracic Outlet Syndrome/

230 Ulnar Nerve Compression Syndromes/

231 white finger?.ti,ab.

232 (work-related adj3 upper extremit$).ti,ab.

233 Wrist Injuries/

234 or/180-233

235 179 or 234

236 45 and 158 and 235

237 animals/ not humans/

238 236 not 237

239 limit 238 to yr="2008-current"

240 limit 239 to yr="2013-current"

241 limit 240 to "reviews (maximizes specificity)"