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The Effectiveness of Workplace Musculoskeletal Injury Risk Factor Screening Tools for Guiding Injury Prevention Interventions:

A Systematic Review

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ABSTRACT

Background:
Musculoskeletal injury (MSI) materially contributes to global health burdens. Effective MSI prevention is necessary. MSI risk factor screening tools can be used by employers to identify and mitigate occupational hazards. A rigorous synthesis of the effectiveness of these tools has not taken place. We sought to synthesize available literature on the effectiveness of MSI risk factor screening tools for informing injury prevention interventions.

Methods:
A literature search of MEDLINE, EMBASE, Cochrane Library (Trials), CINAHL, Scopus and PsycInfo databases was performed. Included studies required an analytic design, utilized an MSI risk factor screening tool to guide an intervention in a working-age population, and reported at minimum an outcome of MSI development, injury, or compensation/work absence. Two authors independently assessed study eligibility. Data extraction and study quality rating (Downs and Black criteria) were completed by one author with verification by another author. Study outcomes were synthesized when possible.

Results:
18 articles representing 14 studies met our inclusion criteria. No high-quality studies were identified (maximum Downs and Black score of 19) and results were inconsistent. Outcome measure heterogeneity precluded meaningful meta-analysis.

Conclusions:
There is limited evidence regarding use of MSI risk factor screening tools to guide interventions for MSI-related outcome prevention. Rigorous studies evaluating commonly used tools are needed.

Key words:
Occupational Health, Musculoskeletal Pain; Cumulative Trauma Disorders, Insurance, Disability; Compensation and Redress; Workers' Compensation; Sick Leave; Ergonomics; Employment

EXECUTIVE SUMMARY

Key points

What is already known about this subject:

- Musculoskeletal injuries occur commonly at work and can lead to work absence, productivity loss as well as other health- and disability-associated costs.
- Workplace prevention of new musculoskeletal injury (MSI) through targeted interventions may reduce the global burden of MSI.
- MSI risk factor screening tools identified in the literature are not consistently validated in workplace settings, and no high-quality literature synthesis is available on the effectiveness of MSI risk factor screening tools for informing injury prevention interventions in workplace settings.

What this study adds:

- This systematic review synthesizes literature on the effectiveness of MSI risk factor screening tools for informing injury prevention interventions in the workplace.
- MSI risk factor screening tools in the literature are typically purpose-built for specific occupational niches and used in a single instance.
- Available research is small in study quantity, lacks high-quality, peer reviewed trials, and suggests insufficient evidence or limited evidence of nonsignificant and mixed effects regarding MSI risk factor screening tool use for prevention of MSI outcomes in the workplace.

What impact this may have on practice or policy:

- When used alone or in the context of a broader injury prevention program, current evidence is insufficient to characterize the effect of MSI risk factor screening tool use for informing injury prevention interventions.
- Considering the available evidence, this study does not recommend heavy or exclusive reliance on MSI risk factor screening tools in broader programmatic interventions to prevent incident workplace MSI.
- High-quality evaluations of commonly used MSI risk factor screening tools are needed before they can be widely recommended for use.

BODY OF REPORT (3,980 words)

Introduction

Musculoskeletal injuries (MSI) are among the largest contributors to the global burden of pain, disability, and work loss[1]. The prevalence of MSI is increasing worldwide, most notably among low and middle income countries.[2] We lack a unified international-level strategy to prioritize their treatment, as exists more generally for communicable diseases[2]. Given these substantial burdens and alongside current treatment barriers, there is a definitive need for strategies that mitigate MSI symptoms or prevent incident MSI (primary prevention)[3]. The latter strategy is especially important and can be enacted through targeted and effective interventions in populations who are most at risk of an MSI. Workers are a key population for these targeted approaches. Since 2000, occupational exposure causing neck and back pain has alone contributed nearly 14% of all occupational disability-adjusted life years globally[4].

Occupational health and safety regulations often have employers identify, assess, and control or reduce occupational risk factors associated with MSIs. Various MSI risk factor screening tools exist and are aimed at risk identification. These tools include, but are not limited to, questionnaires as well as observational criteria to identify types of workload risk – including intensity, frequency, or duration of tasks[5]. A recent scoping review identified 19 different risk assessment tools, concluding this was a “large number of observational assessment tools”[5].

Throughout this review, MSI risk factor screening tools are viewed in the context of informing interventions to prevent MSI and its effects. Previous research has reviewed the measurement properties of MSI risk factor screening tools, with varying reliability and validity reported[6]. Reliability appears to vary across items within individual tools and depends on rater experience[7]. However, their effectiveness of MSI risk factor screening tools for informing injury prevention programs has not been studied. In the context of informing interventions, the effectiveness of the MSI screening tool depends on how accurately the tool identifies risk factors as well as how effectively it informs the implementation of targeted prevention intervention(s).

Despite the apparent breadth of MSI risk factor screening tools, some researchers have raised concerns about their utility and effectiveness[8, 9]. MSI risk factor screening tools are typically developed using biomechanical, laboratory or consensus studies, rather than through methodologically rigorous trials in actual work environments. Furthermore, rationales for adoption of industrial standards and threshold limits for workload exposures have been criticized as lacking rigor or transparency. Armstrong et al. recommend a solution – formal evaluation of these risk assessment procedures using the same techniques required for medical or public health standards[9].

Research is needed to assess the current scientific literature involving evaluation of the effectiveness of MSI risk factor screening tools for informing injury prevention interventions through a rigorous epidemiological lens. This will provide critically important information regarding the validity and effectiveness of these tools for guiding interventions to prevent MSI. Therefore, this systematic review seeks to summarize the

evidence available regarding the effectiveness of MSI screening tool use for preventing MSI.

Methods

This review followed Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines[10]. The review protocol was registered with the International Prospective Register of Systematic Reviews (CRD42021232747).

A systematic literature search was carried out by a health sciences librarian (LD) in MEDLINE via Ovid (1946-March 18, 2021), EMBASE via Ovid (1974-March 18, 2021), SCOPUS (searched March 19, 2021), CINAHL Plus with Full Text (via EBSCOhost) (1937-March 19, 2021), Wiley Cochrane Central Register of Controlled Trials (CENTRAL) (searched March 19, 2021) and APA PsycInfo (1806-November Week 3, 2021) databases. Team members (DG, TS, RR, and LD) collaborated to develop a sensitive search strategy that utilized two approaches: 1) searching by the names of specific tools identified in a preliminary literature review or provided by stakeholders (DL), and 2) searching generically with combinations of subject headings and keywords pertaining to MSI, occupational settings and screening tools. The results of both approaches were limited to quantitative primary research studies only. The grey literature was not searched, which is a change from our protocol. After preliminary searching of the voluminous grey literature, it was determined that this searching would not result in rigorous evaluations, which was the focus of this study.

Our definition of MSI was adapted from WorkSafeBC's definition that encompasses injuries and disorders of muscles, tendons, ligaments, joints and soft tissues (nerve and

vascular injury)[11]. For this study, we did not include generic search terms for vascular, nerve, or vibration-induced injuries, but did include specific search terms for carpal tunnel syndrome. The full search strategy is available (see Appendix S1).

A PICOS (Population, Intervention, Comparison, Outcome, Study Design) framework was used for development of article inclusion criteria. Articles were eligible if they assessed a working-age population in a working environment (exclusion of pre-employment screening and studies in military populations), applied an MSI risk factor screening tool using individual or workplace-related risk factors to guide a tool-guided intervention intended to prevent MSI injury and its impact (exclusion of studies reporting only measurement properties such as predictive validity), reported on at least one outcome related to MSI development, injury, or compensation/insurance claims, and utilized an analytic study design (i.e., randomized clinical trial; cohort, case-control study, quasi-experimental studies). Articles were required to have an English-language title and abstract.

We made modifications to our review protocol prior to our analysis. Specifically, to capture all potentially relevant articles, studies did not require a minimum sample size to be included. Additionally, we clarified that eligible study populations must not have been identified as injured prior to study enrolment; thus, eligible outcomes became incident MSI, compensation claims, or insurance claims.

Following completion of the database search, article titles and abstracts were added to online review manager Covidence[12] and de-duplicated. Titles and abstracts were then independently screened for initial inclusion by research team members. If two research team members concluded that an article potentially met inclusion criteria, or that

eligibility could not be ascertained from title and abstract alone, the full-text article was obtained. Disagreements at abstract stage were resolved first by consensus, then by a senior research team member if any remained unresolved (DG).

Full-text articles were independently assessed for eligibility by a smaller subset of the research team (RR, DG, TS). Articles had to be deemed eligible by two team members, and disagreements at full-text stage were resolved by consensus prior to or after consulting the third team member. Articles for which consensus was not reached at the full-text stage were provided to the entire research team for discussion.

Additional articles were identified directly for full-text eligibility screen through citation searching of included articles and systematic reviews identified during screening. One article was identified as a subsequent analysis of a study population from an article included at full-text stage and was retrieved for full-text eligibility screening.

A standardized spreadsheet was used for data extraction of included articles. One reviewer performed the initial data extraction, with verification by a second reviewer. Extracted article data included study design, study setting and context, participant characteristics, MSI screening tool descriptions and alternative treatments of study arms, outcome measure descriptions, and reported outcome results. Effect estimates were presented where possible.

Included articles were synthesized depending on their method of MSI risk factor screening tool application. The first category of “single-tool” articles contains studies which, in at least one study arm, applied a single MSI screening tool to inform an intervention in isolation from any other additional screening tools, assessments or

interventions. These study designs provide the most direct assessments of MSI screening tool effect. The second category of “multiple-tool/intervention” articles applied one or more MSI risk factor screening tools in combination with other assessments and interventions (which may or may not have been informed by the screening tool of interest). For this latter group of articles, it was deemed that the causal effect of any single MSI screening tool use could not be meaningfully isolated from the causal effect of distinctly separate, but concurrently applied assessments and associated interventions. Consultation with community partners indicated that prevention interventions within industry contexts are most often pragmatically applied in “multiple-tool/intervention” situations.

The Downs and Black (D&B) quality assessment checklist was used to assess included article quality[13]. The quality assessment checklist contains 27 questions assessing quality of reported material, internal validity stemming from selection bias, information bias and confounding, as well as external validity and study power[13]. The checklist is appropriate for quasi-experimental, cohort and randomized control trial (RCT) study designs, allowing simple comparison between a plurality of study methodologies. The Downs and Black score was assigned out of a total possible 28 points for each article. Score interpretation has previously used quality bands of excellent (>25), good (20-25), fair (15-19) and poor (≤14) article quality[14].

This review follows principles of best evidence synthesis and incorporates components of Synthesis Without Meta-analysis reporting guidelines, the latter of which is intended to complement PRISMA reporting guidelines[15, 16]. All included articles of medium quality or higher (D&B of fair or better) were retained for narrative synthesis. Study

outcome categorizations were adapted from the original protocol, and included musculoskeletal discomfort, work absence, health resource utilization, changes to workplace behaviour, self-assessed health status, workplace-related MSI, and claims cost. Outcome metrics were standardized using effect direction as recommended by Boon and Thomson (direction reported if >70% of categorized study outcomes had similar direction of effect), with consistency of evidence for these outcomes assessed using an effect direction plot adapted from the same authors[17]. A sign test was not performable for assessment of outcome heterogeneity due to too few articles. An algorithm for evidence level (strong to insufficient) was adapted from the Institute for Work and Health[18] (Figure 1).

Results

The initial database search yielded 12,207 results. 4,025 duplicates were removed. 8,182 articles were screened for potential eligibility, of which 79 full-text articles were reviewed for inclusion. Percent agreement during abstract screening ranged from 88% to 100% and all discrepancies were resolved through consensus. Fourteen articles met inclusion criteria following full-text review and were included for analysis. Citation searching from the included articles, key systematic reviews and incidental related articles yielded 15 articles that were retrieved for full-text analysis. Four articles were retained from this second identification group. In total, 18 articles were included for quality assessment and data extraction. Most articles excluded at full-text stage did not evaluate the effect of an MSI risk factor screening tool (see Figure 2).

Article quality appraisal was applied using the Downs and Black criteria (Table S1). Articles of at least medium quality were retained for narrative synthesis. No high-quality articles were identified.

Characteristics of Single-Tool Articles

Five single-tool articles representing four studies were identified and retained following quality assessment. All five articles were scored as medium-quality, meeting at least half of the methodological criteria[19–23]. Positives included reporting of most necessary information, real-world study environments, reasonable intervention compliance, low likelihood of influence from participants lost to follow-up, and typically adequate power. Negatives included poor reporting of potential adverse events or characteristics of participants lost to follow-up, poor generalizability from participant selection and sampling methodology, mixed accuracy of outcome measures, and some incomplete adjustment for potential confounders.

Table S3 (upper half) summarizes the characteristics of retained single-tool studies, all of which are RCTs. One study, reported in two articles, assessed an MSI screening tool and tool-guided interventions based on occupational health[22] and economic[23] outcomes. Study participants were either computer users[20, 21] or part of a general working population[19, 22, 23]. Participants were followed anywhere from 2 weeks to 2 years[19, 20] following tool use, and screening tool arm sample sizes ranged from 35 to 1,374 participants[19, 21]. MSI risk factor screening tools were used in these studies to inform a variety of work modifications, including administrative controls and physical hazard elimination[19], ergonomic workplace adjustment[20, 21], and a multicomponent intervention program[22, 23]. Data sources for outcome measures included self-report

questionnaires[20–23], daily symptom diaries[21], and company-provided occupational data[19, 22, 23]. Other comparator arms included tool-assisted risk assessment but withholding tool recommendations until completion of follow-up[20, 22, 23] and providing a variety of general[21] or specific[19] occupational health information to participants. The computer user studies focussed heavily on measurements of musculoskeletal discomfort[20, 21] while also including some behavioural change measures. The general working population studies more frequently reported measures of work absence[19, 22, 23] and one included resource utilization measures[23].

