December 2008

Effectiveness and implementation of health and safety in small enterprises:

A systematic review of quantitative and qualitative literature

Institute for Work & Health
Research Excellence Advancing Employee Health

sharing best evidence

About this report:

Authors: Ellen MacEachen, Ph.D.[1,2], Curtis Breslin, Ph.D.[1,2,3], Natasha Kyle, M.Sc.[1], Emma Irvin[1], Agnieszka Kosny, Ph.D.[1,2], Phil Bigelow, Ph.D.[1,4], Quenby Mahood[1], Krista Scott-Dixon, Ph.D.[1], Sara Morassaei[1], Marcia Facey, Ph.D.[1,2], Lori Chambers[1,5], Rachel Couban[1], Harry Shannon, Ph.D.[1,6], Kimberley Cullen, M.Sc.[1,7] and Benjamin C. Amick III, Ph.D.[1,8,9]

[1] Institute for Work & Health, Toronto, Canada
[2] University of Toronto, Dalla Lana School of Public Health, Toronto, Canada
[3] Seneca College, Toronto, Canada
[4] University of Waterloo, Health Studies & Gerontology, Waterloo, Canada
[5] University of Toronto, Department of Social Work, M.S.W. student, Toronto, Canada
[6] McMaster University, Clinical Epidemiology & Biostatistics, Hamilton, Canada
[7] University of Guelph, Ph.D. student department of Human Health and Nutritional Sciences, Guelph, Canada
[8] University of Texas, School of Public Health, Division of Environmental & Occupational Health, Houston, Southwest Center for Occupational & Environmental Health, Houston, TX, U.S.A.
[9] University of Texas, School of Public Health, Division of Health Promotion & Behavioral Sciences, Houston, TX, U.S.A.

Acknowledgements
The authors wish to thank: Lisa Brosseau for her expert advice; Kiera Keown and Anita Dubey for their editorial advice and Kiera for her Stakeholder relations; and Shanti Raktoe for administrative support.

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

Institute for Work & Health
481 University Avenue, Suite 800
Toronto, Ontario, M5G 2E9

E-mail: info@iwh.on.ca

Or you can visit our web site at www.iwh.on.ca

Please cite this report as: MacEachen E, Breslin C, Kyle N, Irvin E, Kosny A, Bigelow P, Mahood Q, Scott-Dixon K, Morassaei S, Facey M, Chambers L, Couban R, Shannon H, Cullen K, Amick B. Effectiveness and implementation of health and safety programs in small enterprises: A systematic review of qualitative and quantitative literature. Toronto: Institute for Work & Health; 2008.

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 group has the expertise to perform mixed method reviews of both qualitative and quantitative studies.

- 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 Institute staff members participated in this systematic review. External reviewers in academic and workplace leadership positions also 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, 2008

Summary

Objective

Small businesses play an important role in the economy. Over half of the labour force in the Canadian private sector is employed in small firms. However, there are challenges to delivering occupational health and safety (OHS) support to small businesses. Although workplace fatality rates are frequently higher in industries dominated by small businesses, an accident at any one firm is relatively rare. This relative invisibility of risk in small firms is compounded by the economic instability of small firms. These create challenges in workplace health education, surveillance and interventions.

This systematic review was conducted to identify effective occupational health and safety interventions and implementation directions for small businesses. The overall research question addressed by this systematic review was: "What understandings, processes and interventions influence OHS in small businesses?" Sub-questions were: "Do OHS interventions in small businesses have an effect on OHS outcomes?" and "How do small business workplace parties understand and enact processes related to OHS?"

Methods

A previous scoping review of peer-reviewed literature on work and health in small businesses indicated that adequate literature was available for a mixed method systematic review. The scope and focus of this systematic review was designed with stakeholder consultation. The review focused on small businesses with 100 or fewer employees, on peer-reviewed literature in a broad range of languages, and was not limited by publication date. It examined qualitative studies and quantitative studies. Multidisciplinary research teams with diverse methodological specialties assessed the quality of all relevant articles and extracted data from studies assessed as medium or high quality. This extracted data was then synthesized.

Results

During this systematic review, an initial literature search yielded 5,067 articles. Once these articles were screened for relevance, the review included 20 qualitative articles and 23 quantitative articles. The quantitative literature search focused only on intervention studies. The qualitative literature search was not restricted. After quality assessment, 14 qualitative and five quantitative intervention articles proceeded to data extraction and evidence synthesis.

Quality assessment findings point to directions for improving the quantitative and qualitative literatures on this topic, and show substantive gaps in the literature.

The quantitative literature addressed the question, "Do OHS interventions in small businesses have an effect on OHS outcomes?" Overall, this synthesis found a moderate level of evidence for intervention effectiveness, and found no evidence that any intervention had adverse outcome effects. Specifically, there was a limited amount of evidence for the benefits of a combination of training and safety audits, and for a combination of engineering, training, safety audits and motivational components. There was moderate evidence that the interventions had a positive effect on safety attitudes and beliefs.

The qualitative literature addressed the question: "How do small business workplace parties understand and enact processes related to OHS?" The evidence synthesis showed that small firms could lack knowledge of OHS rules and approaches, and they didn't have formal processes for addressing workplace health issues. In addition, policies and information weren't always relevant to their situations. Informal working relationships in small businesses could lead both employers and workers to underestimate work hazards. Workplace health approaches in small businesses could be focused on individual worker strategies for avoiding risk rather than on strategic workplace health initiatives.

The synthesis of quantitative and qualitative literatures suggests that small businesses might:

- require support for understanding OHS rules and approaches.
- require occupational health support that considers the personal social working relationships in small firms, which can prompt an overlooking of hazards.
- require finely tailored workplace health support that considers issues related to sector, size (e.g. affordability, informal task division) and jurisdiction (e.g. cultural norms, legislative requirements).
- benefit from multi-component interventions involving safety audits and training.

Conclusions

Even though there were few studies that adequately evaluated small business interventions, there are several health and safety practices to consider in small businesses. These include training and safety audits, and a combination of engineering, training, safety audits and motivational components. The qualitative literature showed that small businesses have limited understandings of OHS responsibilities and hazards. It also revealed how the informal working relationships and flexible processes that characterize small businesses affect the way these workplaces approach health and safety.

1.0 Introduction

Small businesses play an important role in the economy. As of 2006, these businesses, defined as those with fewer than 100 employees, employed approximately five million individuals in Canada. This equals 48 percent of the total labour force in the private sector. These firms make up 97 percent of goods-producing businesses and 98 percent of all service-producing businesses in Canada (1).

Workplace fatality rates are frequently higher in industries dominated by small workplaces (2, 3). There are unique challenges in designing occupational health and safety (OHS) interventions for small businesses. Although accident rates are clear in small business sector statistics, the issue is not obvious to employers as accidents are relatively rare in any one workplace. Another challenge is the relative instability of small businesses. A phenomenon of "churning" in this sector involves the entry and exit of firms in the economy (1). This instability creates a challenge in OHS education, surveillance and interventions, as efforts must be continually renewed as new firms emerge. Also, as small businesses are often financially fragile, occupational health investments may be unattractive to owners because the financial benefits of prevention are not obvious in the short term (2,3).

Models developed for larger corporations have proven to be largely ineffective for small businesses, showing that small firms should not be treated as "small" large organizations (4). At the same time, the uniqueness of small businesses is evident in policy flexibility and OHS exemptions for them. For instance, most firms in Ontario with 20 employees or fewer are exempt from the requirement to have Joint Health and Safety Committees. In the United States, federal and state standards and regulations have traditionally not applied to, or have been modified for small businesses, and these firms have been exempt from some record-keeping requirements (7).

Small businesses have a significant role in the economy and unique OHS challenges. This leads to questions about how they understand and manage OHS, and which interventions influence workplace health outcomes. This systematic review examines the existing knowledge about these issues by integrating observations from qualitative and quantitative studies out of the international research literature. The knowledge from this systematic review contributes to identifying future intervention and implementation research directions, and to developing a foundation for knowledge transfer and exchange for employers, insurance companies, workers, unions and other stakeholders.

2.0 Methods

2.1 Background: Scoping review

In 2006, the Institute for Work & Health conducted a scoping review of the extent and scope of peer-reviewed scientific literature on work and health in small businesses. Six key themes were identified in the scoping review:

1. Characteristics of the management/organization of small businesses that bear on OHS.
2. Problems/issues around health insurance for workers in small businesses in the U.S.A.
3. OHS problems concentrated in small business sectors.
4. Problems with regulation, support and enforcement of OHS in small businesses.
5. Small business OHS problems in context of economic transformation and change.
6. Wellness and health promotion in small businesses.

Much of the literature identified in the scoping review showed that OHS-related educational materials, interventions and policy were geared to a model based on large organizations and that this model was not useful for small businesses. Themes one, three and four identified particular organizational features of small businesses that distinguished them from large organizations. These themes also suggested that small businesses had needs that required unique consideration from policy-makers and occupational health educators. These three themes, which are the most persistent and well represented in the small business OHS literature, directed the formation of this systematic review question.

This preliminary review showed that the volume and quality of both quantitative intervention and qualitative literature was sufficient to enable a mixed method systematic review to be undertaken on what understandings, processes and interventions influence OHS in small businesses.

2.2 The systematic review process

A team of 15 researchers was invited to participate in the systematic review. Some reviewers were identified based on their expertise in conducting epidemiologic or intervention studies. Others were recruited for their expertise in conducting qualitative research and meta-synthesis. Some were recruited for their experience in conducting systematic reviews. Members of the review team had backgrounds in industrial hygiene, biostatistics, clinical psychology, sociology, epidemiology and biomechanics.

The basic steps of the systematic review process are listed below. The review team used a consensus process for each step of the review:

- Formulate the review question and search terms.
- Hold a stakeholder workshop for feedback on the question.
- Identify articles expected in literature search from all review team members.
- Contact international content experts to identify key articles.
- Conduct literature search and pool articles with those submitted by experts.
- Review titles and abstracts: select studies for relevance, based on six screening criteria.
- Review full articles: select studies for relevance, based on six screening criteria.
- Divide full team into two subgroups: qualitative and quantitative.
- Conduct sub-team quality assessment and partial data extraction: assess quality of relevant quantitative articles with scoring on 22 criteria and of relevant qualitative articles using 17 criteria.
- Conduct sub-team data extraction: extract data from all relevant articles to compile data for tables for synthesis.
- Conduct partial data extraction on all quantitative and qualitative evidence meeting relevance requirements.
- Synthesize quantitative and qualitative evidence.
- Convene stakeholder meetings to review evidence synthesis and develop key messages.

The overall research question addressed by this systematic review is:

> "What understandings, processes and interventions influence OHS in small businesses?"

The sub-questions are:

> "Do OHS interventions in small businesses have an effect on OHS outcomes?"
>
> "How do small business workplace parties understand and enact processes related to OHS?"

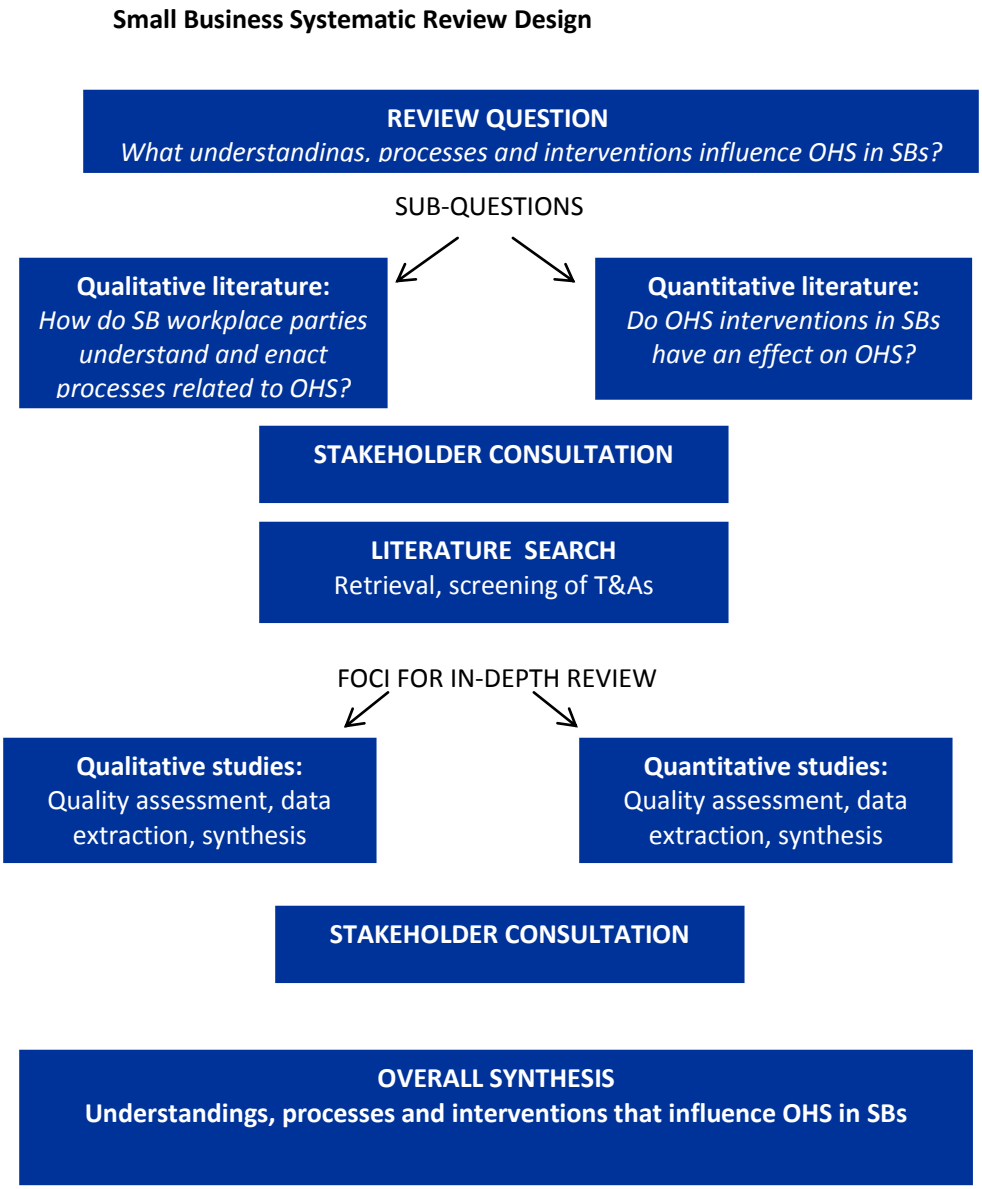

Figure 1: Flowchart of systematic review design

2.3 Definition of terms

Several terms from the overall review question as well as from the sub-questions were defined and used to develop the literature search criteria.

