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A systematic review of injury/illness prevention and loss control programs (IPCs)

sharing best evidence

About this report:

Authors:
Shelley Brewer[1, 2], Eden King[3], Benjamin C. Amick III[1,4,5], George Delclos[1], Jerome Spear, M[6], Emma Irvin[4], Quenby Mahood[4], Linda Lee[7], Cindy Lewis[8], Lois Tetrick[3], David Gimeno[9], Renee Williams[10]

Affiliations:

1. The University of Texas, School of Public Health, Division of Environmental and Occupational Health, Houston, TX, USA
2. ChemPlan, Inc., Sarasota, FL, USA
3. George Mason University, Department of Industrial and Organizational Psychology, Fairfax, VA, USA
4. The Institute for Work & Health, Toronto, Canada
5. The University of Texas, School of Public Health, Division of Health Promotion and Behavioral Sciences, Houston, TX, USA
6. JE Spear Consulting, Magnolia, TX, USA
7. MD Anderson Cancer Center, Environmental Health and Safety, Houston, TX, USA
8. Creative Safety Solutions, Houston, TX, USA
9. University College London, Department of Epidemiology & Public Health, London, England, UK
10. McMaster University, Department of Rehabilitation Sciences, Hamilton, Ontario, Canada

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If you have questions about this or any of our other reports, please contact us at:

Institute for Work & Health
481 University Avenue, Suite 800
Toronto, Ontario, M5G 2E9
Email: info@iwh.on.ca
Or you can visit our web site at www.iwh.on.ca

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Table of Contents

Appendices

List of Tables

List of Figures

Foreword

In recent years, the Institute for Work & Health has been actively engaged in building relationships with Prevention System agencies and organizations in Ontario.

In these encounters, we often hear that potential research users want more evidence about the effectiveness of interventions aimed at protecting workers' health. We are also told that even when research evidence exists, it is often hard to access, difficult to understand and is not always presented in language and formats suitable to non-scientific audiences.

In response to these needs, the Institute for Work & Health has established a dedicated group to conduct systematic reviews of relevant research studies in the area of workplace injury and illness prevention.

- Our systematic review team monitors developments in the international research literature on workplace health protection and selects timely, relevant topics for evidence review.
- Our scientists then synthesize both established and emerging evidence on each topic through the application of rigorous methods.
- We then present summaries of the research evidence and recommendations following from this evidence in formats which are accessible to non-scientific audiences.

The Institute consults regularly with workplace parties to identify areas of workplace health protection that might lend themselves to a systematic review of the evidence.

We appreciate the support of the Ontario Workplace Safety & Insurance Board (WSIB) in funding this four-year Prevention Systematic Reviews initiative. As the major funder, the WSIB demonstrates its own commitment to protecting workers' health by supporting consensus-based policy development which incorporates the best available research evidence.

Many members of the Institute's staff participated in conducting this Systematic Review. A number of external reviewers in academic and workplace leadership positions provided valuable comments on earlier versions of the report. On behalf of the Institute, I would like to express gratitude for these contributions.

Dr. Cameron Mustard
President, Institute for Work & Health
December, 2007

1.0 Introduction

Injuries among workers have adverse consequences for the worker, the employer and the general population. Workers suffer both physical and monetary losses following an on-the- job injury. Employers often incur production problems and rising insurance premiums as a result of an injured employee. Increased insurance premiums and production costs often translate to higher product prices for consumers. In addition, injured workers and their families may incur negative psychological or emotional effects following a workplace injury.

Injury/illness prevention and loss control programs (IPCs) are developed and enacted in the workplace as a means to protect workers, meet regulatory requirements, reduce the adverse consequences of worker injuries, and manage costs. Employers often establish prevention programs as a proactive way of reducing injury frequency, and they set up loss control programs to minimize the costs and disability associated with injuries after they've occurred. Studies of workplace IPCs are heterogeneous in both the factors studied and the outcomes evaluated. The effects of IPCs have proven difficult to study because a standard concept or definition of what constitutes "injury/illness prevention and loss control programs" is not used by either practitioners or researchers. Also, it is difficult to determine which specific components of broad-based IPCs are directly affecting worker injuries.

Injury/illness prevention and loss control programs are an aggregate of human resource, safety management, regulatory compliance, environmental protection and disability management policies. Teasing out the effects that the intermingled policies have on employees is difficult. A specific program's effectiveness may not be accurately represented when heterogeneous IPCs are combined and considered only at the organizational level.

Employers are faced with selecting from an array of workplace IPCs and are often guided by regulatory need and product marketing rather than scientifically credible evidence on program effectiveness. In an attempt to provide employers with scientific knowledge to assist in selecting effective IPCs, researchers have evaluated programs, policies, practices and concepts such as safety climate, safety culture, leadership training, organizational policies/practices (OPPs) and occupational health and safety management systems (OHMS) (1). The research has attempted to quantify the effects that IPCs have on reducing injury frequency, severity and associated costs (1). The difficulty in studying IPCs is that they are multidimensional, overlapping and applied differently depending on the type and physical location of the workplace. A systematic review of the IPC literature would provide

employers with valuable information concerning which workplace programs have scientific evidence demonstrating effectiveness.

The heterogeneity in existing research provides a challenge for researchers who would like to synthesize the IPC evidence by conducting a systematic review. The systematic review process provides a structured methodology for evaluating, synthesizing and discovering gaps in the literature (2; 3; 4; 5).

The purpose of this systematic review was to identify studies that evaluated the effect of IPCs on reducing the frequency and/or severity of workplace injuries. Studies that met our design and quality criteria were evaluated in detail, and study data were synthesized. The review included both primary and secondary prevention studies. By definition, loss control programs focused on secondary prevention. Based on our synthesis, we made recommendations about program effectiveness related to primary and secondary prevention of work-related injuries and illnesses. We also discussed the need for further, high quality workplace intervention studies.

1.1 Organization of the report

Following this introduction, readers will find:

- a detailed description of the methods we used to search for and select relevant studies
- details about quality assessment, data extraction and best evidence synthesis of the methodology of quantitative studies
- results of the systematic review, including information about the number of studies found; their methodological quality; the types of interventions examined; and study characteristics
- results of our synthesis of evidence according to intervention categories
- conclusions about the levels of evidence
- messages about the current state of the peer-reviewed literature and recommendations for future intervention research and evaluation

2.0 Materials and methods

Observational and intervention studies were systematically reviewed using processes developed by Cochrane (6), Coté (3) and Slavin (5). A review team of professionals including both researchers and practitioners participated. Team members were invited to participate based on their expertise in occupational medicine, safety management/engineering, epidemiologic intervention studies, organizational psychology, disability management and/or their experience conducting systematic reviews.

The more extensive IPC review encompassed the safety culture/climate and IPC measurement tool literature. Scoping reviews of the sustainability of safety culture/climate and IPC measurement tools were also conducted. Scoping reviews provide a description of the breadth of the literature and themes that emerge in each area, rather than a full synthesis of findings. The results from these reviews are presented in other manuscripts.

The basic steps of the systematic review follow a standard protocol (2; 7; 1) and are:

Step 1 Formulate review questions and search terms.
Step 2 Identify articles that are relevant to the review questions and are expected to be found by the search ("must-have" articles).
Step 3 Conduct stakeholder meetings to receive input from target audiences regarding the relevance of the search terms and questions.
Step 4 Contact content experts to identify key articles (including grey literature).
Step 5 Conduct literature search and pool articles with those submitted by experts.
Step 6 Level 1 review: Select articles for inclusion based on relevance to the review questions and quality screening criteria.
- Identify articles relevant to the scoping reviews.
- Summarize scoping review articles.

Step 7 Level 2 review: Assess quality of relevant articles and calculate a quality score.
Step 8 Level 3 review: Conduct data extraction of relevant articles.
Step 9 Conduct evidence synthesis.
Step 10 Present results to stakeholders.
Step 11 Prepare report incorporating stakeholder input.

The review team developed and reached consensus on the IPC review questions and the breadth of the scoping reviews. The questions were examined by considering both primary and secondary prevention studies.

The review was limited to articles published or in press in the English, Spanish or French languages, in peer-reviewed publications, from 1970

forward. In 1970, the Occupational Safety & Health Act (OSHA) was enacted in the United States, where the majority of the literature was expected to originate. Book chapters and conference proceedings were excluded unless suggested by content experts (experts are listed in Appendix A). The primary reasons for the stated limitations were the language proficiency of the team and the time available to complete the review steps.

A sound literature search required defining the key terms in the review questions. The identified terms determined the breadth of the search. The three key definitions needed prior to performing the literature search were for: injury/illness prevention and loss control programs, injury/illness outcomes and workplace/workers.

Injury/illness prevention and loss control programs (IPCs)

Many concepts and definitions were reviewed to determine how to best define injury/illness prevention and loss control programs. The following framework was taken and adapted from a 1976 *Professional Safety* article, reprinted in 2003, which was written by Ted Ferry to help describe IPCs (8).

In a workplace, the planning process begins with determining organizational objectives. The planning next turns to policies, procedures and practices (what he calls "performance") used to achieve objectives. There are three functional levels in most organizations. The policy level is associated with top management. The procedures level is a function of middle management, while actual work practices are at a lower or general worker level. Functional divisions by organizational level are seldom this clear-cut and are often known by other names. The policies, procedures and practices combine to create workplace IPCs.

What separates prevention strategies and control strategies is not absolute; prevention is considered to be the activities that focus on preventing injuries, while control strategies focus on minimizing losses associated with injuries once they have occurred. This approach to planning provides a practical explanation of IPCs.

In this review, some programs and policies that are often considered part of a company's IPC were excluded from the search because their effects in the workplace were not expected to be generalizable to other IPCs. Programs and policies that addressed the following areas were excluded: employee assistance programs (EAP), violence prevention, substance abuse, Americans with Disabilities Act (ADA), quality management, health-care utilization and mental health/illness.

Studies that addressed regulatory programs with injury/illnesses and/or workers' compensation claims as the outcome were included. Programs that

dealt solely with regulatory compliance or fitness for duty were excluded. Surgical interventions among workers with work-related injuries or illnesses were also excluded.

Medical surveillance and screening programs often overlap with IPCs. The studies relevant to the review questions were believed to include medical surveillance or screening components. Surveillance/screening studies were handled on a case-by-case basis to determine if IPCs were being evaluated. Surveillance/screening studies that did not link their testing to an IPC or IPC measurement tool's effect on injuries/illnesses or workers' compensation outcomes were excluded.

Injury/illness outcomes

The primary outcomes were clinical diagnoses of employees, injury/illnesses rates, workers' compensation claims (rates, duration or costs) or employee injury/illness self-reports. Studies that reported near-misses and accident reporting as sole outcomes were excluded. The focus of this review was on employee injury/illnesses, and not on accident reporting. Accidents and injuries are not interchangeable terms. Accidents refer to damage to equipment or facilities, while injuries refer to physical harm incurred by people. Workers' compensation and reports required by regulation (i.e. OSHA logs) were included despite the validity and reliability vulnerabilities of these data sources because this information was relevant to stakeholders.

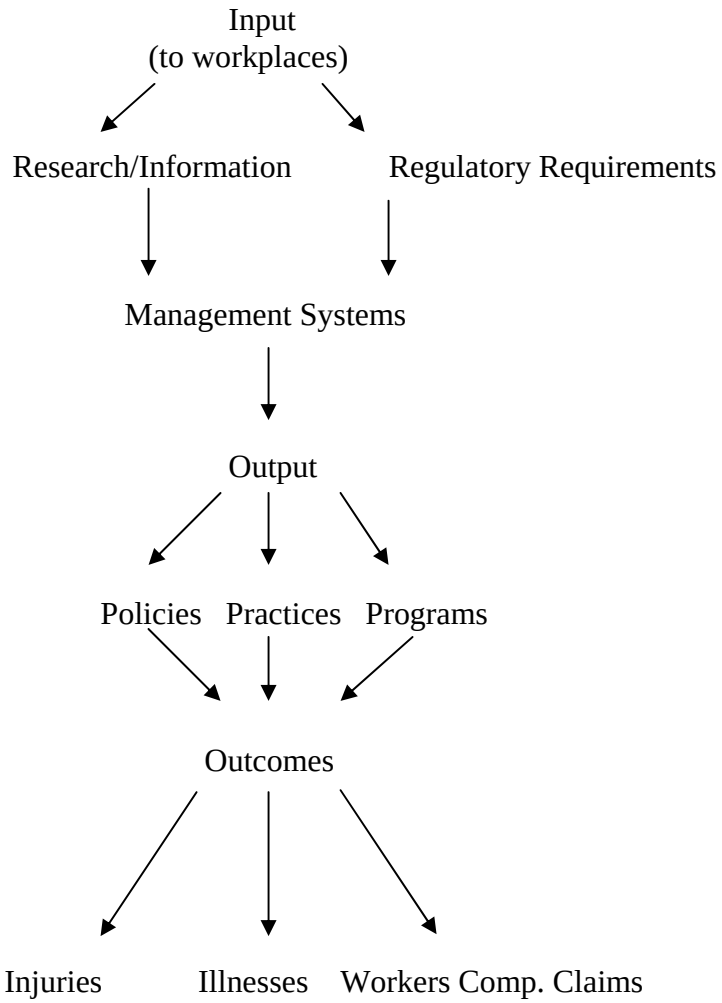
Injury/illness outcomes were expected to be more directly related to occupational injury/illness prevention programs, while workers' compensation outcomes were expected to be more related to loss control.

Work setting and workers

Workplaces were limited to those locations that employed adults (18 years or older). Workplaces/workers that were not included in the review were agricultural workers, migrant workers, tele-workers, home offices/workers, military installations, commercial fishing and workplaces that employed only those 17 years old and younger. The workplaces were excluded as the team believed these sites were unique and difficult to generalize to other workplaces. Laboratory studies were also excluded.

Figure 1 depicts the focus of the review in regards to interventions and outcomes.

Figure 1: IPC framework



2.1 Stakeholder input (prior to search)

Stakeholders representing industry, unions and regulatory agencies were invited to provide feedback on the review. The purpose was to solicit input on the following topics: the review questions, search terms, information that stakeholders would use to make decisions in the workplace, and quality assessment processes to evaluate the literature.

Two stakeholder meetings were held, one at the Institute for Work & Health (IWH) in Toronto, Ontario and the other at the School of Public Health, University of Texas in Houston, Texas. Meetings were held in two locations to ensure the review was relevant to a diverse group of stakeholders.

Six stakeholders representing insurance companies, government agencies, occupational health and safety consultants and trade organizations attended a two-hour meeting in Toronto. In Houston, four stakeholders joined in person while two joined over the phone for a 1.5 hour meeting. The Houston stakeholders represented oil and gas companies, construction companies, chemical companies, food manufacturers/distributors and municipalities (Appendix B lists the stakeholder meeting attendees). Stakeholders agreed the review topic was important and expressed interest in review results.

The original questions for the full systematic review that were presented were:

- Do injury prevention and control programs reduce workplace injury/illnesses and/or workers' compensation claims?
- Does the injury prevention and control program literature provide a set of measurement tools that can be used to predict employee injuries/illnesses and workers' compensation claims?

The stakeholders suggested making the full review questions more specific so that the literature could be used to answer different questions about outcomes. The final questions developed from stakeholder input were:

- Are injury/illness prevention and loss control programs effective in reducing workplace injury/illnesses and/or workers' compensation claims?
- Which injury/illness prevention and loss control tools are effective at assessing the risk of workplace injuries/illnesses?
- Which injury/illness and loss control tools are effective at assessing the frequency and/or duration of workers' compensation claims?

The stakeholders also suggested broadening the search. The terms that they suggested adding are included in Appendix C. The review team went over all proposed search term additions with IWH library professionals. The search was conducted in "steps" to determine the impact that the added terms had on the number of articles identified.

The stakeholders reported that they use websites (e.g. Institute for Work & Health, National Institute of Occupational Safety and Health [NIOSH], Bureau of Labor Statistics, Occupational Safety and Health Administration), conference proceedings and trade journals/magazines when looking for information. They were concerned that excluding the non-peer-reviewed literature may cause the review team to miss a large part of the literature they use. Content experts were asked to try to identify the relevant grey literature rather than having the review team search the grey literature in its entirety. The review team considered the task of incorporating all the non-peer-reviewed literature beyond the project's scope, but felt it would be critical to

publish the results of the review in the resources identified by stakeholders (i.e. *Professional Safety*, *Accident Prevention*, IWH website).

The stakeholders reported that clinical outcomes and measures required by regulation (e.g. OSHA logs, workers' compensation claims) were more meaningful to them than employee self-reports of symptoms. The information they wanted the review to provide was, "What was the most effective IPC program?", "What doesn't work?" and "What is the most cost-effective program?" The stakeholders also asked for the results to be presented in a tiered manner. This approach would link the program's effectiveness with the amount of time it took to experience the benefits (reduction in injuries, illnesses or claims). The team made an explicit decision not to collect data on cost benefit. The only costs that were included related to reporting workers' compensation information. The team believed economic evaluations of programs was an issue related to, but not covered by, the stated questions. In addition, another systematic review describing the economic evaluation of programs has recently been completed (9).

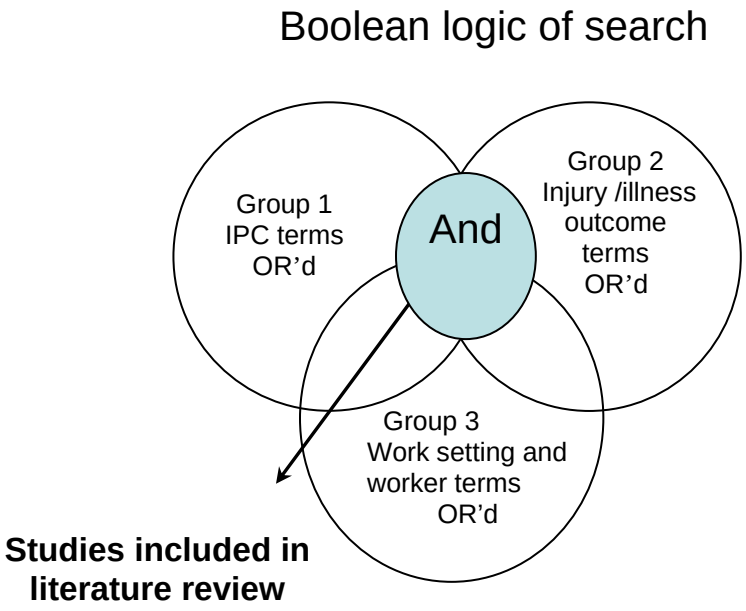
2.2 Literature Search

Search terms were identified in three broad areas defined earlier in this section: injury/illness prevention and loss control (IPC) programs, worker or work setting and injury/illness outcome terms. Search terms are listed in Appendix D. The specific search terms used were decided by group consensus and stakeholder input. The search categories were chosen to be inclusive (IPC and work setting terms) and to be exclusive (injury outcome terms). The search strategy is graphically represented by the Venn diagram in Figure 2.

The review team members were asked to assemble a list of articles from their personal libraries that were expected to be captured in the literature search ("must-have" articles). The combined lists were used as a preliminary check of the search's face validity. "Must-have" articles identified by the team are listed in Appendix E. The search would be considered invalid if the group determined the search did not capture the identified relevant articles. The group would then examine the search terms to determine reasons for article omission. The literature search was completed using the extended keyword list to ensure capture of relevant articles. The Level 1 review began after the search was considered valid.