Characteristics of Multiple-Intervention Articles

Thirteen multiple-intervention articles were identified[24–36] and seven, representing 5 studies, were retained following quality assessment[25–30, 32]. All seven retained articles were scored as medium quality. Compared to the single-tool articles, multiple-intervention articles described confounding variables and patients lost to follow-up less frequently and did not give *a priori* indicators of follow-up articles for related same-study articles. The multiple-intervention study populations did, however, have higher representativeness of their source populations.

Table S3 (lower half) summarizes the characteristics of retained multiple-intervention studies. One study encompassed 3 follow-up articles[25, 29, 30] published from 2002 to 2005, with an original 2001 article not retained due to poor article quality[24]. Study design variety was larger in these studies, with three quasi-experimental study designs[25, 27, 29, 30, 32] and two RCTs[26, 28]. Participants in the studies included health workers from Canada[32] and Australia[25, 29, 30], construction workers from the Netherlands[26], foundry workers from Italy[27] and farmers from the United

States[28]. Follow-up was typically longer than included study counterparts – 12 months at minimum. The range of sample sizes was comparable with included studies. Data sources for the retained multiple-intervention studies included workplace-associated records[25–27, 29, 30], insurance compensation documents[25, 29, 30], regional occupational health records[32], as well as self-report forms[26, 28] and standardized phone calls[28]. Five studies reported count or rate outcomes of workplace-associated MSI[25, 27–30, 32], all but one reported a measure of work absence[25–30], one reported a measure of musculoskeletal discomfort[26] and three reported a measure of claims cost[25, 28–30]. One study reported on measures of other healthcare utilization[28] and another reported on self-assessed health status[26].

Six articles were scored as poor quality and are not characterized in this paper beyond their quality appraisals[24, 33–37]. Compared to retained articles, these poor-quality articles less frequently reported on study characteristics, were significantly less representative of their source populations, did not necessarily recruit comparable groups for screening tool use and control groups, did not adequately adjust for differing participant follow-up time or confounding by other means, and used less valid outcome measurement instruments.

Synthesis of Included Study Results

Figure 3 presents the effect direction plot showing consistency of outcomes for included studies. In total, seven outcome categories were provided from included studies – musculoskeletal discomfort, work absence, health resource utilization, work behavior modification, workplace-associated MSI, claims cost, and self-rated health status.

No high-quality studies are present in the analysis and each study utilizes a different MSI risk factor screening tool. Therefore, there is insufficient evidence to determine the effect of any specific MSI risk factor screening tool on any of the previously identified outcome categories.

Effects on Musculoskeletal Discomfort

Three medium-quality single-tool studies show either conflicting evidence[20, 21] or no change[22, 23] in musculoskeletal discomfort measures following their respective MSI risk factor screening tool-guided interventions. One medium-quality multiple-intervention study shows no change[26] in musculoskeletal discomfort measures following the use of an MSI risk factor screening tool as an intervention component. Therefore, there is limited evidence that MSI risk factor screening tools either do not influence or inconsistently influence musculoskeletal discomfort when used by themselves, and insufficient evidence of their effect on musculoskeletal discomfort when used in combination with other interventions.

Effects on Work Absence

Two medium-quality single-tool studies show no change[19, 22, 23] in work absence measures following their respective MSI risk factor screening tool-guided interventions. Three medium-quality multiple-intervention studies show no change in work absence measures[26–28] and one medium-quality study shows a decrease in work absence measures[25, 29, 30] following the use of an MSI risk factor screening tool as an intervention component. Therefore, there is limited evidence that MSI risk factor

screening tools either do not influence or inconsistently influence work absence, both when used by themselves or in combination with other interventions.

Effects on Health Resource Utilization

One medium-quality study shows no change[22, 23] in measures of health resource utilization following an MSI risk factor screening tool-guided intervention. No included multiple-intervention studies assessed health resource utilization outcomes following the use of an MSI risk factor screening tool as an intervention component. Therefore, there is insufficient evidence regarding the effect of MSI risk factor screening tools on health resource utilization, both when used by themselves or in combination with other interventions.

Effects on Workplace Behaviour

One medium-quality study shows conflicting evidence[20] in measures of workplace behavior modification following an MSI risk factor screening tool-guided intervention. No included multiple-intervention studies assessed workplace behavior modification outcomes following the use of an MSI risk factor screening tool as an intervention component. There is insufficient evidence regarding the effect of MSI risk factor screening tools on work behavior modification, both when used by themselves or in combination with other interventions.

Effects on Workplace Associated MSI

No included single-tool studies assessed workplace associated-MSI outcomes following an MSI risk factor screening tool-guided intervention. Two medium-quality multiple-intervention studies show decreases in workplace-associated MSI[25, 27, 29, 30],

another shows an increase in workplace-associated MSI[32], and another shows no change[28] following the use of an MSI risk factor screening tool as an intervention component. Therefore, there is insufficient evidence regarding the effect of MSI risk factor screening tools on workplace-associated MSI when used by themselves, and mixed evidence when used in combination with other interventions.

Effects on Claims Costs

No included single-tool studies assessed measures of claims cost following an MSI risk factor screening tool-guided intervention. One medium-quality multiple-intervention study shows decreases in claims cost[25, 29, 30] and another medium-quality multiple-intervention study shows no change in claims cost[28] following the use of an MSI risk factor screening tool as an intervention component. Therefore, there is insufficient evidence regarding the effect of MSI risk factor screening tools on claims cost when used by themselves, and mixed evidence when used in combination with other interventions.

Effects on Self-Rated Health Status

No included single-tool studies assessed measures of self-rated health status following an MSI risk factor screening tool-guided intervention. One medium-quality multiple-intervention study shows no change[26] in measures of self-rated health status following the use of an MSI risk factor screening tool as an intervention component. Therefore, there is insufficient evidence for the use of MSI risk factor screening tools on self-rated health status both when used by themselves or in combination with other interventions.

Discussion

This study utilized rigorous epidemiological data synthesis methods to assess the current state of scientific literature regarding the effect of using MSI risk factor screening tools to inform injury prevention interventions on important outcomes such as MSI and related claims and resource utilization. In total, 18 articles representing 14 studies met the article inclusion criteria dictated in the final protocol. Of these 18 articles, only 12 met the minimum quality criteria for retention in the literature synthesis. Of these 12 articles, only 5—representing 4 studies and containing no overlap in screening tools used—used an MSI risk factor screening tool to guide an intervention in a manner that allowed for meaningful isolation of the effect of the tool as compared to the effect of other distinctly separate but concurrent tools and interventions. Despite plausible isolation of the effects of these remaining screening tools, outcome measures were too heterogeneous to allow effect size data pooling; rather, the highest level of evidence that could be gleaned from the current literature is, overall, whether screening tools were or were not associated with a positive health impact for specified outcome measure categories.

When used by themselves, current evidence is insufficient to characterize the effect of MSI risk factor screening tool use on health resource utilization, work behavior modification, workplace-associated MSI, claims cost, or self-rated health status. The available evidence demonstrates either an inconsistent or lack of effect of screening tool use on musculoskeletal discomfort and work absence.

When used in combination with other tools and interventions in the context of a broader injury prevention program, current evidence is insufficient to characterize the effect of

MSI risk factor screening tool use on musculoskeletal discomfort, health resource utilization, work behaviour modification, or self-rated health status. Available evidence demonstrates either an inconsistent or lack of effect of screening tool use on work absence. There is mixed evidence for the effect of multiple-intervention MSI risk factor screening tools on workplace-associated MSI and claims cost.

This study provides, to the authors' knowledge, the first systematic review specifically assessing the effects of MSI risk factor screening tools in actual work environments for informing MSI prevention programs. Strengths of the study included the use of a robust database search strategy created through collaboration with an experienced health sciences librarian, use of up-to-date guidelines on systematic review structure and reporting, and involvement of multiple stakeholder groups to provide guidance on practical needs of the occupational health and safety industry. Previous research synthesis has focused instead on the variety of available MSI risk factor screening tools[5], the effect of overall occupational health and safety interventions on preventing similar categories of MSI outcomes[18], and on the use of clinical decision support tools to identify useful interventions for already-injured patients with disabling musculoskeletal disorders[38]. However, the conclusions from this review show similarities to those from the occupational health and safety intervention review – both identify significant areas of evidence limited in certainty by a lack of high-quality literature, albeit the latter involving a substantially larger 36 studies[18]. Considering the wide array of available MSI risk factor screening tools, this lack of data may point to the possibility of missed MSI screening tool use in the grey literature, which was not searched. This constitutes a

limitation to our methods, yet we are confident we located the highest quality peer-reviewed articles in this research area.

There are numerous incidental findings from this systematic review. Firstly, none of the named tools from the preliminary database search that were identified as commonly used were found to have been evaluated rigorously, beyond their own validation studies. This literature shows that instead, MSI risk factor screening tools are in practice typically purpose-built or adopted from local occupational health centres. Occupational health and safety professionals designing these novel tools would see minimal examples supporting the use of specific screening tools in the literature, and instead may base their designs on international standards for biomechanical risk factors, which themselves are not definitively robust[9]. Any documentation of a high quality, targeted, and real-world application using a previously validated tool would significantly strengthen the state of current MSI risk factor screening tool literature, especially if such studies also employ the use of clearly defined, replicable outcome measures. In time, tool use resulting in more consistent positive health effects could be identified, adopted, and refined.

Secondly, there is a distinct difference between the characteristics of single-tool and multiple-intervention studies, the former group requiring that the effect of a single tool be identifiable. Notably, the selected study sample in multiple-intervention studies was more consistently representative of its source population. These studies used a more pragmatic approach to screening and intervention, and may better reflect actual practice, where often numerous assessment tools and potential interventions are simultaneously introduced in an attempt to improve some aspect of MSI. One

conclusion that can be taken from this finding is that MSI risk factor screening tool use is commonly only one component of a broader MSI risk mitigation strategy. It remains unclear how the effect of MSI screening tools changes with different types of concurrent interventions. This is an additional research avenue, made clear from the results of the current systematic review.

Overall, there is a small quantity of insufficient and limited evidence regarding the use of MSI risk factor screening tools for informing injury preventing interventions. For more certain conclusions on the utility and effectiveness of MSI risk factor screening tools, high-quality research on the currently available tools is necessary.

References

[1] Briggs AM, Woolf AD, Dreinhöfer K, et al. Reducing the global burden of musculoskeletal conditions. *Bulletin of the World Health Organization* 2018; 96: 366–368.

[2] Briggs AM, Jordan JE, Kopansky-Giles D, et al. The need for adaptable global guidance in health systems strengthening for musculoskeletal health: a qualitative study of international key informants. *Glob Heal Res Policy* 2021; 6: 24.

[3] Foster NE, Anema JR, Cherkin D, et al. Prevention and treatment of low back pain: evidence, challenges, and promising directions. *The Lancet* 2018; 391: 2368–2383.

[4] World Health Organization and the International Labour Organization. *WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury, 2000–2016: global monitoring report:* Geneva, http://www.ilo.org/global/topics/safety-and-health-at-work/resources-library/publications/WCMS_819788/lang--en/index.htm (2021, accessed 29 October 2021).

[5] Wilhelmus Johannes Andreas G, Johanssons E. Observational Methods for Assessing Ergonomic Risks for Work-Related Musculoskeletal Disorders. A Scoping Review. *Rev Ciencias la Salud* 2018; 16: 8–38.

[6] Kee D. Systematic Comparison of OWAS, RULA, and REBA Based on a Literature Review. *International Journal of Environmental Research and Public Health*; 19. Epub ahead of print 1 January 2022. DOI: 10.3390/ijerph19010595.

[7] Rimando CRD, Batay CML, Canita VES, et al. Validity and Reliability of the Modified RULA (mRULA) among Public and Private Office Workers. In: *Journal of Physics: Conference Series*. Institute of Physics Publishing, p. 32056.

[8] Colombini D, Occhipinti E. Scientific basis of the OCRA method for risk assessment of biomechanical overload of upper limb, as preferred method in ISO standards on biomechanical risk factors. *Scandinavian Journal of Work, Environment and Health* 2018; 44: 436–438.

[9] Armstrong TJ, Burdorf A, Descatha A, et al. Scientific basis of ISO standards on biomechanical risk factors. *Scand J Work Environ Heal* 2018; 44: 323–329.

[10] Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *The BMJ*; 372. Epub ahead of print 29 March 2021. DOI: 10.1136/bmj.n71.

[11] WorkSafeBC, https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-04-general-conditions#SectionNumber:4.46 (accessed 15 March 2022).

[12] Veritas Health Innovation. Covidence systematic review software, https://www.covidence.org/.

[13] Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998; 52: 377–384.

[14] Hooper P, Jutai JW, Strong G, et al. Age-related macular degeneration and low-

vision rehabilitation: A systematic review. *Canadian Journal of Ophthalmology* 2008; 43: 180–187.

[15] Slavin RE. Best evidence synthesis: An intelligent alternative to meta-analysis. *J Clin Epidemiol* 1995; 48: 9–18.

[16] Campbell M, McKenzie JE, Sowden A, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: Reporting guideline. *BMJ*; 368. Epub ahead of print 16 January 2020. DOI: 10.1136/bmj.l6890.

[17] Boon MH, Thomson H. The effect direction plot revisited: Application of the 2019 Cochrane Handbook guidance on alternative synthesis methods. *Res Synth Methods* 2021; 12: 29–33.

[18] Kennedy CA, Amick III BC, Dennerlein JT, et al. Systematic Review of the Role of Occupational Health and Safety Interventions in the Prevention of Upper Extremity Musculoskeletal Symptoms, Signs, Disorders, Injuries, Claims and Lost Time. *J Occup Rehabil* 2010; 20: 127–162.