Workplace: Workplaces were limited to those locations that employed teenagers (15 years or older) and/or adults. We excluded military installations from the review as we believed the sites were unique and findings would be difficult to generalize to other workplaces. Laboratory studies were also excluded.

Small: A review of official definitions of "small" as used by Canadian policy-makers yielded a variety of possibilities, as per Figure 2 below. We defined small workplaces as those with 100 or fewer employees. Our definition was based on consultation with stakeholders, the definitions reported in Figure 2, and observations from the scoping review that the definition of "small" could vary from three to 250.

Industry Canada: "The size of a business can be defined in many ways, by the value of its annual sales or shipments, for example, or by its annual gross or net revenue, the size of its assets or the number of its employees. Many institutions define small businesses according to their own needs: the Canadian Bankers' Association classifies a company as 'small' if it qualifies for a loan authorization of less than $250,000, while the Export Development Corporation defines small or 'emerging' exporters as firms with export sales under $1 million. Industry Canada has often used a definition based on the number of employees: goods-producing firms are considered 'small' if they have fewer than 100 employees, while for service producing firms the cut-off point is seen as 50 employees. Above that size, and up to 499 employees, a firm is considered medium-sized. The smallest of small businesses are called micro-enterprises, most often defined as having fewer than five employees. The term 'SME' (for small and medium-sized enterprise) is used to refer to all businesses with fewer than 500 employees, while firms with 500 or more employees are classified as 'large' businesses" (1).

Workplace Safety and Insurance Board (WSIB): The WSIB currently defines small business as those with fewer than 20 employees (8).

Figure 2: Definition of small business

Intervention: A planned systematic program or strategy aimed at reducing occupational health problems, including programs focusing on education to workplace staff and/or programs focusing on general organizational factors.

Occupational health: The focus was primarily on unintentional non-fatal and fatal injuries. We included studies examining acute/traumatic injuries (e.g. cuts, burns, fractures) as well as those that focused on musculoskeletal

injuries (e.g. low-back pain). Other occupational health outcomes included were work-related injuries, symptoms, disorders, occupational disease and work absence.

Behaviour: We included behavioural outcomes such as safety practices. These included compliance with personal protective equipment use such as hard hat use, safety behaviours, gloves, safety glasses, safety (steel-toed) shoes, hearing protection, fall protection, respiratory protection, housekeeping (cleaning workspace), safety inspections, guards, near misses, fire protection and fire safety.

Language: The review team considered peer-reviewed scientific articles published or in press in English, Spanish, Italian, French, Portuguese and German. Language proficiency of team members was the primary reason for language exclusions. Book chapters, dissertations and conference proceedings were excluded as it was expected that key findings would be reported in the peer-reviewed literature.

2.4 Stakeholder Engagement

Two stakeholder workshops were held to solicit feedback on the systematic review design and findings. An initial stakeholder meeting was conducted in May 2007 to gather input on the research questions and search terms. As a result of this meeting, some search terms and inclusion/ exclusion criteria were modified. For instance, the decision was made to define "small" workplaces as those with 100 or fewer employees. Also, the review team agreed to gather descriptive details about all relevant articles including those not meeting quality criteria. A second stakeholder meeting was conducted near completion of the review in June 2008. This final meeting gave stakeholders an opportunity to provide feedback on preliminary findings and priority issues. Participants at these stakeholder meetings included representatives from Ontario's Workplace Safety and Insurance Board, the OHS Branch of the Ontario Ministry of Labour, and some of the Health and Safety Associations in Ontario (see Appendix A for list of participants).

2.5 Literature searches and selection of relevant articles

Nine databases of peer-reviewed scientific literature were searched from their inception to February 2008. The researchers used key terms and also reviewed known information sources such as content experts and reference lists. See Appendix B for list of search terms. The electronic databases were:

- MEDLINE
- EMBASE
- CINAHL
- PsychINFO
- Sociological Abstracts

- ASSIA (Applied Social Sciences Index and Abstracts)
- ABI (American Business Index) Inform
- EconLit
- Business Source Premier.

The search strategy was broad and was limited by language in databases where possible. Articles in non-included languages were excluded at the next stage at title and abstract screening. Articles not already captured by our search strategy, such as those identified by content experts and from reference lists, were retrieved for review until July 2008 (see Appendix C for list of experts).

Inclusion and exclusion criteria were established (see Table 1). Small businesses were defined as those with 100 or fewer employees. Workplaces included those employing youth and adults (but not solely youth) and excluded military sites as these were considered to be atypical of small businesses. Studies were included if they had an analytic focus on the functioning of work and health in small businesses, rather than indirect findings, for instance, that business size was a risk factor for occupational accidents. Studies were also identified by methodology (qualitative or quantitative) and for intervention design.

Table 1: Inclusion/exclusion criteria for title and abstract review and in-depth full article review

Questions	Response Options				Comments
1. Is this a peer-reviewed study (including articles in press or accepted for publication)?	YES	NO		UNCLEAR	If no, exclude
2. Does this study focus analytically on "small" businesses?	YES	NO		UNCLEAR	If no, exclude
3. Does this study include outcomes or findings regarding OHS, behaviour, exposure, cognition and/or work organization?	YES	NO		UNCLEAR	If no, exclude
4. Is this a conceptual article with no empirical data (e.g. opinion/editorial pieces, theoretical papers, narrative reviews, commentaries)?	YES	NO		UNCLEAR	If yes, exclude
5. This article includes the following methodology (check only one):	Qual	Quant	Mixed	Unclear	Not applicable

The titles and abstracts of each article were screened by team members for inclusion. In cases where there was insufficient information from this screening, full text articles were retrieved.

As the title and abstract review was conducted by single reviewers, a quality control check was conducted by a reviewer not involved in this process, to reduce the possibility of selection biases. Five per cent of the studies were reviewed for quality control. These were randomly chosen from sets of studies assessed by each of the eight reviewers. The sets of studies selected included an equal number of those that had passed and not passed inclusion screening. A minimum of 70 per cent level of agreement between the reviewers and the quality control reviewer was sought. If agreement was below this level, title and abstract screening would halt and the team would meet to identify areas of difference and to build consensus.

Each article that passed initial title and abstract screening criteria was then reviewed in full by two reviewers. To reduce bias, members of each pair were interchanged during the review process. A consensus method was used to resolve any disagreements between the two reviewers regarding study inclusion. When agreement could not be reached, a third reviewer was consulted. To assure comprehensive literature coverage, the reference lists of articles undergoing full review were also scanned for articles that might be included in the review.

After full article screening, the review team divided into two sub-teams by methodology and focus. One sub-team focused on all qualitative articles, and another sub-team focused on quantitative articles. Articles that passed inclusion criteria were categorized by method and focus, and then reviewed by the specialized sub-teams for final inclusion. Articles identified as mixed methods were assigned to both sub-teams. At this stage, verification of method, focus and inclusion criteria led to the exclusion of incorrectly sorted studies. Ambiguities in assessment were discussed by pairs of reviewers, and unresolved decisions about inclusion were made by sub-team consensus. For example, studies marked “qualitative” that were survey studies were excluded from the qualitative roster, and transferred to the quantitative team.

When studies passed inclusion criteria, they proceeded to quality assessment.

2.6 Quality assessment

The goal of quality assessment was to identify studies of sufficient quality to be included in the evidence synthesis. Each article was evaluated by pairs of team members using a quality review process specific to the foci of the methodological sub-teams. To reduce reviewer bias, reviewers were paired on an article by article basis to ensure each reviewer worked with multiple partners. Reviewers did not review articles that they authored or co-authored.

Studies were reviewed for *content* (i.e. what the study actually said) and *presence* (i.e. were the appropriate elements present or included in the study) (see Appendices D and E for quality assessment questions). Each pair of reviewers met to review quality assessment ratings and resolve differences in assessment through discussion and consensus. Unresolved differences between pair members were resolved through further discussion with the quantitative or qualitative team lead, and if necessary by the study team.

Where articles appeared to be essentially the same piece of work produced by the same authors, the group decided by consensus which article best represented the research conducted, and assessed the quality of only that article. Following the standard set by previous Institute for Work & Health systematic review groups, the evaluation team considered one study to be the "primary" study and others "secondary" studies, and grouped them together. If the study proceeded to data extraction, all relevant information was gathered from duplicate studies.

At the request of the stakeholders, we conducted a limited data extraction to identify certain features from all relevant studies, even those that did not meet quality criteria. (see Appendix F for data extraction form).

Quantitative studies (intervention effectiveness)

Each article was reviewed by two team members of the quantitative sub-team: a junior researcher paired with a senior researcher. Papers with engineering interventions were assigned to an industrial hygienist and a junior reviewer.

The quality of the quantitative studies was assessed on 22 criteria relating to design and objectives, recruitment level, intervention characteristics, intervention intensity, risk factors, confounders and analysis (Table 2). Each of the questions was given a weight on a three-point scale ranging from "not important" to "very important."

Table 2: Quality assessment questions and weight (quantitative studies)

Question	Weight
1. Were concurrent comparison groups used?	3
2. Were time-based comparisons used?	3
3. Was there a follow-up 3 or more months after the implementation of the intervention?	2
4. Was the intervention allocation described?	3
5. Was the intervention allocation random?	3
6. Was the research question clearly stated?	2
7. Was the recruitment rate reported?	2
8. Were pre-intervention characteristics described?	2
9. Did researchers report evaluating any differences across groups at pre-intervention?	2
10. Was the attrition rate reported?	2
11. Did they report checking for important differences between remaining and drop-out participants after the intervention?	2
12. Was the intervention described?	2
13. Was the process by which the intervention was selected/developed described?	1
14. Was participation in the intervention documented?	1
15. Was contamination between groups assessed/accounted for?	2
16. Was information on exposure sources ascertained pre AND post intervention?	2
17. Were measurement properties of outcomes described or cited?	2
18. Regarding engineering – what type of sampling exposure occurred (if applicable)?	2
19. Were the statistical analyses appropriate to the study design?	3
20. Was consideration given to power to detect intervention effect(s)?	1
21. Were any effect modifiers/confounders assessed in the analyses?	2
22. Was there adjustment for pre-intervention differences?	2

Sample size was not included as an explicit aspect of quality assessment because there were no clear criteria that would provide an empirically-supported threshold for what constituted a "sufficient" sample. This issue is especially complex because the number of firms (i.e. having a sufficient

sample size at the firm-level) is as or more important as the total number of employees across all firms (i.e. sample size at the individual level) (9).

The articles were rated based on methodological criteria developed by group consensus and piloted for inter-rater reliability. Quality categories of low, medium and high, based on the criteria, were established to determine which articles were of sufficient quality to continue to data extraction. The weighted criteria were used to develop a normalized quality score for each study. Quality categories were:

- high quality = 80 to 100% of the criteria are met
- medium quality = 50% to 79% of the criteria are met
- low quality = 0% to 49% of the criteria are met.

Studies of medium quality or higher proceeded to data extraction for inclusion in the review findings.

Qualitative studies (OHS understanding and processes)

Each article was reviewed by two members of the qualitative sub-team. The quality of studies was assessed using 17 criteria related to: methodology (study design, sampling and execution); analysis of data (theoretical approach, process, diversity in perspective, sensitivity to context); reporting (detail, depth and complexity); reflexivity (careful attention to the context in which research occurs); neutrality; and ethics. These criteria were adapted from those developed by Spencer et al. (2003). Spencer et al.'s criteria were based on literature reviews of qualitative research standards, methods used in evaluation studies, and existing frameworks for reviewing quality in qualitative research (10). They also based the framework on findings from in-depth interviews with commissioners and managers of research, policy-makers, research funders, and academics and practitioners involved in conducting qualitative research and writing about quality.

Table 3: Quality assessment questions (qualitative studies)
(adapted from Spencer et al. 2003)

1. How defensible (appropriate) is the research design?
2. How well defended is the sample design/target selection of cases?
3. How well was the eventual sample composition/case inclusion described?
4. How well was the data collection carried out?
5. How well was the approach to/formulation of the analysis conveyed?
6. How well was the context of data sources retained and portrayed?
7. How well has diversity of perspective and content been explored in the analysis?
8. How well has detail, depth and complexity (i.e. richness) of data been conveyed?
9. How clear are the links between data, interpretation and conclusions – i.e. how well can the routes to any conclusions be seen?
10. How clear and coherent is the reporting?
11. How clear are the assumptions/theoretical perspectives/values that shaped the form and output of the study?
12. What evidence is there of attention to ethical issues?
13. How adequately has the research process been documented?
14. How credible are the findings?
15. How has knowledge/understanding of small business and OHS been extended by the research?
16. How well does the study address its original aims and purpose?
17. How well was the scope for drawing wider inference about small business OHS explained?

Reviewers categorized studies as high, medium or low quality. Studies ranked as high quality provided good description, analytic detail and an explanatory framework. Studies ranked as medium quality provided good descriptive detail and analysis, but weaker explanatory or theoretical frameworks for the findings. Studies ranked as low quality provided weak description and evidence and/or had a major flaw in the design of the study. Studies ranked as medium quality or higher proceeded to data extraction for inclusion in the evidence synthesis. (See Table 4 for quality ranking of qualitative studies).

Table 4: Quality ranking table (qualitative studies)

High quality studies
Have explanatory value. Clearly describe and justify methods. Provide rich context. Clearly convey analysis process, clear links between the data and reported findings. Portray nuances and intricacies in the data, e.g. explanations for incongruent findings. Address relevant ethical issues and the effect the researcher might have had on the data collection and analytic processes.
Medium quality studies
Often descriptive in nature, rather than explanatory. Have some shortcomings related to the methodological approach, analytic process or reporting. For instance: • Not clear why a specific approach was best suited to address the research question. • Lack of rich background information about relevant contexts. • Lack of nuanced analysis of underlying factors and influences • Contradictory findings reported but not explained.
Low quality studies
Study is undermined by a major flaw in the way that the data was collected or during the analysis process. For instance: • Reporting is difficult to follow and inadequate. • Study design is poorly suited to the research question. • Data collection compromised by research process. • Analysis process poorly explained; incongruities between the data and the reported findings. • Ethical considerations and outside influences that might have shaped findings and the data collection not discussed.

2.7 Data extraction

The purpose of data extraction was to identify and extract information relevant to the review question to begin aggregating and synthesizing the collective evidence. Two reviewers independently extracted data from included studies and met to reach consensus. Members of each pair were interchanged during the review process. Partial data were extracted from all of the relevant studies. Full data were extracted from studies ranked by the review teams as medium or high quality.

Quantitative studies

Pairs of reviewers extracted data on: year of study, jurisdiction, study design and sample characteristics, intervention, the nature and characteristics of measures, statistical analyses, covariates/confounders and study findings (Table 5). During the data extraction process, reviewers reconsidered the methodological quality rating scores for each study. Any quality rating changes at this level were made with consensus from the entire review team.