A list of terms was generated *a priori* that were expected to identify articles that were not relevant to the review questions by bringing in non-workplace literature. The suspect terms were used in multiple fields and had diverse meanings. The team agreed on terms that should be tested in the search to determine what impact they had on the number of identified articles. The "stepped" search is a valuable component of describing the literature and helps identify topic areas for future systematic reviews.

Figure 2: Venn diagram depicting search strategy



The search strategy combined the three sets of keywords using an "AND" strategy, with the terms within each group being OR'd. The titles, abstracts, case registry or subject headings were searched for keywords when available. Due to the different algorithms employed by the different databases this was not always possible.

The search strategy was designed to be inclusive and to identify as many relevant studies as possible. The inclusive search captured non-relevant studies; therefore subsequent steps in the review process were designed to identify and omit non-relevant studies from further review.

The review team identified 19 relevant articles prior to the search that were used to test the face validity of the literature search. An initial search missed 10 of the 19 articles, due primarily to the absence of keywords in the "IPC" category (Appendix D). The search was expanded to include the terms "organizational policies and practices." A second search captured 17 of the 19 must have articles and was considered to have face validity.

Content experts identified by the review team were also requested to provide relevant peer-reviewed articles. Six external content experts provided 22 relevant articles that were not identified by the search strategy.

A key part of the literature would be classified as grey literature (i.e. literature that has not been peer-reviewed). The grey literature is difficult to identify in a systematic manner. Studies done specifically for a workplace, association or governmental body are often not published in documents found in the databases we searched, nor are conference proceedings. The grey area literature was also tracked with the help of content experts.

In addition, a specific author search was conducted on three authors known by practitioners as experts in the IPC area to ensure the relevance of the search.

2.3 Level 1 - Selection for relevance

Develop abstract and screening tool for Level 1 and Level 1 B review

Because a large number of articles were identified by the search, the relevancy exclusions had to be completed in two steps. Level 1 review involved reviewing only the title and abstracts. Level 1 B review involved reviewing the full article. One person reviewed the articles at Level 1 and Level 1 B. However, two reviewers had to agree that a study did not have a control group or concurrent comparison (see Table 1, question 7).

Team members were provided with a "Reviewer Guide" for each level of review as the project progressed. Reviewer Guides were developed to reduce individual biases during the review. The guides listed each question to be answered and the definitions team members were to use while reviewing the articles. The guides were developed during the review process, as team input and group consensus were a vital part of the project. At each stage of the review process, the review team collectively reviewed a small set of articles using a draft guide and met to discuss the review experience. Clarifications and additions were made to the guides based on team consensus.

In Level 1, the preliminary exclusion step, article titles and abstracts identified during the literature search were evaluated to determine the study's relevance to the review questions based on the criteria listed in Table 1 (see also Appendix F for the Level 1 guide to reviewers). The grey blocks indicate answers that led to the automatic exclusion of studies. The studies that were not excluded advanced to the next stage of the review. If the answer was "unclear," the study also moved to the next stage.

Level 1 B was a review of the full article using the questions from the Level 1 review, as well as an outcome question and a control group question (see Table 1, questions #6 and #7).

Table 1: Level 1 – Screening questions and the response that leads to exclusion*

Intervention	Yes	No	Unclear	Comments
1. Did the study occur in a workplace?				If no, exclude
2. Does the study report on IPC or IPC measurement tools?				If no, exclude
3. Is reference from a peer-reviewed publication (in press or accepted for publication)?				If no, exclude
Study Parameters	Yes	No	Unclear	Comments
4. Is article a review, commentary, letter to the editor, editorial or 2 pages or less in length?				If yes, exclude
5. Language of article in English, Spanish or French.				If no, exclude
6. Is the outcome injuries/illnesses or worker compensation claim/costs?				If no, exclude
7. Is there a control or concurrent comparison group?				If no, exclude
* An exclusionary response to any one question would exclude the article from further review. Question #7 required consensus between two reviewers.				

A possibility of selection bias existed at Level 1 since the review was done by a single reviewer. A quality control (QC) check was done at this level by an independent reviewer (QC reviewer) using questions 1 – 5 from Table 1.

To do the QC review, a random 1% sample including studies that were excluded and included from each reviewer was selected. Responses from the QC reviewer were entered into a spreadsheet and compared to the responses from individual reviewers.

The QC reviewer's responses matched the review team's responses for approximately 90% of the articles. The remaining 10% of the articles were included by the QC reviewer and had been excluded by the review team. Upon reviewing the articles, it was determined that all the articles would have been excluded had the full article been available to the QC reviewer. Therefore, we consider the quality of the Level 1 review process acceptable.

Review cited references in articles remaining after Level 1 B review

To assure that the process captured the literature as comprehensively as possible, all reference lists for articles continuing to Level 2 were reviewed to ascertain any omitted references. All relevant references identified by team members at this stage had been identified during the initial search.

2.4 Level 2 - Quality Assessment

In Level 2, articles deemed relevant following the title/abstract and full article screening (Level 1 and 1 B review) underwent a methodological quality assessment (QA). The team developed 16 questions with different weightings to assess article quality (Table 2). The purpose of the QA stage was to identify threats to internal and external validity. Stated differently, the QA established the criteria to assess the confidence a person could have that an observed effect was due to the IPC and not to something else (10). Each article was reviewed independently by two reviewers. To reduce bias, members of each pair were interchanged during the review process. Reviewers were therefore randomly paired with at least two other team members. Reviewers were required to reach consensus on all answers. Reviewers did not review articles that they authored, co-authored or consulted on.

Table 2: Level 2 - Quality appraisal questions and weights

Study Design	Weight
1. Were time-based comparisons used?	3
2. Was a random intervention allocation described?	3
3. Is the research question clearly stated?	2
Level of Recruitment	
4. Was recruitment rate reported?	1
5. Was the recruitment rate >40%?	2
6. Were pre-intervention characteristics described?	2
7. Were there any differences across groups at pre-intervention?	2
8. Was the loss to follow up (attrition) <35%?	2
9. Were there any important differences between remaining and drop out participants after the intervention?	2
Intervention	
10. Was the intervention process described?	3
Intensity of the Intervention	
11. Was the participation in the intervention documented?	2
12. Was the calendar duration of the intervention documented?	3
Outcomes	
13. When were injury/illness or workers' compensation outcomes measured?	2
Potential Confounders	
14. Were any confounders/effect modifiers measured?	2
Analysis	
15. Were the statistical analyses appropriate to the study design?	3
16. Was there adjustment for relevant pre-intervention differences?	2

In cases where consensus by the primary reviewers could not be reached, a third reviewer was consulted to ensure consensus was obtained (see Appendix G for the Quality Appraisal (QA) Guide for Reviewers).

The methodological quality scores for each article were determined by a weighted sum score of the 16 quality criteria. By weighting the items, the team acknowledged that not all criteria were equally important as validity threats. The three-point weighting of each criterion, from "important" (1 point) to "very important" (3 points), was based on an *a priori* team consensus process. The highest weighted score possible was 36. Each article received a quality ranking score by dividing the weighted score by 36 and multiplying by 100%. The quality ranking score was used to group articles into high quality (85% to 100%), medium quality (50% to 84%) and low quality (0% to 49%) categories.

The quality categories were determined by team consensus with reference to the review methodology literature (11; 6; 5). The review team required high quality studies to possess most of the methodological characteristics listed so that the observed effect could be stated with confidence to be related to the IPC intervention.

2.5 Level 3 - Data extraction/synthesis

Data were extracted from each paper by two reviewers. Reviewer pairs were rotated with at least two team members during the review process to reduce bias. Team members did not review articles they had consulted on, authored or co-authored. Differences in extracted data between reviewers were identified and resolved to reach consensus. A third reviewer was consulted to ensure consensus was obtained in cases where the primary reviewers could not reach agreement.

The team developed standardized data extraction forms based on previous forms and data extraction procedures (4) (see Appendix H for the Data Extraction (DE) Guide to Reviewers). The data were placed in summary tables that were used as a basis for the evidence synthesis and recommendations.

The reviewer pairs extracted data on: year of study; study design; sample characteristics; length of follow-up; intervention; injury outcome measures; statistical analyses; covariates/confounders; and study findings (see Table 3 for data extraction questions). The review team decided to focus on the study effects reported for the longest follow-up period. If other effects were considered important, they were noted in a findings table.

The methodological quality rating scores for each study were reconsidered during the data extraction process. The in-depth data extraction process

allowed us to insure the answers provided during quality assessment were accurate. Any quality rating changes at this level were made with consensus from the primary authors of this review (S. Brewer and B. Amick). Effect sizes were not calculated due to the varied outcome measures and lack of information necessary to calculate effect sizes in some studies.

Table 3: Data extraction questions

1. State the research question(s)/objective(s).
2. State the primary hypothesis.
3. State additional hypotheses not listed in question #2.
4. Write the last name of the first author and the year of publication.
5. List the jurisdiction (country, state) where the study was completed.
6. List the sector(s) that the study was conducted in.
7. List the job titles/classification of the participants that participated in the study.
8. List the inclusion criteria described in the study.
9. List the exclusion criteria described in the study.
10. What is the study design?
11. What type of prevention did the study investigate?
12. Describe all interventions evaluated.
13. Was there confirmation the intervention occurred?
14. How long after the intervention implementation did confirmation occur?
15. What was the duration of the intervention in months/days/hours?
16. Indicate the time period between the baseline measurement and all subsequent follow-up measurements.
17. Describe overall (study) group.
18. Describe the intervention group(s).
19. Describe the referent group(s).
20. When were potential covariates/confounders measured?
21. Provide a list of covariates/confounding variables that were controlled for in the final test of the intervention effectiveness.
22. Does the study use “administrative” records to collect measurements of injury/illness outcomes?
23. Does the study use self-report records as completed by the employee to collect measurements of injury/illness outcomes?
24. Does the study use clinical diagnosis or physical exams to collect measurements of injury/illness outcomes?
25. Was the population studied “fixed” or “open”?
26. What sources were used to “count” employee injuries?
27. How were employee hours collected?
28. Indicate at what level employee hours were ascertained and/or estimated.
29. If injury rates were calculated, list the equation(s) used.

30. Did the study discuss how they handled any of the following special issues related to administrative record keeping?
31. Check all body regions where symptoms were ascertained by questionnaire.
32. Describe when follow-up injury/illness outcomes (symptoms) were measured.
33. Check all body regions where specific clinical disorders were ascertained by physical examination or laboratory test.
34. Was masking of physical assessment done?
35. Was a standard protocol used for the clinical exams?
36. Please check the types of final analyses done for testing the observed effects of the intervention.
37. Was there a direct statistical test or estimation of effect for the differences between the intervention and the control group?
38. Describe for each illness/injury outcome the observed intervention effects.

The studies reviewed were heterogeneous as they were completed in different industry sectors and different countries, and they involved different kinds of IPC interventions, used different health outcome measurements and involved substantially different levels of statistical analyses.

The high level of heterogeneity required the use of a synthesis approach adapted from Slavin and others (3; 4; 5). This is known as "best evidence synthesis." The best evidence synthesis approach considers the quality of the articles, the quantity of articles and the consistency of the findings among the articles (Table 4). "Quality" refers to the methodological strength of the studies as determined in QA. "Quantity" refers to the number of studies that provide evidence on the same intervention. "Consistency" refers to the similarity of results observed across the studies on the same outcome.

The guidelines were adapted from those used in three systematic reviews: workplace-based return-to-work interventions (4), office ergonomic interventions (2) and prevention incentives (12). A study with any positive results and no negative results (on a single intervention) was classified as a **positive effect** study. A study with both positive effects and no effects (i.e. no differences between groups on a single intervention) was also classified as a **positive effect** study. A study with only no effects was classified as a **no effect** study. A study with any negative results was reviewed by a third team member to confirm the negative result and consensus was reached on a case-by-case basis whether the overall intervention effect was negative. Each intervention category was ranked as having: strong evidence; moderate evidence; mixed evidence or insufficient evidence based on the synthesis guidelines (see Table 4).

Table 4: Best evidence synthesis guidelines

Level of evidence	Minimum quality	Minimum quantity	Consistency
Strong	High (≥85%)	>=3 studies	All high quality studies converge on the same findings.
Moderate	Medium (50-84%)	>=2 studies	Majority of medium quality studies converge on the same findings.
Mixed	Medium (50-84%)	>=2 studies	Medium and better quality studies have inconsistent findings.
Partial	Low (0-49%)	>=2 studies	Majority of low quality studies converge on the same findings.
Insufficient	The above criteria are not met.		

In order to apply the best evidence guidelines uniformly some decisions were used in the systematic review:

- If a reviewed study did not have the primary outcome as an injury, illness or workers' compensation claim/cost but data was reported in any of these areas, the evidence was included in the synthesis.
- Values were abstracted from figures (e.g. graphs, tables) where specific data was not reported.
- When multiple findings were reported, we examined whether multiple comparisons were conducted appropriately. If not, the results were reviewed by the team and consensus was reached.
- Pain and discomfort were classified as injuries, and comfort and satisfaction were not.
- Medical interventions were not considered an IPC.
- Some interventions were considered "programs" (e.g. return-to-work, disability management) and the reported effects were considered as an indication of effectiveness of the program rather than the effectiveness of an individual program component.

3.0 Results

3.1 Literature search and selection for relevance

In total, 12,393 articles were identified in the literature search using the terms in Appendix D. This number reflects the total number of articles obtained after merging the different databases, removing duplicate articles and adding the articles provided by the content experts (Figure 3).

A total of 11,492 articles were excluded during Level 1 review of titles and abstracts. The articles were excluded based on the answers to questions 1 – 5 in Table 1.

A total of 901 articles proceeded to Level 1 B review. Using the exclusion criteria in questions 1 – 7 in Table 1, the full articles were reviewed by two team members. This led to the exclusion of 709 articles and the identification of 127 measurement tool studies. (For more details about the number of articles excluded by Level 1 and 1 B criteria, see Appendix I).

A total of 72 studies proceeded to Level 2 methodological quality assessment. These 72 studies were each reviewed by two reviewers using our quality assessment questions (see Table 2).

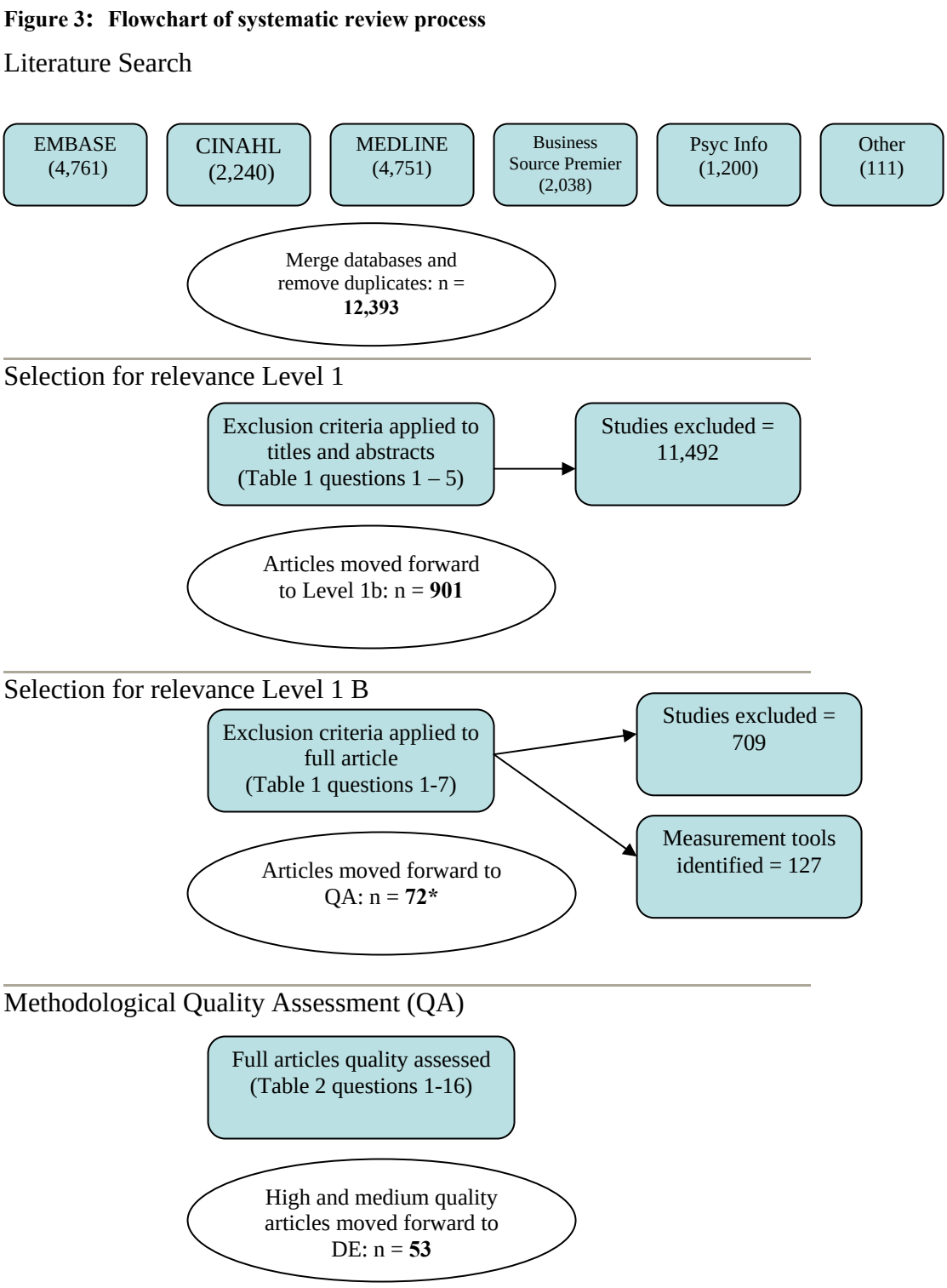
Data extraction was completed on the 53 studies, of which nine were high quality and 44 were medium quality. The low quality studies were not included in data extraction.

3.2 Methodological quality assessment

The 72 studies that met the relevance criteria were assessed for methodological quality using 16 quality criteria (See Appendix J). These criteria addressed important aspects of assessing internal and external validity. The criteria were weighted according to the importance of each item as decided by the entire review team.

The weighted criteria were used to develop a normalized quality score for each study. The studies were placed into three quality categories: high (85 – 100%), medium (50-84%) and low (0-49%) based on the weighted scores of the 16 quality criteria. Only high and medium quality studies were included in the data extraction process.

Figure 3: Flowchart of systematic review process



* Two Bohr articles were combined as they were determined to be reporting the same study. This figure also includes measurement tool articles that concerned IPC programs only. The Martin and Gatty articles and the Hlobil and Staal articles were combined as the papers were determined to be reporting on the same studies. The total of 72 includes some measurement tool articles; thus, the numbers for Level 1 B will not add up.

High quality studies

Nine studies were determined to be of high quality (Amick et al. 2003; Bohr et al. 2000; Faucett et al. 2002; Gerr et al. 2005; Hlobil et al. 2005; Jensen et al. 2005; Jensen et al. 2006; Rempel et al. 2006; Martin et al. 2003). The high quality studies had quality scores ranging between 31 and 34 out of a possible 36 (86-94%). Despite being categorized as high quality, only five of the studies reported drop-out rates. Only six reported their recruitment rate and had a recruitment rate > 40%.