[19] Frost P, Haahr JP, Andersen JH. Reduction of pain-related disability in working populations: A randomized intervention study of the effects of an educational booklet addressing psychosocial risk factors and screening workplaces for physical health hazards. *Spine (Phila Pa 1976)* 2007; 32: 1949–1954.

[20] Ho WY, Sung CYY, Yu QH, et al. Effectiveness of computerized risk assessment system on enhancing workers' occupational health and attitudes towards occupational health. *Work* 2014; 48: 471–484.

[21] Ketola R, Toivonen R, Häkkänen M, et al. Effects of ergonomic intervention in work with video display units. *Scand J Work Environ Heal* 2002; 28: 18–24.

[22] Speklé EM, Hoozemans MJ, Blatter BM, et al. Effectiveness of a questionnaire based intervention programme on the prevalence of arm, shoulder and neck symptoms, risk factors and sick leave in computer workers: A cluster randomised controlled trial in an occupational setting. *BMC Musculoskelet Disord*; 11. Epub ahead of print 2010. DOI: 10.1186/1471-2474-11-99.

[23] Speklé EM, Heinrich J, Hoozemans MJ, et al. The cost-effectiveness of the RSI quickscan intervention programme for computer workers: Results of an economic evaluation alongside a randomised controlled trial. *BMC Musculoskelet Disord*; 11. Epub ahead of print 2010. DOI: 10.1186/1471-2474-11-259.

[24] Carrivick PJW, Lee AH, Yau KKW. Consultative team to assess manual handling and reduce the risk of occupational injury. *Occup Environ Med* 2001; 58: 339–344.

[25] Carrivick PJW, Lee AH, Yau KKW. Effectiveness of a participatory workplace risk assessment team in reducing the risk and severity of musculoskeletal injury. *J Occup Health* 2002; 44: 221–225.

[26] Oude Hengel KM, Blatter BM, van der Molen HF, et al. The effectiveness of a construction worksite prevention program on work ability, health, and sick leave: Results from a cluster randomized controlled trial. *Scand J Work Environ Heal* 2013; 39: 456–467.

[27] Porru S, Calza S, Arici C. Prevention of occupational injuries: Evidence for

effective good practices in foundries. *J Safety Res* 2017; 60: 53–69.

[28] Rautiainen RH, Lange JL, Hodne CJ, et al. Injuries in the Iowa certified safe farm study. *J Agric Saf Health* 2004; 10: 51–63.

[29] Carrivick PJW, Lee AH, Yau KKW. Effectiveness of a workplace risk assessment team in reducing the rate, cost, and duration of occupational injury. *J Occup Environ Med* 2002; 44: 155–159.

[30] Carrivick PJW, Lee AH, Yau KKW, et al. Evaluating the effectiveness of a participatory ergonomics approach in reducing the risk and severity of injuries from manual handling. *Ergonomics* 2005; 48: 907–914.

[31] Cheng AS, Chan EP-S. The Effect of Individual Job Coaching and Use of Health Threat in a Job-Specific Occupational Health Education Program on Prevention of Work-Related Musculoskeletal Back Injury. *J Occup Environ Med* 2009; 51: 1413–1421.

[32] Craib KJP, Hackett G, Back C, et al. Injury rates, predictors of workplace injuries, and results of an intervention program among community health workers: Populations at risk across the lifespan: Empirical studies. *Public Health Nurs* 2007; 24: 121–131.

[33] Johnson KA, Ruppe J. A Job Safety Program for Construction Workers Designed to Reduce the Potential for Occupational Injury Using Tool Box Training Sessions and Computer-Assisted Biofeedback Stress Management Techniques. *Int J Occup Saf Ergon* 2002; 8: 321–329.

[34] Laing AC, Frazer MB, Cole DC, et al. Study of the effectiveness of a participatory ergonomics intervention in reducing worker pain severity through physical exposure pathways. *Ergonomics* 2005; 48: 150–170.

[35] Laing AC, Cole DC, Theberge N, et al. Effectiveness of a participatory ergonomics intervention in improving communication and psychosocial exposures. *Ergonomics* 2007; 50: 1092–1109.

[36] Melhorn JM, Wilkinson L, Riggs JD. Management of musculoskeletal pain in the workplace. *J Occup Environ Med* 2001; 43: 83–93.

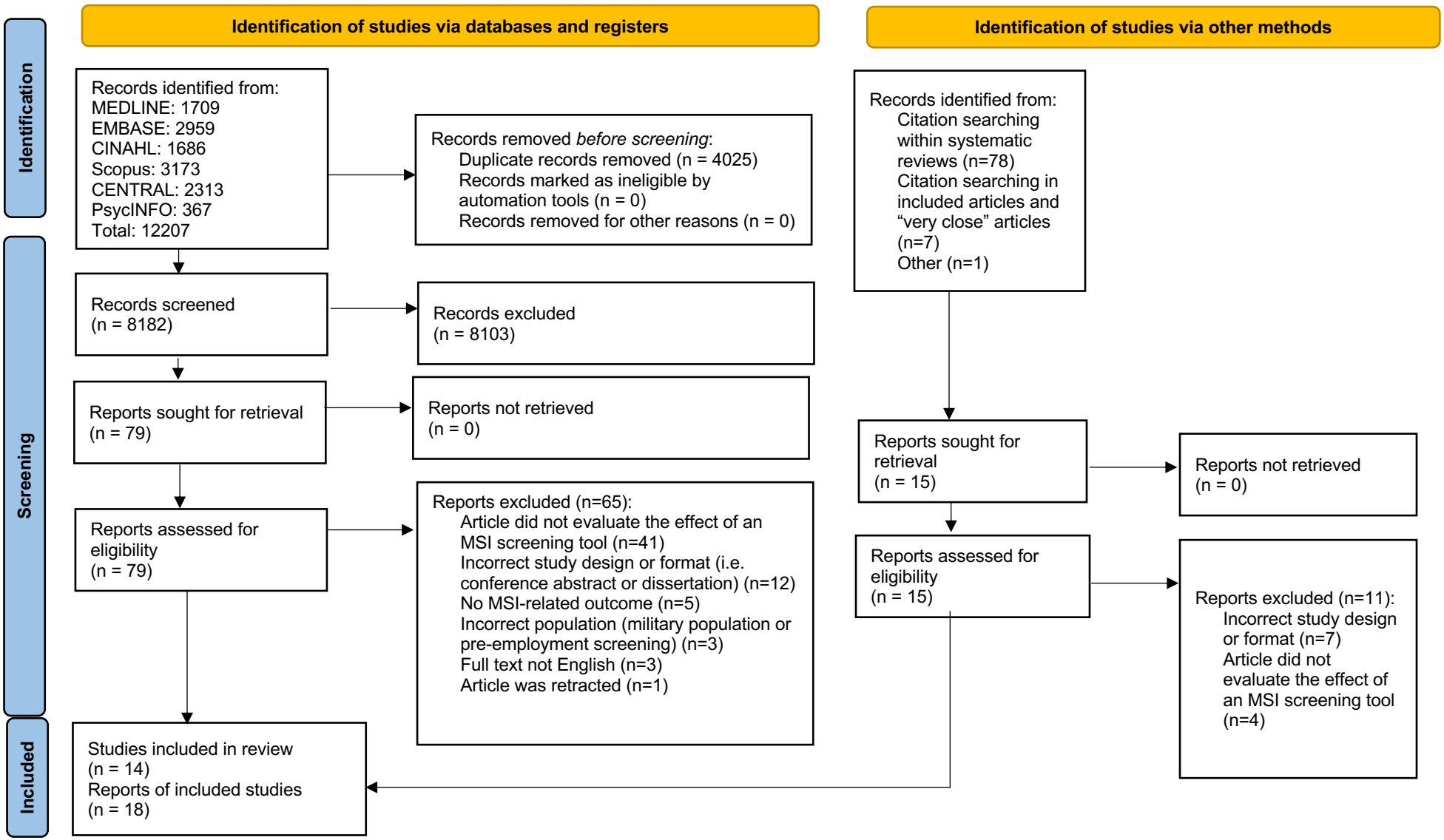
[37] Cheng AS, Chan EP-S. The Effect of Individual Job Coaching and Use of Health Threat in a Job-Specific Occupational Health Education Program on Prevention of Work-Related Musculoskeletal Back Injury. *J Occup Environ Med*; 51, https://journals.lww.com/joem/Fulltext/2009/12000/The_Effect_of_Individual_Job_Coaching_and_Use_of.11.aspx (2009).

[38] Gross DP, Armijo-Olivo S, Shaw WS, et al. Clinical Decision Support Tools for Selecting Interventions for Patients with Disabling Musculoskeletal Disorders: A Scoping Review. *J Occup Rehabil* 2016; 26: 286–318.

Figure 1: Decision algorithm for levels of evidence

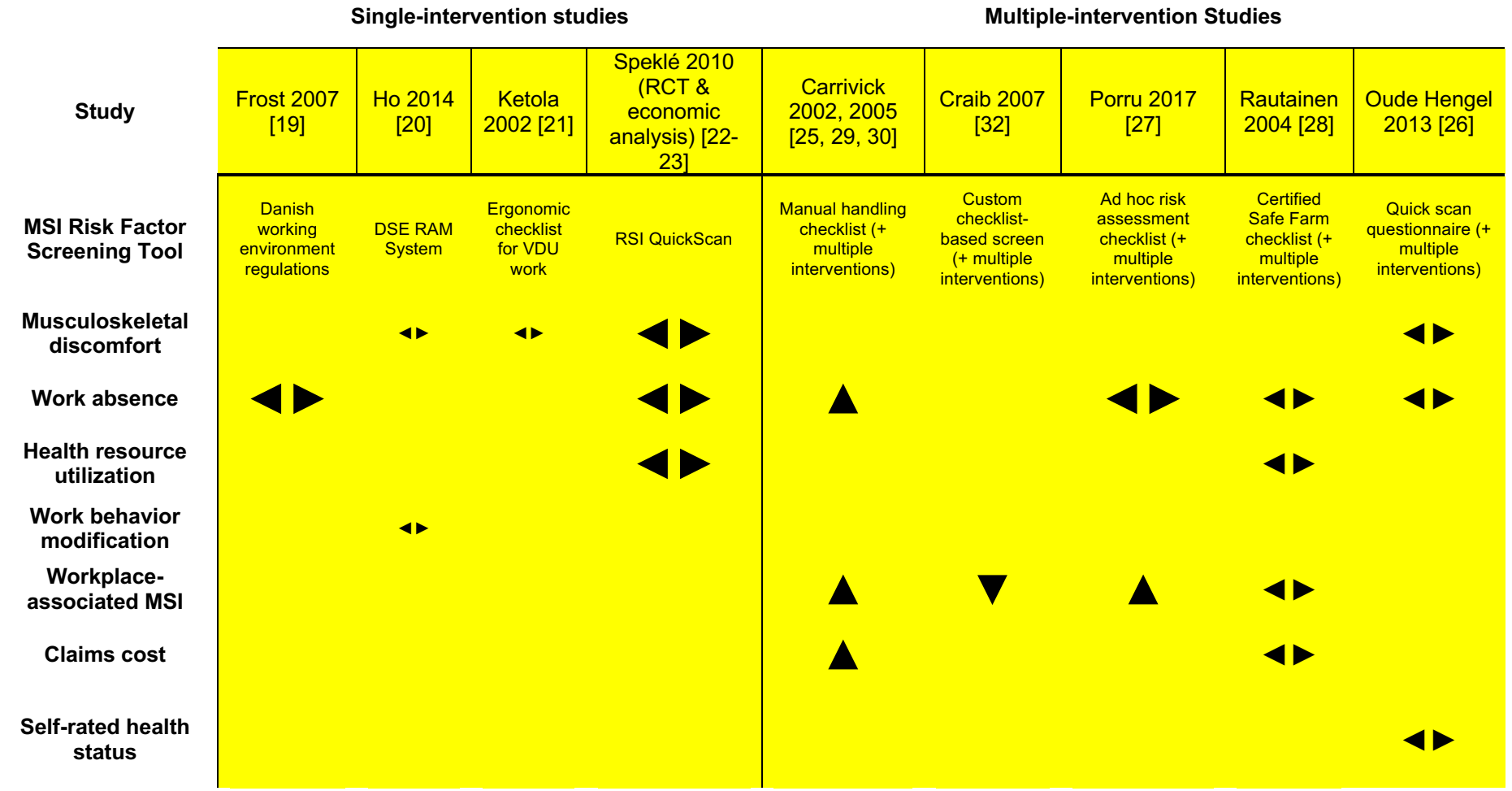
Evidence Level	Minimum study quality according to Downs & Black (D&B) Rating	Minimum study quantity	Consistency
Strong	High (D&B score band of good or better)	3 or more studies	Agreement of effect direction in 3 high quality studies. For ≥3 studies, at least 75% of high- and medium-quality studies agree in effect direction
Moderate	Medium (D&B score band of fair)	2 high quality OR 2 medium quality and 1 high quality	Effect directions from 2 high quality studies agree OR effect directions from 2 medium studies and 1 high quality study agree. For ≥3 studies, effect direction agreement in more than 66% of studies
Limited	Medium (D&B score band of fair)	1 high quality OR 2 medium quality OR 1 medium and 1 high quality	Effect directions from 2 medium- or high-quality studies agree. If ≥2 studies, more than 50% of medium and high-quality studies agree
Mixed	Medium or high D&B score bands	2 studies	Effect directions from medium and high-quality studies are contradictory
Insufficient	No high quality, only 1 medium quality, any number of low (score band of poor) quality studies		

Figure 2: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

Figure 3: Effect direction plot of included studies



LEGEND:

Effect direction: upward arrow ▲= positive health impact, downward arrow ▼= negative health impact, sideways arrow ◄►= no change/mixed effects/conflicting findings

Sample size: Final sample size (individuals) in intervention group: large arrow ▲ >300; medium arrow ▲ 50-300; small arrow ▲ <50

Study quality (Downs and Black): denoted by column colour: green = high quality; yellow = medium quality; red = low quality

Supplementary Material S1: Search Strategy

Ovid MEDLINE(R) ALL 1946 to March 18, 2021

Date searched: March 19, 2021

Results: 1709

1. Accidents, Occupational/ or workers' compensation/ or Occupational Health/ or Occupational Injuries/ or Occupational Health Services/

2. employment/ or Work/ or work performance/ or Workplace/

3. exp *health personnel/

4. industry/ or beauty culture/ or forestry/ or health care sector/ or laundering/ or manufacturing industry/ or construction industry/ or chemical industry/ or exp "extraction and processing industry"/ or textile industry/ or power plants/

5. occupational groups/ or administrative personnel/ or farmers/ or government employees/ or laboratory personnel/ or metal workers/ or miners/

6. (white-collar or blue-collar or shift-worker* or attorney* or lawyer* or miners or mining-industry or office-worker* or desk-worker* or secretarial-worker* or administrative-assistant* or secretaries or manual-labourer* or manual-laborer* or physical-labourer* or physical-laborer* or farmworker* or ((warehous* or construction or farm or agricultur* or fast-food or food-service or grocery or store or retail or maintenance) adj3 (work* or employ* or job* or labor* or labour* or industry)) or steelworker* or iron worker* or ironworker* or mill-worker* or railway-worker* or vehicle-operator* or equipment-operator* or machinery-operator* or transit-operator* or bus-driver* or government-employees or hairdresser* or barber* or esthetician or child-care-providers or child-care-workers or housecleaners or janitor*).mp.