Table 5: Data extraction items (quantitative studies)

1. Name the 1st author and year of publication.
2. State the research question(s)/objective(s).
3. List the inclusion criteria described in the study.
4. List the exclusion criteria described in the study.
5. Describe all interventions in the study.
6. Describe the process by which the intervention(s) was selected/developed (if any).
7. For studies with non-engineering components, what was the duration of the intervention in months/days/hours?
8. Indicate the time period between the baseline measurement and each follow-up period.
9. Describe the overall study group.
10. Describe the Intervention group(s).
11. Describe the Referent group(s).
12. When were potential covariates/confounders measured?
13. Provide a list of covariates/confounding variables that were controlled for in the final test of the intervention evaluation.
14. Provide a list of outcome variables used to evaluate intervention effectiveness.
15. If injury/claim rates were presented, how were they calculated (e.g. equation, type of denominator such as employee hours)?
16. Did the researchers discuss how they handled any special issues (e.g. turnover rate) related to outcome?
17. What changes were implemented as a result of the intervention (e.g. tasks, processes, organization)?
18. Mark the types of final analyses done to test the observed effects of the intervention.
19. Describe for each outcome, the observed intervention effect.
20. Were additional statistical analyses conducted to increase your confidence in the observed effect?
21. Remark on the findings or enter information that is unique about the study that may not be adequately captured in the other data extraction questions (e.g. power to detect effects).

Qualitative studies

Reviewers extracted data on: the research question, theoretical orientation of the study, study method, sampling strategy, participants, study context, analysis of data, reflexivity, study findings and how/why the findings were relevant to small business workplace parties understanding and enacting processes related to OHS (Table 6). The reviewers met to discuss their findings, and to reach agreement about overall data extraction elements.

Table 6: Data extraction items (qualitative studies)

A1. What is the research question?
B1. Provide the theoretical orientation of study (description given *or* unstated/implicit perspective) B2. What is the impact of theoretical perspective on method and findings (i.e. strengths, weaknesses, areas for enhancement)
C1. What is the impact of method on findings (i.e. strengths, weaknesses, areas for enhancement)
D1. Describe the unit of analysis: a) How many? b) Describe participants (workers, managers, employers, external resources, other) D2. How were they recruited? D3. What health problems and risks were examined?
E1. Give the author's description of how the analysis proceeded E2. Provide your comments on analysis scope, depth, integrity
F1. Summarize study findings (themes and key issues) F2. How does this paper contribute to the following concepts*: a) Constant comparison (comparing same construct); b) Refutation (contradictory findings); c) Line of argument (varied findings which, when pulled together, create a story)

* see Table 8 for a full explanation

Partial data extraction

For partial data extraction, which we did at the request of stakeholders, the information extracted included: study/sample location; workplace size and age; unionization; industry and occupation; study method and design; time frame in which study was conducted; sampling method and description; and intervention type (if applicable)

2.8 Evidence synthesis

Quantitative studies

Due to the high level of heterogeneity of the studies reviewed, the synthesis approach adapted from Slavin and others (6,7) known as "best evidence synthesis" was used. The best evidence synthesis approach considers the quality and quantity of the articles and the consistency of the findings among

the articles (Table 7). "Quality" refers to the methodological strength of the studies as discussed above. "Quantity" refers to the number of studies that provided evidence on the same health outcome. "Consistency" refers to the similarity of results observed across the studies on the same outcome. When studies reported on effects from multiple outcomes within a category (e.g. three attitude/belief measures), they were classified as an effect if even one of the measures showed a significant between-group difference.

Table 7: Best evidence synthesis guidelines

Level of Evidence	Minimum quality	Minimum quantity	Consistency
Strong	High (>80%)	>=3 studies	Three high quality studies agree. If more than three studies, ¾ of the medium and high quality studies agree.
Moderate	Medium (50-79%)	>=2 studies	Two high quality studies agree. OR Two medium quality studies and one high quality study agree. If more than three studies, more than ⅔ of the medium and high quality studies agree.
Limited	Medium (50-79%)	One high quality OR two medium quality OR one medium quality and one high quality	If two studies (medium and/or high quality), the studies agree. If more than two studies, more than ½ of the medium and high quality studies agree.
Partial	Low (0-49%)	>=2 studies	Findings from medium and high quality studies are contradictory.
Insufficient	No high quality studies, only one medium quality study, and/or any number of low quality studies.		

Qualitative studies

Findings from the qualitative studies were systematically reviewed and integrated using the general principles of meta-ethnography (14, 15).

The final synthesis was determined through a process of identifying concepts in studies, and grouping them into themes. Concepts were distinctive characteristics of each study that were relevant to our review question about work and health in small businesses.

We examined studies according to whether they were comparable (constant comparison), contradictory (refutation), or whether they resulted in inferences about the topic as a whole (line of argument) (Table 8).

Table 8: General principles of meta-ethnography

Constant comparison, or reciprocal translation, involves the comparison of similar or analogous concepts or findings, which may include continual refinement of a given concept. In this instance, the reviewer aims to identify the shared or comparable features of each study, with the intent to develop a cohesive whole in the final report.
Refutation identifies findings from a study that contradict or conflict with findings from other studies. The reviewer attempts to reconcile or account for the conflict.
The *line of argument* develops a narrative through layering, adding or "weaving together" various findings.

Overall, syntheses of qualitative studies will tend to contain some of each of these elements of comparison, refutation and lines of argument. However, depending on the final sample of studies, the synthesis will generally be dominated by one of the three principles. In this review, the final synthesis contained mainly "constant comparison" findings.

Concepts that were found in three or more studies were grouped into overarching themes. These themes were created through reciprocal translations of concepts considered in comparison to those in other studies (8).

Mixed method synthesis

Once findings from the quantitative and the quantitative literatures were synthesized, integrative and interpretive analyses were conducted (10). The "integrative" analysis involved examining qualitative and quantitative findings for basic comparability between phenomena. We examined how data might be *pooled and assembled*. For instance, we found that both literatures emphasized the role of behaviour and attitudes in small business workplace health. The "interpretive" analysis involved the development of a framework for how the qualitative and the quantitative data *connected and interacted*. Here, the focus was on how the findings complemented each other to provide a more comprehensive picture of work and health in small businesses. For instance, some quantitative intervention designs were

complex, with multiple components. The qualitative literature provided context on small business understandings and knowledge that supported the need for such intervention complexity. The mixed method synthesis was an iterative process involving all team members. The lead author consolidated the final synthesis.

3.0 Results

3.1 Literature search and relevance selection

We identified 5,067 articles in our literature search using the terms listed in Appendix B. This figure reflects the total number of articles obtained after different databases were merged, duplicate articles were removed, and any additional unique articles provided by content experts and identified by reviewers were included (Figure 3).

A total of 4,256 articles did not meet our inclusion criteria and were excluded during the title and abstract screening (Table 1). An additional 202 articles provided by content experts were excluded as they did not meet language inclusion criteria.

A total of 609 articles proceeded to full article screening. After this stage, 503 articles were excluded.

In total, 76 articles met the inclusion criteria and proceeded to the specialized sub-teams to be categorized by method (qualitative or quantitative) and for final inclusion. Of those, 43 were initially grouped as quantitative or mixed method interventions and 33 as qualitative or mixed method. Articles identified as mixed methods were assigned to both sub-teams. Verification of method and inclusion criteria led to the exclusion of incorrectly included studies. Of these 76 articles, eight were identified as mixed methods studies.

A total of 23 quantitative and 20 qualitative studies proceeded to partial data extraction. Five quantitative and 14 qualitative studies that met quality criteria proceeded to full data extraction and evidence synthesis.

FLOW CHART OF STUDIES

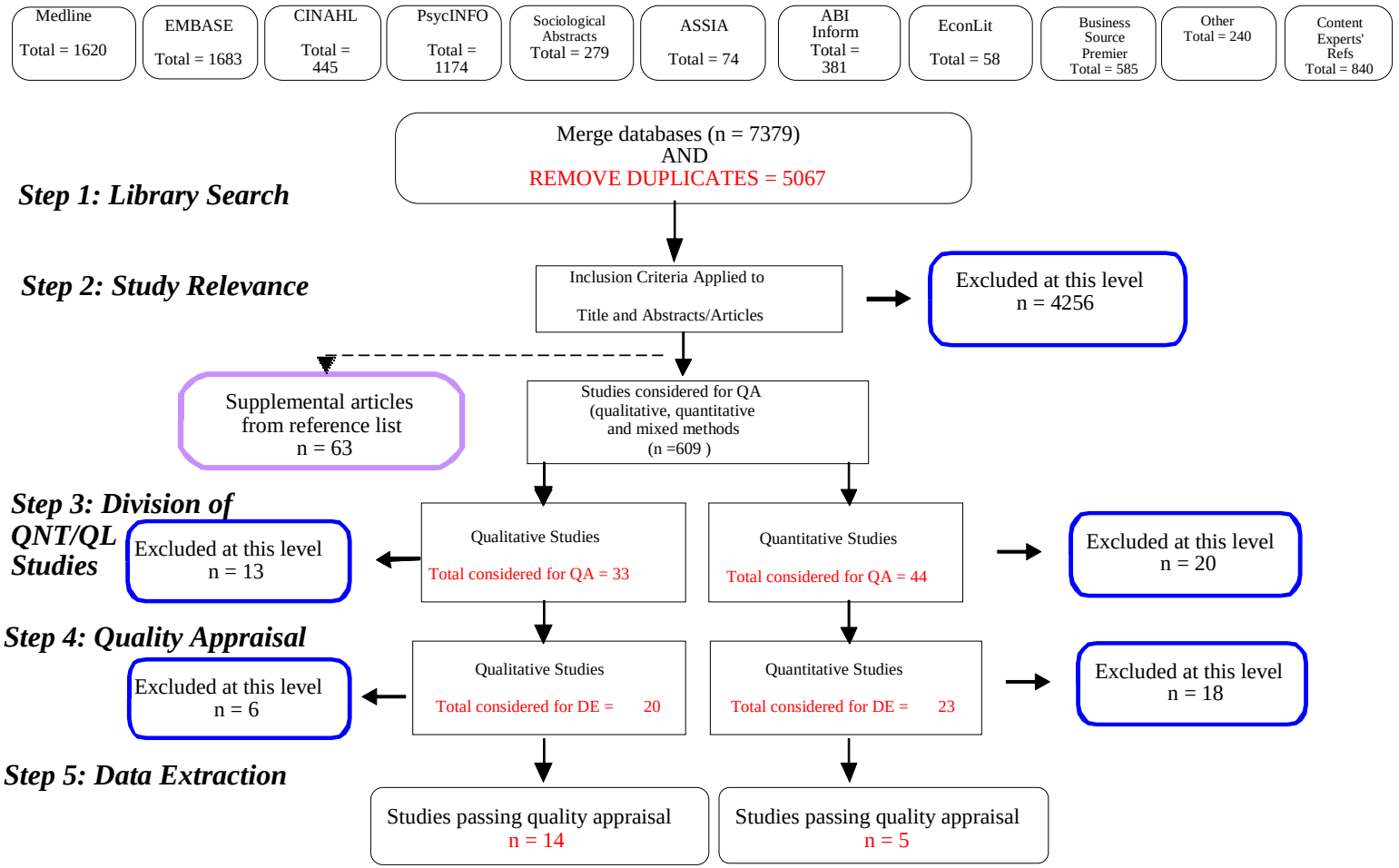

Figure 3: Flowchart of systematic review process

3.2 Overview of relevant studies

A partial data extraction was conducted on all studies passing relevance criteria. We gathered data on the study jurisdiction, business size, unionisation, occupation and sector. We also assessed the study design, method and intervention type.

We found 23 quantitative and 20 qualitative articles that were relevant to our research question. Of these, five quantitative intervention and 14 qualitative articles proceeded to full data extraction.

Relevant studies came from many jurisdictions. Most were from the United Kingdom, Australia and Canada. Other studies came from Europe, Asia, Africa and the United States. Studies from three jurisdictions proceeded to data extraction for quantitative articles; studies from seven jurisdictions proceeded to data extraction for qualitative articles (see Table 9).

The sizes of businesses in relevant articles were somewhat evenly distributed across the employee number ranges. Each article may have examined businesses of various sizes, ranging up to 100 employees. We categorized them as having strictly less than five, less than 20 and less than 50 employees. Fewer articles were found for the largest category of less than 100. The studies proceeding to full data extraction had a similar profile.

The quantitative articles did not provide information on unionization. Six qualitative articles provided information on unionization; all six proceeded to full data extraction.

The relevant studies included a focus on 10 sectors. The most common were: manufacturing, multiple sectors, other services and agriculture. Only four studies of the construction sector were identified.

The relevant quantitative studies included nine study designs. These included: prospective cohort, randomized controlled trial, time-series studies and pre-post test. The studies that met quality requirements and proceeded to full data extraction included only the pre-post test design. The relevant qualitative studies included nine study designs. These included semi-structured interviews, focus groups, participant observation and mixed methods. The studies proceeding to full data extraction included each of these methods.

The relevant quantitative articles used probability and convenience samples, with one “other” sample type, which was pre- and post-intervention with a different firm at each time point. The quantitative articles proceeding to full data extraction included these three approaches. The relevant qualitative articles used mostly theoretical and purposive samples. They also included key informant, random and medical exam sampling strategies. The

qualitative articles proceeding to full data extraction included all of these approaches except the medical exam sampling strategy.

The intervention types in the relevant quantitative articles included, in order of frequency, administrative techniques, "other" (e.g. support and advice; legislative and regulatory interventions; visits by occupational health professionals); engineering solutions; and engineering solutions combined with another type of intervention. Those proceeding to full data extraction did not include any "other" interventions.

A description of the relevant articles and those proceeding to full data extraction are in Table 9.