Medium quality studies

We classified 44 of the studies as medium quality. The medium quality studies often differed from the high quality studies in randomization (only 16 described randomization), not describing the loss to follow-up (14 described loss to follow-up) or making adjustment for pre-intervention differences between groups. Similar to the high quality studies, the medium quality studies did not generally describe recruitment rate (16 of 44 did) or report drop-out differences between the groups. All but one study had an adequately stated research question, as did the high quality studies. The medium quality studies did not score 100% on any of the individual quality criteria, compared with nine questions in the high quality studies that did score 100%.

Low quality studies

Nineteen studies were rated as low quality. The low quality studies scored above 90% on only the research question criterion. They scored above 50% on only four of the 16 quality criteria (were time-based comparisons used; was a research question clearly stated; was the intervention process described; when were outcomes measured). Overall, the low quality studies did not provide detailed information regarding factors that could affect the validity of the statistics presented in the studies (e.g. drop out rates, loss to follow-up, confounders/covariates).

3.3 Data extraction results

Data was extracted from the 53 high and medium quality studies. Of these studies, only 46 completed direct statistical testing between the intervention and control groups; therefore, only 46 studies are discussed in data extraction and evidence synthesis. The 46 studies were categorized by intervention category. The categories were developed and agreed upon by the main authors of this review. Appendix K includes the intervention categories and detailed descriptions of interventions in each study.

Intervention categories

Twenty different interventions were identified. Five of the studies evaluated more than one intervention:

- Return-to-work/disability management programs (RTW/DM) were the most common intervention evaluated (eight of the 46 studies).
- Ergonomic training was evaluated in seven studies.
- Programs (regulatory) and workstation adjustment were each evaluated in five studies.
- Other intervention categories examined in two or three studies included: arm supports, data entry devices, exercise, policy (employer-level) and manual lifting.
- The remaining interventions were represented by single studies.

The categories were established with an attempt to separate the interventions into programs, policies or practices. However, the heterogeneity of the interventions, sectors and outcomes made this difficult. The categorization of interventions is important because it directly affects the strength and generalizability of the results.

Appendix L lists the characteristics of the reviewed studies that are important to consider when considering generalizability.

Countries of origin

The studies reviewed originated from 12 different countries. The majority of the studies were from the USA (n=26). Sweden and Canada were the only other countries that accounted for more than two studies (Sweden had four and Canada had three).

Types of industry/jobs

Office environments and data entry jobs were the most common industry and job function in the reviewed studies. No other industry or sector dominated the studies reviewed. Both white collar and blue collar workers were represented almost equally.

Study designs

The data extraction studies included 21 randomized field trials, 20 non-randomized field trials, three randomized crossovers and two quasi-experimental designs. Eight of the nine high quality studies were randomized field trials.

Sample sizes and numbers lost to follow-up

Over half of the studies did not report loss to follow-up numbers for all the groups included in their study. The sample sizes ranged from 27 (Hager et al. 1982) to over 5,000 (Wassell et al. 2000). The larger sample sizes were typically in the policy and program interventions.

Length of observation

The length of observation in the studies ranged from two weeks (Greene et al. 2005) to 15 years (Mancini et al. 2005). The studies that covered multiple years were typically the studies evaluating policies or programs and not specific practices.

Years published

Only three of the studies were published in the 1980s. The majority of the studies were published in the 2000s (n=34) with the remaining studies published in the 1990s (n=9).

Research question

All but three studies presented some form of a research question. Each category – high, medium and low – had one study that did not state the research question.

Randomized allocation

All but one of the high quality studies were randomized (eight of nine). In contrast, the low quality studies only had one randomized study (one of 19). Finally, the medium quality studies had 16 studies that were randomized (16 of 44).

Recruitment rate

The recruitment rate was not reported consistently. Over two-thirds (67%) of the high quality studies reported recruitment rates. Only 36% of the medium quality studies and fewer than 20% of the low quality studies did. Several studies were evaluating regulatory programs and recruitment is not typically a consideration when evaluating regulations. Several studies were also done using employer-level information. The authors did not typically report how many employers were contacted before permission to conduct the study was granted.

Covariates and confounders

All of the high quality studies measured confounders/covariates. Only 70% of the medium and less than 5% of the low quality studies accounted for confounders/covariates. Twelve studies controlled for covariates in the final analysis (The breakdown was eight of nine high quality and four of 22 medium quality studies.).

Statistical analysis

The sophistication of statistical analysis varied across the studies. All the high quality studies reported pre-intervention differences between groups and 78% adjusted for the pre-intervention differences in their final analysis (n=7). Of the medium quality studies, 91% reported pre-intervention differences

between groups, but only 32% adjusted for the differences in analysis. The low quality studies reported on the pre-intervention differences less than half of the time, and adjusted for the differences in fewer than 10% of the studies.

Seven of the medium quality studies did not perform a direct statistical test of the intervention's effectiveness between groups. In contrast, all the high quality studies provided direct statistical tests between the groups.

No studies provided information to establish whether there were differences between participants and non-participants for covariates/confounders. Many studies stated that there were no differences but did not show any statistical testing or other information to support this claim.

Outcomes of interest

The outcomes evaluated included injuries, illnesses and workers' compensation claim/costs. No studies directly reported illnesses. Ten studies reported on controlling injuries and/or costs by evaluating return to work, days lost, number of claims or costs of claims. Eight studies reported on injury rates while 25 studies reported on symptoms or pain.
The program and policy studies typically focused on injury or claim rates while the “practice” interventions used pain or symptoms as outcomes.

In summary, the studies varied in all descriptive categories evaluated. North America accounted for over half of the studies. Slightly over a half of those studies were completed in office environments. The trend that emerged was that policy and program interventions tended to have larger sample sizes and a longer length of observation.

3.4 Evidence synthesis

Appendix M presents a summary of the intervention effects using the best evidence synthesis guidelines. Since effect sizes could not be consistently calculated, we present the effects as they were reported by the studies. We used the algorithm from Table 4 to determine the level of evidence for effects of IPCs on injury/illness and workers' compensation outcomes. The findings for each intervention type are summarized in Table 5.

Studies that did not conduct a direct statistical test by comparing the intervention effects with control/comparison group effects were not moved forward to evidence synthesis (excluded studies are highlighted in grey in the QA Table – Appendix J).

Table 5: Intervention evidence

	Inter-vention	Effects		Evidence
Programs (regulatory)				Mixed - Programs have a positive effect
Bell, 2006	M	no effect		
Nelson, 1997	M	positive		
Mancini, 2005	M	positive		
Hager, 1982	M	no effect		
Feinauer, 1993	M	no effect		
Policy (employer-level)				Mixed - Policy has an effect
Wassell, 2000	M	no effect		
Hager, 1982	M	positive	negative	
Rosenblum, 2006	M	positive	no effect	
RTW/DM				Strong - RTW/DM has a positive effect
Hlobil, 2005 (& Staal 2004)	H	positive	no effect	
Jensen, 2005	H	positive		
Feuerstein, 1993	M	positive		
Greenwood, 1990	M	no effect		
Brown, 1992	M	positive	no effect	
Durand, 2001	M	positive		
Loisel, 2002	M	positive		
Arnetz, 2003	M	positive		
Data entry office				Mixed - Data entry devices have a positive effect
Swanson, 2006	M	positive		
Rempel, 2006	H	positive	no effect	
Tittiranonda, 1999	M	positive	no effect	
Arm supports - office				Mixed - Arm supports have an effect
Lintula, 2001	M	no effect		
Rempel, 2006	H	positive	no effect	
Workstation adjustment				Moderate - Workstation adjustment does not have an effect
Robertson, 2003	M	no effect		
Gerr, 2005	H	no effect		
Psihogios, 2001	M	no effect		

	Inter-vention	Effects		Evidence
Workstation adjustment and training				Moderate - Workstation adjustment & training has positive effects
Robertson, 2003	M	positive		
Martin, 2003 (& Gatty 2004)	H	positive		
May, 2004	M	positive		
Training (manual lifting)				Mixed - Manual lifting training has a positive effect in non-office environments
Fanello, 2002	M	positive		
Tuchin, 1998	M	positive	no effect	
Jensen, 2006	H	no effect		
Supervisor practices				Moderate - Supervisor practices have a positive effect
Shaw, 2006	M	positive		
Zohar, 2002	M	positive		
Exercise				Moderate - Exercise has a positive effect
Ludewig, 2003	M	positive		
Sjogren, 2006	M	positive		
Dehlin, 1981	M	no effect		
Ergonomic training				Moderate - Ergonomic training has no effect
Peper, 2004	M	positive	no effect	
Daltroy, 1997	M	no effect		
Greene, 2005	M	no effect		
Bohr 2000 & 2002	H	positive	no effect	
Faucett, 2002	H	no effect		
Amick, 2003	H	no effect		
Dehlin, 1981	M	no effect		
Only One Study				
Bricklaying method	M	no effect		Insufficient
Chair	H	no effect	positive	Insufficient
Loss Control	M	positive		Insufficient

	Inter-vention	Effects		Evidence
New Office	M	no effect		Insufficient
Participatory Ergonomics	M	no effect		Insufficient
Hearing Protectors	M	no effect		Insufficient
Safety Training	M	no effect		Insufficient
Skin Care Training	M	positive		Insufficient
Training & Equipment Forklifts	M	no effect		Insufficient

Programs (regulatory)

Five medium quality studies evaluated programs that focused on the effectiveness of IPCs required by regulation. The programs evaluated were logger safety training (Bell et al. 2006), fall protection (Nelson et al. 1997), eye protection (Mancini et al. 2005), hearing protection (Hager et al. 1982) and drug testing (Feinauer et al. 1993). The Mancini and Nelson studies reported positive effects while the Hager, Feinauer and Bell studies showed no effect. The Bell study used workers' compensation claim rates as the outcome while the other studies used injury rates or counts. Since the medium quality studies did not converge on the same findings (60% negative and 40% positive), we concluded that there is **mixed evidence** that programs (regulatory) have an effect on injuries/illnesses.

Policy (employer-level)

Three medium quality studies reported effects of employer-enacted policies. The policies studied were back belts (Wassell et al. 2000), hearing protectors (Hager et al. 1982) and pre-employment strength testing (Rosenblum et al. 2006). The Wassell study had no effect. The Rosenblum study had both positive effects (for MSD injuries and injury costs) and no effects (for non-MSD injuries). The Hager study had both positive effects (for mandatory policies) and negative effects (for voluntary policies). We determined that there is a **mixed level of evidence** that employer-level policy has an effect on injuries/illnesses as the studies demonstrated inconsistent findings.

RTW/DM (return to work/disability management)

Return-to-work or disability management programs were evaluated in two high quality studies (Jensen et al. 2005; Staal et al.) and six medium quality studies (Arnetz et al. 2003; Brown et al. 1992; Durand et al. 2001; Feuerstein et al. 1993; Greenwood et al. 1990; Loisel et al. 2002). The Loisel study had cost benefits as its primary outcome while three studies evaluated cost and RTW (Arnetz et al. 2003; Brown et al. 1992; Greenwood 1990). Four studies

focused on just RTW (Durand et al. 2001; Feuerstein et al. 1993; Jensen et al. 2005; Staal et al. 2004).

The high quality studies examined graded activity and rehabilitation as interventions. The medium quality studies included the following interventions: therapy (Durand et al. 2001; Feuerstein et al. 1993), early intervention (Greenwood et al. 1990), disability case management (Arnetz et al. 2003; Loisel et al. 2002) and RTW policies (Brown et al. 1992).

One high quality study had both positive effects (RTW) and no effects (functional status and pain) (Staal 2004). The second high quality study also had positive effects for RTW (Jensen, 2005). The medium quality studies all had a positive effect, except for Greenwood (1990). It had no effect for an early intervention program. The Brown study had positive effects for a back school used as a secondary prevention intervention of reinjury. It demonstrated no effects when evaluating program costs. The number of studies (n=8) and consistency of the effects (all but one study had positive effects) demonstrate a **strong level of evidence** that return-to-work and disability management programs have a **positive effect** on controlling injuries/illnesses and workers' compensation claim costs.

Data entry devices – office

One high quality study (Rempel et al. 2006) and two medium quality studies (Swanson et al. 2006; Tittiranonda et al. 1999) evaluated data entry devices used in offices. The Rempel study evaluated a trackball and the Tittiranonda and Swanson studies compared alternative versus conventional keyboards. The Swanson study showed a positive effect for the alternative keyboard versus the conventional keyboard. The Tittiranonda study found positive effects for one split keyboard and no effects for two other split keyboards, when compared to a conventional keyboard. The Rempel study found both positive and no effects for the trackball; however the positive effects were just for the left side of the body, which was the non-mousing side for all study participants. The data entry devices – office category had only three studies and the studies do not converge on the same findings. The studies are considered to provide a **mixed level of evidence** that data entry devices have an effect on injuries/illnesses.

Arm supports - office

There were two studies on arm supports. One high quality study found positive effects on musculoskeletal (MSK) outcomes (Rempel et al. 2006). One medium quality study found no positive effects on injury/illness outcomes (Lintula et al. 2001). The arm support studies provide **mixed evidence** that arm supports have an effect on injury/illness outcomes.

Workstation adjustments

There were three studies on workstation adjustments. One was high quality (Gerr et al. 2005) and two were medium quality (Psihogios et al. 2001; Robertson et al. 2003). All found no effect for workstation adjustments. The Psihogios study focused on gaze angle while the Gerr and Robertson studies altered several conditions in the workplace. The Gerr study included training in both intervention arms while the Robertson study had an adjustment-only arm and an adjustment and training arm. The workstation adjustment studies provide **moderate evidence** that workstation adjustment alone has **no effect** on injuries/illnesses.

Workstation adjustments and training

There were three studies on workstation adjustments and training. One was high quality (Martin et al. 2003) and two were medium quality (May et al. 2004; Robertson et al. 2003). All found positive effects. The studies all provided ergonomic adjustments to participants' offices and provided training focused on ergonomics. The studies adjusted more than just one workplace factor and the Martin study also included stretching exercises. The studies provide **moderate evidence** that workstation adjustments and training have a **positive effect** on injuries/illnesses.

Training (manual lifting)

Manual lifting training was evaluated by one high quality study (Jensen et al. 2006) and two medium quality studies (Fanello et al. 2002; Tuchin et al. 1998). The studies provided training and hands on instruction in proper lifting techniques. All three studies were conducted in non-office environments. The high quality study by Jensen resulted in no effect. The Fanello study had a positive effect. The Tuchin study showed a positive effect compared to a group that received no training and no effects when compared to a group told to perform daily exercises on their own. However, this study was looking at costs, while the other studies examined outcomes for low-back pain. The training (manual lifting) studies provide **mixed evidence** that the studies have an effect on injuries/illnesses.

Supervisor practices

Two medium quality studies evaluated supervisor practices (Shaw et al. 2006; Zohar 2002). The Shaw study conducted a workshop on supervisor practices. The Zohar study provided training, questionnaires and feedback. The Zohar study showed a positive effect on "microaccidents" (which includes small injuries) and the Shaw study showed a positive effect on injuries/illnesses or workers' compensation claims. The studies provide a **moderate level of evidence** that supervisor practices have a **positive effect** on injuries/illnesses.

Exercise

Three medium quality studies evaluated exercise programs (Dehlin et al. 1981; Ludewig et al. 2003; Sjogren et al. 2006). The Ludewig and Sjogren studies found a positive effect while the Dehlin study found no effect. The Ludewig intervention was a workplace program that involved a home exercise regiment that was tracked at work. The Dehlin and Sjogren studies focused on physical fitness training in the workplace. The studies provide a **moderate level of evidence** that exercise has a **positive effect** on injuries/illnesses.

Ergonomic training

Ergonomic training was evaluated by three high quality studies (Amick et al. 2003; Bohr et al. 2000; Faucett et al. 2002) and four medium quality studies (Daltroy et al. 1997; Dehlin 1981; Greene et al. 2005; Peper et al. 2004). The training was conducted in various sectors: postal, industrial, health-care and office. The Bohr study had both positive effects (upper body) and no effects (lower body). The remaining studies showed no effect on symptoms or on the number of injuries/illnesses. The studies provide a **moderate level of evidence** that ergonomic training alone has **no effect** on injuries/illnesses.

Single study interventions

Interventions with only one study can only have insufficient evidence. An intervention needs to be examined in enough studies that meet the quality, quantity and consistency requirements before it can be evaluated for a higher level of evidence. The interventions that occurred in only one study are listed below and further details are in the appendices. The Nave 2004 study should be noted as it was the only study identified that evaluated loss control as a service. Companies providing insurance within the U.S. are mandated to provide loss control services. The Nave study reported positive results for providing flexible loss control services compared to employers who did not receive the services. While this study provides insufficient evidence, it does show that loss control as a service can be evaluated using rigorous scientific methods.

- Bricklaying methods – Luijsterburg et al. 2005
- Hearing protectors – Erlandsson et al. 1980
- New chair – Amick et al. 2003
- Loss control as a service – Nave et al. 2004
- New office – Nelson et al. 1998
- Participatory ergonomics – Laing et al. 2005
- Safety training – Sinclair et al. 2003
- Skin care training – Loffler et al. 2006
- Training & equipment forklifts – Shinozaki et al. 2001

4.0 Conclusions

This systematic review used a standardized approach to review and appraise the literature, synthesize the results and then answer the review question: "Are injury/illness prevention and loss control programs effective in reducing workplace injury/illnesses and/or workers' compensation claims?"

The literature reviewed was heterogeneous in both the interventions and outcomes studied. Many industry sectors were evaluated. The quality of the studies reviewed ranged from very poor to very high. The higher quality studies were typically conducted in office environments rather than in sectors considered more industrial.

From an initial number of just over 12,000 articles, we identified 53 studies in which the methodological quality was ranked as either high (nine studies) or medium (44 studies). Seven of the medium quality studies did not include statistical comparisons between groups, and they were excluded. As a result, 46 studies were included in the evidence synthesis.

Based on the criteria for evidence synthesis (Table 4), at least three high quality studies with consistent findings were needed to determine the existence of "strong evidence." The levels of evidence were based on the quality, quantity and consistency of effects among the studies reviewed in data extraction.

Across all studies, the results suggest a mixed level of evidence for the effect of injury/illness prevention and loss control programs. However, when the "prevention" interventions were separated from the "loss control" programs, as suggested by our stakeholder groups, the results took on a different appearance. The prevention programs still provide a mixed level of evidence. The loss control programs – those focusing on reducing the duration of injuries, associated injury costs and insurance costs – show a strong level of evidence for positive effects on both the duration and costs of injuries/illnesses.

While previous systematic reviews have shown that RTW programs have positive effects (4) and have a cost benefit (9), this fact becomes even more important when you consider RTW/DM in the broad spectrum of workplace programs, policies and practices. The evidence raises the question whether employers focus on loss control programs because such programs directly affect their costs and are easier to justify when compared to prevention programs. Prevention programs are more difficult to relate to cost savings as there is no guarantee that spending $10,000 on a training program will save twice that amount by reducing injuries. The money spent on workers'

compensation and medical bills is much easier to quantify. Employers know that if they have an experience modification ratio/rating (the number used to calculate workers' compensation insurance premium) of greater than one, their costs will rise. Whereas they may choose not to invest in a training program and still have the same amount of injuries, thus saving money up front.