7. (((hospital adj (worker* or employee*)) or healthcare aide* or surgeon* or doctor* or physician* or general practitioner* or nurse* or dentist* or hygienist* or masseur* or masseuse or massage therapist*) and (pain or safety or safe or unsafe* or accident* or injur* or re-injur* or ergonomic or postur* or msk or strain or musculoskeletal)).ti.

8. (occupation* or (work* not social work) or employ*).jw.

9. ((work* not working-memory) or occupation* or employ* or job or jobs).ti,kf.

10. (work-related or job-related or employment-related or working-conditions or work environment* or workplace* or work place* or worksite* or work site* or jobsite or job site or "at work" or "on the job" or "while working" or Work-related or work* compensation).mp.

11. (Accidents/ or Accident Prevention/ or Safety/) and (employ* or work* or occupation* or job* or industr* or labourer* or laborer*).mp.

12. ((safety or safe or safely or unsafe* or accident* or hazard* or injur* or re-injur*) adj10 (employ* or (work* not working-memory) or occupation* or job* or industr* or labourer* or laborer*)).mp.

13. occupational disease*.mp.

14. (job-specific or work-specific or preemployment or pre-employment or work assessment or job assessment or jobfit or job matching).mp.

15. or/1-14

16. Musculoskeletal Diseases/ or joint instability/ or joint loose bodies/ or synovitis/ or ischemic contracture/ or contracture/ or dupuytren contracture/ or exp arm injuries/ or exp back injuries/ or contusions/ or exp dislocations/ or exp "fractures, bone"/ or "fractures, cartilage"/ or exp hand injuries/ or exp hip injuries/ or exp leg injuries/ or exp neck injuries/ or occupational injuries/ or soft tissue injuries/ or exp spinal injuries/ or exp "sprains and strains"/ or exp tendon injuries/ or intervertebral disc degeneration/ or intervertebral disc displacement/ or musculoskeletal pain/ or exp back pain/ or Sciatica/ or neck pain/ or myofascial pain syndromes/ or exp tendinopathy/ or patellofemoral pain syndrome/ or tennis elbow/ or fasciitis, plantar/ or heel spur/ or bursitis/ or shoulder impingement syndrome/

17. ((Pain* or ache* or discomfort* or injur* or sore* or excruciat* or tear or tears or injur* or sprain* or strain* or dislocat* or impingement or instabilit* or fracture*) adj8 (musc* or MSK or tendon* or ligament* or joint or joints or bone or bones or soft-tissue or spine or cranial or neck or arm or arms or shoulder* or elbow* or wrist* or hand* or lumbar or back or hip* or knee* or ankle* or foot or feet or heel* or pelvic or rotator cuff or lower extremit* or lower limb* or upper extremit* or upper limb* or leg or legs)).mp.

18. (injur* adj5 (repetitive or overexertion* or lifting or manual handling)).mp.

19. (LBP or lumbago or backache or whiplash or sciatica or carpal tunnel or tendinitis or tendinosis or tendinopath* or axial-pain or spinal injur* or spinal pain or frozen shoulder or shoulder impingement or myofascial pain or patellofemoral pain or regional pain disorder* or cumulative trauma disorder* or osteoarthritis or (hernia* adj3 (disc or discs)) or (injur* adj5 (repetitive or overexertion* or lifting)) or tennis-elbow or epicondylitis or compartment-syndrome or myositis or polymyositis or pyomyositis or bursitis or chondritis or enthesitis or osteitis or epicondylitis or periostitis or periarthritis or synovitis).mp.

20. or/16-19

21. ((predict* or risk or screen*) adj8 (Likert or scale* or questionnaire* or index or checklist* or tool or tools or test or tests or instrument or instruments or score* or inventory)).mp.

22. (job matching or job fit or jobfit or ((pre-employment or job-specific or employment or workhab) adj5 (functional capacity or functional testing or screening or examination*))).mp.

23. (job assessment* or work assessment* or workplace systems assessment* or ergonomic assessment* or (risk adj4 assess* adj8 (job* or work* or ergonomic* or occupation*))).mp.

24. or/21-23

25. (Rapid entire body assessment or Rapid Upper limb assessment or (liberty mutual* adj4 tables) or Snook tables or NIOSH lifting equation* or quick exposure check* or occupational repetitive actions or "Washington Industrial Safety and Health Act" or WISHA or quick ergonomic check or Dutch Musculoskeletal Questionnaire or Assessment of Repetitive Task* or Cumulative Trauma Disorder Risk Assessment Model or Hand Activity Level or ((Threshold Limit value or tlv) adj4 hand activity) or Hand Arm Risk Assessment Method or Keyserling* Cumulative Trauma Checklist or Key Indicator Methods or Loading on the Upper Body Assessment or Ovako Working Posture Analysis System or "Posture, Activity, Tools, and Handling" or PLIBEL or Risk Management Assessment Tool for Manual Handling Proactively or Workplace Ergonomic Risk Assessment or Job strain index or 3DSSPP or senz or life booster or jobfit systems or Pre-Employment Functional Assessments or PEFAs or Industrial Lumbar Motion Monitor or ergoweb or humantech or higher level screening tool).mp.

26. ((QEC or REBA or RULA or OCRA or LUBA or OWAS or PEFA) and (ergonomic* or injur* or risk or job or musculoskeletal or posture or work-related or occupation* or msk or pain)).mp.

27. 25 or 26

28. (15 and 20 and 24) or 27

29. exp Clinical trial/ or (randomi* or randomly or quasi-random* or quasirandom* or groups or subgroups or trial or placebo).tw. or (random adj4 (allocat* or distribut* or assign*)).tw.

30. (((interventional or clinical or experimental) adj1 (design or study or research)) or control group).mp.

31. (("N of 1" or single subject or single case) adj3 (experiment* or design or study or research)).mp.

32. Comparative studies/ or Epidemiologic studies/ or exp case control studies/ or exp cohort studies/ or ((observational adj (study or studies)) or case-control or cohort or follow-up or longitudinal or prospective or Retrospective or consecutive or long-term or longterm or matched-pair or baseline or comparative or pilot study or pilot project).mp.

33. or/29-32

34. 28 and 33

Embase 1974 to 2021 March 18 (OVID Interface)

Date searched: March 19, 2021

Results: 2959

1. (((hospital adj (worker* or employee*)) or healthcare aide* or surgeon* or doctor* or physician* or general practitioner* or nurse* or dentist* or hygienist* or masseur* or massage therapist*) and (pain or safety or safe or unsafe* or accident* or injur* or re-injur* or ergonomic or postur*)).ti.

2. occupational accident/ or workman compensation/ or exp Occupational Health/ or employment/ or Work/ or job performance/ or manual labor/ or shift work/ or work capacity/ or work environment/ or workplace/

3. (exp industry/ or exp nonmedical occupations/) not (athlete/ or military personnel/ or veteran/)

4. (white-collar or blue-collar or shift-worker* or attorney* or lawyer* or miners or mining-industry or office-worker* or desk-worker* or secretarial-worker* or administrative-assistant* or secretaries or manual-labourer* or manual-laborer* or physical-labourer* or physical-laborer* or farmworker* or ((warehous* or construction or farm or agricultur* or fast-food or food-service or grocery or store or retail or maintenance) adj3 (work* or employ* or job* or labor* or labour* or industry)) or steelworker* or iron worker* or ironworker* or mill-worker* or railway-worker* or vehicle-operator* or equipment-operator* or machinery-operator* or transit-operator* or bus-driver* or government-employees or hairdresser* or barber* or esthetician or child-care-providers or child-care-workers or housecleaners or janitor*).mp.

5. (occupation* or (work* not social work) or employ*).jx.

6. ((work* not working-memory) or occupation* or employ* or job or jobs).ti,kw.

7. (work environment* or workplace* or work place* or worksite* or work site* or jobsite or job site or "at work" or "on the job" or "while working" or Work-related or work* compensation).mp.

8. (accident/ or accident prevention/ or accidental injury/ or injury/) and (employ* or (work* not working memory) or occupation* or job* or industr* or labourer* or laborer*).mp.

9. ((safety or safe or safely or unsafe* or accident* or hazard* or injur* or re-injur*) adj10 (employ* or (work* not working-memory) or occupation* or job* or industr* or labourer* or laborer*)).mp.

10. occupational disease*.mp.

11. (job-specific or work-specific or preemployment or pre-employment or work assessment or job assessment or jobfit or job matching).mp.

12. or/1-11

13. musculoskeletal disease/ or ankylosis/ or temporomandibular ankylosis/ or arthropathy/ or ankle instability/ or arthralgia/ or joint contracture/ or joint degeneration/ or joint destruction/ or joint effusion/ or joint laxity/ or joint limitation/ or joint stiffness/ or joint swelling/ or neuropathic joint disease/ or patellofemoral pain syndrome/ or exp periarticular joint disease/ or temporomandibular joint disorder/ or exp osteoarthritis/ or exp joint injury/ or exp joint instability/ or osteoarthropathy/ or exp bone injury/ or fasciitis/ or fascia disease/ or eosinophilic fasciitis/ or plantar fasciitis/ or exp contracture/ or exp enthesopathy/ or exp ligament disease/ or exp limb injury/ or exp limb pain/ or muscle disease/ or anterior tibial syndrome/ or muscle atrophy/ or exp muscle contracture/ or muscle diastasis/ or muscle hypertrophy/ or muscle injury/ or muscle rigidity/ or muscle strain/ or muscle tightness/ or myalgia/ or exp compartment syndrome/ or myositis/ or polymyositis/ or pyomyositis/ or neuromuscular disease/ or musculoskeletal chest pain/ or exp musculoskeletal injury/ or exp musculoskeletal pain/ or exp musculoskeletal stiffness/ or musculoskeletal system inflammation/ or bursitis/ or exp chondritis/ or enthesitis/ or osteitis/ or exp epicondylitis/ or periostitis/ or exp periarthritis/ or exp synovitis/ or exp tendon disease/ or sciatica/ or injury/ or crush trauma/ or limb injury/ or microtrauma/

14. ((Pain* or ache* or discomfort* or injur* or sore* or excruciat* or tear or tears or injur* or sprain* or strain* or dislocat* or impingement or instabilit* or fracture*) adj8 (musc* or MSK or tendon* or ligament* or joint or joints or bone or bones or soft-tissue or spine or cranial or neck or arm or arms or shoulder* or elbow* or wrist* or hand* or lumbar or back or hip* or knee* or ankle* or foot or feet or heel* or pelvic or rotator cuff or lower extremit* or lower limb* or upper extremit* or upper limb* or leg or legs)).mp.

15. (injur* adj5 (repetitive or overexertion* or lifting or manual handling)).mp.

16. (LBP or lumbago or backache or whiplash or sciatica or spinal-pain or spinal-injury or tendinitis or tendinosis or tendinopathy or carpal tunnel or frozen shoulder or shoulder impingement or tennis-elbow or epicondylitis or bursitis or chondritis or enthesitis or osteitis or periostitis or myofascial pain or regional pain disorder* or cumulative trauma disorder* or disc-displacement or disc-degeneration or (hernia* adj3 (disc or discs))).mp.

17. or/13-16

18. ((predict* or risk or screen*) adj8 (Likert or scale* or questionnaire* or index or checklist* or tool or tools or test or tests or instrument or instruments or score* or inventory)).mp.

19. (job matching or job fit or jobfit or ((pre-employment or job-specific or employment or workhab) adj5 (functional capacity or functional testing or screening or examination*))).mp.

20. (job assessment* or work assessment* or workplace systems assessment* or ergonomic assessment* or (risk adj4 assess* adj8 (job* or work* or ergonomic* or occupation*))).mp.