Table 9: Description of relevant studies

	QUALITATIVE STUDIES			QUANTITATIVE STUDIES		
	Total	**Included**	**Excluded**	**Total**	**Included**	**Excluded**
Yes	14	14	0	5	5	0
No	6	0	6	18	0	18
	20	**14**	**6**	**23**	**5**	**18**
Jurisdiction						
	Total*	**Included**	**Excl**	**Total***	**Included**	**Excluded**
Australia	3	2	1	5	0	5
Canada	5	5	0	0	0	0
Denmark	1	1	0	1	1	0
Finland	0	0	0	1	0	1
Germany	2	1	1	1	0	1
Italy	0	0	0	1	0	1
Korea	0	0	0	1	0	1
Nigeria	1	0	1	0	0	0
Norway	1	1	0	1	1	0
Sweden	1	0	1	0	0	0
Thailand	0	0	0	1	0	1
United Kingdom	7	5	2	3	0	3
United States	0	0	0	7	3	4
Not reported	0	0	0	1	0	1
	22	**16**	**6**	**23**	**5**	**18**

**total may be greater than total number of qualitative (QL)/quantitative (QN) studies since some papers covered multiple jurisdictions*

Size Range

	Total	Included	Excluded	Total	Included	Excluded
<5	2	1	1	2	1	1
<20	5	5	0	6	1	5
<50	6	6	0	4	1	3
<100	7	2	5	9	2	7
Total	**20**	**14**	**6**	**21**	**5**	**16**

**total may be greater than total number of QL/QN studies since some papers included multiple jurisdictions*

Business Age

	Total*	Included	Excluded	Total*	Included	Excluded
< 6 months	0	0	0	0	0	0
6-12 months	0	0	0	1	1	0
1-2 years	0	0	0	0	0	0
2-5 years	1	1	0	0	0	0
5-10 years	2	1	1	0	0	0
>10 years	0	0	0	1	0	1
Not provided	18	13	5	21	4	17
	21	**15**	**6**	**23**	**5**	**18**

**total may be greater than total number of QL/QN studies since some papers covered multiple jurisdictions*

Unionized

	Total	Included	Excl	Total	Included	Excluded
Yes	4	4	0	0	0	0
No	2	2	0	0	0	0
Not provided	14	8	6	23	5	18
	20	**14**	**6**	**23**	**5**	**18**

**total may be greater than total number of QL studies since some papers covered multiple jurisdictions*

Occupation(s) of sample						
	Total	**Included**	**Excluded**	**Total**	**Included**	**Excluded**
Mgmt occupations	5	2	3	1	1	0
Business, finance and administrative occupations	1	0	1	0	0	0
Natural and applied sciences and related occupations	1	1	0	0	0	0
Sales and service occupations	2	2	0	0	0	0
Trades, transport and equipment operators and related occupations	5	4	1	8	1	7
Occupations unique to primary industry	2	2	0	1	1	0
Occupations unique to processing, manufacturing and utilities	1	1	0	3	1	2
Multiple occupations (multi-occup stated)	4	2	2	0	0	0
Occupation not provided/not specified	4	4	0	10	1	9
	25	**18**	**7**	**23**	**5**	**18**
**total may be greater than total number of QL/QN studies since some papers covered multiple jurisdictions*						
Business Sector/Types						
	Total*	**Included**	**Excluded**	**Total***	**Included**	**Excluded**
Agriculture, forestry, fishing and hunting	2	2	0	1	1	0
Construction	4	3	1	0	0	0
Manufacturing	4	4	0	10	3	7
Retail trade	1	1	0	1	1	0
Professional, scientific and technical services	1	1	0	2	1	1
Administrative and support and waste mgmt & remediation services	0	0	0	1	0	1
Other services	2	2	0	6	1	5

Public administration	0	0	0	1	1	0
Multiple sectors (multi-sectors stated)	8	4	4	1	1	0
Industry sector not provided/not specified	1	0	1	6	0	6
	23	**17**	**6**	**29**	**9**	**20**

**total may be greater than total number of QL/QN studies since some papers covered multiple jurisdictions*

Study design

	Total	**Included**	**Excluded**	**Total**	**Included**	**Excluded**
Mixed method	8	4	4	1	0	1
	8	**4**	**4**	**1**	**0**	**1**

Study method

	Total*	**Included**	**Excluded**	**Total***	**Included**	**Excluded**
Unstructured interview	3	2	1	0	0	0
Semi-structured interview	12	9	3	0	0	0
Structured interview	4	2	2	0	0	0
Focus groups	2	2	0	0	0	0
Case study	1	1	0	0	0	0
Document review	3	3	0	0	0	0
Participant observation	2	2	0	0	0	0
Mixed methods (Enter description of methods used)	3	2	1	0	0	0
Other qualitative method	4	1	3	0	0	0
Prospective cohort study	0	0	0	1	0	1
Retrospective cohort study	0	0	0	0	0	0
Case-control study	0	0	0	1	0	1
Cross-sectional study	0	0	0	3	0	3
Randomized control trial	0	0	0	2	0	2

Non-randomized control trial	0	0	0	0	0	0
Pre/post test	0	0	0	12	5	7
Time series study with comparison group	0	0	0	1	0	1
Time series study without comparison group	0	0	0	3	0	3
Other quantitative method	0	0	0	0	0	0
	34	**24**	**10**	**23**	**5**	**18**

**total may be greater than total number of QL/QN studies since some papers used more than one method*

Sampling Strategy

	Total*	**Included**	**Excluded**	**Total***	**Included**	**Excluded**
Purposive/theoretical sampling	16	11	5	0	0	0
Key informant	5	3	2	0	0	0
Random	4	4	0	0	0	0
Snowball	1	1	0	0	0	0
Entire population	0	0	0	0	0	0
Probability sample	0	0	0	13	3	10
Convenience sample	0	0	0	7	1	6
Other sampling strategy (describe)	1	0	1	3	1	4
	27	**19**	**8**	**23**	**5**	**20**

**total may be greater than total number of QL/QN studies since some papers used more than one sampling strategy*

3.3 Quality assessment and study descriptions

Quantitative studies (intervention effectiveness)

The 23 studies that met our relevance criteria were assessed for methodological quality using 22 quality criteria (Table 10).

High quality studies

Two studies were of high quality (Lazovich et al. 2002, Rasmussen et al. 2003). The high quality studies were quite consistent in their methodological quality. Both met 17 of the 22 criteria. However, neither study reported checking for differences between remaining and drop-out participants after the intervention. Also, neither described "contamination" between groups. Contamination occurs when workers in a control group are exposed to the intervention. One of the main differences between the high quality and the medium quality studies is that the high quality studies evaluated differences across groups pre-intervention but the medium quality studies did not.

Medium quality studies

We classified three studies as medium quality (Crouch et al. 1999, Torp 2008, Wells et al. 1997). These studies each had strong methodological characteristics similar to the high quality studies: concurrent comparison (control) group(s); time-based comparisons (pre-post); follow-up length of three months or greater; description of the research question; description of the intervention; and optimization of the statistical analyses.

None of the medium quality studies met the criteria for evaluating differences across groups pre-intervention, while both of the high quality studies did. Also, the medium quality studies did not meet the criteria for consideration given to power, while one of the high quality studies did.

Low quality studies

We classified 18 studies as low quality (15-31). The low quality studies often did not meet some or all of the criteria related to selection/sampling issues, measurement issues, and/or statistical issues.

Table 10: Methodological quality assessment (quantitative studies)
Refer to Table 2 for the quality assessment criteria.

Criteria		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	QR*
Author	Weight	3	3	2	3	3	2	2	2	2	2	2	2	1	1	2	2	2	2	3	1	2	2	
High Quality Ranking																								
Lazovich et al., 2002		1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	91%
Rasmussen et al., 2003		1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	0	NA	1	0	1	1	84%
Criteria met		2	2	2	2	2	2	2	2	2	2	0	2	2	2	0	2	1	1	2	1	2	2	
Percentage of criteria met (%)		100	100	100	100	100	100	100	100	100	100	0	100	100	100	0	100	50	50	100	50	100	100	
Medium Quality Ranking																								
Wells et al., 1997		1	1	1	1	1	1	1	0	0	1	0	1	0	0	0	1	0	NA	1	0	1	1	70%
Torp, 2008		1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	0	0	NA	1	0	0	0	64%
Crouch et al., 1999		1	1	0	0	0	1	0	1	0	0	0	1	1	0	0	1	1	1	1	0	0	0	48%
Criteria met		3	3	2	2	1	3	2	2	0	1	1	3	2	1	1	2	1	1	3	0	1	1	
Percentage of criteria met (%)		100	100	67	67	33	100	67	67	0	33	33	100	67	33	33	67	33	33	100	0	33	33	

*QR=quality ranking

Low Quality Ranking																							
Fine et al., 2004	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	0	NA	0	0	0	0	66%
Martyny et al., 1988	1	1	1	1	1	0	0	1	0	0	0	1	0	0	0	1	0	NA	0	0	0	0	45%
Earnest et al., 2002	0	1	0	0	0	1	0	0	0	1	0	1	1	0	0	1	1	1	1	0	0	0	41%
Waugh and Forcier, 1990	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	NA	0	0	0	0	39%
Tuskes and Key, 1988	0	1	1	1	0	1	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	37%
Sheehy et al., 1989	1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	1	1	1	0	0	0	37%
Lingard, 2001	0	1	0	1	0	0	1	1	1	1	0	1	0	0	0	0	0	NA	0	0	0	0	36%
Pearse, 2002	0	1	1	0	0	1	1	0	0	1	0	1	0	0	0	0	1	NA	0	0	0	0	34%
Mayhew and Young, 1999	1	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0	NA	0	0	0	0	34%
Houston et al., 1999	0	1	1	0	0	1	1	1	0	1	0	1	0	0	0	0	0	NA	0	0	0	0	34%
Krungkraiwong et al., 2006	0	0	1	1	0	1	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	30%
Walker and Tait, 2004	0	1	0	0	0	1	1	1	0	1	0	1	0	0	0	0	0	NA	0	0	0	0	30%
Mayhew and Ferris, 1998	0	1	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	NA	0	0	1	0	30%
Raffi et al., 1995	0	1	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	30%
Sohn et al., 1998	1	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	NA	0	0	0	0	23%
Baars et al., 2003	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	NA	0	1	0	0	18%
Niskanen and Anttonen, 2001	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	9%
Scherer et al., 1993	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	NA	0	0	0	0	7%
Criteria met	6	12	11	8	4	16	8	9	2	7	0	16	6	3	1	5	3	6	2	1	1	1	
Percentage of criteria met (%)	32	63	58	42	21	84	42	47	11	37	0	84	32	16	5	26	16	32	11	5	5	5	

Descriptions of intervention categories

Table 11 shows the intervention categories and provides a detailed description of the interventions. Some of the five studies had multiple components in their intervention (i.e. having a training component and an engineering control component). Each study assessed at least one intervention. Intervention sub-components for each study are also identified. These were determined through discussion with the review team.

- The intervention sub-component that was most commonly evaluated involved some type of training (Lazovich et al. 2002, Torp 2008, Rasmussen et al. 2003, Wells et al. 1997). There were different types of training. The most common objective was education; other goals were interactive problem-solving and increasing motivation for safety.
- Two studies included interventions that implemented engineering controls (Crouch et al. 1999, Lazovich et al. 2002). In one study (Crouch et al. 1999), the engineering component was the only intervention applied.
- Workplace safety audits were part of the intervention in two studies (Torp 2008, Rasmussen et al. 2003) .

Within these intervention categories, there was substantial heterogeneity with respect to type of engineering controls, training method and audit protocols.

Table 11: Description of interventions in data synthesis (quantitative studies)

Intervention Components	Author, Year	Quality rating	Business Size	Intervention description	Study design
Engineering Training	Lazovich et al., 2002	High	5-25	I_1:a) feedback on ventilation system and dust control practices b) recommendations for reducing dust levels c) meeting with industrial hygienist for detailed assessment and recommendation on ventilation d) one-hour training on dust control e) financial incentive for new equipment or expertise f) opportunity to visit 'model' business C_1: a) feedback on ventilation system and dust control practices b) recommendations for reducing dust levels	Pre-post
Training Safety audit and recommendations	Torp, 2008	Medium	2-140	I_1: four seminars for managers covering health and safety risks, relevant OHS regulations, OHS management systems, and how to implement OHS management system C_1: no seminars	Pre-post
Training Farm safety audit	Rasmussen et al., 2003	High	<5	I_1: a) safety audit of 71 farm practices b) written feedback on reducing hazards c) one-day session with multiple farmers to problem-solve implementation C_1: no audit or group session	Pre-post
Training	Wells et al., 1997	Medium	2-500	I_1: H&S coordinators from each firm attended a 'train-the-trainers' program that provided information on new OHS regulations and on behaviour and environmental OHS strategies. C_1: no training program	Pre-post

Engineering	Crouch et al., 1999	Medium	10	I_1: one fresh air supply unit to reception/office/copy area (unknown flow rate) I_2: one fresh air supply unit to press area (940 CFM from 4 ceiling outlets) I_3: two local exhaust inlets in the press area next to Press 1 and Press 2 (exhausting 450 and 420 cfm, respectively (total 870 cfm)) I_4 : air-to-air heat exchanger for two fresh air units (not really that relevant) I_5- Flange added to one exhaust hood (temporary experiment) C: press 3 (Operator C) had no local exhaust	Pre-post

Countries of origin

Three studies were conducted in the United States (Wells et al. 1997; Crouch et al. 1999; Lazovich et al.2002) and one each was done in Norway (Torp 2008) and Denmark (Rasmussen et al. 2003).

Size of businesses

Two studies included businesses with a range of sizes up to 100 employees (Wells et al. 1997; Torp 2008). Two included businesses with 50 or fewer employees (Crouch et al. 1999; Lazovich et al.2002). One study included businesses with five or fewer employees (Rasmussen et al. 2003).

Business industry sector

One study occurred in multiple sectors (Wells et al. 1997). Two studies took place in the manufacturing sector (Crouch et al. 1999; Lazovich et al.2002), one was in the agricultural sector (Rasmussen et al. 2003) and one was in other services, such as repair and maintenance (Torp 2008).

Study designs

The studies that proceeded to data extraction were four randomized trials and one quasi-experimental design. All were pre- versus post-test designs. Also, they all had some type of comparison group or comparison workstation (e.g. a printing press without modifications). One study had "open" employee samples in which employees entered and left over the assessment period (Lazovich et al.2002). A fixed population design, in which the same participants were followed over time, was used in four of the five studies.

Sample size

The sample sizes in the studies varied greatly from three employees and one firm (Crouch et al. 1999) to 721 employees in 226 firms (Torp 2008). Loss to follow-up details were often lacking in study descriptions. When reported, the number of firms lost to follow up varied from one of 48 (two per cent) (Lazovich et al. 2002) to 12 of 90 (13 per cent) (Wells et al. 1997).

Length of intervention

In one study, the length of the intervention was not specified (Crouch et al. 1999). In four studies that specified a duration (Lazovich et al. 2002, Torp 2008, Rasmussen et al. 2003, Wells et al. 1997), the time period varied substantially. Also, it was difficult to quantify durations for studies with multiple intervention components. The studies that included a training component tended to report the duration of training sessions. One study clearly specified that each of the four training sessions lasted six hours and occurred over the course of two years (Torp 2008). Another study (Wells et al. 1997) referred to a multiple day training session, but the exact duration was not provided.

Length of observation

The length of observation, between baseline and the last follow up varied substantially from one month (Crouch et al. 1999) to two years (Torp 2008).

Age

The age of employees was reported in three of the studies (Lazovich et al. 2002, Torp 2008, Rasmussen et al. 2003). Of these, the group mean age of employees varied from 32.5 (Lazovich et al. 2002) to 36.8 (Rasmussen et al. 2003).

Gender

Gender of employees was noted in three of the five studies. The percentage of women in an intervention or control group varied from <5% (Torp 2008, Lazovich et al.2002) to 40.6% (Rasmussen et al. 2003).