RTW/DM was the only intervention category associated with a **strong level of evidence** in having a **positive effect** on injuries/illnesses and workers' compensation claims/costs. The RTW/DM studies, except for Brown et al. 1992, used "usual care" as the control/concurrent comparison group. This fact should not be surprising as the programs focused on treating injured employees. It would not be ethical or informative to determine if caring for the employee provided better outcomes than withholding care.

A **moderate level of evidence** was found for five intervention categories.

- Supervisor practices have a **positive effect** on reducing injuries/illnesses.
- Workstation adjustments and training have a **positive effect** on reducing injuries/illnesses.
- Exercise has a **positive effect** on reducing injuries/illnesses.
- Workstation adjustment alone has **no effect** on reducing injuries/illnesses.
- Ergonomic training alone has **no effect** on reducing injuries/illnesses.

The category of workplace adjustments aggregated studies that made different types of adjustments. There is not enough evidence to group each adjustment separately and the study authors typically aggregated all the changes into an "adjustment" category when they performed their analyses. Reporting the effects of adjusting only one piece of equipment would be preferable. However, it is not often practical as most programs would offer a range of potential workstation adjustments to accommodate the vast heterogeneity of employees and workstations often encountered in office environments.

Similarly, the training and exercise interventions in different studies were not identical in the topics covered or in the way they were administered to employees.

There were enough studies of ergonomic training programs to separate them from other training programs. Although there is moderate evidence showing that ergonomic training programs alone do not have a positive effect on injuries, an important observation is that when they are combined with workstation adjustments, there is moderate evidence to support a positive effect. These findings point to the effectiveness of multi-component injury

prevention programs, which was observed in another recent systematic review (13).

In order to advance the field and shift the level of evidence from moderate to strong, further research of these interventions should be of high methodological quality (see Table 2 for quality criteria).

There was a **mixed level of evidence** for the following interventions and their effect on injury/illness and workers' compensation outcomes:

- policy (employer-level)
- data entry devices
- arm supports, training (manual lifting)
- programs (regulatory)

The studies on regulatory programs were not examining the effectiveness of regulations. These studies concentrated on determining how certain regulatory programs related to a reduction in injuries/illnesses and workers' compensation claims within specified workplaces. This created unique challenges and opportunities. The regulatory studies typically had the opportunity to build large sample sizes. However, they had a challenge in reporting loss to follow-up information, which was typically not available from the data sources used to build the large samples (e.g. state OHSA data).

Interventions with a mixed or moderate level of evidence should be of particular importance to researchers, funders, labour (unions) and employers participating in research. For the these categories, the addition of one or two high quality studies could have shifted the level of evidence from mixed to moderate, or moderate to strong.

Overall, the interventions that had a mixed level of evidence typically focused on practices or policies and not on programs. The interventions with moderate and strong levels of evidence that had positive outcomes typically focused on multi-component programs rather than on a specific employee practice.

The Hager (1982) study is notable as it is the only study with a reported negative effect. However, the negative effect represents a comparison between workers in a voluntary hearing protection program and a control group of workers. The same study showed that a mandatory hearing protection program had a positive effect on hearing loss. This study also demonstrates the value of using a long time-series to study the effectiveness of IPCs.

Finally, due to the breadth of the subject being evaluated, we found several unique interventions that were done in only one study. Single study

interventions provide an insufficient level of evidence to enable us to draw conclusions or make recommendations.
There was insufficient evidence for the following interventions:

- bricklaying method
- new chair
- loss control as a service
- new office
- participatory ergonomics
- hearing protectors
- safety training
- skin care training
- training and equipment forklifts.

Some types of interventions were not included in the evidence synthesis despite the impact they have on employees, because they did not make it to the data extraction phase. These studies were on: evaluating confined spaces, fall protection, driver injuries not as a result of driving, hazard communication, respiratory protection or power presses. These areas are frequently associated with many injuries/illnesses (including deaths), cited violations by OSHA and workers' compensation claims. None of the publications from the grey literature, identified by content experts, made it to the data extraction phase either.

Also worthy of noting is that, of the 72 studies identified as evaluating safety climate/culture, only one that met the criteria of being an IPC and having a relevant outcome made it to the evidence synthesis stage (Zohar 2002). The outcomes in the majority of the safety climate/culture articles were change in behaviour or per cent safe behaviours, and these outcomes were not included in this review. Several of the safety climate/culture articles were classified as a measurement tool or measurement model, but did not meet the IPC relevancy criteria.

The majority of high quality studies were completed in office environments and focused on reports of pain and discomfort. Each high quality study was designed to limit threats to internal and external validity. However, few measured similar outcomes, making it a challenge to integrate findings or generalize the findings to other business sectors.

One potential action for stakeholders would be to discuss how to complete high quality research in the sectors that were under-represented in the review. These sectors include construction and manufacturing, which generally have a greater number of hazards than those presented by office environments. Due to the use of technology, construction and manufacturing environments have similar ergonomic risks as office environments plus additional hazards such as confined spaces, working at heights, chemical exposures, etc. The

under-represented sectors provide an opportunity to study a wider range of IPCs than can be found in typical office environments.

4.1 Strengths of conducting a systematic review

The number of studies published in any given field is more than most practitioners or researchers can track or synthesize. When one considers all the information a workplace must track to even stay current with regulatory requirements, it becomes clear that a systematic review can provide much needed information. Systematic reviews are useful tools to help researchers, health and safety practitioners, employees, employers, and policy- makers remain current with the evidence.

The systematic review process is designed to be transparent and reproducible. By following an explicit process of scrutinizing, tabulating and integrating all relevant studies that address a specific review question, a systematic review aims to eliminate bias in the selection and synthesis of the evidence. The goal is to produce an objective appraisal that can help practitioners and researchers resolve uncertainty. Such uncertainty often occurs when original studies and editorials disagree on the conclusions to be drawn from the evidence for a particular review question. Systematic reviews also help those unfamiliar with statistics by showing the difference between what a study claims to be analyzing and what the analysis really supports.

Another benefit of doing a systematic review is that it can help identify gaps in the quantity and quality of studies in a particular area. This can be used to suggest an agenda for further research and evaluation.

4.2 Limitations of this systematic review

We identified studies by searching the peer-reviewed literature. We also scanned reference lists from selected studies and references suggested by content experts. A broader search of the grey literature, conference proceedings and dissertations might have yielded further relevant evidence specific to the research question. A goal of this review was to identify the articles and journals more typically read by practitioners. The criterion of only accepting peer-reviewed literature may have limited the journals referenced by practitioners. Also several peer-reviewed journals used by practitioners may not index their articles in the same manner as Medline, which affects which articles are identified.

Due to differences in health-care systems and terminology, it is possible some relevant articles were excluded. American researchers refer to their workers as “workers” while some European literature referred to those injured in the workplace as “patients.” The review team was focusing on workplaces and workers and not “patients.”

Researchers and practitioners also use the terms “accidents” and “injuries” differently, which may have resulted in relevant studies being excluded. The review was focusing on injured workers and not the number or cause of accidents.

Also, because of time constraints, the review team was unable to clarify specific questions with the study authors. The review was limited to articles published in the English, French and Spanish languages. It is possible that articles excluded on the basis of language might have provided relevant evidence that could have been used to answer the review question.

Finally, the review team made a decision not to include articles where either a change in a hazardous exposure or a change in behaviour was the outcome. We recognize their omission could affect the interventions we examined and perhaps the overall conclusions. Certainly in multi-component programs exposures and/or behaviours may be targeted as leading indicators of program success. However, the review team felt it was not reasonable to assume that reducing an exposure or behaviour directly relates to a change in injuries or illnesses. Since the focus was on injury/illness and loss control programs, the most reasonable outcomes to evaluate program effectiveness were the direct outcomes.

4.3 Strengths of this systematic review

The review was inclusive in regards to outcomes and interventions studied, and described a large amount of the IPC literature. The review team included members with varied backgrounds and specializations (e.g. expertise in the systematic review process, ergonomics, physical therapy, occupational medicine, industrial hygiene, safety and epidemiology). The outcomes and interventions were therefore reviewed by knowledgeable professionals. We believe this broad expertise contributed to the internal validity of our review.

We also contacted external experts to request potentially relevant published articles, along with articles in press or in the grey literature. This provided another means to ensure that as much relevant literature as possible was reviewed. A specific author search was conducted on three authors known by practitioners as experts in the IPC area (Geller, Krause and Peterson). The author search was conducted to try to capture the articles that may have been published in peer-reviewed journals not typically identified in database searches (e.g. *Professional Safety*).

The review team used a quality control process to assess the early phase of article exclusion. We also used a process of arbitrarily pairing reviewers at each phase to improve independent assessment by at least two team members. Whenever possible, the reviewers used a transparent approach, and all decisions were made using consensus.

4.4 Next steps

The current review answers a general question about the effectiveness of IPCs on injury/illnesses and workers' compensation claims/costs. The review team believes that the systematic review process should continue to develop in several ways when considering the IPC literature:

- It is important to include non-English articles in the search.
- If necessary, article authors should be contacted to clarify findings in the published studies.
- Journals used by practitioners should be reviewed to determine if the indexing of articles is the same as the more traditional research journals.
- When possible studies in which between-group comparisons were not made should be re-analyzed to provide evidence that can be included in data synthesis.
- Workplace interventions should focus on programs and policies not just practices. The practices are often done as a component of a program and looking at the practices independently of the program could misrepresent the overall effect.
- Studies that have intermediate end-points such as hazardous exposure changes or behaviour changes should be included.

The information from this review should be used as a tool to start a dialogue between researchers and stakeholders regarding where and which programs, policies and practices should be studied. The review highlighted that the high quality research is being done in a limited number of sectors. It also showed research is missing in industrial, construction, service and transportation sectors where major causes of injuries and illnesses are known, and the effectiveness of IPCs in reducing injuries and illnesses are unknown.

5.0 Messages

Before making recommendations regarding policy and best practices, the review team felt there should be a strong level of evidence. Recommendations demand consistent findings from a number of high quality studies. The review found strong evidence only for work/disability management programs. The interventions with a moderate level of evidence for a positive effect can be viewed as "practices to consider." The team was not comfortable using the term "Best Practices" as several team members who are practitioners restrict this phrase to programs, policies or practices that have been proven to be effective over time with no negative consequences.

The RTW/disability management programs demonstrated strong evidence in controlling injuries. Therefore, we recommend that employers examine what occurs to their employees following an injury. The literature shows that a well-designed and -managed disability management program, which integrates proper medical interventions with oversight from the worksite, results in earlier return to work for employees and a cost saving to employers. All but one of the multi-component secondary prevention programs had a positive effect on return-to-work outcomes.

- **Stakeholders are recommended to develop a multi-component disability management program that includes an integrated approach involving the health-care provider, company supervision and workers' compensation carriers.**

The Institute for Work & Health has identified seven basic principles for successful return-to-work programs (www.iwh.on.ca) based on research evidence. Stakeholders should consult this and other non-partisan information resources to design and/or purchase evidence-informed RTW and disability management programs.

The return to work/disability management studies (RTW/DM) included both high and medium quality studies and converged on a positive effect for the specific outcome of return to work. The RTW/DM studies focus on "control" rather than preventing injuries and thus often study employees from various sectors. The nature of the RTW/DM programs makes them more generalizable to various industries because the focus of the programs is not anchored in practices of the workers at their worksites.

Five intervention categories had a moderate level of evidence; however two of those demonstrated NO effect on injuries/illness or workers' compensation outcomes (ergonomic training and workstation adjustment). The three programs, policies and practices that were found to have a moderate level of

evidence with a positive effect were exercise, supervisor practices, and workstation adjustment and training.

However in two intervention categories where the results showed moderate levels of evidence, the interventions evaluated were very different between studies and "practices to consider" were not clear-cut. The exercise interventions included a workplace-based program and a home-based program, so either intervention does not seem to be a practice to consider. The supervisor practices interventions were also varied, as each study used a different intervention to try to change behaviour to reduce injuries.

The third category with a moderate level of evidence was workstation adjustment and training. This is significant because, when initiated as separate interventions, ergonomic training and workstation adjustment each showed a moderate level of evidence for NO effect. Even though the workstation adjustments varied across all the studies, a **practice to consider** is that workstation adjustment and training appear to be more effective when used together compared to using either intervention independently.

An important message is that the current state of the peer-reviewed literature provides limited high quality studies and the majority of the better quality studies examining IPCs are completed in office environments.

As more research is conducted and supported by employers, labour and government, here are some issues to consider:

- Researchers should use concurrent worksite control groups as opposed to study designs with simulated controls, statistical controls or cross-over designs. True concurrent controls contribute results that are more generalizable across industrial sectors.
- Field studies should have adequate sample sizes to reduce the risk of mistakenly concluding an intervention has no effect, simply because the sample is too small.
- Researchers should present outcomes using standard approaches that are common to the reporting requirements demanded of stakeholders when using workers' compensation, injury records or other regulated injury reporting systems.
- Covariates and confounders should be measured and adjusted for using multivariate statistical models. This is especially true when the researchers are unable to randomize workers into either intervention or control groups.

The review resulted in many lessons learned about search strategies, the varied use of terms across disciplines and which interventions were being studied. However, two major points emerged from trying to consider the IPC literature as a whole rather than studying only one part.

1) Of the articles that remained after the Level 1 review, studies in the office sector and health-care accounted for 44% of the literature. Again, this is important because two business sectors are dominating the field. The office sector specifically is known for frequency of injuries but not necessarily severity (e.g. fatalities). One also has to consider how generalizable a back school completed in a health-care or office environment is to the transportation, construction or manufacturing sectors.
2) The interventions used to control injuries are the only area where a strong level evidence of positive effects exists. This finding is important because it emerged while trying to characterize the broad field of IPCs. We found no prevention programs that had a strong effect. This does not mean prevention does not work. What it demonstrates is that studies of prevention programs are not completed often enough to find a strong level of evidence. Researchers and stakeholders should consider this an important finding and work together to develop high quality studies that are generalizable across business sectors.

The amount of literature reviewed in this study was enormous. The team was amazed and somewhat frustrated by the levels of evidence that emerged from the literature. The review proved fertile ground for discovering gaps in the IPC literature. Because researchers and stakeholders use terms differently, this a key factor when trying to create actionable messages from research. The small lessons learned, major points to consider and level of evidence findings combine to create a not-so-surprising message. Researchers completing workplace research can design and conduct a high quality study if they approach the study with the realization that involving the people in the workplace prior to designing the study is integral to their scientific success.

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Appendix A: Content experts

Name	Country
Barbara Silverstein	USA
David M. Dejoy	USA
Dov Zohar	USA
Glenn Pransky	USA
Harry Shannon	Canada
Julian Barling	Canada
Kaj Frick	Sweden
Karen Belkic	Sweden
Kevin Kelloway	Canada
Larry Murphy	USA
Lynda Robson	Canada
Michael Burke	USA
Michael Frone	USA
Michael Kompier	Netherlands
Michael Quinlan	Australia
Norbert Semmer	Germany
Pamela L. Perrew	USA
Phillip Bigelow	Canada
Rick Iverson	Canada
Robert Emery	USA
Robert Sinclair	USA
Robyn Gershon	USA
Sarah Felknor	USA
Scott Geller	USA
Sharon Parker	Australia
Steve Jex	USA
Tahira Probst	Canada
Thomas Krause	USA

Appendix B: Stakeholder meeting attendees

Toronto – August 8, 2006
Jonathan Tyson – Pulp and Paper Health and Safety Association
Enzo Garritano – Construction Safety Association of Ontario
Shannon Maracle – Electrical and Utility Safety Association
Monika Sharma – Industrial Accident Prevention Association
Lorraine Davison – Canadian Centre for Occupational Health and Safety
Norma Akinbiyi – Workplace Safety and Insurance Board

Houston – August 15, 2006
Paul Garcia – City of Houston
Betty Ramos – City of Houston
Sandra Carson – Sysco Foods
Sue Iha – Exxon Mobil
Chas Capitano – Shockey Companies
Doug Drawhorn – Chevron Phillips

Toronto – November 2, 2007
Enzo Garritano – Construction Safety Association of Ontario
Kiran Kapoor – Industrial Accident Prevention Association
Shannon Maracle – Electrical and Utility Safety Association
Donna Campbell – Occupational Health Clinics for Ontario Workers
Wayne de l'Orme – Ministry of Labour
Guy Taillon – Ministry of Labour
Evelyn Stefov – Ministry of Labour
Alice Peter – Workplace Safety and Insurance Board
Marianne Minaker – Ontario Service Safety Alliance

Appendix C: Stakeholder search terms

IPC:

- Near miss reporting
- Lockout
- Workplace inspections
- Job hazard analysis
- Back injury prevention
- Modified work
- General heath, safety training (H&S training)
- Guarding (machine)
- JHSC training / safety training / certified H&S training
- Internal responsibility training
- H&S representatives / JHSC
- RTW/ESRTW (early and safe return to work)
- Job observation program
- Certificate of recognition program
- Incentive/benefit programs
- Safety standards
- Compliance
- Audit tools
- Violence programs
- Workplace hazardous materials information system (WHMIS)

Workplace terms:

- Cargo shipping
- Automotive
- Manager/supervisor responsibility
- Forestry
- Food
- Plumbing
- Butcher
- Banking
- Librarian
- Carpenter
- Linemen
- Manual work
- Pulp and paper
- Contractors
- Small business
- Service sector – tourism, postal, etc
- Commuting/work related travel
- NOT self employed

Outcome terms:

- Accidents
- Near misses
- Assault
- Back pain
- Encephalitis
- Non fatal injuries
- Mental disorders
- Mental diseases
- Needle stick
- Struck by
- Vision/ eye injury
- Radiation
- Cut/lacerations
- TB
- Hepatitis
- HIV
- Neuralgias
- Burns
- Inhalation
- Motor vehicle accidents