21. or/18-20

22. (Rapid entire body assessment or Rapid Upper limb assessment or (liberty mutual* adj4 tables) or Snook tables or NIOSH lifting equation* or quick exposure check* or occupational repetitive actions or "Washington Industrial Safety and Health Act" or WISHA or quick ergonomic check or Dutch Musculoskeletal Questionnaire or Assessment of Repetitive Task* or Cumulative Trauma Disorder Risk Assessment Model or Hand Activity Level or ((Threshold Limit value or tlv) adj4 hand activity) or Hand Arm Risk Assessment Method or Keyserling* Cumulative Trauma Checklist or Key Indicator Methods or Loading on the Upper Body Assessment or Ovako Working Posture Analysis System or "Posture, Activity, Tools, and Handling" or PLIBEL or Risk Management Assessment Tool for Manual Handling Proactively or Workplace Ergonomic Risk Assessment or Job strain index or 3DSSPP or senz or life booster or jobfit systems or Pre-Employment Functional Assessments or PEFAs or Industrial Lumbar Motion Monitor or ergoweb or humantech or higher level screening tool).mp.

23. ((QEC or REBA or RULA or OCRA or LUBA or OWAS or PEFA) and (ergonomic* or injur* or risk or job or musculoskeletal or posture or work-related or occupation*)).mp.

24. 22 or 23

25. (12 and 17 and 21) or 24

26. limit 25 to conference abstracts

27. 25 not 26

28. exp Clinical trial/ or (randomi* or randomly or quasi-random* or quasirandom* or groups or subgroups or trial or placebo).tw. or (random adj4 (allocat* or distribut* or assign*)).tw.

29. (((interventional or clinical or experimental) adj1 (design or study or research)) or control group).mp.

30. (("N of 1" or single subject or single case) adj3 (experiment* or design or study or research)).mp.

31. Comparative study/ or Clinical study/ or exp Case control study/ or Longitudinal study/ or Retrospective study/ or Prospective study/ or Cohort analysis/ or ((observational adj (study or studies)) or pilot study or pilot project or case-control or

cohort or follow-up or longitudinal or prospective or Retrospective or consecutive or long-term or longterm or baseline or comparative).mp.

32. 28 or 29 or 30 or 31

33. 27 and 32

APA PsycInfo 1806 to November Week 3 2021

Date searched: November 25, 2021

Results: 367

1. occupational health/ or work related illnesses/ or occupational safety/

2. working conditions/ or working space/

3. industrial accidents/

4. workplace intervention/

5. Job Performance/ or Employee Productivity/

6. exp *health personnel/

7. professional personnel/ or librarians/ or engineers/

8. personnel/ or exp artists/ or exp "business and industrial personnel"/ or child care workers/ or exp emergency personnel/ or exp government personnel/

9. occupations/ or job characteristics/

10. hospitality industry/

11. (miners or mining industry or office worker* or desk worker* or secretarial worker* or administrative assistant* or secretaries or manual labourer* or manual laborer* or physical labourer* or physical laborer* or ((warehous* or construction or farm or agricultur* or fast food or food-service or grocery or store or retail) adj3 (work* or employ* or job* or labor* or labour* or industry)) or steelworker* or iron worker* or ironworker* or mill worker* or railway worker* or vehicle operator* or equipment operator* or machinery operator* or transit operator* or bus driver* or government employees or hairdresser* or barber*).mp.

12. (((hospital adj (worker* or employee*)) or healthcare aide* or surgeon* or doctor* or physician* or general practitioner* or nurse* or dentist* or hygienist* or masseur* or masseuse or massage therapist*) and (pain or safety or safe or unsafe* or accident* or injur* or re-injur* or ergonomic or postur*)).ti.

13. (occupation* or (work* not social work) or employ*).jx.

14. ((work* not working-memory) or occupation* or employ* or job or jobs).ti,id.

15. (work-related or job-related or employment-related or work environment* or workplace* or work place* or worksite* or work site* or jobsite or job site or "at work" or "on the job" or "while working" or Work-related or work* compensation).mp.

16. (Accidents/ or Accident Prevention/ or Safety/) and (employ* or work* or occupation* or job* or industr* or labourer* or laborer*).mp.

17. ((safety or safe or safely or unsafe* or accident* or hazard* or injur* or re-injur*) adj10 (employ* or (work* not working-memory) or occupation* or job* or industr* or labourer* or laborer*)).mp.

18. occupational disease*.mp.

19. (job-specific or work-specific or preemployment or pre-employment or work assessment or job assessment or jobfit or job matching).mp.

20. or/1-19

21. exp musculoskeletal disorders/

22. back pain/ or chronic pain/ or myofascial pain/ or exp neuralgia/

23. injuries/

24. ((Pain* or ache* or discomfort* or injur* or sore* or excruciat* or tear or tears or injur* or sprain* or strain* or dislocat* or impingement or instabilit* or fracture*) adj8 (musc* or MSK or tendon* or ligament* or joint or joints or bone or bones or soft-tissue or spine or cranial or neck or arm or arms or shoulder* or elbow* or wrist* or hand* or lumbar or back or hip* or knee* or ankle* or foot or feet or heel* or pelvic or rotator cuff or lower extremit* or lower limb* or upper extremit* or upper limb* or leg or legs)).mp.

25. (injur* adj5 (repetitive or overexertion* or lifting or manual handling)).mp.

26. (LBP or lumbago or backache or whiplash or sciatica or carpal tunnel or tendinitis or tendinosis or tendinopath* or axial-pain or spinal injur* or spinal pain or frozen shoulder or shoulder impingement or myofascial pain or patellofemoral pain or regional pain disorder* or cumulative trauma disorder* or osteoarthritis or (hernia* adj3 (disc or discs)) or (injur* adj5 (repetitive or overexertion* or lifting)) or tennis-elbow or epicondylitis or compartment-syndrome or myositis or polymyositis or pyomyositis or bursitis or chondritis or enthesitis or osteitis or epicondylitis or periostitis or periarthritis or synovitis).mp.

27. or/21-26

28. ((predict* or risk or screen*) adj8 (Likert or scale* or questionnaire* or index or checklist* or tool or tools or test or tests or instrument or instruments or score* or inventory)).mp.

29. (job matching or job fit or jobfit or ((pre-employment or job-specific or employment or workhab) adj5 (functional capacity or functional testing or screening or examination*))).mp.

30. (job assessment* or work assessment* or workplace systems assessment* or ergonomic assessment* or (risk assessment adj8 (job* or work* or ergonomic* or occupation*))).mp.

31. 28 or 29 or 30

32. (Rapid entire body assessment or Rapid Upper limb assessment or (liberty mutual* adj4 tables) or Snook tables or NIOSH lifting equation* or quick exposure check* or occupational repetitive actions or "Washington Industrial Safety and Health Act" or WISHA or quick ergonomic check or Dutch Musculoskeletal Questionnaire or Assessment of Repetitive Task* or Cumulative Trauma Disorder Risk Assessment Model or Hand Activity Level or ((Threshold Limit value or tlv) adj4 hand activity) or Hand Arm Risk Assessment Method or Keyserling* Cumulative Trauma Checklist or Key Indicator Methods or Loading on the Upper Body Assessment or Ovako Working Posture Analysis System or "Posture, Activity, Tools, and Handling" or PLIBEL or Risk Management Assessment Tool for Manual Handling Proactively or Workplace Ergonomic Risk Assessment or Job strain index or 3DSSPP or senz or life booster or jobfit systems or Pre-Employment Functional Assessments or PEFAs or Industrial Lumbar Motion Monitor or ergoweb or humantech or higher level screening tool).mp.

33. ((QEC or REBA or RULA or OCRA or LUBA or OWAS or PEFA) and (ergonomic* or injur* or pain or risk or job or musculoskeletal or msk or pain or posture or work-related or occupation*)).mp.

34. 32 or 33

35. (20 and 27 and 31) or 34

36. exp clinical trials/

37. exp experimental design/

38. (randomi or randomly or quasi-random* or quasirandom* or groups or subgroups or trial or placebo or (random adj4 (allocat* or distribut* or assign*))).tw.

39. (((interventional or clinical or experimental) adj1 (design or study or research)) or control group).mp.

40. (("N of 1" or single subject or single case) adj3 (experiment* or design or study or research)).mp.

41. ((observational adj (study or studies)) or case-control or cohort or follow-up or longitudinal or prospective or Retrospective or consecutive or long-term or longterm or matched pair* or baseline or comparative or pilot study or pilot project).mp.

42. or/36-41

43. 35 and 42

Cochrane Library (Trials database only) (Wiley Interface)

Date searched: March 19, 2021

Results: 2313

#1 [mh ^"Accidents, Occupational"] or [mh ^"workers' compensation"] or [mh ^"Occupational Health"] or [mh ^"Occupational Injuries"] or [mh ^"Occupational Health Services"] or [mh ^"employment"] or [mh ^"Work"] or [mh ^"work performance"] or [mh ^"Workplace"] or [mh "health personnel"[mj]] or or [mh ^"industry"] or [mh ^"beauty culture"] or [mh ^"forestry"] or [mh ^"health care sector"] or [mh ^"laundering"] or [mh ^"manufacturing industry"] or [mh ^"construction industry"] or [mh ^"chemical industry"] or [mh "extraction and processing industry"] or [mh ^"textile industry"] or [mh ^"power plants"] or [mh ^"occupational groups"] or [mh ^"administrative personnel"] or [mh ^"farmers"] or [mh ^"government employees"] or [mh ^"laboratory personnel"] or [mh ^"metal workers"] or [mh ^"miners"]

#2 (white-collar or blue-collar or shift-worker* or attorney* or lawyer* or miners or mining-industry or office-worker* or desk-worker* or secretarial-worker* or administrative-assistant* or secretaries or manual-labourer* or manual-laborer* or physical-labourer* or physical-laborer* or farmworker* or ((warehous* or construction or farm or agricultur* or fast-food or food-service or grocery or store or retail or maintenance) near/3 (work* or employ* or job* or labor* or labour* or industry)) or steelworker* or iron-worker* or ironworker* or mill-worker* or railway-worker* or vehicle-operator* or equipment-operator* or machinery-operator* or transit-operator* or bus-driver* or government-employees or hairdresser* or barber* or esthetician or child-care-providers or child-care-workers or housecleaners or janitor*):ti,ab,kw

#3 (((hospital near/2 (worker* or employee*)) or healthcare-aide or surgeon* or doctor* or physician* or general-practitioner or nurse* or dentist* or hygienist* or masseur* or masseuse or massage-therapist) and (pain or safety or safe or unsafe* or accident* or injur* or re-injur* or ergonomic or postur* or msk or strain or musculoskeletal)):ti

#4 (occupation* or (work* not social work) or employ*):so

#5 ((work* not working-memory) or occupation* or employ* or job or jobs):ti

#6 ([mh ^"Accidents"] or [mh ^"Accident Prevention"] or [mh ^"Safety"]) and (employ* or work* or occupation* or job* or industr* or labourer* or laborer*):ti,ab,kw

#7 ((safety or safe or safely or unsafe* or accident* or hazard* or injur* or re-injur*) near/10 (employ* or (work* not working-memory) or occupation* or job* or industr* or labourer* or laborer*)):ti,ab,kw

#8 (job-specific or work-specific or preemployment or pre-employment or work assessment or job assessment or jobfit or job matching or occupational-disease or occupational-health):ti,ab,kw

#9 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8

#10 [mh ^"Musculoskeletal Diseases"] or [mh ^"joint instability"] or [mh ^"joint loose bodies"] or [mh ^"synovitis"] or [mh ^"ischemic contracture"] or [mh ^"contracture"] or [mh ^"dupuytren contracture"] or [mh "arm injuries"] or [mh "back injuries"] or [mh ^"contusions"] or [mh "dislocations"] or [mh "fractures, bone"] or [mh ^"fractures, cartilage"] or [mh "hand injuries"] or [mh "hip injuries"] or [mh "leg injuries"] or [mh "neck injuries"] or [mh ^"occupational injuries"] or [mh ^"soft tissue injuries"] or [mh "spinal injuries"] or [mh "sprains and strains"] or [mh "tendon injuries"] or [mh ^"intervertebral disc degeneration"] or [mh ^"intervertebral disc displacement"] or [mh ^"musculoskeletal pain"] or [mh "back pain"] or [mh ^"Sciatica"] or [mh ^"neck pain"] or [mh ^"myofascial pain syndromes"] or [mh "tendinopathy"] or [mh ^"patellofemoral pain syndrome"] or [mh ^"tennis elbow"] or [mh ^"fasciitis, plantar"] or [mh ^"heel spur"] or [mh ^"bursitis"] or [mh ^"shoulder impingement syndrome"]

#11 ((Pain* or ache* or discomfort* or injur* or sore* or excruciat* or tear or tears or injur* or sprain* or strain* or dislocat* or impingement or instabilit* or fracture*) near/8 (musc* or MSK or tendon* or ligament* or joint or joints or bone or bones or soft-tissue or spine or cranial or neck or arm or arms or shoulder* or elbow* or wrist* or hand* or lumbar or back or hip* or knee* or ankle* or foot or feet or heel* or pelvic or rotator-cuff or lower-extremities or lower-limb or upper-extremities or upper-limb or leg or legs)):ti,ab,kw

#12 (injur* near/5 (repetitive or overexertion* or lifting or manual handling)):ti,ab,kw

#13 (LBP or lumbago or backache or whiplash or sciatica or carpal tunnel or tendinitis or tendinosis or tendinopath* or axial-pain or spinal-injur* or spinal-pain or frozen-shoulder or shoulder-impingement or myofascial-pain or patellofemoral-pain or regional-pain-disorder* or cumulative-trauma-disorder* or osteoarthritis or (hernia* near/3 (disc or discs)) or (injur* near/5 (repetitive or overexertion* or lifting)) or tennis-elbow or epicondylitis or compartment-syndrome or myositis or polymyositis or pyomyositis or

bursitis or chondritis or enthesitis or osteitis or epicondylitis or periostitis or periarthritis or synovitis):ti,ab,kw

#14 #10 OR #11 OR #12 OR #13

#15 ((predict* or risk or screen*) near/8 (Likert or scale* or questionnaire* or index or checklist* or tool or tools or test or tests or instrument or instruments or score* or inventory)):ti,ab,kw