Research question

The detail in the research questions and objectives varied in both the high and medium quality studies. For example, in one high quality study, there was an explicit objective to obtain a specific percentage reduction of a workplace exposure (Lazovich et al. 2002). Other studies did not provide that level of detail in their research objective. Only one study provided explicit hypotheses on what behavioural or attitudinal changes would be linked to changes in health outcomes.

Inclusion and exclusion criteria

All five studies provided some inclusion criteria. Some of the criteria were based on firms' listing in a particular business directory or association; this may have influenced the representativeness of the sample (Torp 2008, Rasmussen et al. 2003). Several studies had the number of employees as a specific criterion (e.g. five to 25 employees in the firm) (Crouch et al. 1999, Lazovich et al. 2002). Another study used other inclusion criteria (e.g. listing in a directory of small businesses in a particular geographic area) to indirectly focus on small businesses (Wells et al. 1997).

Only two of the five studies described exclusion criteria (Torp 2008, Rasmussen et al. 2003). The exclusion criteria referred to possible cross-contamination of the intervention and within-firm changes that would adversely affect the intervention and/or the outcome measures.

See Table 12 for study and intervention details, including the research question, sample size, inclusion/exclusion criteria and final analyses described.

Table 12: Study and intervention details (quantitative studies)

Intervention Components	Author, Year	Rating	Research question	Sample size	Inclusion/exclusion criteria	Final Analyses
Engineering Training	Lazovich et al, 2002	High	To assess the effectiveness of an intervention aimed at reducing wood dust by approximately 26% in small woodworking businesses.	Study total n = 48 businesses (354 employees at baseline) I_1n = 24 businesses (196 employees at baseline) C_1n = 24 businesses (158 employees at baseline, 169 at follow up)	Inclusion for businesses: 1) listed in either Minnesota Forest Products Directory, Minnesota Manufacturers Register, American Business Disc or the World Pages, 2) between 5 and 25 employees; 3) in business at least 1 year, 4) engaged in manufacture of wood cabinets, furniture or fixtures (SIC 2434, 2511, 2512, 2521, 2531, 2541). For employees (exposure sampling): 1) production workers. Exclusion: none	1. Multilevel regression (linear or logistic) Text response: mixed effect multiple regression (group assignment & time fixed and business and date of sampling random) 2. Percentage of change

Intervention Components	Author, Year	Rating	Research question	Sample size	Inclusion/exclusion criteria	Final Analyses
Training Safety audit and recommen-dations	Torp, 2008	Medium	Two objectives: 1) To investigate whether managers in small- and medium-sized companies participating in an H&S management training program implemented more H&S management procedures than managers of comparable companies not taking part in such training; and 2) to investigate whether managers' H&S management training had any effect on how the workers regarded the physical and psychosocial working environment and their health.	Study total n=292 garages I_1 n=113 garages, n = 363 employees C_1n = 113 garages, n= 358 employees	Inclusion criteria: 1) participating garages were a member of the Norwegian Association of Motor Car Dealers and Service Organization, 2) having at least one employee. Exclusion criteria: Comparison group could not have a branch or a managerial relation to another garage participating in the H&S management training.	1. ANOVA (ANCOVA) 2. Linear/logistic regression

Intervention Components	Author, Year	Rating	Research question	Sample size	Inclusion/exclusion criteria	Final Analyses
Training Farm safety audit	Rasmus-sen et al., 2003	High	The aim was to evaluate the effect of an intervention aimed at improving safety behaviour among farm workers on work accidents and injuries.	Study total n = 201 I_1 n = 99 C_1 n = 102	Inclusion criteria: 1) farms in Ringkoebing county still actively engaged in farming, 2) participating in farm work more than 1 hour/week. Exclusion criteria: 1) Change in farm structure, 2) Change of ownership, 3) Farmer health problems.	Poisson regression Other parametric Matched test
Training	Wells et al., 1997	Medium	Evaluating the effectiveness of a train-the-trainer program called REACH OUT. It was developed to assist small businesses in complying with legislation requiring an Injury and Illness Prevention Program from employers.	Study total n=90 employees in 8 companies I_1 n=51 employees in 4 companies C_1 n=39 employees in 4 companies	Inclusion: 1) Small companies in southern California. Some randomly sampled, asked for interest in participation. Then, of volunteer companies, matched pairs, randomly allocated one group to intervention, the other to be control. 2) Sampled up to 50 workers in each company. Exclusion: not provided	ANOVA, but tested firm size for treatment interaction.

Intervention Components	Author, Year	Rating	Research question	Sample size	Inclusion/exclusion criteria	Final Analyses
Engineering	Crouch et al., 1999	Medium	The National Institute for Occupational Safety and Health (NIOSH) conducted a demonstration project in the commercial lithographic printing industry, which consists largely of small companies, in an effort to establish suitable control technology for airborne solvent vapours released primarily during press cleaning operations. The study proposes to reduce lithographic printers' airborne exposures to cleaning solvent vapours.	Study total n=3 press operators at 1 printing facility $I_{1\text{-}4}$ n=2 press operators C_1 n=1 press operator	Inclusion: 1) firm with less than 20 employees in the commercial printing industry, 2) the case study was part of a larger NIOSH study focusing on small businesses in commercial printing industry. Exclusion: none	ANOVA (ANCOVA) ratio of operator C's personal sampling to the mean of A's and B's calculated for 4 sampling days. Average of these ratios for pre- days compared to post-installation compared by ANOVA ($p<0.10$).

Covariates and confounders

All five studies assessed covariates and confounders. The variables considered varied substantially with little consistency across studies. Four of five studies assessed possible covariates/confounders and also integrated some variables into their statistical analyses when assessing the effectiveness of the intervention (Lazovich et al. 2002, Torp 2008, Rasmussen et al. 2003, and Crouch et al. 1999). Two studies provided information to establish whether there were between-group differences for covariates and confounders (Lazovich et al. 2002, Torp 2008).

Statistical analyses

One study developed a multivariate statistical model based on the Poisson distribution. Two studies used univariate statistical tests such as the ANOVA (Wells et al. 1997, Crouch et al. 1999). Two studies used a combination of univariate and multivariate model to assess between-group differences (Torp 2008, Rasmussen et al. 2003).

Outcomes of interest

The outcomes of interest were constructed by the review team and fell into four general categories:

- *Workplace exposures.* These measures refer to exposure to potentially harmful chemical, physical or biological agents in the work environment. For example, this may include exposures to wood dust.

- *Behaviours.* These refer to specific actions related to safety (e.g. personal protective equipment use). Behavioural measures were typically self-reported, but one study included observational measures of behaviour (Lazovich et al. 2002). Because of issues such as recall bias, both measurements would ideally be used.

- *Attitudes and beliefs*. Attitudes and beliefs refer to cognitive or psychological variables hypothesized in several theoretical models of preventive behaviour to influence the likelihood of action. The theoretical models included Azjen's Theory of Planned Behaviour and Bandura's Social Cognitive Theory. These theories include constructs such as perceived importance, confidence in engaging in safety practices and perceived barriers. Another theoretical model evident in at least one study (Torp 2008) was Karasek's Demand/Control model, with measures such as decision authority and social support.

- *Health*. These measures refer to work-related indices of injury, disability or pain.

Two studies included workplace exposure measures (Lazovich et al. 2002, Crouch et al. 1999). Behavioural measures were included in three of the five studies (Lazovich et al. 2002, Torp 2008, Rasmussen et al. 2003). Some measures focused on specific types of behaviour, such as self-reported dust control behaviour (Lazovich et al. 2002), while others examined a more general list of actions related to H&S management behaviours.

Attitudes and beliefs were assessed in three of five studies. Two studies showed that perceived barriers to personal protective equipment or safety procedures in general were common. (Lazovich et al. 2002, Wells et al. 1997). One study assessed confidence in engaging in safety practices and readiness to change (Lazovich et al. 2002). Another study assessed whether the intervention changed employee decision authority and social support at work (Torp 2008).

Health outcomes were assessed in three of four studies. Two studies assessed rate of injury and frequency of illness (Wells et al. 1997, Rasmussen et al. 2003). Another measured musculoskeletal pain (Torp 2008).

No study assessed all four types of outcomes. However, two studies assessed three out of the four categories (Lazovich et al. 2002, Torp 2008).

Qualitative studies (OHS understandings and processes)

The 20 studies that met our relevance criteria were assessed for methodological quality using 17 criteria (Table 13).

High quality studies

There were five studies of high quality (Corneliussen 2005; Eakin & MacEachen 1998; Eakin 1992; Eakin et al. 2003, Mayhew & Quinlan 1997) . These studies provided a clear description of the methods employed and justification for why a particular approach was best suited to answer the research question. The studies were rich in context. For example, they provided detailed information about a particular sector or workplace that enhanced the understanding of research findings. The process of analysis was clearly conveyed and there were clear links between the data (quotes, case studies, etc.) and reported findings. The nuances and intricacies in the data were portrayed. The analytic process in the high quality studies considered contradictions in the data and offered explanations for incongruent findings. The reporting of the findings was clear and linked to the stated aims of the study. The high quality studies implicitly or explicitly addressed relevant ethical issues and the bearing that the position of the researcher might have had on the data collection and analytic processes.

Medium quality studies

There were nine medium quality studies (Andersen et al. 2007; Aragon et al. 2001; Eakin et al. 2001; Holmes et al. 1999; Niewohner et al. 2004; Shain et al. 1998; Walters 1987; Walters 1998; Wulfhorst et al. 1996). These studies typically had one or two shortcomings related to the methodological approach, analytic process or reporting. For example, methods may have been clearly conveyed but it was not clear why a specific approach was best suited to address the research question. These studies usually did not provide the same sort of rich background information about the workplaces that were being studied and their broader contexts. Medium-ranked studies tended to be descriptive in nature. While descriptions of findings were detailed and well-supported by the data, these were often reported without a nuanced analysis of underlying factors and influences. Contradictory findings were reported but explanations were not always offered for why such findings existed. In some instances, reporting was unclear and ethical issues were only briefly addressed.

Low quality studies

There were six low quality studies (Akande 1992; Dugdill et al. 2000; Fishwick 2005; Hetzel et al. 2006; Johansson & Johansson 1992; Lingard 2002)(45-50). The credibility of low quality studies was undermined by a major flaw in the way that the data was collected or during the analysis process. Reporting was often difficult to follow and inadequate. In some instances the design of the study was poorly suited to the research questions and the research process itself seriously compromised the quality of the data collected. In most cases the process of analysis was poorly explained and there were incongruities between the data (interview quotes, case studies etc.) and the reported findings. Often findings were not supported by data and appeared to have been shaped by the authors' own ideas. Ethical considerations and outside influences that might have shaped findings and the data collection were not discussed.

Table 13: Quality assessment (qualitative studies)

Study	Ranking**	Rationale for Ranking
Akande (1992)	**Low**	This paper uses multiple methods (i.e. quantitative, qualitative, literature review) and it is difficult to discern which findings are derived via which method. The reporting of study findings is problematic and filled with what appear to be general notions about stress relief. There is some indication that the author imposed his/her own ideas on the data rather than linking findings back to the data. No discussion of ethics.
Andersen et al. (2007)	**Med**	The paper is clearly written and organized by themes. However, the paper is fairly descriptive and not analytical. Some arguments are not fully illustrative of the findings. There is some attention to diversity of perspectives. Authors draw out and offer explanations for divergence between reported attitudes and behaviour. Minimal discussion of ethics.
Aragon et al. (2001)	**Med**	The study provides a well-conceptualized analysis of OHS within a specific cultural framework, and the paper is well presented with a concise description of methods, and a good balance of author discussion and participant quotes. Although the study examines a fairly specific example of the experience of small business owners with OHS, wider inferences can be drawn in understanding the unique features of small business workplaces when developing OHS initiatives. The discussion digresses to discuss methodological reliability and validity that seemed ill-suited for this particular paper. Although the conclusions make sense, they are not fully developed or discussed. Authors do not reflect on the suggested homogeneity of the sample or on negative cases. Little discussion of ethics.
Corneliussen (2005)	**High**	This paper provides a carefully detailed analysis that explores the complex nature of OHS regulations and their application in the biotech industry. There is extensive, detailed context and background provided in the introduction and discussion section. The analysis carefully considers contradictions and provides an explanation for seeming incongruent data. Findings are well-supported and illuminated by extensive interview extracts. Reporting is clearly structured. No explicit mention of ethics. However, the detailed study description suggests consideration of ethics.

Study	Ranking**	Rationale for Ranking
Dugdill et al. (2000)	**Low**	The rationale for including some businesses and not others is not given. Very little information is provided about how data collection was carried out. There is little information about outliers, exceptions or negative cases. Quotes are short and nuances are not examined. Quotes occasionally do not correspond to authors' reported findings. No evidence is provided to support how thematic or analytic categories are developed. Study is descriptive in nature with little analytical detail. No discussion of ethics.
Eakin (1992)	**High**	The theoretical orientation of this study is clear and the sample is well-described. The findings are well-supported by data and relevant literature. The analysis identifies and explores several aspects underlying small business owners' approaches to OHS and distinguishes between a range and depth of intersecting issues. Reporting is clearly organized and key findings/conclusions are well-articulated. There is extensive reflection on the implications of these findings and recommendations for further research/policy initiatives. Little explicit discussion of ethics.
Eakin & MacEachen (1998)	**High**	Rich background information is provided about the organization setting and the broader political economy. The article discusses sampling strategy clearly, including limitations. The interpretive process is comprehensive and well-supported by data. There is a detailed discussion of the findings. The authors provide an in-depth description of the analytic approach. Clear narrative and signposting leads to the conceptualization of findings. Authors address and are sensitive to important ethical issues.
Eakin et al. (2001)	**Med**	Some context is provided about the labour market trends at the time of the study but little information is given about the workplaces or participants. The approach to data collection is clearly described but there is no discussion how the choice of methods might have influenced the findings. The analysis process is well-described. Complexity of experiences and understandings is often suggested rather than demonstrated through the use of clear data excerpts. Reporting is well-structured and clear. Little discussion of ethical issues.

Study	Ranking**	Rationale for Ranking
Eakin et al. (2003)	**High**	The study has a strong research design, using multiple data sources (interviews, observation, documents) and analytical approaches (grounded theory and "structural interactionist" analysis) in order to link behaviour and interactions within small businesses to broader social and cultural constructs. Analysis is iterative and clearly presented. Data are used in compelling ways to support the conceptualization put forward. The paper also uses illustrative approaches (case study, policy analysis) to support the findings. The authors discuss different standpoints and stakes according to employer/employee experiences but also demonstrate the ways in which they converge. Important ethical issues are considered.
Fishwick (2005)	**Low**	This study has an unclear research design and data sources. It is unclear when the findings are based on the empirical data or when the author is editorializing. The data collection process is not well-described. Textual extracts are presented as lists and are decontextualized. Minimal attention is paid to developing nuances within the data or to explain responses. Reporting is vague and categories derived are descriptive not analytic. No attention is paid to ethics.
Hetzel et al. (2006)	**Low**	The study design is not well-described and sample criteria are not provided. It is unclear how the data relate to findings. There is limited discussion of analytical process. Although an existing theoretical orientation is presented, there is little discussion of the link between the theory and the study findings, nor does the resulting model seem to relate to study findings. Ethical issues are not addressed.