Appendix D - Literature search terms

IPC terms	accident prevention, administrative controls, back school, behavior based safety, bloodborne pathogen, burning, chemical safety, confined space, crane training, defensive driving, disability management, education, energy control, engineering controls, equipment training, ergonomic, exposure monitoring, eye protection, face protection, fall protection, foot protection, forklift training, guard in, hand protection, hazardous communication, "hazardous materials training", health and safety training, health promotion, hearing protection, heat shielding/protection, housekeeping, human engineering, human factor, illness free environment, injury free environment, intervention studies, joint health and safety committee, job hazard analysis, job observation, leadership based safety, leadership training, lockout/tagout, loss control, loss prevention, machine guarding, manual lifting, material handling, mechanical lifting, mental health near miss reporting, noise, observational studies, "occupational cancer", occupational health, organizational climate, organizational culture, people based safety, personal protective equipment, radiation safety, regulatory programs, respiratory protection, return to work, risk control, safety climate, safety culture, safety culture surveys, safety climate surveys, safety incentive programs, safety perception surveys, safety management, safety training, slips, trips, falls prevention, supervisor training, training, vibration, violence prevention, welding, wellness programs workplace surveillance NOTS: ADA, chronic disease management, continuous quality improvement, Deming, depression management, disease management, employee assistance program (EAP), environmental programs, health management, healthcare services, healthcare utilization, management systems, mental illness, obesity, productivity management, quality programs, six sigma, smoking cessation, total quality management, weight loss
Work setting and Worker terms	Accounting, administrative assembly, automotive assembly, banking, blue collar worker, boilermaker, burner, cargo shipping, carpenter, civil work, companies, computerized office, concrete worker, construction, contingent worker, contractors, distributors, doctors, driver, driving, editor, education, electric, employer, employment, engineer, engineering, federal government, finance, fitter, forestry, gas, healthcare, helper, hospitals, hotels, housekeeping, industry, information technology, leaders, insurance, knowledge worker, laboratory worker, laborer, leaders, legal, lineman, loader, local government, machinist, manager, manual laborer, manufacturing, meat

	packers, mining, municipalities, newspaper, nurses, office, office worker, oil and gas, operator, painter, pipe fitter, plumbers, postal, precarious worker, public administration, provincial worker, pulp and paper, reporter, retail, sanitary, service, shipping, state government, supervisor, support, teacher, telecommunication, temporary worker, transportation Warehousing, welder, white collar worker, worker, workplace NOTS: agricultural workers, children, commercial fishing, farm workers, home offices, migrant workers, military installations, soldiers, students, teleworkers, youth worker
Injury/Illness outcome terms	"sprains and strains", accidents, acute toxic hepatitis, ankle injuries, arm injuries, arthralgia, arthritis, asbestosis, assault, back injuries, back pain, barotraumas, black lung, bladder cancer, brain injuries, bronchogenic carcinoma, bruises, burns, bursitis, carpal tunnel syndrome, caught between, causalgia, cervico-brachial neuralgia, claim rate, claims, contact allergic dermatitis, contact irritant, dermatitis, contusions, crush, cumulative trauma disorders, cuts, deaths, elevated blood lead, encephalitis, epicondylitis, experience modification ratio, extremity injuries, eye injuries, falls (from above, same level), fatality (ies), finger injuries, forearm injuries, fractures, hand injuries, head injuries, hepatitis, impairment rating, inhalation, knee injuries, lacerations, lead poisoning, lead toxicity, leg injuries, loss ratio, lost time injury, lost work day, lumbar, maximum medical improvement, medical treatment, mental disorders, mental illnesses, mesothelioma, motor vehicle accidents, muscular diseases, musculoskeletal diseases, musculoskeletal injuries, musculoskeletal system, myofascial pain syndromes, neck injuries, needlestick injuries, nerve compression syndromes, neuralgia, noise induced hearing loss, non fatal injuries, occupational asthma, OSHA logs, osteoarthritis, permanent partial disability, pneumoconiosis, polyneuritis, polyradiculoneuritis, puncture, radiation injury, radiculopathy, recordable, repetitive trauma, respiratory illnesses, RSI, restricted work days, shoulder impingement syndrome, silicosis, slips, soft tissue injuries, spinal cord injuries, spine injuries, struck by, synovitis, TB, temporary partial disability, tendonitis, tendon injuries, tennis elbow, tenosynovitis, thoracic outlet syndrome, total disability, toxic inhalation, trips, trunk injuries, ulnar nerve compression syndrome, vision disorders, welding fume fever, work-aggravated asthma, work-related asthma, wrist injuries NOTS: cancer, depression, floc lung, incidents, leukemia, neoplasms, productivity

Appendix E: Must-have articles

Aaras A, Horgen et al.	Musculoskeletal, visual, and psychosocial stress in VDU operators before and after multidisciplinary ergonomic interventions: A 6 years prospective study. Part II. Applied Ergonomics. 2001; 32, 559-57.
Amick BC III et al	Measuring the Impact of Organizational Behaviors on Work Disability Prevention and Management. Journal of Occupational Rehabilitation. 2000; Vol 10, No 1. pp. 21- 37.
Cullen KL et al	Workplace organizational policies and practices in Ontario educational facilities. Journal of Occupational Rehabilitation. 2005;15(3):417-433.
Dejoy D	Behavior Change Versus Culture Change: Divergent Approaches to Managing Workplace Safety", Safety Science (vol 43 pp 105-129 2005)
Geldart S et al	Have Companies Improved Their Health and Safety Approaches Over the Last Decade? A Longitudinal Study. American Journal of Industrial Medicine 47:227-236 (2005).
Gershon RR et al	Hospital safety climate and its relationship with safe work practices and workplace exposure incidents American Journal of Infection Control. 2000. 28(3):211-21.
Hinze J	Moving toward a zero injury objective. Journal of Construction Engineering and Management. September/October 2000.
Hinze J	Safety on large building construction projects. Journal of Construction Engineering and Management. June 1988.
Hunt RV et al	Employer factors related to workers' compensation claims and disability management, Rehab Counseling Bull, 1991, 34:210-26.
Hunt A et al	Disability Prevention Among Michigan Employers 1988-1993, Upjohn Institute Technical Report No. 93-004.
Jaselskis E et al.	Strategies for achieving excellence in construction safety performance. Journal of Construction and Management. March 1996.
Katz J et al	Determinants of Work Absence Following Surgery for Carpal Tunnel Syndrome. American Journal of Industrial Medicine 47:120-130, 2005
Krause,TR et al	Long-term Evaluation of a Behavior-Based Method for Improving Safety Performance: A Meta Analysis of 73 Interrupted Time Series Replications." Safety Science, 32:1-18, 1999.
May DR et al	Ergonomic office design and aging: A quasi-experimental field study of employee reactions to an ergonomics intervention program. Journal of Occupational Health Psychology. 2004; 9, 123-135.
Westmorland MG et al	Disability management practices in Ontario workplaces: employees' perceptions. Disability and Rehabilitation. 2005; 27(14):825-835.
Williams RM et al	Disability management practices in education, hotel/motel and health care workplaces. Am J Industrial Med. 2005; 47:217-226.
Willliams RM et al	Disability management in practices Ontario health care workplaces. Journal of Occupational Rehabilitation. 2007; 17: 153-165.

Zohar D	Modifying Supervisory Practices to Improve Subunit Safety;A Leadership Based Intervention Model, J of Applied Psychology, 2002, 87, No. 1, 156-163.
Zohar D,	A Group-Level Model of Safety Climate: Testing the Effect of Group Climate on Micro accidents in Manufacturing Jobs, J of Applied Psychology, 2000, 85 (4): 587-595.

Appendix F: Reviewer Guide Level 1

LEVEL 1 FORM

Question	Study Content
1. Did the study occur in a workplace?	Yes
	Unclear
	No
2. Does the study report on IPC or IPC measurement tools?	Yes
	Unclear
	No
3. Is reference from a peer reviewed publication (in press or accepted for publication)?	Yes
	Unclear
	No
4. Is article a review, commentary, letter to the editor, editorial or 2 pages or less in length?	Yes
	Unclear
	No
5. Is the language of article in English, Spanish or French?	Yes
	Unclear
	No

Level 1 Guide for Reviewers

The guide is designed to provide all reviewers with the same information. Each reviewer should become thoroughly familiar the guide prior to conducting a review. Inter-rater variability should be minimized by each rater's familiarity with the guide. The bolded materials below are included in the table in Memo 1 and in the SRS on-line form.

Questions 1–5 are designed to remove articles not relevant to our research questions. All questions should be answered so we can collect the totals regarding why articles were excluded.

Please do not interpret or vary from the definitions supplied in the guide. Please contact Shelley If you are unclear or have problems using the guide as written. We are trying to minimize differences between reviewers by strictly following the definitions as outlined in Memo 1.

Q1. Did the study occur in a workplace?

The reviewer is first asked to determine if the paper should be excluded because it did not occur in a workplace. Workplaces will be limited to locations that employ adults (18 years or older). Workplaces(ers) that will not be included in the review are agricultural workers, migrant workers, teleworkers, home offices, military installations, commercial fishing, soldiers, students and those workplaces that employ only those 17 years old and younger. **Laboratory studies** will also be excluded.

a) **Yes**
b) **Unclear**
c) **No**

Q2. Does the study report on IPC or IPC measurement tools?

IPC and IPC tools are being considered in the broadest perspective. IPC include all those workplace policies, procedures and practices used to minimize either the frequency or severity of workplace injuries/illnesses. IPC tools include tools used to evaluate the workplace IPC (in part or in their entirety). Excluded from this definition are those programs and policies that address the following: employee assistance programs (EAP), substance abuse, American with Disabilities Act (ADA), quality management, healthcare utilization and mental health/illness. Studies that address regulatory programs with injury/illnesses and/or workers' compensation claims as outcome will be included. Regulatory programs that deal solely with compliance, fitness for duty or surgical outcomes will be excluded.

a) **Yes**
b) **Unclear**
c) **No**

Q3. Is reference from a peer reviewed publication (in press or accepted for publication)?

The reviewer is asked to determine if the paper should be excluded because it is not from a peer reviewed publication. A list of known peer-reviewed journals has been provided to each team member and should be referenced as needed. The peer reviewed list is included as Attachment 4 in Memo 1.

a) **Yes**
b) **Unclear**
c) **No**

Q4. Is article a review, commentary, letter to the editor, editorial or 2 pages or less in length?

These articles are being excluded as the review is focusing on original studies. The information needed to answer this question is often found in the title.

a) **Yes**
b) **Unclear**
c) **No**

Q5. Is the language of article in English, Spanish or French?

Please note in the comment box if the language of the article is in Spanish or French as these articles will have to be directed to specific team members with the needed language skills.

a) **Yes**
b) **Unclear**
c) **No**

Appendix G: Quality Appraisal Reviewer Guide

Quality Appraisal Guide for Reviewers

The quality assessment will be conducted on the studies that remain following the exclusion step – Level 1. The quality assessment process involves a review of the full article to evaluate the overall quality of the article and provide a quality ranking. The ranking determines if the article should continue to the data extraction step of the review.

The guide is designed to provide all reviewers with the same information. Each reviewer should become thoroughly familiar with the guide prior to conducting a quality assessment review. Inter-rater variability should be minimized by following the guide. The bolded materials below are included in the SRS on-line form.

Question 1 is designed to remove articles that could not be removed in Level 1 review due to lack of information. The reviewer is asked to apply the same criteria used in Level 1 review as an initial screen of the article.

If the reviewer selects a - e to Q1 then only Q1 and Q25 must be answered and the reviewer can submit the form. The remaining questions will be automatically dropped in SRS.

Quality Control

Q1. Should the article have been excluded in the Level 1 review for any of the following reasons? (check all that apply)

Choose "f" if the study meets our relevance criteria and should be included with the studies that are being assessed for quality. Remember to use the definitions for workplace, IPC/IPC tools and injury/illness outcomes stated in memo 1. Injuries/illnesses can also include reports of pain or discomfort.

a) **Did not occur in a workplace**
b) **Does not report on IPC programs or IPC measurement tools**
c) **Article is a review, commentary, letter to the editor, editorial or 2 pages or less in length**
d) **Is not written in English, Spanish or French**
e) **Outcome is not injuries/illnesses, workers' comp claims/costs or related symptoms**
f) **Article is relevant & should proceed through QA**

Design and Objectives

Q2. Is the study assessing the effectiveness or reporting on the use of a workplace IPC measurement tool ONLY?

The studies reporting only on IPC measurement tools will be quality assessed using different criteria. Studies that report findings for both IPCs and IPC measurement tools

will be quality assessed using both sets of criteria. Examples of IPC measurement tool studies are organizational policy and practice (OPP) studies and those that involve primarily psychometric analyses (e.g., and instrument reliability/validity studies). These studies may be cross-sectional. Our primary focus here will be on measurement tools that have been used to assess IPCs and more diagnostic tools like safety climate, safety culture or a standard set of organizational policies or practices – like ergonomic policies.

a) **IPC Measurement Tool <u>Only</u>**
b) **IPC <u>Only</u> (Program, Policy or Practice)**
c) **Both IPC Program and IPC Measurement Tool**
d) **Unclear**

All questions following Q2 do not need to be answered if the answer to Q2 is "a"

<u>The remaining questions are for IPC studies only. If a study includes both IPCs and IPC measurement tools, answer the remaining questions focusing on the IPC portion of the study.</u>

Q3. Were concurrent comparison groups(s) used? (choose only one answer)

A comparison group is important to document and account for the potential effects of unexpected secular changes. Having a closely analogous referent group, with similar exposure to causal risk factors as the intervention subjects is a major strength of a workplace intervention study. A comparison group can receive a 'placebo; and thus be considered a comparison. By 'concurrent' it is expected the information on the control or comparison group is collected at the same times as the treatment group. Comparison groups are actual groups of individuals; *statistically generated references created for comparison do not constitute a control.*

a) **Yes; single referent group**
One comparison group was used against which the intervention's effect was evaluated.
b) **Yes; multiple referent groups**
More than one comparison group was used to evaluate the intervention's effects. Referents can be within the same plant (such as different departments), or outside the intervention plant (such as a similar company in the same industry, etc.) and may have received no interventions, or some interventions that differ from those of the study group.
c) **Unclear**
d) **No Control or Comparison Group**
No concurrent comparison groups were used in the study.

All questions following Q3 do not need to be answered if the answer to Q3 is "d"

Q4. Were time-based comparisons used? (choose only one answer)

a) Yes; pre-post

Evaluations of the intervention took place at two time points – before (or at the beginning stages of the intervention) and after (or towards the end) the intervention**.**

b) Unclear

c) No

Evaluation took place at only one time point during the study, i.e. the study is cross-sectional or post-intervention only.

Q5. Was a random intervention allocation described?

Inadequate description of the exposure/intervention allocation strategy makes it impossible to reproduce the intervention in another population. This should be clearly stated in the study to allow for interventions to be reproducible by others. Effects of confounding may be reduced when participants are matched. However, random allocation of treatment/intervention conditions is the preferred scientific method as it is most likely to control for confounding.

a) Yes; random

Study participants, work units or organizations are described as randomly receiving the intervention. Randomization of intervention conditions is typically preferred because it avoids systematic confounding by known and unknown factors.

b) Unclear

c) No

Q6. Is the research question clearly stated?

If the aim of the study is not clearly stated then results are likely of limited value. A clear, explicit statement of objectives should be included in the study.

a) Yes

b) Unclear

c) No

Q7. Please indicate which levels of recruitment were described (check all that apply)

Recruitment is considered the effort by the investigator to obtain participation by specific groups or individuals. Workplace interventions can typically occur at different levels. It is important to distinguish between the various levels so that results can be interpreted in relation to the level at which interventions were applied. Also, differences in recruitment strategies for individuals, groups and workplaces could lead to differences in characteristics of the participants.

a) Employees/workers

b) Department/supervisors

c) Organizations/workplace

d) Unclear

e) Not Described

Level of Recruitment

Q8. Was recruitment rate reported?

a) **Yes**
b) **Unclear**
c) **No**

Q9. Was the recruitment rate >40% for the following? (if yes, then check all that apply)

In relation to each of the levels of recruitment identified below, indicate whether the number of eligible participants from the study population that refused to participate in the study is identified. A greater rate of participation (or recruitment) reduces non-response bias. Please report the recruitment rate in the comment box for each level of recruitment that is reported and is greater than 40%. Sometimes the information to calculate a recruitment (or participation rate) must be abstracted from information reported in tables.

a) **Employees/workers**
b) **Department/supervisors**
c) **Organizations/workplace**
d) **Unclear**
e) **Not Applicable**

Q10. Were pre-intervention characteristics described? (if yes, then check all that apply)

Indicate if pre-intervention characteristics are described, these may include job related factors, individual characteristics, and factors related to exposures and outcomes (for example baseline pain levels across groups).

a) **Employees/workers**
   Individual level information – for example years on job
b) **Department/supervisors**
   Information on department level – for example percent female
c) **Organizations/workplace**
   Information at site level – for example percent of workers in each department [could also include percent females and males]
d) **Unclear**
e) **Not Described**

Q11. Were there any differences across groups at pre-intervention? (if yes, then check all that apply)

If there are no major significant differences between the groups on pre-intervention characteristics or other demographic variables, one can be confident that selection bias to participate in the study was minimal and that the results obtained are not likely affected by these differences.

a) **Employees/workers**
b) **Department/supervisors**
c) **Organizations/workplace**
d) **Unclear**
e) **No Differences**
f) **Not Reported (More than one group)**
g) **Not Applicable (Only one group)**

Q12. Was the loss to follow up (attrition) <35% for (if yes, then check all that apply)

There should be adequate follow up rate for each of the levels of recruitment identified above. The amount lost to follow up introduces the potential for exclusion bias, reduces the available sample size and reduces the confidence in the results obtained.

a) **Employees/workers**
b) **Department/supervisors**
c) **Organizations/workplace**
d) **Unclear**
e) **Not Reported or ≥ 35%**

Q13. Were there any important differences between remaining and drop out participants after the intervention? (if yes, then check all that apply)

Differential attrition of subjects poses a major threat to internal validity. Exclusion bias can result if certain subjects are systematically more likely to be lost to follow-up than others. Comparisons should be made for drop-outs and remaining participants on pre-intervention characteristics or other demographic variables, as available. When there are no statistical differences between these groups, one can be more confident that attrition bias did not occur.

a) **Employees/workers**
b) **Department/supervisors**
c) **Organizations/workplace**
d) **Unclear**
e) **No Differences**
f) **Not Reported**

Intervention

Q14. Was the intervention process described? (choose only one answer)

Inadequate description of the intervention strategy makes it impossible to reproduce the intervention in another population. The setting of the intervention, (i.e., where it was carried out) what was changed and how, are important aspects to document.

a) Yes

All or most aspects of the intervention are clearly described.

b) Unclear

There is not enough information provided, the intervention process is not clearly described.

c) No

The intervention process is not described.

Q15. What was the intervention type? (check all that apply)

a) Engineering Solution

An intervention with a goal of physically eliminating the hazard through redesign, automation or other means.

b) Administrative Technique

Administrative methods include job rotation, training, adjustment, exercise or stretching. These techniques do not eliminate the hazards; they function to reduce the time or exposure to the hazards.

c) Personal Protective Equipment

Interventions that provide employees with equipment such as mechanical lifts, wrist guards, eye glasses, foot stools, etc. These interventions rely on the correct use of the equipment by the employees as the hazards have not been reduced or mitigated.

d) Other

e) None

Intensity of the Intervention

Q16. Was the participation in the intervention documented?

Examining the intensity with which the intervention is implemented within the organization is an important part of an evaluation, which has not been extensively documented in the literature. In the case of a participatory ergonomics program, one way the intensity of an intervention can be assessed is by looking at the extent to which the workplace parties actually participate in the intervention process. We are not valuing the extent of the participation, rather that the researchers document it.

a) Yes

b) Unclear

c) No

Q17. Was the calendar duration of the intervention documented?

The calendar duration refers to the number of months or years over which the intervention took place. The duration of the intervention is an important aspect to document. Interventions of short duration (i.e., a couple of months) could have insufficient time between evaluations to allow for the changes to exert their effects particularly with respect to musculoskeletal health outcomes that take a long time to develop. Conversely, interventions that take too long (i.e., 5 yrs) may also hinder the evaluation. Workplaces are dynamic environments and many changes other than the intervention may have taken place during that period of time, which can confound the results.

a) Yes
b) Unclear
c) No

Outcomes

Q18. What injury/illness or workers' compensation outcomes were reported? (check all that apply)

a) Self Reports

Self reports or interviews were used before the intervention took place (or at the beginning stages of the intervention). Reports can include injuries, illnesses, symptoms, pain or discomfort.

b) Physical Exam Findings

Outcomes were described as results of a physical exam**.**

c) Clinical Diagnosis

A doctor's findings were used as the outcome of interest**.**

d) OSHA (Occupational Safety & Health Administration) Log information (or similar injury/illness reporting)
e) Claims Data
f) None of the Above

Please describe in comment box

Q19. When were injury/illness or workers' compensation outcomes measured?