#16 (job-matching or job-fit or jobfit or ((pre-employment or job-specific or employment or workhab) near/5 (functional-capacity or functional-testing or screening or examination*))):ti,ab,kw

#17 (job assessment* or work assessment* or workplace systems assessment* or ergonomic assessment* or (risk near/4 assess* near/8 (job* or work* or ergonomic* or occupation*))):ti,ab,kw

#18 #15 OR #16 OR #17

#19 ("Rapid entire body assessment" or "Rapid Upper limb assessment" or (liberty-mutual near/4 tables) or Snook-tables or NIOSH-lifting-equation or quick-exposure-check or occupational-repetitive-actions or "Washington Industrial Safety and Health Act" or WISHA or quick-ergonomic-check or Dutch-Musculoskeletal-Questionnaire or Assessment-of-Repetitive-Task* or Cumulative-Trauma-Disorder-Risk-Assessment-Model or Hand-Activity-Level or ((Threshold-Limit-value or tlv) near/4 hand-activity) or Hand-Arm-Risk-Assessment-Method or Keyserling-Cumulative-Trauma-Checklist or Key-Indicator-Methods or Loading-on-the-Upper-Body-Assessment or Ovako-Working-Posture-Analysis-System or "Posture, Activity, Tools, and Handling" or PLIBEL or "Risk Management Assessment Tool for Manual Handling Proactively" or "Workplace Ergonomic Risk Assessment" or "Job strain index" or 3DSSPP or senz or life booster or jobfit systems or "Pre-Employment Functional Assessments" or PEFAs or "Industrial Lumbar Motion Monitor" or ergoweb or humantech or "higher level screening tool"):ti,ab,kw

#20 ((QEC or REBA or RULA or OCRA or LUBA or OWAS or PEFA) and (ergonomic* or injur* or risk or job or musculoskeletal or posture or work-related or occupation* or msk or pain)):ti,ab,kw

#21 #19 OR #20

#22 (#9 AND #14 AND #18) OR #21

CINAHL Plus with Full Text (Ebscohost interface)

Date searched: March 19, 2021

Results: 1686

Deselect "Apply equivalent subjects" to all search lines

S1 (miners or mining industry or office worker* or desk worker* or secretarial worker* or administrative assistant* or secretaries or manual labourer* or manual laborer* or physical labourer* or physical laborer* or ((warehous* or construction or farm or agricultur* or fast food or food-service or grocery or store or retail) N3 (work* or employ* or job* or labor* or labour* or industry)) or steelworker* or iron worker* or ironworker* or mill worker* or railway worker* or vehicle operator* or equipment operator* or machinery operator* or transit operator* or bus driver* or government employees or hairdresser* or barber*)

S2 TI(((hospital N1 (worker* or employee*)) or healthcare aide* or surgeon* or doctor* or physician* or general practitioner* or nurse* or dentist* or hygienist* or masseur* or masseuse or massage therapist*) and (pain or safety or safe or unsafe* or accident* or injur* or re-injur* or ergonomic or postur* or msk or strain or musculoskeletal))

S3 SO(occupation* or (work* not social work) or employ*)

S4 TI((work* not working-memory) or occupation* or employ* or job or jobs)

S5 (work-related or job-related or employment-related or working-conditions or work-environment* or workplace* or work-place* or worksite* or work-site* or jobsite or job-site or "at work" or "on the job" or "while working" or work* compensation or occupational-disease* or job-specific or work-specific or preemployment or pre-employment or work-assessment or job-assessment or jobfit or job-matching)

S6 ((MH "Safety") OR (MH "Accidents")) and (employ* or work* or occupation* or job* or industr* or labourer* or laborer*)

S7 ((safety or safe or safely or unsafe* or accident* or hazard* or injur* or re-injur*) N10 (employ* or (work* not working-memory) or occupation* or job* or industr* or labourer* or laborer*))

S8 (MH "Accidents, Occupational+") OR (MH "Occupational Health+") OR (MH "Impairment, Health Professional") or (MH "Work Environment") OR (MH "Employment") OR (MH "Occupations and Professions") OR (MH "Worker's Compensation") OR (MH "Named Groups by Occupation") OR (MH "Blue Collar Workers") OR (MH "Child Care Providers") OR (MH "Correctional Facilities Personnel") OR (MH "Farmworkers") OR (MH "Firefighters") OR (MH "Government Employees") OR (MM "Health Personnel+") OR (MH "Librarians+") OR (MH "Pilots") OR (MH "Teachers") OR (MH "White Collar Workers") OR (MH "Administrative Personnel") OR (MH "Attorneys+") OR (MH "Estheticians")

S9 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8

S10 (MH "Musculoskeletal Diseases+") OR (MH "Facial Pain") OR (MH "Knee Pain+") OR (MH "Muscle Pain") OR (MH "Referred Pain") OR (MH "Neck Pain") OR (MH "Neuralgia+") or (MH "Leg Injuries+") OR (MH "Ligament Injuries+") OR (MH "Neck Injuries+") OR (MH "Sprains and Strains+") OR (MH "Tendon Injuries+") OR (MH "Hand Injuries+") OR (MH "Dislocations+") OR (MH "Back Injuries+") OR (MH "Arm Injuries+") OR (MH "Accidental Injuries") OR (MH "Crush Injuries") OR (MH "Fractures+") OR (MH "Occupational-Related Injuries") OR (MH "Soft Tissue Injuries+") OR (MH "Spinal Injuries+") OR (MH "Tears and Lacerations+")

S11 ((Pain* or ache* or discomfort* or injur* or sore* or excruciat* or tear or tears or injur* or sprain* or strain* or dislocat* or impingement or instabilit* or fracture*) N8 (musc* or MSK or tendon* or ligament* or joint or joints or bone or bones or soft-tissue or spine or cranial or neck or arm or arms or shoulder* or elbow* or wrist* or hand* or lumbar or back or hip* or knee* or ankle* or foot or feet or heel* or pelvic or rotator-cuff or lower-extremit* or lower-limb* or upper-extremit* or upper-limb* or leg or legs)) OR (injur* N5 (repetitive or overexertion* or lifting or manual handling)) OR LBP or lumbago or backache or whiplash or sciatica or carpal-tunnel or tendinitis or tendinosis or tendinopath* or axial-pain or spinal-injur* or spinal-pain or frozen-shoulder or shoulder-impingement or myofascial-pain or patellofemoral-pain or regional-pain-disorder* or cumulative-trauma-disorder* or osteoarthritis or (hernia* N3 (disc or discs)) or (injur* N5 (repetitive or overexertion* or lifting)) or tennis-elbow or epicondylitis or compartment-syndrome or myositis or polymyositis or pyomyositis or bursitis or chondritis or enthesitis or osteitis or epicondylitis or periostitis or periarthritis or synovitis

S12 ((predict* or risk or screen*) N8 (Likert or scale* or questionnaire* or index or checklist* or tool or tools or test or tests or instrument or instruments or score* or inventory)) OR job matching or job fit or jobfit or ((pre-employment or job-specific or employment or workhab) N5 (functional capacity or functional testing or screening or examination*)) OR job-assessment* or work-assessment* or workplace-systems-assessment* or ergonomic-assessment* or ((risk N4 assess*) N8 (job* or work* or ergonomic* or occupation*))

S13 (Rapid-entire-body-assessment or Rapid-Upper-limb-assessment or (liberty-mutual* N4 tables) or Snook-tables or NIOSH-lifting-equation* or quick-exposure-check* or occupational-repetitive-actions or "Washington Industrial Safety and Health Act" or WISHA or quick-ergonomic-check or Dutch-Musculoskeletal-Questionnaire or Assessment-of-Repetitive-Task* or Cumulative-Trauma-Disorder-Risk-Assessment-Model or Hand-Activity-Level or ((Threshold-Limit-value or tlv) N4 hand-activity) or Hand-Arm-Risk-Assessment-Method or Keyserling*-Cumulative-Trauma-Checklist or Key-Indicator-Methods or Loading-on-the-Upper-Body-Assessment or Ovako-Working-

Posture-Analysis-System or "Posture, Activity, Tools, and Handling" or PLIBEL or Risk-Management-Assessment-Tool for Manual-Handling-Proactively or Workplace-Ergonomic-Risk-Assessment or Job-strain-index or 3DSSPP or senz or life-booster or jobfit-systems or Pre-Employment-Functional-Assessments or PEFAs or Industrial-Lumbar-Motion-Monitor or ergoweb or humantech or higher-level-screening-tool) OR ((QEC or REBA or RULA or OCRA or LUBA or OWAS or PEFA) and (ergonomic* or injur* or risk or job or musculoskeletal or posture or work-related or occupation* or msk or pain))

S14 (S9 AND (S10 OR S11) AND S12) OR S13

S15 ((MH "Experimental Studies") OR (MH "Clinical Trials+") OR (MH "Community Trials") OR (MH "Controlled Before-After Studies") OR (MH "Nonrandomized Trials") OR (MH "Static Group Comparison") OR (MH "Pretest-Posttest Design+")) OR ((randomi* or randomly or quasi-random* or quasirandom* or groups or subgroups or trial or placebo) or (random N4 (allocat* or distribut* or assign*))) OR ((((interventional or clinical or experimental) N1 (design or study or research)) or control group)) OR ((("N of 1" or single subject or single case) N3 (experiment* or design or study or research)))

S16 ((MH "Case Control Studies+") OR (MH "Double-Blind Studies") OR (MH "Prospective Studies+") OR (MH "Single-Blind Studies") OR (MH "Triple-Blind Studies")) OR (((observational N1 (study or studies)) or case-control or cohort or follow-up or longitudinal or prospective or Retrospective or consecutive or long-term or longterm or matched-pair or baseline or comparative or pilot study or pilot project))

S17 S15 OR S16

S18 S14 AND S17

Scopus

Date searched: March 19, 2021

Results: 3173

#1 TITLE-ABS-KEY (white-collar OR blue-collar OR shift-worker* OR attorney* OR lawyer* OR miners OR mining-industry OR office-worker* OR desk-worker* OR secretarial-worker* OR administrative-assistant* OR secretaries OR manual-labourer* OR manual-laborer* OR physical-labourer* OR physical-laborer* OR farmworker* OR ((warehous* OR construction OR farm OR agricultur* OR fast-food OR food-service OR grocery OR store OR retail OR maintenance) W/3 (work* OR employ* OR job* OR labor* OR labour* OR industry)) OR

steelworker* OR iron-worker* OR ironworker* OR mill-worker* OR railway-worker* OR vehicle-operator* OR equipment-operator* OR machinery-operator* OR transit-operator* OR bus-driver* OR government-employees OR hairdresser* OR barber* OR esthetician OR child-care-providers OR child-care-workers OR housecleaners OR janitor*) OR TITLE (((hospital W/1 (worker* OR employee*)) OR healthcare-aide* OR surgeon* OR doctor* OR physician* OR general-practitioner* OR nurse* OR dentist* OR hygienist* OR masseur* OR masseuse OR massage-therapist*) AND (pain OR safety OR safe OR unsafe* OR accident* OR injur* OR re-injur* OR ergonomic OR postur* OR msk OR strain OR musculoskeletal)) OR SRCTITLE (occupation* OR (work* AND NOT social-work) OR employ*) OR TITLE ((work* AND NOT working-memory) OR occupation* OR employ* OR job OR jobs) OR TITLE-ABS-KEY (work-related OR job-related OR employment-related OR working-conditions OR work-environment* OR workplace* OR work-place* OR worksite* OR work-site* OR jobsite OR job-site OR "at work" OR "on the job" OR "while working" OR work*-compensation OR occupational-disease* OR occupational-health OR occupational-safety OR job-specific OR work-specific OR preemployment OR pre-employment OR work-assessment OR job-assessment OR jobfit OR job-matching) OR (KEY (safety OR accident) AND TITLE-ABS-KEY (employ* OR work* OR occupation* OR job* OR industr* OR labourer* OR laborer*)) OR TITLE-ABS-KEY ((safety OR safe OR safely OR unsafe* OR accident* OR hazard* OR injur* OR re-injur*) W/10 (employ* OR (work* AND NOT working-memory) OR occupation* OR job* OR industr* OR labourer* OR laborer*))

#2 KEY (musculoskeletal-disease OR ankylosis OR temporomandibular-ankylosis OR arthropathy OR ankle-instability OR arthralgia OR joint-contracture OR joint-degeneration OR joint-destruction OR joint-effusion OR joint-laxity OR joint-limitation OR joint-stiffness OR joint-swelling OR neuropathic-joint-disease OR patellofemoral-pain OR periarticular-joint-disease OR temporomandibular-joint-disorder OR osteoarthritis OR joint-injury OR joint-instability OR osteoarthropathy OR bone-injury OR fasciitis OR fascia-disease OR eosinophilic-fasciitis OR plantar-fasciitis OR contracture OR enthesopathy OR ligament-disease OR limb-injury OR limb-pain OR muscle-disease OR anterior-tibial-syndrome OR muscle-atrophy OR muscle-contracture OR muscle-diastasis OR muscle-hypertrophy OR muscle-injury OR muscle-rigidity OR muscle-strain OR muscle-tightness OR myalgia OR compartment-syndrome OR myositis OR polymyositis OR pyomyositis OR neuromuscular-disease OR musculoskeletal-chest-pain OR musculoskeletal-injury OR musculoskeletal-pain OR musculoskeletal-stiffness OR musculoskeletal-system-inflammation OR bursitis OR chondritis OR enthesitis OR osteitis OR epicondylitis OR periostitis OR periarthritis OR synovitis OR tendon-disease OR sciatica OR injury OR crush-trauma OR limb-injury OR microtrauma) OR TITLE-ABS-KEY (((pain* OR ache* OR discomfort* OR injur* OR sore* OR excruciat*