Study	Ranking**	Rationale for Ranking
Holmes et al. (1999)	**Med**	The paper is well-organized and clearly states central issues and ideas. The analysis answers the research question. However, there is minimal exploration of divergent views; in general, the authors report group consensus, with little exploration of contradictions (e.g. between owners and workers, or between firms). This analysis presumes shared meaning of "risk" amongst participants with little exploration of alternative explanations. Although the findings are clearly reported, the paper could have benefited from stronger methodological reporting (e.g. rationale for research design, participant recruitment), more analysis of why some participants had certain views, and of why these views were relevant to small businesses. Little discussion of ethics.
Johansson & Johansson (1992)	**Low**	The study is primarily descriptive. It provides cursory detail about small business owners' attitudes toward OHS legislation with little analytic depth. No information is given about the analytic process or how analytic categories were generated. There is little use of data to substantiate findings. Rather, results seem to stem from a worker group's interpretation of the findings (which the authors were part of) rather than from the empirical data. No discussion of ethics.
Lingard (2002)	**Low**	Very little information is provided about recruitment or the firms. Interviews are done in the workplace yet there is no discussion of how talking to participants where they worked might have affected the findings. The study's aim is behaviour change after a workplace-based first aid training, yet the observation process is very short and varies; it was sometimes done right after the training and sometime weeks after. Analysis is thin, and responses are counted without reflection about why they may have shifted or why certain views might be held. Because workers were paid to take the first aid course there is a potential strong social desirability factor, which is not discussed by authors. Ethical issues are not addressed.
Mayhew & Quinlan (1997)	**Med**	There is a well-developed conceptual framework that links particular social and economic structures to OHS. This is a mixed methods study involving a survey and face-to-face interviews. While it is clear from the presentation of findings that richness was achieved in the process, there is little detail on the actual process of conducting the research or on limitations of the design. The presentation of data and analysis show clear links between commentary and the data extracts. There is no discussion of ethical issues.

Study	Ranking**	Rationale for Ranking
Niewohner et al. (2004)	**Med**	The methodological approach is well-described and reasons for non-participation are provided. The authors reflect on implications of the methodological process. Little contextual information is provided-- only some information about the firms. At times, the reporting is unclear with confusing placement of findings. Authors provide a clear narrative from study rationale through data collection to conclusions, with extensive verbatim quotes provided. They explain their interpretations and reflect on alternative explanations for participants' comments. They identify gaps in knowledge where evidence is inadequate to form conclusions. Occasionally conceptual language does not relate well to text extracts. Only brief attention is paid to ethical issues.
Shain et al. (1998)	**Med**	This study provides a clear discussion of the overall research strategy. The analytic process is well-described. Although there are data extracts provided, these are truncated and used sparsely. The diversity of perspectives is addressed and divergences in the data are identified and discussed. There are some problems with the organization of the paper (some information about the sample etc. seems out of place). Ethical issues are not addressed.
Walters (1987)	**Med**	This study provides a clear rationale for the methods used and the study sample. Excellent contextual information is provided about the development of legislation being studied and the implication for OHS in workplaces. Details are given about the sample. There is little information about the research process (such as how and where the interviews were carried out) and few direct quotes from participants. There is a nuanced discussion of why engagement in OHS may be different in small, medium and large workplaces and this analysis is tied to the broader legislative context. Reporting is clear and key messages are highlighted. Ethical issues are not discussed.

Study	Ranking**	Rationale for Ranking
Walters (1998)	**Med**	The paper provides little discussion of methods—it describes only the types of people interviewed and the sort of questions asked. Direct quotes from participants are not provided to illustrate findings. Valuable contextual information is provided about the health and safety scheme, health and safety in agricultural work. Divergent views are addressed and examined. Findings appear credible and nuanced and attention is paid to contextual differences. These indicate a systematic approach to the analysis. No discussion of ethical issues.
Wulfhorst et al. (1996)	**Med**	The paper provides good contextual information about health and safety issues facing hairdressers. The paper is well-structured and outlines the aims of the study and recruitment process. The study provides only a cursory description of the methods used. The intervention is theoretically grounded. There is some reflection about how participants were influenced by the fact that the intervention was taking place and were "pressed" into being engaged. Although the findings are credible, more methodological and analytical detail might have illuminated how the researchers arrived at their findings.
	20 studies	

** see Table 4 for Quality Ranking table

Countries of origin

Five of the studies were conducted in Canada, four in the United Kingdom, two in Australia and one each in Denmark, Germany and Nicaragua.

Size of business

Four studies included businesses with a range of sizes up to 100 employees (Eakin et al. 2001, Eakin et al. 2003, Walters 1987; Wulfhorst et al. 1996). Eight studies included businesses with 50 or fewer employees (Andersen et al. 2007, Corneliusson 2005, Eakin 1992, Eakin & MacEachen 1998, Holmes et al. 1999, Niewohner et al. 2004, Shain et al. 1998, Walters 1998). Two studies included businesses with five or fewer employees (Mayhew & Quinlan 1997, Aragon et al. 2001) (Table 14).

Business industry sector

Five studies were conducted in multiple sectors (Eakin 1992, Eakin & MacEachen 1998, Eakin et al. 2001, Eakin et al. 2003, Shain et al. 1998) . Three studies took place in construction firms (Andersen et al. 2007, Holmes et al. 1999, Mayhew & Quinlan 1997); two in service sector firms (Wulfhorst et al. 1996, Niewohner et al. 2004); two in manufacturing firms (Andersen et al. 2007, Niewohner et al. 2004); and two in agriculture firms (Aragon et al. 2001, Walters 1998). One study included printing firms (Walters 1987) and one included scientific and technical services (Corneliusson, 2005) (Table 14).

Study design

Ten of the studies had a qualitative design, and four used mixed methods. Only qualitative evidence was extracted from the mixed method studies.

Table 14: Description of qualitative studies

Study	Jurisdiction	Number of Employees	Industries of Sample	Primary study design	Study Method	Time frame of study
Akande (1992)	Nigeria (Lagos)	15-100	Not provided	Mixed method	Semi-structured interviews (qualitative), questionnaires (quantitative)	1989
Andersen et al. (2007)	Denmark	<19	Construction, Manufacturing (Metal)	Qualitative	Semi-structured interviews	2004 – 2005
Aragon et al. (2001)	Nicaragua (Chinandega County)	<5	Agriculture	Qualitative	Focus groups	2000 – 2001
Corneliussen (2005)	Scotland and Norway	5-30	Professional/ Scientific/ Technical Services; Management of Companies and Enterprises	Qualitative	Semi-structured interviews; policy analysis	2000-2001
Dugdill et al. (2000)	United Kingdom (Northwest England)	<90	Multiple industries	Mixed method	semi-structured interviews (qualitative), questionnaires (quantitative)	1996 – 1998
Eakin (1992)	Canada (Calgary, AB)	<40	Multiple industries	Qualitative	Semi-structured interviews	1986 – 1987

Study	Jurisdiction	Number of Employees	Industries of Sample	Primary study design	Study Method	Time frame of study
Eakin & MacEachen (1998)	Canada (Toronto, ON)	<50	Multiple industries	Qualitative	Unstructured interviews	1995
Eakin et al. (2001)	Canada (Ontario)	25-99	Multiple industries	Qualitative	Structured interview, document review, participant observation	N/P
Eakin et al. (2003)	Canada (Ontario)	<100	Multiple industries	Qualitative	Unstructured interview, document review, case study, participant observation	N/P
Fishwick (2005)	United Kingdom	primarily <100	Multiple industries	Mixed method	Unstructured interviews (qualitative), survey (quantitative)	2001-2003
Hetzel et al. (2006)	Germany	primarily <100	Multiple industries	Qualitative	Structured interview	N/P
Holmes et al. (1999)	Australia	3-10	Construction	Qualitative	Structured interview	N/P
Johansson & Johansson(1992)	Sweden (Stockholm area)	<50	Multiple industries	Qualitative	Semi-structured interview	N/P
Lingard (2002)	Australia (Victoria)	3-10	Construction	Mixed method	Structured interviews (qualitative); single-case experimental design (quantitative)	N/P

Study	Jurisdiction	Number of Employees	Industries of Sample	Primary study design	Study Method	Time frame of study
Mayhew & Quinlan (1997)	Australia/ United Kingdom	<5	Construction	Mixed method	Semi-structured interviews (qualitative), surveys (quantitative)	1990-1995
Niewohner et al. (2004)	United Kingdom (East Anglia and NW London)	<25	Sales & Services (dry-cleaning); Manufacturing (electrical)	Mixed method	Semi-structured interviews, focus groups (qualitative), questionnaires (quantitative)	N/P
Shain et al. (1998)	Canada (Ontario)	<50	Multiple industries	Mixed method	Semi-structured interviews	N/P
Walters (1987)	United Kingdom	<60	Printing industry	Qualitative	Structured interview	N/P
Walters (1998)	United Kingdom (South England)	<20	Agriculture	Qualitative	Semi-structured interview	1997
Wulfhorst et al. (1996)	Germany (Osnabruck)	<100	Other services (personal care services)	Mixed method	Semi-structured interview (qualitative); medical examination (quantitative)	1993-1994

4.0 Evidence synthesis

4.1 Quantitative studies (intervention effectiveness)

In the quantitative synthesis we addressed the sub-question: "Do OHS interventions in small businesses have an effect on OHS outcomes?" We extracted data from the five studies that were classified as medium or high quality.

Table 15 presents a summary of the intervention effects as reported in these five studies. Since effect sizes could not be consistently calculated, we present the effects as they were reported in the studies. To examine the overall level of evidence for intervention effects across the five studies, we used an algorithm (Table 7). In determining the level of evidence, when studies reported that there were effects from multiple outcomes within a category (e.g. three attitude/belief measures) we classified it as an effect if even one of the measures showed a significant between-group difference.

There were no negative or adverse effects on outcomes in any of the five studies. We therefore consistently report on intervention positive effects or no effects. With respect to the review sub-question, we found a **moderate** level of evidence for the effect of injury prevention interventions, when looking across all outcome domains (i.e. behavioural, workplace exposure, attitudes/beliefs, health).

Engineering plus training, safety audit and motivational components

We found one high quality study that evaluated engineering controls along with training and motivational components (i.e. financial incentive as motivation). The training consisted of an educational component with a series of one-day seminars and an interactive problem-solving component. No statistically significant effect on workplace exposure outcomes was found. However, this study did have a positive effect on attitude and belief measures.

- *As this was a single high quality study, we concluded that there was **limited** evidence that this multi-component intervention had an effect on outcomes of interest.*

Training plus safety audit

Two studies, one each of high and medium quality, examined a training plus safety audit intervention in small firms. The training in the high quality study consisted of an educational component and an interactive problem-solving component (Rasmussen et al. 2003). The training in the medium quality study included only an educational component on health and safety management training (Torp 2008). The high quality study showed a positive effect on behavioural measures (Rasmussen et al. 2003). However, the study showed no effect on health-related outcomes. The medium quality

study showed a positive effect on health and safety management behaviours and in the attitudinal/belief outcome domain (e.g. social support). No significant effect was found in the health outcome domain.

- *Summarizing across outcome domains, the two studies provided **limited** evidence that training plus a safety audit has an effect on OHS-related outcomes.*

Training only

One medium quality study examined training only (Wells et al. 1997). The training consisted of an educational component called REACH OUT, which was a train-the-trainer program. The study reported a positive effect on the health outcome of illness rate. The study also showed a positive effect on perceived access to personal protective equipment.

- *As there was a single study available, we concluded there was **insufficient** evidence to determine that training had an effect on OHS-related outcomes.*

Engineering only

One medium quality study showed positive effects of engineering control on workplace exposure outcomes (Crouch et al. 1999).

- *With just a single study available, we concluded there was **insufficient** evidence regarding the effect of this engineering control on OHS-related outcomes.*

Table 15: Intervention effects in quantitative studies

Intervention Components	Author, Year	Rating	Outcomes	Observed Effect
Engineering, Training, Safety audit, Financial incentive	Lazovich, 2002	High	Workplace exposure • dust concentration Behaviour • % time available • % time used • ratio measured vs. recommended airflow • self-reported dust control behaviour Attitudes/beliefs • interest • importance • informed • confidence • perceived effectiveness • barriers • stage of readiness	**No** effect on workplace exposure outcomes. **No** effect on behavioural changes. **Positive** effect on informed about dust control outcome. **Positive** effect on stage of readiness to control dust outcome.
Training, Safety audit and recommendations	Torp, 2008	Medium	Behaviour • H&S management index Attitudes/beliefs • physical work environment • decision authority • social support • management support Health • prevalence of MSK pain	**Positive** effect on behavioural changes. **Positive** effect for social support and management support. **No** effect for decision authority. **No** effect on health outcome.

Intervention Components	Author, Year	Rating	Outcomes	Observed Effect
Training, Farm safety audit	Rasmussen et al., 2003	High	Behaviour • active • personal protective equipment use Health • injury rate • safety rate	**Positive** effect on behavioural changes. **No** effect health outcomes.
Training	Wells et al., 1997	Medium	Health • # of illnesses Attitude/Beliefs • perceived access to hard hats • perceived access to hair nets	**Positive** effect on health outcome. **Positive** effect on attitude and belief outcomes.
Engineering	Crouch et al., 1999	Medium	Workplace exposure • vapour concentration • area concentration of anti-offset powder	**Positive** effect on workplace exposure outcomes.

Table 16: Effects summary by type of outcome

Intervention component; Author, Year	**Workplace exposure**	**Behavioural change**	**Attitude/beliefs**	**Health**	QA
Engineering; Training Lazovich, 2002	Ø	Ø	+	N/A	H
Training; Safety audit and recommendations Torp, 2008	N/A	+	+/Ø	Ø	M
Training; Farm safety audit Rasmussen et al., 2003	N/A	+	N/A	Ø	H
Training Wells et al., 1997	N/A	N/A	+	+	M
Engineering Crouch et al., 1999	+	N/A	N/A	N/A	M

*Possible Values: + (Positive Effect), Ø (No Effect) or +/Ø (both Positive and No Effect found). N/As indicate the outcome measurement was not used.

Table 16 presents another summary of the same intervention effects reported in the five studies, this time by the four domains of outcomes examined: workplace exposure, behavioural change, attitudes/beliefs and health. In the one high quality and one medium quality study that reported on workplace exposures, one showed a significant improvement associated with the intervention and the other did not.