Our primary outcomes are employee clinical diagnoses, regulatory reported injury/illnesses rates, workers' compensation claims or employee injury/illness self reports. Studies that reported near misses and accident reporting as sole outcomes should be excluded.

a) Baseline at Time of Intervention
b) Baseline –Information Retrieved From/For Years Prior to Intervention

For example – intervention started in 2000 and OSHA records from 1997 were reported as "pre-intervention" data

c) Follow Up
d) Unsure
e) Not Measured

Potential Confounders

Q20. Were any confounders/effect modifiers measured?

A confounder is a variable which is independently related to the exposure (the intervention) and the health outcome (e.g. injury rates). Effect modifiers are variables that modify the association between intervention and outcomes. Potential confounders/effect modifiers relevant to this study could be: age, sex, years employed, work load, work role function, prior history of injury, psychosocial factors, etc. It is extremely important to measure potential confounders as they could mask any true associations that may be present in a given study.

a) Yes
b) Unclear
c) No
d) Not applicable

Analysis

Q21. Were the statistical analyses appropriate to the study design?

a) Yes

Statistical methods are described sufficiently, and the methods used were appropriate and properly applied.

b) Unclear
c) No

An example where the statistical methods would be inappropriate is if the design has a control group and no between group statistical comparisons are made. Similarly, if there are pre/post measures of the outcome the statistical analyses would be inappropriate if the pre-intervention measures are not considered in the analysis.

Q22. Was there adjustment for relevant pre-intervention differences?

Statistical adjustment allows the researchers to control for factors that may potentially confound the relationship between the intervention and outcome. Possible adjustment methods include stratifying based on the difference (for example if sex is different one can do separate analyses for males and females). Another method is including the variable in the statistical model, this does not allow for the variable to vary, which eliminates its effect on the association of interest.

a) Yes
Baseline differences were observed and adjusted for
b) Unclear
c) No
Baseline differences were observed but not adjusted for
d) Not applicable
There were no baseline differences observed so adjustment was not needed

Q23. Should this reference proceed to data extraction? Why?

Using all the information you have gathered on the article and after critically appraising its quality, please assess how confident you are that the results are valid, reliable and that bias in the results was minimal. If certain issues pertaining to the study quality have reduced your confidence in the results, please summarize these in the space provided.

a) Yes
b) No

Q24. Are there other studies listed in this reference list which should be retrieved for consideration? (if yes, please include author/year/publication etc.)

The primary authors will be the ones focusing on this question. However, if in your role as a general reviewer you discover a reference you think is important – please identify it. Often, the search will pick up Part I of a two part publication and we want to ensure we are rating "studies" not articles. It is important for us two both identify studies that might have been missed in the search and to bring together multiple articles that might have been written for one study.

a) Yes
b) No

Q25. Is this the consensus version of the QA?

After consensus between reviewers is reached one reviewer will update their entry to include the consensus answers. The consensus version will move forward to DE.

a) Yes
b) No

Appendix H: Data Extraction Reviewer Guide

Guide to the data extraction form for reviewers

This guide must be read before beginning the data extraction. Print this guide and have it to refer to while doing the data extraction. Please extract the data from the articles you review by completing the form on SRS and entering text in the provided areas. Please read the questions carefully especially the instructions in italics which provide details on how to enter the data. Bolded text provides some additional instructions that will help to ensure that the answers from different reviewers are consistent.

All of the questions in the SRS form should have an answer. If an article lacks the information necessary to answer a particular question then the reviewer should enter "**NP**" (not provided) in the text box. It is important that all questions have answers because we will not know if an article did not have the information or a reviewer forgot to enter it if we allow blank answers. Remember, do not extrapolate just provide the information that is presented in the article. You may need to get information out of tables or figures (e.g., to calculate participation rates).

Study Design and Setting:

1. State the research question(s)/objective(s). Please use the exact wording from the article. If more than one objective; then list all objectives. Be clear to only include *the objectives tested* not broader objectives described.

2. State the primary hypothesis. Please use the exact wording from the article or enter "NP". A clearly stated research question/objective does not mean a clearly stated primary hypothesis has been stated. Hypotheses usually begin with: "We hypothesize…"; "We expect…"; or "We predict…" and explains that a change in X leads to a change in Y.
If the authors list a series of hypotheses but do not declare which is primary then enter all hypotheses stated in question 3.

3. State additional hypotheses not listed in question #2 (list all and number; type "NP" if not applicable).
Please use the exact wording from the article or enter "NP".

4. Write the last name of the first author and the year of publication (Author's last name, yyyy). Give the first author's last name and the year (4 digits) the article was published.

5. List the jurisdiction where the study was completed. Provide information regarding the country, region, province, city, etc. where the study was carried out - enter "NP" where information is not available. For multiple locations enter ‘multi’.

Country
Province
Region (e.g., Mid-western USA)
State
City

6. Describe what setting(s) that the study was conducted in. Please use the language from the article to describe succinctly. Describe the organization and the unit as it is part of the setting. For example, the organization may be a hospital but the units are only surgical units in the hospital. List all if multiple organizations or units are investigated.

7. List the job titles/classification of the participants that participated in the study. Provide the level of detail given in the study or enter “NP”. Reviewers can enter “Multi” if the study refers to more than two job titles or worker classifications.

8. List the inclusion criteria described in the study (please list inclusion criteria clearly). Enter a *numbered* list (see below) of how the study selected their site (S), unit (U), or individuals (I) for inclusion. For studies that use “administrative” data to track outcomes, their inclusion of employees or units could be found in the description of outcome measures. Please also summarize the level for inclusion criteria using the notation “S”, “U”, or “I”. We use an example for administrative data because the inclusion criteria are found in unexpected places.

E.g.,
1. Intervention units selected based on previous injury rate (U)
2. Back injuries defined as upper or lower trunk injury resulting in either lost time or health care expenses (I)

9. List the exclusion criteria described in the study (please list exclusion criteria clearly).
Enter a *numbered* list (see below) of how the study selected their site, unit, or individuals for exclusion. This could be found in the setting description or in the outcome description.. Please also summarize the level for exclusion criteria using the notation “S”, “U”, or “I”.

E.g.,
1. Neck or shoulder injuries (I).
2. Employees in the float pool (U)

10. What is the study design (choose only one)? Please describe any unique characteristics verbatim about the study design in the comment boxes beside the choice you make.

Caution: Do not describe the intervention in great detail. It will be described in Q12.
***Use notation (I_1 –Intervention #1, I_2 –Intervention #2, C_1 Control Group #1, C_2 Control Group #2, I_1C –crossover with intervention first, I_2C –crossover with intervention second)**.

Randomized Field Trial
Non-randomized Field Trial with concurrent comparison group
Randomized Cross-Over Design
Non-randomized Cross-Over Design
Pre-post Design with NO control
Other

Randomized Field Trial -a field study where the intervention assignment is randomized.

R O X O
O O

Non-randomized Field Trial with concurrent comparison group – a field study where the intervention assignment is not randomized and the information on the controls is collected concurrently with the information for the treatment.

O X O
O O

Randomized Cross-Over Design: –a field study where two groups receive the intervention at different times and group assignment is randomized.

R O X O O
O O X O

Non-randomized Cross-Over Design –a field study where two groups receive the intervention at different times and group assignment is not randomized.

O X O O
O O X O

11. What type of prevention did the study investigate (choose only one)? Indicate whether the study evaluated a primary or secondary prevention/intervention. The classical definition of primary prevention is defined as an intervention aimed at preventing healthy people from progressing on to symptom or disorder. The classical definition for tertiary prevention is defined as intervention aiming to prevent people with clinically recognized disorders from further morbidity and mortality. Although these definitions are accepted in public health literature, to be comparable to other IW&H reviews, we will use the terms primary and secondary (instead of tertiary) for those definitions.

To determine what the authors "aimed" to do, reviewers must only answer based on what was reported by the authors. Therefore, any studies where clinical diagnoses or symptoms (as part of a case definition) were used to identify and include participants with disorders will be classified as secondary prevention. If a study excluded employees with clinical diagnoses or symptoms to create a cohort of individuals free from symptoms this would be considered a primary prevention. If no such exclusions were made, then the authors will be assumed to

have intended to prevent both “asymptomatic” employees from developing symptom or disorder and “symptomatic” individuals from further morbidity and mortality, and therefore will be classified as both. If you choose other please provide details.

Primary Prevention
Secondary Prevention
Both
Other

Intervention Characteristics:

12. Describe all interventions evaluated.
If control received some treatment (or portion of an intervention) please describe as it will be important in understanding what is being evaluated.

E.g.: I_1 - exercise ("training to improve physical fitness"); I_2 -ergonomic trainings" to improve lifting technique"; C_1 -no exercise and no "training"
***Organize your description of interventions according to I_1, I_2, C, I_1C, and I_2C**

13. Was there confirmation the intervention occurred (check all that apply)? Provide details in the comment box to support your response.

E.g.: “exercise” could be confirmed either by self-report in exercise logs, attendance in classes, or questionnaire report of exercises done; “ergonomics training” from above could be confirmed by researchers observing “correct” ergonomic lifting technique.

Direct Measurement by Equipment
Observation
Self Report
None

14. How long after the intervention implementation did confirmation occur? Monitoring of attendance would be confirmation “during” the intervention. A questionnaire of self-reported exercise one month after the intervention would be 1 month.

15. What was the duration of the intervention in months/days/hours? (Note this is not the follow-up time but the actual duration of the intervention implementation). Indicate in months if possible, if not in weeks, days etc. or enter “NP”.
***Use notation (I_1, I_2, I_1C, and I_2C) for different intervention groups**.

E.g., Baseline data collected on May 1st, 2000. Intervention implemented June 1st, 2000 continues until June 1st, 2001. Follow-up data collected on May 1st 2002. Note this information may be presented in a number of ways (tables, figures, timelines etc). In this example the duration of intervention is I_1 = 12 months.
For “administrative” data it is best to establish what the intervention period is first (e.g., lifts were installed between April 2002 to July 2002).

16. Indicate the time period between the baseline measurement and all subsequent follow up measurements. Use months to indicate the length of follow up, for example, questionnaires were administered at 6, 12, and 18 months. Indicate in months if possible, if not in weeks, days etc. or enter "NP". Please make sure that you describe all intervention groups and all referent groups using the same group notation throughout the data extraction forms.

E.g., Baseline data collected on May 1st, 2000. Intervention implemented June 1st, 2000 continues until June 1st, 2001. Follow-up data collected on May 1st, 2002. Note this information may be presented in a number of ways (tables, figures, timelines etc). In this example, the length of follow-up is **I_1 =24 months**.

Often in administrative data there are not multiple time points of outcome data collection. Instead there are time periods over which data are collected. For "administrative" data, it is best to establish what the intervention period is first. Then establish the baseline data period for outcome measurements. This period may be a month, 6 months, or years before the intervention. State the full time-period for which baseline outcome data was collected (e.g., "data was collected 3 years prior to lifts installation" answer: April 1998 to April 2002). Finally, establish the follow-up period (e.g., "We compared to 3 years after the lifts were completed installation" answer: July 2002 to July 2005).

Study Group Questions:

17. Describe overall (study) group. Intervention(s) + Control(s)

Sample Size
Age (mean, SD, range)
% female
Loss to Follow up (N)

18. Describe the Intervention group(s). Provide answer(s) for each category - enter "NP" in all comment boxes where information is not available. If design is cross-over then answer for I_1C only.

***Use notation (I_1, I_2, and I_1C)**

Sample Size	*Eg: I_1 =, I_2=, … (or I_1C=)*
Age (mean, SD, range)	*Eg: I_1 =, I_2=, … (or I_1C=)*
% female	*Eg: I_1 =, I_2=, … (or I_1C=)*
Loss to Follow up (N)	*Eg: I_1 =, I_2=, …(or I_1C=)*
Time Period of Measurements (start date to end date)	

19. Describe the Referent group. Provide answer(s) for each category - enter "NP" in all comment boxes where information is not available. If design is cross-over then answer for I_2C only.

***Use notation (C, I_1C, and I_2C)**.

Sample Size *Eg: C_1 , C_2, …(or I_2C= …)*
Age (mean, SD, range) *Eg: C_1 , C_2, …(or I_2C= …)*
% female *Eg: C_1 , C_2, …(or I_2C= …)*
Loss to Follow up (N) *Eg: C_1 , C_2, …(or I_2C= …)*
Time Period of Measurements (start date to end date)

Covariate Questions:

20. When were potential covariates/confounders measured (check all that apply)?
If covariates were measured any time prior to intervention this will be counted as baseline. If unsure then please describe. Shelley will be reviewing all "unsure" answers.

*We do not consider pre-intervention measures of the outcome (i.e., dependant variable) to be a covariate.

Baseline at time of outcome measurement
Baseline near intervention implementation
Follow up
Unsure (please describe)
Not Applicable (Not Measured)

21. Provide a list of covariates/confounding variables that were controlled for in the final test of the intervention effectiveness. Enter "NA" if no covariates/confounders were tested in the final analysis.

Outcome Questions: SRS will drop certain questions depending on the answers to the following 3 outcome questions.

22. Does the study use "administrative" records to collect measurements of injury/illness outcomes?
By administrative records we mean regulatory required employer record keeping data (e.g., OSHA logs), voluntary employer record keeping data (e.g., incident reports), or insurance record keeping systems (e.g., worker's comp). Voluntary employer record keeping systems are any record keeping that either regulatory agencies or insurance agencies do not require.

Describe succinctly in the comment box the type of administrative record.

Yes
No

23. Does the study use self-report questionnaire records to collect measurements of injury/illness outcomes?
Describe succinctly in the comment box the nature of the questionnaire used.

E.g., symptom frequency, VAS pain scale, or intensity.

Yes
No

24. Does the study use <u>clinical diagnosis or physical exams</u> to collect measurements of injury/illness outcomes?

Describe succinctly in the comment box the protocol or type of exam.

Yes
No

25. Was the population studied "fixed" or "open" (check all that apply)?
A "fixed" population is one where the population is fixed at some time and the same participants are followed over time. An open population is where individuals can come in and out of the study. In a worksite population, the intervention happens at some point and different individuals can contribute information before and after the intervention (new hires). In most cases the population will be either fixed or open. However in a small number of studies it may be that a fixed cohort is drawn from a larger open population study.

Fixed Population
Open Population
Unclear

<u>"Administrative" Record Questions</u>

26. What sources were used to "count" employee injuries (check all that apply)?

Regulatory required employer record keeping data (e.g., OSHA logs)
Voluntary employer record keeping data (e.g., incident reports)
Insurance record keeping systems (e.g., workers' compensation claims data)

27. How were employee hours collected (check one only)?
Many studies calculate injury rates for a unit or an organization. A critical piece to the calculation is the collecting employee hours. Estimations of employee hours by calculating from the number of employees are very different from getting actual employee billed hours.

Estimation of employee hours worked from an estimated of number of employees
Estimation of employee hours worked from an actual number of employees
Actual employee hours from a specific number of employees
Employee hours not collected
Unclear (please describe)

28. Indicate at what level employee hours were ascertained and/or estimated.

Individual
Unit
Site

29. If injury rates were calculated, list the equation(s). Please define the numerator and denominator using the author's language explicitly. If the equation is not explicitly explained, type "NP". If injury rates were not calculated, enter "N/A"

30. Did the study discuss how they handled any of the following special issues related to administrative record keeping (check all that apply and describe in comment box)?

Temporary employees, contract employees, or floating employees between units
Turnover rate
Reinjuries to the same employee

Questionnaire Questions

31. Check all body regions where symptoms were ascertained by questionnaire (check all that apply). Provide details in the comment box to support your response. We are only including musculoskeletal symptoms and not function or disability questions.

Hand/wrist/elbow (HWE)
Neck/shoulder (NS)
Upper back (UB)
Lower back (LB)
Legs/knees/feet (LKF)
Not attributed to a body part (NAB)

32. Describe when follow-up injury/illness outcomes (symptoms) were measured (check all that apply). Give details if you select "other". If there is more than one injury/illness outcome identified please use the notation above for each outcome in the comment box beside your measurement choice.

A single time point
Multiple time points assessed and then averaged
Other

Clinical/Physical Exam Questions:

33. Check all body regions where specific disorders were ascertained by physical assessment or laboratory test (check all that apply). Provide details in the comment box to support your response.

Hand/wrist/elbow (HWE)
Neck/shoulder (NS)
Upper back (UB)
Lower back (LB)
Legs/knees/feet (LKF)
Not attributed to a body part (NAB)

34. Was masking of physical assessment done? Provide details in the comment box to support your response. This question is asking if the clinician/investigator was blinded to the intervention group.

Yes
No
Unclear
Not Applicable

35. Was a standard protocol used for the clinical exams?

Yes (list protocol name)
No
Unclear (describe)

Statistical Analysis Questions:

36. Please check the types of final analyses done for testing the observed effects of the intervention. (provide details about the analyses in the comment box) You should select the one that represents the final test not the preliminary analyses. Provide details in the comment box to support your response. Give details if you select "other".

ANOVA (ANCOVA)
MANOVA (MANCOVA)
Linear/Logistic Regression
Multilevel Regression (linear or logistic)
Survival Regression
Poisson Regression
Percentage of change
Nonparametric tests
Nonparametric Matched Test
Nonparametric Unmatched Test
Other Parametric Matched Test
Other Parametric Unmatched Test
No Statistical Test

37. Was there a direct statistical test or estimation of effect for the differences between the intervention and the control group? If differences are not tested then one cannot conclude that the intervention had an effect.

Yes
No
Unclear

38. Describe for each injury/illness outcome the observed intervention effects. (Be brief and concise i.e., enter “effect size”, "risk ratio", "rate differences, "mean differences" etc, the actual number and associated outcome). For administrative data, multiple types of information might be reported. For self-reported and clinical data, please report by body part. PLEASE use notation HWE, NS, UB, LB, LKF, NAB, or O)
***Organize your description of interventions according to I_1, I_2, C, I_1C, and I_2C**

E.g.: I_1 – LWD Rate 13% change pre vs post, I_1 = left arm RR 1.3

39. Remark on the findings or enter information that is unique about the study that may not be adequately captured in the other DE questions. Be clear and concise.

<u>Housekeeping questions:</u>
40. Check the names of both DE reviewers for this study.
BA, SB, GD, EK, LL, CL, JS, LT, RW

41. Is this the consensus – final - version of the DE form? Please select “no” until consensus has been completed.

Yes
No

Appendix I: Level 1 and Level 1 B exclusions

Exclusions	Title & Abstract		Full Article	
Intervention	N	%	N	%
1. Did the study occur in a workplace?	5993	31	41	5
2. Does the study report on IPC or IPC measurement tools?	8098	41	235	32
3. Is reference from a peer reviewed publication?	826	4	0	
Study Parameters				
4. Is article a review, commentary, letter to the editor, editorial or < 2 pages in length?	4468	23	171	23
5. Is there a control group or concurrent comparison?			213	28
6. Is the language of article in English, Spanish or French?	25	<1	0	0
Outcomes				
7. Is outcome injuries/illnesses, workers comp claims/costs?	112	1	45	6
8. Not Relevant (NOS)*			33	4
*NOS = not otherwise specified. These are articles where the software combined answers so specific exclusion numbers were not available.				