OR tear OR tears OR injur* OR sprain* OR strain* OR dislocat* OR impingement OR instabilit* OR fracture*) W/8 (musc* OR msk OR tendon* OR ligament* OR joint OR joints OR bone OR bones OR soft-tissue OR spine OR cranial OR neck OR arm OR arms OR shoulder* OR elbow* OR wrist* OR hand* OR lumbar OR back OR hip* OR knee* OR ankle* OR foot OR feet OR heel* OR pelvic OR rotator-cuff OR lower-extremit* OR lower-limb* OR upper-extremit* OR upper-limb* OR leg OR legs)) OR (injur* W/5 (repetitive OR overexertion* OR lifting OR manual-handling)) OR lbp OR lumbago OR backache OR whiplash OR sciatica OR carpal-tunnel OR tendinitis OR tendinosis OR tendinopath* OR axial-pain OR spinal-injur* OR spinal-pain OR frozen-shoulder OR shoulder-impingement OR myofascial-pain OR patellofemoral-pain OR regional-pain-disorder* OR cumulative-trauma-disorder* OR osteoarthritis OR (hernia* W/3 (disc OR discs)) OR (injur* W/5 (repetitive OR overexertion* OR lifting)) OR tennis-elbow OR epicondylitis OR compartment-syndrome OR myositis OR polymyositis OR pyomyositis OR bursitis OR chondritis OR enthesitis OR osteitis OR epicondylitis OR periostitis OR periarthritis OR synovitis)

#3 TITLE-ABS-KEY(((predict* or risk or screen*) W/8 (Likert or scale* or questionnaire* or index or checklist* or tool or tools or test or tests or instrument or instruments or score* or inventory)) OR job-matching or job-fit or jobfit or ((pre-employment or job-specific or employment or workhab) W/5 (functional-capacity or functional-testing or screening or examination*)) OR job-assessment* or work-assessment* or workplace-systems-assessment* or ergonomic-assessment* or ((risk W/4 assess*) W/8 (job* or work* or ergonomic* or occupation*)))

#4 TITLE-ABS-KEY(Rapid-entire-body-assessment or Rapid-Upper-limb-assessment or (liberty-mutual* W/4 tables) or Snook-tables or NIOSH-lifting-equation* or quick-exposure-check* or occupational-repetitive-actions or "Washington Industrial Safety and Health Act" or WISHA or quick-ergonomic-check or Dutch-Musculoskeletal-Questionnaire or Assessment-of-Repetitive-Task* or Cumulative-Trauma-Disorder-Risk-Assessment-Model or Hand-Activity-Level or ((Threshold-Limit-value or tlv) W/4 hand-activity) or Hand-Arm-Risk-Assessment-Method or Keyserling*-Cumulative-Trauma-Checklist or Key-Indicator-Methods or Loading-on-the-Upper-Body-Assessment or Ovako-Working-Posture-Analysis-System or "Posture, Activity, Tools, and Handling" or PLIBEL or Risk-Management-Assessment-Tool for Manual-Handling-Proactively or Workplace-Ergonomic-Risk-Assessment or Job-strain-index or 3DSSPP or senz or life-booster or jobfit-systems or Pre-Employment-Functional-Assessments or PEFAs or Industrial-Lumbar-Motion-Monitor or ergoweb or humantech or higher-level-screening-tool OR ((QEC or REBA or RULA or OCRA or LUBA or OWAS or PEFA) and (ergonomic* or injur* or risk or job or musculoskeletal or posture or work-related or occupation* or msk or pain)))

#5 (#1 AND #2 AND #3) OR #4

#6 TITLE-ABS-KEY (rct OR randomi* OR randomly OR quasi-random* OR quasirandom* OR groups OR subgroups OR {trial} OR placebo OR (random W/4 (allocat* OR distribut* OR assign*))) OR TITLE-ABS-KEY (((interventional OR clinical OR experimental) W/1 (design OR study OR research)) OR control-group) OR TITLE-ABS-KEY (("N of 1" OR single-subject OR single-case) W/3 (experiment* OR design OR study OR research)) OR KEY (comparative-study OR clinical-study OR case-control-study OR longitudinal-study OR retrospective-study OR prospective-study OR cohort-analysis) OR TITLE-ABS-KEY ((observational W/1 (study OR studies)) OR pilot-study OR pilot-project OR case-control OR cohort OR follow-up OR longitudinal OR prospective OR retrospective OR consecutive OR long-term OR longterm OR baseline OR comparative)

#7 #5 AND #6

Supplementary Material S2: Downs and Black scoring

			Single-intervention included articles					Multiple-intervention included articles							Poor quality articles					
		Possible Score	Frost 2007	Ho 2014	Ketola 2002	Speklé 2010 (RCT)	Speklé 2010 (Economic)	Carrivick 2002 (JOH)	Carrivick 2002 (JOEM)	Carrivick 2005	Craib 2007	Porru 2017	Rautianen 2004	Oude Hengel 2013	Carrivick 2001	Cheng 2009	Johnson 2002	Laing 2005	Laing 2007	Melhorn 2001
Reporting	Q1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	Q2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1
	Q3	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0	0	0
	Q4	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	0
	Q5	2	1	0	1	0	1	0	0	0	0	0	2	1	0	0	0	0	0	1
	Q6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1
	Q7	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	0
	Q8	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Q9	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Q10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
External validity	Q11	1	0	0	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0
	Q12	1	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0
	Q13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Internal validity (Bias)	Q14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Q15	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Q16	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1
	Q17	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1
	Q18	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	0
	Q19	1	1	1	1	0	0	1	1	1	0	1	1	0	1	1	0	1	1	1
	Q20	1	0	0	0	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0
Internal validity (confounding)	Q21	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0
	Q22	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0
	Q23	1	1	1	1	1	1	0	0	0	0	0	1	1	0	1	0	0	0	0
	Q24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Q25	1	0	0	1	1	0	1	1	1	1	0	0	1	1	0	0	0	0	0
	Q26	1	1	1	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	1
Power	Q27	1	1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
	Total	28	18	18	19	18	18	17	16	15	15	17	15	19	14	14	2	13	13	10

Supplementary Material S3: Included Study Characteristics

Study reference	Study design characteristics	Setting and participant characteristics	Name and Description of MSI Risk Factor Screening Tool(s)	Study arm descriptions	Outcome measurement tool	Outcome measures	Key results
Single-tool included studies							
Frost 2007	Cluster RCT; outcome-specific 6 to 8 quarters follow-up	General working population in Western Denmark: work sites with >20 employees and affiliated to 1 of 3 occupational health centres; 4006 participants randomized; convenience sampling (39 worksites from 293 contacted)	"Danish working environment regulations": assessment of lifting burdens, wheeled equipment use, repetitive risky movement patterns	Intervention 1 : Booklet on negative belief patterns and pain; presentation on site-specific workloads (randomized n=1516) Intervention 2: Intervention 1 + application of "Danish working environment regulations" (randomized n=1374) Control: Presentation on site-specific workload (randomized n=1063)	Work absence: Company-provided electronic absence data, provided quarterly	Work absence: 1) >7 day accumulated work absence due to pain (6 quarter follow-up) 2) >14 day accumulated work absence from any cause (8 quarter follow-up)	Work absence: No statistically significant difference in HR for pain-related or general absence-taking between any arms Among participants with new pain-related absence and employed at follow-up, no statistically significant difference in HR for likelihood of being at work between any arms Among participants with new general absence and employed at follow-up, decreased likelihood of booklet+presentation arm being at work (HR 0.80 (95% CI 0.68 - 0.95)); no significant difference for risk screening arm

Ho 2014	Individual RCT; 2 week follow-up	*Trial 1:* Participants from tertiary education institution in Hong Kong; 111 participants randomized; convienence sampling *Trial 2:* sedentary worker participants from major banking corportion in Hong Kong; 75 participants randomized; convenience sampling	Display Screen Equipment Risk Assessment and Management System (DSE RAM System): identification of workstation hazards using age, layout, misfit indices, worker preference of monitor and keyboard position; presentation of workstation change-based recommendations	*Both trials:* Intervention: Use of DSE RAM System risk-assessment and immediate recommendation for workstation modification (Trial 1 n=56, Trial 2 n=38) Control: Use of DSE Ram System, recommendations withheld until after follow-up period (Trial 1 n=55; Trial 2 n=37)	Musculoskeletal discomfort: Self-report musculoskeletal discomfort questionnaire Self-report computer-specific ocupational health attitudes and behavioural checklist	Musculoskeletal discomfort: 1) average self-report score pre- and post-intervention (range 0-10; lower= less discomfort) for 9 body parts (trial 1) / 5 body parts (trial 2) 2) average combined total self report score pre- and post-intervention (range 0-50; lower = less discomfort) (trial 2) Behavioural changes: Odds of answering "Yes", acknowleging specific behaviours in previous two weeks	Musculoskeletal discomfort: Format: pre-intervention -> post-intervention measurements in immediate/delayed intervention group; interaction term present for significance Trial 1: larger pre-post decrease in immediate intervention group for shoulders, elbows, wrists, upper back. *Shoulders:* Immediate intervention group mean(SD): 4.91(2.82) -> 3.78(2.59) Delayed intervention group mean(SD): 5.41(2.67) -> 5.43(2.81); interaction $p < 0.05$ *Elbows*: Immediate intervention group mean(SD): 3.56(2.50) -> 2.62(2.23) Delayed intervention group mean(SD): 3.91(2.65) -> 3.98(2.44); interaction $p < 0.05$ *Wrists:* Immediate intervention group mean(SD): 3.80(2.71) -> 2.60(2.21) Delayed intervention group mean(SD): 4.02(2.65) -> 4.09(2.50); interaction $p < 0.05$ *Upper back:* Immediate intervention group mean(SD): 4.69(2.82) -> 3.22 (2.29) Delayed intervention group mean(SD): 5.46(2.54) -> 5.13(2.84); interaction $p < 0.05$ Trial 2*:* statistically significant larger pre-post decrease in immediate intervention group for combined score. NS for all 5 individual-level body parts *Combined score:* Immediate intervention group mean(SD): 17.97(14.22) -> 14.05(11.97) Delayed intervention group mean(SD): 17.86(10.47) -> 15.06(9.43); interaction $p < 0.05$ Behavioural changes: Trial 2: Odds of taking more frequent rest breaks or increasing the duration of each break (OR 3.65 (CI 1.34 - 9.98)) Odds of attending more frequently to information on occupational safery and health (OR 3.90 (CI 1.20 - 12.69))

Ketola 2002	Individual RCT; follow-up at 2 and 10 months	Office computer users in Finland (more than 4 hours/week using video display units): from 3 administrational units of a medium-sized Finnish city; 124 participants randomized; sampling method unclear	"Ergonomic checklist for VDU work":checklist for workroom layour, workstation adjustments, work breaks	Intervention 1 (reference): one-page leaflet on VDU work; ergonomic consultation at participant request (n=33) Intervention 2: Intervention 1 + "ergonomic checklist for VDU work", followed by consultation with physiotherapist based on checklist results (n=39) Intervention 3: Intervention 1 + 1-hour ergonomics training session + "ergonomic checklist for VDU work" (n=35)	Musculoskeletal discomfort: 2-week daily diary (3 daily measurements) using modified Nordic questionnaire Questionnaire on musculoskeletal strain and pain in the preceeding 30 days	Musculoskeletal discomfort: 1) average daily diary self report score at 2- and 10-month follow up (range 1-5; lower=less discomfort) for 18 anatomical areas 2) Preceding 30 days musculoskeletal strain self-report score (range 1-5; lower=less strain) 3) Preceding 30 days musculoskeletal pain (≥1 day of pain / 0 days)	Musculoskeletal discomfort: Daily diary scores: Format: group mean score(SE), p-value from Dunnett's test comparing to reference group *2 months:* Neck: Intensive 2.7(0.2), p-value < 0.05; education 2.7(0.1), p < 0.05; reference 3.3(0.2) Area between neck and shoulder (right): intensive 2.5(0.1), p < 0.01; education 2.5(0.1), p < 0.01; reference 3.1(0.2) Right shoulder: intensive 2.2(0.2), p < 0.05; reference 2.8(0.2) Left shoulder: intensive 1.9(0.1), p < 0.05; reference group 2.4(0.2) Left hand fingers: intensive 1.8(0.1), p < 0.05; reference group 2.3(0.1) Upper back: intensive 2.2(0.1), p < 0.01, education 2.4(0.1), p < 0.01, reference 2.9(0.1) *10 months:* NS for any body part Questionnaire on musculoskeletal strain and pain (past 30 days): NS at any timepoint
Speklé 2010 (RCT)	Cluster RCT; 12 month follow-up	Mixed general working population from the Netherlands: 7 Dutch organizations of varying occupational characteristics; 1183 participants randomized; purposive non-random sampling	Repetitive Strain Injury (RSI) QuickScan: questionnaire on exposure to risk factors from occupation, relationship with colleagues, ergonomics and musculoskeletal health	Intervention 1: Participants completed and immediately received feedback from RSI QuickScan, defining one of 16 interventions (n=365) Intervention 2 (control): Participants completed RSI QuickScan, but received only general advice. Individuals reporting severe arm, shoulder, neck symptoms referred to occupational physician for consult; all others put on waiting list until post-follow-up (n=376)	Musculoskeletal discomfort: Online questionnaire (Modified Nordic questionnaire - 7 regions) of 6-month and 7-day prevalence of arm, shoulder, neck symptoms Work absence: Sick leave data from human resources department of organizations participating in the study	Musculoskeletal discomfort: Prevalence of arm, shoulder, neck symptoms within last 6 months / 7 days; two categories - proximal and distal appendage symptoms (operationalized as prevalence odds) Work absence: Days of sick leave from study entrance	Musculoskeletal discomfort: *12 months:* NS for prevalence of arm, shoulder neck symptoms (total) (95% CI 0.61 - 1.30) NS for prevalence of proximal symptoms (95% CI 0.54 - 1.12) NS for prevalence of distal symptoms (95% CI 0.49 - 1.67) Work absence: *12 months:* NS for days of sick leave