- *These studies suggest that there was **insufficient evidence** that workplace exposures were influenced by the respective engineering interventions.*

In the one high quality and one medium quality study examining behavioural change, both found positive effects on this outcome. Both interventions had training and safety audit components.

- *These studies suggest that there was **partial evidence** that safety-related behaviours were influenced by the respective interventions.*

In the one high quality and two medium quality studies that assessed attitudes and beliefs, all three showed that significant positive changes were produced on this outcome. All of these interventions had at least some kind of training component.

- *These studies suggest that there was **moderate evidence** that attitudes and beliefs were influenced by the respective interventions.*

In the one high quality and two medium quality studies that assessed health outcomes (e.g. injury/illness rates), one showed positive effects. All interventions had at least a training component, and two also had a safety audit component.

- *These studies suggest that there was **insufficient evidence** that health outcomes were influenced by the respective interventions.*

Conclusion

Our systematic review used a standard approach using a standard process developed by Cochrane 2005 (40) and Slavin (6) that was adapted by the review team to answer the question: "Do OHS interventions in small businesses have an effect on OHS outcomes?"

We found that the literature on OHS interventions in small businesses was heterogeneous in terms of the interventions implemented, quality of the study designs and outcomes measured.

From an initial pool of 44 articles, we identified 23 relevant studies. Two were found to be of high quality, three of medium quality, and the rest of

low quality. We synthesized evidence from the medium and high quality studies.

Based on our evidence criteria for data synthesis, at least three high quality studies with consistent findings would have been needed to find "strong evidence" of an effect. With only two high quality studies, the evidence was not strong.

Our review included studies in different industries including farming, car repair garages, a printing press and woodworking businesses, while one study looked at multiple industries. While stratifying the interventions and effects based on industry would have been desirable, having only five studies precluded this option.

In conclusion, across all interventions and all outcome domains we found a **moderate** level of evidence for the effect of OHS interventions in small businesses on environmental exposure, behaviour, attitudes and beliefs and health. This finding means that a majority of high and medium quality studies found positive effects on outcomes. In addition, we found no evidence that any intervention had a negative or deleterious effect on outcomes.

The highest level of evidence we found was limited. This lack of strong evidence was due, in part, to the low number of studies of sufficient methodological quality on this review topic. We also found that the outcome domain most often affected by the interventions was attitudes/beliefs.

4.2 Qualitative studies (OHS understandings and processes)

In the qualitative synthesis we addressed the sub-question: **"**How do small business workplace parties understand and enact processes related to OHS?"

We identified concepts and organised them into seven themes that characterized OHS understandings and processes in small businesses (see Table 17). These themes are described under three broad headings: structures, policies and systems for small business OHS, understandings of OHS hazards, and managing risk and health problems.

Structures, policies and systems for small business OHS

Lack of knowledge of OHS rules and approaches

The lack of knowledge of OHS rules and regulations among small businesses was prominent in the articles reviewed. The studies showed that small business owners and managers either did not know or did not remember OHS rules and regulations. For instance, Corneliussen (2005) found that managers and owners in the biotechnology industry could not identify or remember the names of regulations governing their industry. Niewohner et al.'s (2004) study of service industry businesses that used

chemicals identified a lack of staff OHS training as a problem. Eakin (1992) found that small business owners were often unaware of the potential consequences of OHS violations. Anderson et al. (2007) found that small business owners had little knowledge that they could have financial or practical support for early RTW initiatives.

In some studies that showed this lack of OHS knowledge, the researchers suggested that it might be due to inferior training standards in some industries (Mayhew & Quinlan 1997, Niewohner et al. 2004) or to better training programs in larger workplaces (Walters 1987). For instance, in a study of small business OHS needs in the dry-cleaning and electronics industries, Niewohner et al. (2004) suggested that varied OHS training by sector explained different risk knowledge and perceptions of responsibility. In this case, dry-cleaners were more informed about OHS risks and safe working practices than electronics industry workers. Mayhew & Quinlan (1997) similarly suggested that the more strongly unionized construction workers in the mining industry were likely to be better informed about OHS risks than disorganized construction workers in the home-building sector. Walters' (1987) study of OHS in printing firms showed that union representatives in small firms had a limited understanding of OHS relative to representatives in larger firms and they spent relatively less time on this vis-à-vis their other union duties.

The authors of some studies noted that small businesses had a lack of knowledge about OHS rules and approaches because small firms tended not to be unionized (Mayhew & Quinlan 1997, Walters 1998). Walters (1998) noted that the agriculture industry had the lowest trade union density in the U.K and suggested a lack of coordinated labour activity contributed to reduced knowledge about OHS among both owners and workers. Mayhew & Quinlan (1997) pointed out that unionization affected whether OHS systems were developed, and how workers understood risk and whether employers were responsible for it.

Other explanations for the relative lack of OHS knowledge in small businesses were exemptions from regulations and relative freedom from safety inspection. In some jurisdictions small businesses were, by virtue of their size, exempt from particular OHS regulations (Mayhew & Quinlan 1997, Wulfhorst et al. 1996). Also, safety inspectors tended to concentrate attention on larger workplaces, so small firms could remain almost inspection-free (Mayhew & Quinlan 1997). Both of these factors might reduce the pressure on small businesses to be aware of and address OHS risks, and employers might be uninformed about relevant OHS regulations because they are not held accountable for these rules. Mayhew & Quinlan (1997) noted that small business OHS exemptions might attract hazardous outsourced work (e.g. asbestos removal, building demolition) from large

firms. When work is dangerous, a lack of knowledge about hazards in small businesses is particularly problematic.

- *The studies showed that small business owners and managers either did not know or did not remember OHS rules and regulations. This may have been due to inconsistent training standards in different industries, better training programs in larger workplaces or lack of systems that come with unionization. It was also possible that small business exemptions from regulations, relative freedom from safety inspection and the comparative lack of unionization in small businesses contributed to conditions for poor knowledge of OHS in small businesses.*

Lack of formal workplace systems and resources for OHS

Small businesses often operated without formal work systems (Aragon et al. 2001, Walters 1987), including systems for OHS. Studies showed that small businesses generally lacked the time and resources to carry out responsibilities such as return to work and prevention activities. Eakin et al. (2003) noted that small businesses did not have the administrative support, such as a human resources department, to monitor worker compliance with return-to-work regulations, manage the paperwork, deal with medical management and issue progress reports to regulatory bodies. Mayhew & Quinlan (1997) found that small business OHS systems could be poorly developed, and attributed this situation to business pressures that prioritized immediate needs related to competition, speed of output and cost-minimization.

Complex contractual relations within an industry could also frustrate the development of systematic work safety practices in small businesses. Mayhew & Quinlan (1997) found that small construction firms had employees and sub-contractors working side-by-side. These varieties of contractual relations on single worksites impeded communication among workers who had different mandates and employers, and adversely affected the systematic establishment of base-level OHS practices.

Workplace health systems could also be absent because owners did not see OHS as within their domain of responsibility, or owners were unclear about their responsibilities. Eakin (1992) found that some small business owners did not see OHS as a bureaucratic function for the enterprise. Rather, health was viewed as a personal responsibility and owners did not see themselves as having legitimate authority to influence worker behaviours. Niewohner et al. (2004) also found that small business managers did not see safety as their responsibility. These managers worked with a model of "diffuse responsibility," with accountability passed back to manufacturers, the factory, landlords or employees. Owners could also be unclear about their responsibility for OHS when industries had non-standard employment

arrangements, such as subcontracting practices in the construction industry. In these contexts, workers' employment status could be ambiguous (Mayhew & Quinlan 1997). A fragmentation of tasks as a result of vertical and horizontal subcontracting created an environment where responsibility for health problems was obscured. Mayhew & Quinlan (1997) proposed that work disorganization in the construction industry blurred responsibility for OHS and contributed to workers' views that injuries were a "part of the job" and "not worth reporting."

This obscuring of responsibility for OHS was also observed by Walters (1987) who linked it to unclear government policy. His study of unionized United Kingdom printing firms showed that both management and unions lacked a structured approach to workplace health. A suggested explanation was because policy was worded in a way that left implementation up to the workplaces. The firms, particularly those that were small, interpreted OHS legislation at levels far below the basic provisions they contained. Likewise, Eakin et al. (2003) found that an absence of detailed direction on handling early return to work led small business owners to use their own business logic. The solutions were centred on ways to avoid expenses more than on conditions for worker rehabilitation.

Another reason why small businesses had difficulties setting up an OHS system was that workers and owners had different perspectives on health. For instance, each might have different ideas about the sources of hazards and solutions for managing them. Eakin et al. (2001) observed that there could be a natural fragmentation among workplace parties. In the absence of a coordinated top management approach, these differences might undermine the development of a workplace health plan.

Interestingly, Corneliusson (2005) found that a lack of formal systems for workplace health did not always imply poor OHS practices. Her study of biotechnological firms showed that although managers appeared to not know OHS policy, their practices were safe because all staff were highly educated professionals with extensive training in safe laboratory procedures. She argued that consideration needs to be taken of the industry and the professionalism of a firm when evaluating OHS compliance.

- *Small businesses lacked the specialized personnel and the resources for formal workplace health systems. Both owners and workers could be unclear about the workplace's responsibilities for worker health. Particular industries, such as construction with its complex subcontracting relationships, could further complicate small business parties' understanding of their responsibility for workplace health.*

Information, policies and legislation do not fit small business reality

OHS policies could be difficult for small businesses to implement because legislation was out of step with their contractual arrangements, policies did not fit with the nature of workplace relationships, and the information provided was too generic.

Mayhew & Quinlan's (1997) examination of the small business construction industry in Australia showed that OHS policy was out of step with the realities of complex subcontracting relationships. In this industry, small firms were contracted to do work for larger firms, and small firms also subcontracted work. Subcontracting created complex relations of legal responsibility, which could confuse the respective responsibilities of contractors and subcontractors. Mayhew & Quinlan (1997) noted that, within this context, under-resourced regulators could be reluctant or even unable to prosecute OHS violations.

Policies might not fit the particular nature of working relationships in small businesses. Eakin et al. (2003) found that early return-to-work (RTW) regulation was a burden for small business owners and upset personal social relations within workplaces. This regulation relied on businesses to provide modified work to enable return to work as soon as possible after an injury or illness. If owners did not enforce early RTW rules they faced financial penalties. Owners therefore complied with early return to work, but complained that doing so disrupted relations of trust and reciprocity that sustained workplace relationships and the informal flow of tasks and responsibilities that characterized small business work organization.

Finally, information sheets about OHS hazards (such as MSDS leaflets) could be generic and technical and therefore difficult for small businesses to understand and apply (Niewohner al. 2004). Such information packages could focus on risks that were more relevant to larger firms, and particular risks of small-scale sites were rarely addressed (Mayhew & Quinlan 1997).

- *OHS legislation and policies did not always fit the situations of small firms. They could be difficult to implement because legal responsibilities were not clear, and they could impose conditions that disrupted personal relationships in small firms. OHS information could be unhelpful to small firms when it was too technical, generic or not relevant to the needs of the business.*

Understandings of OHS hazards in small businesses

Small businesses can downplay risks or not use OHS knowledge

The studies identified the ways that small business parties often considered OHS hazards as "par for the course" or not being really dangerous. The studies showed that occupational health risks such as construction hazards, skin disease, falls and pesticide exposure were "normalized," or considered

by small business parties as acceptable and not preventable. For example, Eakin's (1992) study of small business owners found that many saw work as generally not dangerous, including those in high-risk sectors.

This notion that OHS risks were not preventable and were acceptable emerged in several other studies. Holmes et al.'s (1999) study of small businesses in the construction sector found that workers generally saw long-term risks, such as exposure to conditions for skin disease, to be out of their control. Many also viewed short-term risks, such as falls from ladders, as unavoidable. In addition, Eakin et al. (2001) found that both workers and employers saw workplace stress as inevitable and unavoidable. Similarly, Wulfhorst et al.'s (1996) study of OHS risks in hair salons found that workers did not blame their skin disease problems on their work conditions. They accepted the problem as normal, and as an issue to be "fixed" by a doctor.

Some studies reported that even when supports and information were available to small businesses, they might not be used. Four papers offered cultural explanations for the lack of take-up of OHS training. Aragon et al. (2001) found that although small-scale Nicaraguan farmers were given instruction about occupational health hazards, they did not internalize this information and it did not change their safety practice. Farmers were convinced that the safety practices used by their fathers were also adequate for them. Walters (1998) found that United Kingdom farm workers were resistant to an education intervention that was set up to standardize workplace health approaches within farms. He suggested that the intervention's lack of success was partially due to the cultural insularity of the farms; people were accustomed to working in isolation and to dealing with issues alone. Wulfhorst et al. (1996) found that hairdressers did not always wear gloves to avoid chemical exposure. This was, in part, due to the way gloves interfered with hairdressers' relations with their customers. Likewise, Niewohner at el. (2004) found that dry-cleaners resisted wearing gloves because this made their hands sweat and impeded their handling of garments. The dry-cleaners also resisted using protective barrier creams, which might stain the garments.

Another reason for non-adherence to optimal workplace safety practices was economic concerns. Eakin (1992) found that small business owners were too preoccupied with day-to-day needs to be concerned about health and safety. In line with this, Mayhew & Quinlan (1997) noted that superior OHS knowledge among builders did not readily translate into greater regulatory compliance. These owners recognized safety breaches and rationalized these on the basis of economic survival. Niewohner et al. (2004) found that cost and time constraints were cited as barriers to effective workplace health management. This consideration of costs and benefits of OHS was also

observed by Eakin et al. (2001), who found that employee health was rarely a priority compared with other business demands.

- *Small business workers and employers could downplay occupational health risks or not use injury prevention knowledge. Owners and workers in some sectors, such as farming, resisted outside advice. Workers in service sectors avoided safety advice that might interfere with client relations. Owners also cited lack of time and economic constraints as barriers to workplace health management.*

OHS views shaped by social relationships at work

The studies showed that working relationships in small businesses were typified by personal relations and minimal "we-they" dichotomies between workers and employers (Eakin 1992, Eakin & MacEachen 1998, Aragon et al. 2001). Eakin (1992) found that owners were not only dependent on their employees, but also considered themselves to be "one of the boys." Workers and employers tended to work alongside each other and would sometimes mix roles such as filling in for each other (Aragon et al. 2001, Eakin & MacEachen 1998). Eakin (1992) proposed that workers downplayed health risks because they aligned their interests with the financial needs of the firm. This was because workers were in a position to directly understand how their labour contributed to overall firm survival and therefore to their continued employment. Aragon et al. (2001) similarly noted that small business farmers would downplay pesticide risks because of their awareness of the need for overall farm survival.