Appendix J: Quality assessment table

Study	Time-Based Comparisons	Random Allocation Described	Research Question	Recruitment Rate Reported	Recruitment Rate >40%	Pre-Inter. Chrctrst Described	Pre-Intervention Differences	Loss To Follow-Up <35%	Drop Out Differences	Intervention Described	Participation Documented	Intervn. Duration Documented	Outcomes Measured	Confounders/Effect Modifiers Measured	Statistical Analyses Appropr.	Pre-Intervention Diffs. Adjusted	Quality Score	Quality %
Weight	3	3	2	1	2	2	2	2	2	3	2	3	2	2	3	2	36	100%
High Quality																		
Hlobil, 2005 (& Staal, 2004)	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	34	94%
Faucett, 2002	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	34	94%
Gerr, 2005	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	34	94%
Jensen, 2005	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	33	92%
Jensen, 2006	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	32	89%
Rempel, 2006	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	32	89%
Amick, 2003	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	31	86%
Bohr, 2000 (& Bohr, 2002)	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	31	86%
Martin, 2003 (& Gatty, 2004)	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	31	86%
Criteria Met	9	8	8	6	6	9	9	9	5	9	6	9	9	9	9	7		
Percent Met	100	89	89	67	67	100	100	100	56	100	67	100	100	100	100	78		
Medium Quality																		
Sjogren, 2006	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	30	83%
Brisson, 1999	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	29	81%
Tittiranonda, 1999	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	0	29	81%
Wassell, 2000	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	29	81%

Study	Time-Based Comparisons	Random Allocation Described	Research Question	Recruitment Rate Reported	Recruitment Rate >40%	Pre-Inter. Chrctrst Described	Pre-Intervention Differences	Loss To Follow-Up <35%	Drop Out Differences	Intervention Described	Participation Documented	Intervn. Duration Documented	Outcomes Measured	Confounders/Effect Modifiers Measured	Statistical Analyses Appropr.	Pre-Intervention Diffs. Adjusted	Quality Score	Quality %
Weight	3	3	2	1	2	2	2	2	2	3	2	3	2	2	3	2	36	100%
Arnetz, 2003	1	1	1	0	0	1	1	0	0	1	1	1	1	1	1	1	29	81%
Daltroy, 1997	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	27	75%
Loffler, 2006	1	1	1	0	0	1	1	0	1	1	0	1	1	1	1	0	27	75%
Laing, 2005	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0	27	75%
Sinclair, 2003	1	1	1	1	1	1	1	0	0	1	0	1	1	1	0	1	27	75%
Gundewall, 1993	1	1	1	0	0	1	0	0	1	1	1	1	1	1	0	1	26	72%
Durand, 2001	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1	26	72%
Videman, 1989	1	0	1	1	1	1	1	1	0	1	1	1	1	1	0	0	26	72%
Smedley, 2003	1	0	1	1	1	1	1	0	0	1	0	1	1	1	1	0	25	69%
Lintula, 2001	1	1	1	0	0	1	1	0	0	1	1	1	1	0	1	0	25	69%
Greenwood, 1990	0	1	1	1	0	1	1	1	0	1	0	1	1	1	1	0	25	69%
Loisel, 2002	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	25	69%
Greene, 2005	1	0	1	1	0	1	1	0	0	1	1	1	1	1	1	0	25	69%
van der Molen, 2004	1	1	1	0	0	1	1	0	0	1	1	1	1	0	0	1	24	67%
Brown, 1992	1	0	1	0	0	1	1	1	0	1	0	1	1	0	1	1	24	67%
Shaw, 2006	1	1	1	0	0	1	1	0	0	1	1	1	1	1	0	0	24	67%
Ludewig, 2003	1	1	1	0	0	1	1	0	1	1	0	0	1	1	1	0	24	67%
Bell, 2006	1	0	1	0	0	1	1	0	0	1	1	1	1	1	1	0	24	67%
Nelson, 1997	1	0	1	0	0	1	1	0	0	1	0	1	1	1	1	1	24	67%
Tuchin, 1998	1	1	1	0	0	1	1	1	1	1	0	1	1	0	0	0	24	67%
Zohar, 2002	1	0	1	0	0	1	1	0	0	1	0	1	1	1	1	1	24	67%
Psihogios, 2001	1	0	1	0	0	1	1	0	0	1	1	1	1	0	1	1	24	67%

Study	Time-Based Comparisons	Random Allocation Described	Research Question	Recruitment Rate Reported	Recruitment Rate >40%	Pre-Inter. Chrctrst Described	Pre-Intervention Differences	Loss To Follow-Up <35%	Drop Out Differences	Intervention Described	Participation Documented	Intervn. Duration Documented	Outcomes Measured	Confounders/Effect Modifiers Measured	Statistical Analyses Appropr.	Pre-Intervention Diffs. Adjusted	Quality Score	Quality %
Weight	3	3	2	1	2	2	2	2	2	3	2	3	2	2	3	2	36	100%
Dehlin, 1981	1	0	1	0	0	1	1	1	0	1	1	1	1	1	0	0	23	64%
Rosenblum, 2006	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	0	23	64%
Nave, 2004	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	0	23	64%
Luijsterburg, 2005	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	0	22	61%
Fanello, 2002	1	0	1	1	1	1	1	1	0	0	1	1	1	0	0	0	21	58%
Hager, 1982	1	0	1	0	0	1	0	0	0	1	1	1	1	1	0	1	21	58%
May, 2004	1	0	1	1	1	0	0	1	1	1	1	0	1	1	0	0	21	58%
Erlandsson, 1980	1	0	1	0	0	0	0	0	0	1	1	1	1	1	1	0	20	56%
Robertson, 2003	1	0	1	0	0	1	1	0	0	1	0	1	1	0	1	0	20	56%
Swanson, 2006	1	1	1	0	0	1	0	0	0	1	0	0	1	1	1	0	20	56%
Peper, 2004	1	0	1	0	0	1	1	0	0	1	0	1	1	0	1	0	20	56%
Owen, 2002	1	0	1	0	0	1	1	0	0	1	1	1	1	0	0	0	19	53%
Aaras, 2001	1	0	1	0	0	1	1	0	1	1	0	1	1	0	0	0	19	53%
Feuerstein, 1993	1	0	1	0	0	1	1	1	0	1	0	1	0	1	0	0	19	53%
Mancini, 2005	1	0	1	1	0	0	1	0	0	1	0	1	1	0	1	0	19	53%
Shinozaki, 2001	1	0	0	0	0	1	1	0	0	1	1	1	1	1	0	0	19	53%
Nelson, 1998	1	0	1	1	1	1	0	0	1	0	1	0	1	1	0	0	18	50%
Feinhauer, 1993	1	0	1	0	0	1	1	0	0	0	0	0	1	1	1	1	18	50%
Criteria Met	41	16	43	16	13	40	37	14	10	38	26	38	43	31	27	14		
Per cent Met	93	36	98	36	30	91	84	32	23	86	59	86	98	70	61	32		

Study	Time-Based Comparisons	Random Allocation Described	Research Question	Recruitment Rate Reported	Recruitment Rate >40%	Pre-Inter. Chrctrst Described	Pre-Intervention Differences	Loss To Follow-Up <35%	Drop Out Differences	Intervention Described	Participation Documented	Intervn. Duration Documented	Outcomes Measured	Confounders/Effect Modifiers Measured	Statistical Analyses Appropr.	Pre-Intervention Diffs. Adjusted	Quality Score	Quality %
Weight	3	3	2	1	2	2	2	2	2	3	2	3	2	2	3	2	36	100%
Low Quality																		
Carrivick, 2002	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	0	17	47%
Carrivick, 2001	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	0	17	47%
McCluskey, 2006	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	0	17	47%
Reynolds, 1990	1	0	1	0	0	1	0	1	0	1	1	0	1	0	0	0	16	44%
Baggs, 2003	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	1	16	44%
Lynch, 2000	1	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	15	42%
Adera, 2000	1	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	15	42%
Warburton, 2000	0	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	15	42%
Van Heerden, 1988	1	0	1	1	1	0	0	1	0	1	0	0	1	0	0	0	15	42%
Marras, 2000	1	0	1	0	0	1	0	0	0	1	1	0	1	0	0	0	14	39%
Mendelson, 1998	1	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	14	39%
Yassi, 2001	1	0	1	0	0	0	0	0	0	1	0	1	1	0	0	0	13	36%
Yassi, 1995	1	0	1	1	1	0	0	0	0	0	0	0	1	0	1	0	13	36%
May, 2002	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	13	36%
Carayon, 2006	0	0	1	0	0	1	1	0	1	1	0	0	0	1	0	0	13	36%
Davis, 2004	1	0	1	0	0	0	0	0	0	1	1	0	1	0	0	0	12	33%
Mitchell, 1994	0	0	1	1	0	1	0	0	0	1	0	0	1	1	0	0	12	33%
Poosanthanasam, 2005	1	0	1	0	0	1	0	0	0	1	0	0	1	0	0	0	12	33%
Mayhew, 1999	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	6	17%
Criteria Met	14	1	18	4	2	8	4	2	1	15	6	8	16	4	7	2		
Per cent Met	74	5	95	21	11	42	21	11	5	79	32	42	84	21	37	11		

Appendix K: Intervention description

*key to all abbreviations appears at end of table

Intervention Category	Author, Year	QA*	Study Design	Prevention Type	Intervention Description
Ergonomic training, chair - office	Amick, 2003	H*	non-randomized field trial	Both	I_1: received a highly adjustable chair and one time 90 m office ergonomic training workshop with 3 educational e-mail follow-ups. I_2: received only the training workshop and e-mail follow-ups. C: received the training session at the end of the intervention.
RTW/DM	Arnetz, 2003	M	randomized field trial	Both	I_1: early medical, rehabilitation and vocational intervention. C: received conventional case management.
Programs (regulatory)	Bell, 2006	M	other	Both	I_1: logger safety training program. C: received no intervention.
Ergonomic training - office	Bohr, 2000 (and Bohr, 2002)	H	randomized field trial	Both	I_1: received a 2 hr participatory training with problem solving. I_2: received a 1 hr training consisting of lecture and handouts about office ergonomics. C: received no intervention.
RTW/DM	Brown, 1992	M	non-randomized field trial	Secondary	I_1: back school (6 wks exercise & education). C: received no intervention.
Ergonomic training	Daltroy, 1997	M	randomized field trial	Primary	I_1: back school (back safety, correct lifing & handling posture). C: received no intervention.
Exercise, ergonomic training	Dehlin, 1981	M	non-randomized field trial	Secondary	I_1: physical fitness training (exercise). 1_2: ergonomic education on lifting technique. C: received no intervention.

Intervention Category	Author, Year	QA*	Study Design	Prevention Type	Intervention Description
RTW/DM	Durand, 2001	M	non-randomized field trial	Secondary	I_1: therapeutic return to work (TRW) following functional restoration. $C_{1:}$ functional restoration without TRW. C_2: back pain management in community service model (excluded rehab intervention). C_3: functional restoration and TRW by ortho surgeon but were denied this program by Quebec Workers Comp Board.
Hearing protectors	Erlands-son, 1980	M	non-randomized field trial	Primary	I_1: ear plugs. C: ear muffs.
Training - manual lifting	Fanello, 2002	M	non-randomized field trial	Both	I_1: manual lifting training. C: received no intervention.
Ergonomic training - multi	Faucett, 2002	H	randomized field trial	Primary	I_1: electromyogrpahic biofeedback training. I_2: adult learning education and training intervention. C: received no intervention.
Programs (regulatory)	Feinauer, 1993	M	non-randomized field trial	Both	I_1: Analyzing 3 tpes of drug testing(a) Preemployment; (b) Postaccident; and (c) Reasonable Cause. C: received no intervention.
RTW/DM	Feuerstei n, 1993	M	non-randomized field trial	Secondary	I_1: received multicomponent rehabilitation program. C: received usual care.
Workstation adjustment - office	Gerr, 2005	H	randomized field trial	Primary	I_1: received training and workstation adjustments based on protective factors identified from prior studies. I_2: received training and workstation adjustments based on OSHA, NIOSH and private industry standards. C: received no instruction, but received the same visits from the study staff.

Intervention Category	Author, Year	QA*	Study Design	Prevention Type	Intervention Description
Ergonomic training	Greene, 2005	M	randomized cross-over design	Both	I_1: received an active ergonomic training consisting of two, three hour training sessions in one week. IC_1: received the intervention after two weeks of follow-up. Both groups were followed for 1 year.
RTW/DM	Greenwood, 1990	M	randomized field trial	Secondary	$I_{1:}$ evaluation and rehabilitation services. C: received usual care.
Programs (regulatory), policy (employer-level)	Hager, 1982	M	non-randomized field trial	Primary	I_1: voluntary earmuffs or earplugs use. I_2: mandatory muff or plug use for exposures > 95dB. I_3: mandatory muff use for all employees. $I_{4:}$ OSHA mandatory hearing protection. C: no hearing protection
RTW/DM	Staal, 2004 (and Hlobil, 2005)	H	randomized field trial	Both	I_1: graded activity program. C: usual care
RTW/DM	Jensen, 2005	H	randomized field trial	Secondary	$I_{1:}$ Physical Therapy (PT) intervention aimed at enhancing the physical functioning by individual goal setting, muscular endurance exercise, aerobic training, pool training, relaxation techniques and body awareness therapy. I_2: Cognitive Behavior Therapy (CBT) intervention included activity planning and goal setting, problem solving, applied relaxation cognitive coping techniques, activity pacing, the role of vicious circles and how to break them, the role of significant others and assertion training. $I_{3:}$ full time Behavioral Medicine (BM) Intervention (included both PT and CBT). C: usual care

Intervention Category	Author, Year	QA*	Study Design	Prevention Type	Intervention Description
Training - manual lifting	Jensen, 2006	H	non-randomized field trial	Both	I_1: combination of practical classroom education & instruction at worksite concerning lifting. I_2: SMI addressed work stress in health care through training with group sessions. C: lessons of own choice in matters unrelated to intervention programs.
Participatory ergonomics - Mfg	Laing, 2005	M	randomized field trial	Primary	I_1: participatory ergonomics. C: received no intervention.
Arm supports - office	Lintula, 2001	M	randomized field trial	Both	I_1: received one Ergorest arm support with a mouse pad for the hand that operated the mouse. I_2: received Ergorest arm supports for both hands and a mouse pad for the mousing hand. C: received no arm supports and was instructed not to change their workstations during the study period.
Skin care training - HC	Loffler, 2006	M	randomized field trial	Secondary	I_1: skin care training (skin protective measures, use of emollients, hand washing, and hand disinfection). C: received no intervention.
RTW/DM	Loisel, 2002	M	randomized field trial	Both	I_1: clinical intervention (clinical examination by a back pain specialist, participation in a back school after eight weeks of absence from regular work, and if necessary, a multi-disciplinary work rehabilitation intervention after 12 weeks of absence from work). I_2: occupational intervention (visits to occupational medicine physician and a participatory ergonomics). I_3: Sherbrooke model intervention (combination of I_1 and I_2). C: standard care.
Exercise - construction	Ludewig, 2003	M	non-randomized field trial	Both	I_1: home exercise program. C_1: symptomatic subjects control group. C_2: asymptomatic subjects control group.

Intervention Category	Author, Year	QA*	Study Design	Prevention Type	Intervention Description
Bricklaying method	Luijsterburg, 2005	M	non-randomized field trial	Both	I_1: raised bricklaying. C: not raised bricklaying.
Programs (regulatory)	Mancini, 2005	M	randomized field trial	Primary	I_1: multi-component eye injury prevention program in metal industry. C_1: no intervention construction workers. C_2: no intervention wood/ceramic workers
Workstation adjustment & ergonomic training - office	Martin, 2003 (and Gatty, 2004)	H	non-randomized field trial	Both	I_1: received individualized training for 1 h per week for 4 weeks in body mechanics, workstation adjustments, task modification and stretches. C: received no intervention
Workstation adjustment & ergonomic training - office	May, 2004	M	other	Both	I_1: workshop instruction and office ergonomic enhancements. C: received no intervention
Loss control	Nave, 2004	M	non-randomized field trial	Both	$I_{1:}$ flexible loss control strategy C: received no intervention
Programs (regulatory)	Nelson, 1997	M	non-randomized field trial	Both	$I_{1:\ r}$egulatory inspection for fall protection C: received no inspection
New office	Nelson, 1998	M	randomized field trial	Both	I_1: employees moved from old buildings to a new building with new lighting and equipment and received 1 h of ergonomic training. C: continued working in old buildings. Supervisors received ergonomic training.
Ergonomic training - office	Peper, 2004	M	non-randomized field trial	Both	I_1: received training of 6 weekly 2 h group sessions in ergonomic principles, psychophysiological awareness and control, sEMG practice at the workstation. C: received no intervention.

Intervention Category	Author, Year	QA*	Study Design	Prevention Type	Intervention Description
Workstation adjustment - office	Psihogios, 2001	M	non-randomized field trial	Both	Participants were evenly dichotomized into two conditions based on normal (initial) gaze angle relative to horizontal (0° and -17.5°) I_1: the monitor was moved to shift gaze angle from -17.5° to 0° for two weeks. C_1: the monitor was maintained at a -17.5° gaze angle. I_2: the monitor was placed to shift gaze angle from 0° to -17.5° for two weeks. C_2: the monitor was maintained at a 0° gaze angle.
Data entry devices, arm supports - office	Rempel, 2006	H	randomized field trial	Both	I_1: received a trackball and ergonomic training. I_2: received forearm support board and ergonomic training. I_3: received forearm support board, trackball and ergonomic training. C: received only the ergonomic training.
Workstation adjustment & ergonomic training - office	Robertson, 2003	M	non-randomized field trial	Both	I_1: received new flexible workspace I_2: received new flexible workspace and office ergonomcis training. C: did not receive new workstations or training.
Policy (employer-level)	Rosenblum, 2006	M	randomized field trial	Secondary	I_1: pre-employment isokinetic testing. C: received no intervention.
Supervisor practices	Shaw, 2006	M	randomized cross-over design	Both	I_1: supervisor training workshop. C: received no intervention.

Intervention Category	Author, Year	QA*	Study Design	Prevention Type	Intervention Description
Training & equipment - forklifts	Shinozaki, 2001	M	non-randomized field trial	Both	I_1: personal approach (written & verbal instructions on lumbar support and jacket). I_2: improvement of seats and tires to reduce vibration. C_1: blue collar workers who did not receive intervention. C_2: white collar workers who did not receive intervention.
Safety training	Sinclair, 2003	M	randomized field trial	Both	I_1: multi-topic safety training using multi-media. C: received usual training.
Exercise - workplace	Sjogren, 2006	M	randomized cross-over design	Secondary	I_1: workplace exercise training. IC_1: received delayed intervention.
Data entry devices - office	Swanson, 2006	M	randomized field trial	Both	I_1: alternative keyboard. C: conventional keyboard.
Data entry devices - office	Tittiranonda, 1999	M	randomized field trial	Secondary	I_1: received Apple Adjustable Keyboard™ plus 1 h ergonomic training. I_2: received Comfort Keyboard System™ plus 1 h ergonomic training. I_3: received Microsoft Natural Keyboard™ plus 1 h ergonomic training. C: received conventional keyboard plus 1 h ergonomic training.
Training - manual lifting	Tuchin, 1998	M	randomized field trial	Both	I_1: training detailing (back anatomy, proper lifting and back care). C_1: did not receive education classes (as in I1) was instructed to perform a series of daily exercises. C_2: received no intervention.