Spekké 2010 (Economic analysis)	see above	see above	see above	see above	Resource utilization: Online questionnaire (additional to standard RSI QuickScan) to measure resource utilization	Resource utilization: Direct (practitioner) healthcare costs (Euro) Direct non-healthcare costs (Euro) Intervention cost (Euro) Work absence: Sick leave cost (Euro)	Resource utilization: *12 months:* Direct (practitioner) healthcare costs: NS between groups Direct non-healthcare costs: NS between groups Intervention cost: mean intervention additional cost of 30.73 (95% CI 18.78 - 41.03) Euro Total direct costs (sum of all direct and intervention costs): NS between groups Work absence: *12 months*: Sick leave costs (paid labour): NS between groups
Multiple tool/intervention included studies							
Carrivick 2002 (JOEM)	Quasi-experimental pre-post design with control group; analysis period of 88 months with follow-up associated with duration of employment status	Cleaners (n=137) and orderlies (n=128) from a teaching hospital in Western Australia; nonrandomized	Manual Handling Checklist: assessment of actions, workstataion, posture, qualities of manual handling, loads moved, work environment, skills and demographic factors	Intervention (cleaners) group: 52 months pre-intervention period compared to 36-month intervention period. Over course of intervention period, use of Manual Handling Checklist, injury data, communication from staff; eventual categorization of injury risk for specific identified hazards, then providing risk reduction via varied hazard controls (n=137) Control (orderlies) group: 52 months pre-intervention period compared to 36-month intervention period. Usual training, access to hospital occupational safety services(n=128)	Workplace-associated MSI: Personnel records and incident datasheets Work absence: Personnel records Claims cost: Personnel records, financial records, insurer workers compensation documents	Workplace-associated MSI: Pre-post lost time injury count and rate (per hours worked) Frequency distributrion of injury count (0, 1, >1) Work absence: Pre-post working hours lost from injury - count and rate (per hours worked) Claims cost: Pre-post total compensation costs from lost time injuries (count and rate)	Workplace-associated MSI: Injury frequency distribution: significant pre-post association between proportion of injured (1+ injuries) and non-injured (0 injury) individuals ($p < 0.01$) *Univariate analysis* **Pre-WRAT mean(SE) -> post-WRAT mean (SE); 95% CI for difference** Workplace-associated MSI: Injury frequency rate (units not given): Cleaners: 0.892(0.148) -> 0.399(0.125); -0.863 - -0.124 Orderlies: 1.048(0.158) -> 1.450(0.197); 0.022 - 0.784 Work absence: Injury duration rate (units not given): Cleaners: 2.419(0.186) -> 1.765(0.163); -1.069 - -0.239 Orderlies: 2.273(0.210) -> 3.112(0.237); 0.334 - 1.344 Claims cost: Injury claims cost rate (units not given): Cleaners: 3.285(0.286) -> 2.058(0.228); -1.855 - -0.599 Orderlies: 3.263(0.323) -> 4.364(0.365); 0.211 - 1.791 *Multivariate (generalized linear mixed modelling) analysis (Odds ratio and 95% CI, random variance):* Workplace-associated MSI: Frequency rate: Cleaners: OR 0.354(0.226 - 0.554); random variance 1.963 Orderlies: OR 1.536 (1.174 - 2.009); random variance 1.282 Work absence: Injury duration rate: Cleaners: NS Orderlies: OR 2.361 (1.345 - 4.143); random variance 2.371 Claims cost : Claims cost rate: Cleaners: OR 0.275 (0.117 - 0.646); random variance 2.319 Orderlies: OR 2.660 (1.114 - 6.450); random variance 5.326

Carrivick 2002 (JOH)	see above (additional analysis)	see above (additional analysis)	see above (additional analysis)	see above (additional analysis)	see above (additional analysis)	Workplace-associated MSI: Pre-post lost time injury count and rate (per hours worked), stratified by injury type (musculoskeletal versus non-musculoskeletal) Work absence: Pre-post working hours lost from injury - count and rate (per hours worked), stratified by injury type (musculoskeletal versus non-musculoskeletal) Claims cost: Pre-post total compensation costs from lost time injuries (count and rate), stratified by injury type (musculoskeletal versus non-musculoskeletal)	**Univariate analysis (type: mean pre-intervention (SD) -> mean post-intervention (SD); (95% CIs of difference, p value of difference))** Workplace-associated MSI: Frequency rate (count per 10,000 hours worked): Musculoskeletal injury rate 0.720(0.134) -> 0.299(0.116), (0.071 - 0.770) $p < 0.05$ Non-musculoskeletal injury frequency rate NS Work absence: Duration rate (logarithmic scale per 10,000 hours worked): Musculoskeletal injury duration rate 2.200(0.177) -> 1.617(0.146); (0.172 - 0.995) $p = 0.006$ Non-musculoskeletal injury duration rate NS Claims cost: Claims cost rate (logarithmic scale per 10,000 hours worked) Musculoskeletal injury claims cost rate 2.926(0.273) -> 1.816(0.198); (0.494 - 1.727) $p > 0.01$ Non-musculoskeletal injury claims cost rate NS **Generalized linear mixed model analysis (incidence rate ratios pre-post, 95% CI, random effect variance):** Workplace-associated MSI: Injury frequency rate: musculoskeletal injury 0.353 (0.220 - 0.504, 2.359) Non-musculoskeletal injury 0.367 (0.229 - 0.589, 4.972) Work absence: Injury duration rate: musculoskeletal injury 0.605 (0.397 - 0.923, 0.648) Non-musculoskeletal NS Claims cost: Claims cost rate: musculoskeletal injury 0.342 (0.182 - 0.643, 1.167) Non-musculoskeletal NS

Carrivick 2005	see above (additional analysis): difference - cleaners group present in analysis, orderlies group (population control group) not present in analysis	see above (additional analysis): difference - cleaners group present in analysis, orderlies group not present in analysis	See above (additional analysis)	See above: difference - cleaners group present in analysis, orderlies group not present in analysis	See above (additional analysis)	Workplace-associated MSI: Pre-post lost time injury count and rate (per hours worked), stratified by injury mechanism (manual handling versus non-manual handling) Work absence: Pre-post working hours lost from injury - count and rate (per hours worked), stratified by injury mechanism (manual handling versus non-manual handling) Claims cost: Pre-post total compensation costs from lost time injuries (count and rate), stratified by injury mechanism (manual handling versus non-manual handling)	**Univariate pre-post intervention analysis (mean rate before (SE) -> after (SE), 95% CI of difference, p value:** Workplace-associated MSI: Frequency rate per 10,000 hours worked (manual handling injuries): 0.619 (0.126) -> 0.185 (0.063), 0.164 - 0.704, p < 0.01 Non manual-handling injuries NS Work absence: Duration rate (logarithmic scale per 10,000 hours worked) (manual handling injuries): 2.090 (0.179) -> 1.584 (0.141), 0.128 - 0.886, p < 0.01 Non manual-handling injuries NS Claims cost: Claims cost rate (logarithmic scale per 10,000 hours worked) (manual handling injuries): 2.028 (0.194) -> 1.763 (0.189), 0.398 - 1.540, p < 0.01 Non manual-handling injuries NS **Measures of association in adjusted analysis (95% CI):** Workplace-associated MSI: Manual handling injury frequency rate ratio of 0.328 (CI 0.226 - 0.476) Non manual-handling injury frequency rate of 0.365 (CI 0.231 - 0.575) Work absence: Manual handling injury duration rate ratio of 0.642 (CI 0.434 - 0.951) Non manual-handling injury rate ratio NS Claims cost: Manual handling injury claims cost rate ratio of 0.382 (CI 0.212 - 0.689) Non manual-handling injury claims cost rate ratio NS
Craib 2007	Quasi-experimental study (non-randomized experimental groups); 12 months follow-up	Community health workers from British Columbia, Canada: 6 organizations; nonrandomized; total n=648; organizations volunteered for inclusion	Checklist-based tool: summary sheet, hazard identification and assessment, biomechanics guide, handwashing technique, hazard prevention measures	Intervention groups (5 organizations): One or more of a combination of an education and training module, checklist-based risk assessment tool, lift equipment registry (total n=535) Control group (1 organization): No intervention provided. (n=171)	Workplace-associated MSI: WorkSafeBC (provincial regulatory agency for injuries)	Workplace-associated MSI: Annual injury incidence proportion (all reported injuries; lost-time injuries) - operationalized as "time to first reported injury" and "time to first time-loss injury"	Workplace-associated MSI: Univariate analysis: Time to first reported injury: 13.9% annual injury (non-intervention program); 24.5% annual injury (intervention program); risk ratio 1.93 (95% CI 1.23 - 3.02; p-value < 0.05) Time to first time-loss injury: 11.2% annual injury (non-intervention program); 6.9% annual injury (intervention program); risk ratio 0.61 (95% CI 0.35 - 1.07; NS) Multivariate analysis (adjusted risk ratio): Time to first reported injury: risk ratio for intervention 1.78 (95% CI 1.12 - 2.81) Time to first reported time-loss injury 0.58 (95% CI 0.33 - 1.04, NS)

Porru 2017	Quasi-experimental study (ITS); up to 7 years pre-intervention and 3 years post-intervention follow-up; yearly follow-up	Foundry workers from North/central Italy, categorized into 2 groups: ferrous foundries (n=22, 2750 individuals in 2007-08) and non-ferrous foundries (n=7, 710 individuals in 2007-08); foundries volunteered for inclusion	Ad-hoc risk assessment checklist: assessment of injury and near-miss data; provides foundry-specific recommendations for preventing similar accidents	Intervention: Use of risk assessment checklist and recommendations during telephone and on-site audits; improving worker access to occupational physician recommendations (including task adjustment); increased health surveillance; protective equipment prescriptioning (all foundries) Control: Pre-intervention period in each foundry (all foundries)	Workplace-associated MSI: Company-level databases of formally registered injuries of >3 days lost work Work absence: Company-level databases of formally registered injuries of >3 days lost work	Workplace-associated MSI: Injury rate (incidence / population denominator) Injury rate (injury density / hours-based rate) Work absence: Work absence rate (workdays lost per hours worked)	Workplace-associated MSI: Pre-post injury rate (incidence / population-based dedomination): 74% of initial injury rate following intervention (95% CI 57% - 95%) NS for change in injury rate trend NS for hours-based rate (rate or change in trend) Work absence: NS for work absence rate (rate or change in trend)
Rautianen 2004	Matched pair RCT; total of 3 years of follow-up	Farmers from a nine-county area in Iowa; n=125 for intervention and control cohorts for a total of 300 farms; participation based on respsnse from postage sent from US Postal mailing list	Certified Safe Farm (CSF)Checklist: identification and removal of farm hazards associated with illness and injury	Intervention group: CSF Checklist utilized during yearly on-farm safety reviews, health screening during clinic visits, informational and focus groups regarding intervention, $200 USD yearly payment (n=152) Control group: $75 USD yearly payment (n=164)	Workplace-associated MSI: Annual occupational history forms; quarterly phone calls with standardized question formats; CSF-associated health calendars Claims cost: Quarterly phone calls with standardized question formats Resource utilization: Quarterly phone calls with standardized question formats Work absence: Unclear data collection mechanism (likely, a combination of resources used for collection of workplace-associated MSI data)	Workplace-associated MSI: Injury rate (individual count, quarterly injury rate (person-years) Claims cost: Mean injury cost (USD) and characteristics of insurance coverage (percent of injuries fully, partially, not covered by insurance) Resource utilization: Rate of injuries requiring hospitalization or professional care visit (person-year rate) Work absence: Rate of injuries requiring >1 day disability (person-years)	Workplace-associated MSI: Univariate analysis: Intervention effect: NS Claims cost: Mean injury cost of $163 USD NS between intervention and control groups ($p > 0.05$) Resource utilization: Rate of injuries requiring hospitalization: NS between groups Rate of injuries requiring professional care: NS between groups Work absence: Rate of injuries requiring >1 day disability (person-years): NS

Oude Hengel 2013	Cluster RCT; follow-up at 3, 6 and 12 months	Construction workers from 6 Dutch commercial construction companies (total n=293; comprised of 15 clusters)	"Quick scan questionnaire"	Intervention group: 1) Use of quick scan questionnaire by physiotherapist alongside 15-minute workplace inspection; 3 tailored recommendations made to reduce physical workload; discussion-based training session 4 months following initial intervention 2) Use of rest-break flow chart 3) 1 hour interactive training session for workplace empowerment (total n=171) Control group: No intervention provided (total n=122)	Musculoskeletal discomfort: Self-report Dutch musculoskeletal questionnaire (DMQ) 4-point scale for pain and discomfort; operationalized as no symptoms / symptoms Sick leave: Workplace databases from companies participating in the study Self-rated health status: Self-report SF-12 health survey	Musculoskeletal discomfort: Percent of individuals reporting symptoms for back, neck/shoulder, upper extremities, lower extremities Sick leave: Dichotomous outcome: Count of individuals with 6+ days of sick leave in previous 6 months Self-rated health status: Average score of SF-12 health survey	Musculoskeletal discomfort: NS between intervention and control groups at 3, 6, or 12 months compared to baseline Sick leave: NS between intervention and control groups at 3, 6, or 12 months compared to baseline Self-rated health status: NS between intervention and control groups at 3, 6 or 12 months compared to baseline
Key: RCT=randomized controlled trial, HR=hazard ratio, CI=confidence interval, SD=standard deviation, NS=no statistical significance, OR=odds ratio, VDU=video display unit, USD=United States Dollars							