Intervention Category	Author, Year	QA*	Study Design	Prevention Type	Intervention Description
Policy (employer-level)	Wassell, 2000	M	non-randomized field trial	Primary	$I_{1:}$ mandatory back belt use and training session on proper lifting and back belt use. C: voluntary back belt on request and new hire training session on proper lifting and back belt use.
Supervisor practices	Zohar, 2002	M	randomized field trial	Both	$I_{1:}$ during the 3-month period prior to the experiment, baseline rates of safety-oriented supervisory interactions and microaccidents were established and feedback was provided to supervisors. C: received same interviews as I_1 but supervisors not provided with feedback.

QA=Quality assessment
H=high
M=medium

I=intervention group
C=control group

Appendix L: Study description

*key to all abbreviations appears at end of table

Intervention category	Author, year	Country	Industry/Sector	Job titles	Sample size	Loss to follow-up	Length of observation
Arm supports – office	Lintula, 2001	Finland	NP*	Office employees and researchers	I_1 n=7, I_2 n=7, C n=7	NP	6 weeks
Bricklaying method	Luijsterburg, 2005	Netherlands	Construction	Brick Layers	I_1 n=44, C n=158	NP	10 months
Data entry devices - office	Swanson, 2006	US	Office - Insurance	Word processing, claims	I_1 n=94, C n=95	NP	1 year
Data entry devices - office	Tittiranonda, 1999	US	Lawrence Livermore National Laboratory	Professional, scientific or technical services	I_1 n=20, I_2 n=20, I_3 n=20, C n=20	I_1 n=1, I_2 n=9, I_3 n=1, C n=0	24 weeks
Data entry devices, arm supports - office	Rempel, 2006	US	Customer service centre sites (sites A and B) of a large healthcare company	Registered nurses, healthcare specialists (operating as customer service operators)	I_1 n=45, I_2 n=46, I_3 n=45, C n=46	I_1 n=4, I_2 n=1, $I_{3\ n}$= 4, C n=1	12 months
Ergonomic training - office	Peper, 2004	NP	Metropolitan University	NP	I_1 n=16, C n=12	NP	6 weeks
Ergonomic training	Daltroy, 1997	US	Postal	Mail handlers, maintenance workers & clerks	I_1 n=1703, C n=1894	NP	5.5 years
Ergonomic training	Greene, 2005	US	State university	Office workers	I_1 n=43, IC_1= 44	NP	2 weeks
Ergonomic training - multi	Faucett, 2002	US	Office and assembly	Engineers and telemarketers	I_1 n=46, I_2 n=46, C n=47	I_1 n=14, I_2 n=9, C n=6	72 weeks
Ergonomic training - office	Bohr, 2000 (and Bohr, 2002)	US	Centralized reservation center	Reservation agents	I_1 n=50, I_2 n=51, C n=53	I_1 n=12, I_2 n=12, C n=6	12 months
Ergonomic training, chair - office	Amick, 2003	US	State dept of revenue services	Sedentary computer-intensive jobs	I_1 n=87, I_2 n=52, C n=53	I_1+I_2+C n=24	12 months

Intervention category	Author, year	Country	Industry/Sector	Job titles	Sample size	Loss to follow-up	Length of observation
Exercise - construction	Ludewig, 2003	US	Construction	Journeymen	I_1 n=34, C_1 n=32, C_2 n=25	I_1 n=4, C_1 n=1, C_2 n=2	4 weeks
Exercise - workplace	Sjogren, 2006	Finland	Departments in city central administration	Office workers	I_1 n=21, IC_1 n=15	I_1 n=2, IC_1 n=1	15 weeks
Exercise, ergonomic Training	Dehlin, 1981	Sweden	Geriatric Hospital	Nursing aides	I_1 n=15, I_2 n=14, C n=16	I_1 n=2, I_2 n=3, C n=1	NP
Hearing protectors	Erlandsson, 1980	Sweden	Shipyard (assembly and boiler shop)	NP	I_1 n=30, C n=20	NP	3 years
Loss control	Nave, 2004	US	Small and Medium Companies	Not relevant - based on employers	I_1 n=82, C n=45	I_1 n=0, C n=0	18 months
New office	Nelson, 1998	US	Office	Clerical, administrative, and professional support	I_1 target n=1616, matched n=577, C target n=187, matched n=55	I_1 n=682	12 months
Participatory ergonomics - mfg	Laing, 2005	Canada	Automotive Mfg	NP	I_1 n=44, C n=39	NP	10 months
Policy (employer-level)	Rosenblum, 2006	US	Drywall distributor	Driver, helper and combination of driver/helper	I_1 n=503, C n=1423	NP	33 months
Policy (employer-level)	Wassell, 2000	US	Combination supermarket and merchandise	Receiver, unloader, stocker, department manager	I_1 n=5178, C n=4180	I_1 n=1770, C n=1292	6.5 months
Programs (regulatory)	Mancini, 2005	Italy	Factories	Metal workers, construction workers, and ceramic/wood workers	NP	NP	15 years
Programs (regulatory)	Bell, 2006	US	Timber	Fellers, etc.	I_1 n=36 (4 yrs), C n=NP	NP	4 years

Intervention category	Author, year	Country	Industry/Sector	Job titles	Sample size	Loss to follow-up	Length of observation
Programs (regulatory)	Feinauer, 1993	US	Wisconsin - business that pay workers comp.	NP	NP	NP	NP
Programs (regulatory)	Nelson, 1997	US	Construction employers	Multi - industrial, construction, service	I_1 n=784, C n=8301	NP	5 years
Programs (regulatory), Policy (employer-level)	Hager, 1982	US	Western Electric Works	(for intervention group jobs not specified) control group = stock clerks, shipping & receiving clerks, forklift drivers	I_1 n=24, I_2 n=22, I_3=NP, I_4=37, C n=24	NP	10 years
RTW/DM	Durand, 2001	Canada	University hospital based work rehabilitation facility	Multi	I_1 n=28, C_1=49, C_2=49, C_3=21	I_1=NP, C_1 n=15, C_2 n=0, C_3 n=3	16 months
RTW/DM	Loisel, 2002	Canada	Manufacturing, services, healthcare	Multi	I_1 n=31, I_2 n=22, I_3 n=25, C n=26	NP	6.4 years
RTW/DM	Jensen, 2005	Denmark	Elder care wards in home care, sheltered housing & nursing homes	Homecare workers, nurses, nurses' aids	I_1 n=54, I_2 n=49, I_3 n=63, C n= 97	I_1 n=68, I_2 n=45, I_3 n=48, C n=0	3 years
RTW/DM	Staal, 2004 (and Hlobil, 2005)	Netherlands	Airport	Passenger services, engineering and maintenance, cargo, cabin, cockpit, etc.	I_1 n=67, C n=67	I_1 n=3, C=NP	6 months
RTW/DM	Arnetz, 2003	Sweden	Multi	Blue collar & white collar	I_1 n=65, C n=72	NP	12 months
RTW/DM	Greenwood, 1990	US	Underground coal mining	NP	I_1 n=121 claims to 117 workers, C n=163 claims for 161 workers	NP	18 months

Intervention category	Author, year	Country	Industry/Sector	Job titles	Sample size	Loss to follow-up	Length of observation
RTW/DM	Brown, 1992	US	Municipal	Sanitation, police, engineering etc.	I_1 n=70, C n=70	NP	2.5 years
RTW/DM	Feuerstein, 1993	US	Center for Occupational Rehabilitation	NP	I_1 n=19, C n=15		17 months
Safety training	Sinclair, 2003	US	Food service companies	Managers and line employees	I_1 n=30 units, C n=64 units	NP	3 months
Skin care training - HC	Loffler, 2006	Germany	Nursing Schools - healthcare	Nurses (students)	I_1+C n=521	I+C n=196	18 months
Supervisor practices	Zohar, 2002	Israel	Maintenance center specializing in repair	Supervisors and line workers	I+C n=397	NP	40 weeks
Supervisor practices	Shaw, 2006	US	Food processing plant	Supervisors	IC_1 n=400, IC_2 n=400	NP	14 months
Training - manual lifting	Tuchin, 1998	Australia	Mailing house	NP	I_1 n=34, C_1 n=27, C_2 n=60	I_1 n=0, C_1 n=0, C_{+G14} n=0	6 months
Training - manual lifting	Fanello, 2002	France	Hospital	cleaning staff, nursing assistants and male and nurses	I_1 n=136, C n=136	I_1 n=10, C n=21	2 years
Training - manual lifting	Jensen, 2006	Sweden	np	Blue collar & service/care workers	I_1 n=53, I_2 n=49, C n=61	NP	2 years
Training & equipment - forklifts	Shinozaki, 2001	Japan	Copper-smelter plant	Forklift truck operators, blue-collar workers, white collar workers	I_1 n=27, C_1 n=233, C_2 n=55	I_1 n=8, C_1=NP, C_2=NP	24 months
Workstation adjustment - office	Psihogios, 2001	NP	Software company	Software developers, quality assurance analysts, managers and technical support	I_1 n=8, I_2 n=8, C_1 n=2, C_2 n=2	NP	4 weeks
Workstation adjustment - office	Gerr, 2005	US	Office	Computer users - insurance, financial, food producers and universities	I_1 n=121(ah) &126(ns), I_2 n=130(ah) & 122(ns), C n=119(ah) &113(ns)	I_1 n=83(ah) & 90(ns), I_2 n=89(ah) & 85(ns), C n=87(ah) & 84(ns)	6 months

Intervention category	Author, year	Country	Industry/Sector	Job titles	Sample size	Loss to follow-up	Length of observation
Workstation adjustment & ergonomic training - office	Martin, 2003 (and Gatty, 2004)	US	College	Clerical, Office	I_1 n=7, C n=8	I_1 n=0, C n=1	5 weeks
Workstation adjustment & ergonomic training – office	May, 2004	US	Municipal offices	Clerical employees	I_1 n=61, C n=26	NP	8 months
Workstation adjustment & ergonomic training - office	Robertson, 2003	US	Office	Partner, associate partner, manager, consultant/specialist, analyst, assistant	I_1 n=494; I_2 n=45, C_1 n=94	I_1=NP, I_2 n=15 (laid off), C=NP	3 months

NP=not provided
I=intervention group
C=control group

Appendix M: Effects table

*key to all abbreviations appears at end of table

Intervention category	Author, Year	QA*	Effect (positive, no, negative) on: injury/illness outcomes[A]	Effect (positive, no, negative) on: loss control/disability management outcomes[A]
Arm supports - office	Lintula, 2001	M	**no** effect (I_1 vs I_2 and I_1, I_2 vs C) on the neck/shoulder/arm region	
Bricklaying method	Luijsterburg, 2005	M	**no** effect (I_1 vs C) on MSK symptoms	
Data entry devices - office	Swanson, 2006	M	**positive** effect (I_1 vs C) for left shoulder symptoms **no** effect for neck, right shoulder, arms, hands or back symptoms	
Data entry devices - office	Tittiranonda, 1999	M	**positive** effect (I_3 vs C) on arm/hand symptoms or change in overall pain severity **no** effect (I_1, I_2 vs C) on arm/hand symptoms or change in overall pain severity	
Data entry devices, arm supports - office	Rempel, 2006	H	**Arm support**: **positive** effect (arm supports vs no arm supports) on neck/shoulder pain and disorders or right upper extremity pain. **No** effect on left upper extremity pain. **No** effect (arm supports vs no arm supports) on days of pain medication use **Pointing device**: **positive** effect on left upper extremity pain and disorders. **No** effect (trackball vs mouse) on neck/shoulder pain and disorders or right upper extremity pain. **No** effect (trackball vs mouse) on days of pain medication use	
Ergonomic training - office	Peper, 2004	M	**positive** effect (I_1 vs C) on head, neck/shoulder, arms, wrists/hands symptoms or overall tiredness **no** effect (I_1 vs C) on back, leg or eye symptoms	

Intervention category	Author, Year	QA*	Effect (positive, no, negative) on: injury/illness outcomes[A]	Effect (positive, no, negative) on: loss control/disability management outcomes[A]
Ergonomic training	Daltroy, 1997	M		**no** effect (I_1 vs C) for time off work or median costs
Ergonomic training	Greene, 2005	M	**no** effect (I_1 vs C) on symptoms of upper back or upper extremities	
Ergonomic training - multi	Faucett, 2002	H	**no** effect (I_1, I_2 vs C) at 72 weeks on symptoms	
Ergonomic training - office	Bohr, 2000 (and Bohr, 2002)	H	**positive** effect (I_1 vs C) on upper body pain/discomfort or total body pain/discomfort **no** effect (I_2 vs C) on upper body pain/discomfort or total body discomfort **no** effect (I_1, I_2 vs C) on lower body pain/discomfort	
Ergonomic training, chair - office	Amick, 2003	H	**Training**: **no** effect (I_2 vs C) on total body symptoms or symptom growth **New Chair**: **positive** effect (I_1 vs C) on total body symptoms or symptom growth	
Exercise - construction	Ludewig, 2003	M	**positive** effects (I_1 vs C_1 and C_2) for pain or disability	
Exercise - workplace	Sjogren, 2006	M	**positive** effect (I_1 vs C) for low back symptoms	
Exercise, ergonomic training	Dehlin, 1981	M	**no** effect (I_1 vs C) for intensity, duration or frequency of low back pain/symptoms **no** effect (I_2 vs C) for intensity, duration or frequency of low back pain/symptoms	
Hearing protectors	Erlandsson, 1980	M	**no** effect (I_1 vs C) that ear plugs are better than ear muffs	

Intervention category	Author, Year	QA*	Effect (positive, no, negative) on: injury/illness outcomes[A]	Effect (positive, no, negative) on: loss control/disability management outcomes[A]
Loss control	Nave, 2004	M		**positive** effect (I_1 vs C) for number of claims or claim costs
New office	Nelson, 1998	M	**no** effect (I_1 vs C) on hand/arm symptoms, leg symptoms or neck/shoulder symptoms	
Participatory ergonomics - mfg	Laing, 2005	M	**no** effect (I_1 vs C) for pain severity levels	
Policy (employer-level)	Rosenblum, 2006	M	**positive** effect (I_1 vs C) MSD injuries and lower injury costs **no** effect (I_1 vs C) for non-MSD injuries	
Policy (employer-level)	Wassell, 2000	M	**no** effect (I_1 vs C) on injury rates or back pain	
Programs (regulatory)	Bell, 2006	M	**no** effect (I_1 vs C (non-participating companies) for worker comp. claim rates at 4 yrs	
Programs (regulatory)	Feinauer, 1993	M	**no** effect (I_1 vs C) for reducing injury/illness rates	
Programs (regulatory)	Mancini, 2005	M	**positive** effect (I_1 vs C_1 and C_2) for eye injuries	
Programs (regulatory)	Nelson, 1997	M	**positive** effect (I_1 vs C) on injury claim rates	
Programs (regulatory), Policy (employer-level)	Hager, 1982	M	**Policy: positive** effect (I_2, I_3 vs C_1 at 10 years) for hearing level index **Policy: negative** effect (I_1 vs C_1 at 10 years) for hearing level index **Policy**: **positive** effect (I_1 vs I_2 & I_3) for hearing level index **Program**: **no** effect (I_4 vs C_1 at 5 years) for hearing level index	

Intervention category	Author, Year	QA*	Effect (positive, no, negative) on: injury/illness outcomes[A]	Effect (positive, no, negative) on: loss control/disability management outcomes[A]
RTW/DM	Arnetz, 2003	M		**positive** effect (I_1 vs C) for mean sick days, total reimbursement or RTW
RTW/DM	Brown, 1992	M	**positive** effect (I_1 vs C) for injuries	**no** effect (I_1 vs C) in terms of time or cost
RTW/DM	Durand, 2001	M		**positive** effect (I_1 vs C_1, C_3) on RTW **no** effect (I_1 vs C_2) on RTW
RTW/DM	Feuerstein, 1993	M		**positive** effect (I_1 vs C) for return to work
`RTW/DM	Greenwood, 1990	M		**no** effect (I_1 vs C) on RTW, days off work, disability paid, medical paid, litigation rates or number of hospitalizations
RTW/DM	Jensen, 2005	H	**no** effect (I_1, I_2, I_3 vs C) for days absent	**positive** effect (I_3 vs C) for RTW **no** effect (I_1, I_2 vs C) for RTW
RTW/DM	Loisel, 2002	M		**positive** effect (I_1, I_2, I_3 vs C) for cost benefits
RTW/DM	Staal, 2004 (and Hlobil, 2005)	H	**no** effect (I_1 vs C) at 12 mths for functional status or pain	**positive** effect (I_1 vs C) at 12 months for RTW

Intervention category	Author, Year	QA*	Effect (positive, no, negative) on: injury/illness outcomes[A]	Effect (positive, no, negative) on: loss control/disability management outcomes[A]
Safety training	Sinclair, 2003	M	**no** effect (I_1 vs C) on injury claim rates	
Skin care training – HC	Loffler, 2006	M	**positive** effect (I_1 vs C) on skin condition or skin disease	
Supervisor practices	Shaw, 2006	M	**positive** effect (I_1 vs C) on types of injuries	
Supervisor practices	Zohar, 2002	M	**positive** effect (I_1 vs C) for minor injury rate	
Training - manual lifting	Fanello, 2002	M	**positive** effect (I_1 vs C) for low back pain or rate of new back pain cases	
Training - manual lifting	Jensen, 2006	H	**no** effect (I_1, I_2 vs C) for low back pain	
Training - manual lifting	Tuchin, 1998	M		**positive** effect (I_1 vs C_2) for costs of injury at 3 and 6 mths **no** effect (I_1 vs C_1) for cost at 3 mths
Training & equipment - forklifts	Shinozaki, 2001	M	**no** effect (I_1 vs C_1, C_2) at 1 year for low back pain	
Workstation adjustment - office	Gerr, 2005	H	**no** effect (I_1, I_2 vs C) for neck/shoulder or arm/hand	
Workstation adjustment - office	Psihogios, 2001	M	**no** effect (I_1 vs C) on body part or visual discomfort or headache	

Intervention category	Author, Year	QA*	Effect (positive, no, negative) on: injury/illness outcomes[A]	Effect (positive, no, negative) on: loss control/disability management outcomes[A]
Workstation adjustment & ergonomic training - office	Martin, 2003 (and Gatty, 2004)	H	**positive** effect (I_1 vs C) at 16 weeks on elbow/forearm symptoms or headache intensity	
Workstation adjustment & ergonomic training - office	May, 2004	M	**positive** effect (I_1 vs C) for upper back pain **no** effect (I_1 vs C) for overall body pain	
Workstation adjustment & ergonomic training - office	Robertson, 2003	M	**Adjustment & Training** - **positive** effect (I_2 vs C) for MSDs **Adjustment Only** - **no** effect (I_1 vs C) for MSDs	

A = the primary intervention effect is bolded and underlined for each study

QA=quality assessment
H=high
M=medium

I=intervention group
C=control group