While most studies reported that positive social relationships in small businesses led workers to overlook workplace hazards, some found that strained social relations could lead to workers' lack of trust in employers and workplace health initiatives. Eakin & MacEachen (1998) found that injury attributions in small firms were contingent on the quality of the employment relationship. They observed that employment relations in small businesses were personalized as a result of overlapping tasks between employers and workers, and their close working proximity. Workers viewed health problems as "part of the job" when employment relations were positive and supportive. However, when employment relations were strained, workers came to see that "family-like" work relations were fundamentally profit-based employment relations. In situations where there was a reframing of social relationships within a business perspective, workers did not downplay their health problems and they drew attention to workplace health issues. Niewenhauser et al. (2004) also pointed to the negative impact of poor employment relationships on small business OHS. They found that workers' sense of a lack of control and trust in management inhibited their uptake of workplace health risk information.

- *Workers' views of workplace health were shaped by the type and quality of social relationships in the workplace. Side-by-side working relationships in small businesses enabled workers to understand the financial needs of the business. This could lead to under-recognition and over-tolerance of workplace hazards. However, when employment relations were poor, workers' awareness of workplace risks might be enhanced.*

Risk as individually navigated

The studies reported that workplace health risks in small businesses were seen as a phenomenon to be individually navigated by workers. These studies, which focused on varied industries ranging from dry-cleaning to construction, found that workers placed a strong emphasis on individual control over health risks and employers did not claim management of OHS. Workers felt they should navigate risks by "taking greater care" (Holmes et al. 1999), coping more effectively (Eakin et al. 2001), and becoming more educated about risk (Holmes et al. 1999). Eakin et al.'s (2001) study of occupational health nurses' attempts to introduce workplace stress reduction programs in small businesses found that workers tended to focus on stress management techniques as a solution, therefore implicating individual coping ability as the problem. Niewohner et al. (2004) also showed how small business workers found individual ways to manage risk; for instance, by claiming a resilience to particular hazards. The authors noted that both workers and managers tended to overestimate their level of personal control over OHS risk. Therefore optimal OHS performance was related not simply to improved knowledge, but also to beliefs in personal control.

Eakin (1992) explained that employers left workers to find ways to manage risk because they saw workers as colleagues who had personal autonomy and responsibility. In another study, Eakin et al. (2001) found that employers viewed worker stress as a personal, individual problem, and preferred not to consider workplace determinants of stress. Recognizing stress as a workplace issue might entail complex, time-consuming organizational solutions, and might "stir up trouble" among workers. Walters (1998) found that farm workers preferred to manage risk on their own, but offered different reasons. He found that workers had concerns about workplace health but that in the context of "close and participative" working relations the workers wanted to resolve OHS issues without implicating their employers. Mayhew & Quinlan's (1997) study of construction workers likewise found that workers viewed OHS risks as something to be individually navigated. Their suggested explanation was that workers in this industry tended to shift back and forth between employee and self-employed positions and this oriented workers to self-reliance. Additionally, these workers tended to view health and safety as part of the craft-based control over their tools, which made it an individual rather than a managerial matter.

- *The studies reported that small business workers and owners viewed workplace risks as something to be managed by workers themselves. Several reasons were offered for this view: small business workplace norms of autonomy, worker orientation to their work as a craft, and owner avoidance of time-consuming formal workplace health programs.*

Managing risk and health problems in small businesses

The social disruption of injury

Although workers and employers might minimize the problem of OHS risk, once a health problem occurred, its interpretation and management could be disruptive to work relations. A worker's absence could have a significant impact on a small business. For some owners, it signalled a "catastrophe" when the worker was absent but the employer could not hire a replacement (Eakin et al. 2003). Worker injury could also be an administrative headache as small business employers lacked resources to enforce and monitor return to work. Most importantly, injury could disrupt trust relations that underpinned functioning in small businesses where task allocation could be informal, impromptu "pinch-hitting" was needed, and much work was done without supervision (Eakin et al. 2003).

Workplace injury in small businesses could precipitate a re-evaluation of employment relations whereby the worker questioned the employer's goodwill and the employer doubted the worker's commitment to the enterprise (Eakin et al. 2003, Eakin & MacEachen1998). Eakin et al. (2003) found that employers could "harden" their stance to injured employees after experiencing the economic costs of an accident. Supporting this notion, Shain et al. (1998) found that "philanthropist" or generous types of employers reported changing their stance to less trusting and cynical "calculator" types when confronted with employee problems. The research therefore identified injury as a turning point in an employment relationship. As small businesses often had few possibilities for modified work, employers who did not value a worker might not make the effort to accommodate the worker when injured, thus effectively ending the worker's employment with the firm (Anderson et al. 2007, Eakin et al. 2003).

- *The effect of an injury on small business production could be profound. The business strain posed by a work injury could lead employers to re-evaluate the value of the injured worker and might threaten his or her continued employment.*

Small business strategies for managing health

The studies pointed to ways that small businesses adapted their workplace health practices to suit the limited resources of the business. Workers engaged in "proxy" (or adapted) behaviours to manage risks, and owners

engaged in "playing it smart" (or calculating practices) to navigate disability management requirements.

Workers were found to engage in "proxy" behaviours, such as washing hands instead of wearing gloves, re-using gloves, opening a window rather than wearing a mask, or using a wet kerchief in place of a mask (Niewohner et al. 2004, Wulfhorst et al. 1996, Aragon et al 2001). Walters (1987) found that small businesses had informal OHS practices and procedures compared with larger firms in the same industry and that they lacked OHS training. Wulfhorst et al. (1996) found that although hairdressers assimilated the knowledge that wearing gloves protected against chemicals, they didn't fully implement this knowledge. For instance, they turned their gloves inside out and re-used them. Similarly, Aragon et al. (2001) found that although Nicaraguan farmers had training through well-developed OHS initiatives, they attempted to avoid risk by engaging in proxy behaviours. They drank milk because they thought it was an antidote to pesticides, and wore wet kerchiefs over their face to avoid pesticide exposure. Studies suggested that small business workers engaged in such proxy behaviours because they were resistant to training or because they lacked supports, such as an adequate supply of gloves or masks (Wulfhorst et al. 1996, Niewohner et al. 2004).

Owners also adapted their workplace health practices to suit the needs of the business. Anderson et al. (2007) found that small business owners did not always follow rules about return to work. For instance, their statements about the availability of modified work appeared to be contingent on the quality of the relations with the worker. Similarly, Eakin et al. (2003) found that owners would give an unattractive job offer or no job offer to injured workers who were not liked, or would avoid workers' claims for compensation by routinely contesting the claims.

- *The studies showed that when small business workers were provided with OHS resources that were not suitable or easily implemented, workers engaged in "proxy" health protection practices. Owners also adapted their health management strategies to business realities by, for instance, altering return-to-work practices according to the re-employment desirability of the worker.*

Table 17: Thematic matrix of qualitative studies

H indicates concept that appears in studies with high rating; M indicates concept that appears in studies with medium rating.

	Ander-sen et al. 2007 (<20)	Aragon et al. 2001 (<5)	Corneliu-ssen 2005 (<50)	Eakin 1992 (<50)	Eakin & Mac-Eachen 1998 (<50)	Eakin et al. 2001 (<50)	Eakin et al. 2003 (<100)	Holmes et al. 1999 (<20)	Mayhew & Quinlan 1997 (<50)	Niew-ohner et al. 2004 (<20)	Shain et al. 1998 (<50)	Walters 1987 (<100)	Walters 1998 (<20)	Wulf-horst et al. 1996 (<100)
Lack of knowledge of OHS rules & resources														
Don't know OHS rules		**M**	**H**	**H**					**M**	**M**		**M**		**M**
Lack training									**M**	**M**		**M**		
Regulation exempt									**M**					**M**
Low safety inspection									**M**					
Non-unionization impact									**M**				**M**	
Lack formal workplace systems & resources for OHS														
Lack systems		**M**	**H**	**H**		**M**	**H**		**M**	**M**		**M**		
Too busy for OHS							**H**		**M**					
Contracts complicate OHS									**M**					
Owners don't feel responsible									**M**	**M**				
Responsibility is obscured							**H**		**M**	**M**		**M**		
Varied workplace perspectives on health responsibility						**M**								
Systems not always determinant of safe OHS			**H**											

	Ander-sen et al. 2007 (<20)	Aragon et al. 2001 (<5)	Corneliu-ssen 2005 (<50)	Eakin 1992 (<50)	Eakin & Mac-Eachen 1998 (<50)	Eakin et al. 2001 (<50)	Eakin et al. 2003 (<100)	Holmes et al. 1999 (<20)	Mayhew & Quinlan 1997 (<50)	Niew-ohner et al. 2004 (<20)	Shain et al. 1998 (<50)	Walters 1987 (<100)	Walters 1998 (<20)	Wulf-horst et al. 1996 (<100)
Information, policies and legislation don't fit small businesses														
OHS info not relevant or useful									**M**	**M**				
Regulations difficult to implement						**M**								
Policy out of step with small business contract realities									**M**					
Small businesses can normalize/ not use OHS knowledge														
OHS hazards normalized culture affects OHS take-up		**M**		**H**		**M**							**M**	
Client-focused relations affect OHS practices										**M**				**M**
Economic constraints affect OHS adherence				**H**		**M**			**M**	**M**				
OHS views shaped by relations of work														
Close work roles affect views		**M**		**H**	**H**									
Strained relations affect health & OHS understandings				**H**					**M**					

	Ander-sen et al. 2007 (<20)	Aragon et al. 2001 (<5)	Corneliu-ssen 2005 (<50)	Eakin 1992 (<50)	Eakin & Mac-Eachen 1998 (<50)	Eakin et al. 2001 (<50)	Eakin et al. 2003 (<100)	Holmes et al. 1999 (<20)	Mayhew & Quinlan 1997 (<50)	Niew-ohner et al. 2004 (<20)	Shain et al. 1998 (<50)	Walters 1987 (<100)	Walters 1998 (<20)	Wulf-horst et al. 1996 (<100)
Risk as individually navigated														
Risk as an individual worker problem				**H**		**M**		**M**	**M**	**M**			**M**	
Workers manage by coping						**M**		**M**						
Workers don't need to be babied				**H**										
Work environment solutions too complex						**M**								
Workers prefer own solutions									**M**				**M**	
The social disruption of injury														
Lost productivity							**H**							
Injury management an administrative headache							**H**							
Re-evaluation of employment relations	**M**				**H**		**H**				**M**			
SB strategies for managing OHS														
Proxy behaviours		**M**								**M**				**M**
Uninformed OHS practices												**M**		
Lack support for adequate OHS										**M**				
Owners apply business logic	**M**						**H**							

Qualitative literature analysis

Heterogeneity of small businesses has implications for OHS research

Small business research assumes a certain consistency among firms due to their size. The themes described in the previous section identify cross-cutting similarities among different types of small firms. However, an examination of the articles shows that attention also needs to be paid to heterogeneity among small firms.

Small business heterogeneity was evident across studies. The studies drew attention to disparate conditions for health exposure and health management in small business sectors. They also showed that there were differences between local neighbourhood enterprises and small firms that were technologically sophisticated and engaged in the global economy.

Studies that examined OHS problems *across industry sectors* (Eakin 1992, Eakin et al. 2001, Eakin et al. 2003, Eakin & MacEachen 1998) detected similarities related to smallness of businesses and associated conditions, such as informal social relations. However, studies that focused on a *particular sector* drew out the relevance of health risks and management approaches for that sector. The construction sector dealt with distinct hazards such as falls and crushes (Holmes et al. 1999), and health and safety in this industry could be compromised by complex layers of sub-contracting (Mayhew & Quinlan 1997). Service sectors faced problems with workers who did not or could not use personal protective equipment, such as gloves, if it interfered with their customer's needs (Wulfhorst et al. 1996, Niewohner, Aragon et al. 2001) . Two of these studies indicated customer relationships inhibited the use of safety equipment. Studies also drew attention to variations in OHS training and unionization by sector and how this might affect workplace health (Niewohner et al. 2004, Mayhew & Quinlan 1997). Sector-based studies of small business OHS have the potential to enhance our understandings of particular workplace health conditions and the possibility for interventions.

The studies also drew attention to the differences between small businesses that are neighbourhood firms and those that operate in the global arena. In the context of advanced communication systems and globalized economies, small firms have become increasingly diverse (Walters 2002). They are no longer restricted to local operations and their ability to be nimble might actually put small firms at an advantage in the global economy. A key contrast between the studies of "traditional" small businesses (e.g. dry-cleaning, hair salons, printers, farms, construction) and small firms in the globalized economy was found in Corneliusson's (2005) examination of OHS in biotechnology firms. These firms operated across national jurisdictions. They had many features of large businesses, including the need to observe multiple regulations, the ability to outsource hazardous work,

need or ability to pay OHS advisors, hire professional and highly skilled staff, and manage regulatory compliance.

Layers of complexity in analyses of small business OHS

Examining all of the studies showed the layers of complexity in a comprehensive analysis of how small businesses understand and enact processes in relation to OHS. At the level of *individual workers and managers*, studies showed varied beliefs, attitudes and practices. There were differences between managers and workers and among workers in different types of businesses. At the level of *social interaction* within businesses, the studies showed how understandings occurred in the context of the financial and production needs and activities of the firm. For instance, there were findings about the social disruption of injury and how personal workplace relationships in small firms could account for certain injury experiences. At a *cultural level,* studies showed how small businesses in different sectors would variably interpret or react to OHS issues (e.g. culture of insularity, culture of client-focused relations). Finally, at a *structural level*, the studies identified how policies (e.g. small business regulations exemptions), contractual relations (e.g. sub-contracting arrangements), and labour conditions (e.g. unionization) shaped how OHS was understood and functioned in small businesses.

The individual and social levels were found in studies sampling in single or mixed sectors. However, we found that the studies engaging at a cultural and structural level tended to focus on a particular sector. Some government policies, such as return-to-work policy, affected all small businesses and could be analyzed across sectors. Yet other structural issues, such as types of contractual relationships, characterized activity within a particular sector. Therefore to discern cultural and structural impacts on small business OHS activities, studies might need to consider the conditions of a sector (e.g. contractual norms, type of labour, particular policies or workers' compensation arrangements).

Intervention challenges and possibilities in small businesses

The articles in this review identified conditions that were required for OHS improvements and interventions in small businesses. The studies showed that interventions needed to be based on more than providing education about hazards. Consideration also needed to be taken of how to present the knowledge in an accessible, relevant way to small businesses and of pre-conditions for workplaces to be able to work safely (e.g. budgets, cost considerations).

The studies also showed how interventions need to be tailored to small businesses and to be relevant to their industry sector (Corneliusson 2005, Aragon et al. 2001). Importantly, if working relations are poor then employees might not use information about how to avoid risk, because they

do not trust the employer (Eakin & MacEachen 1998, Niewohner 2004) . Also if accountability about OHS is unclear within a small business, then this can affect the success of an intervention (Walters 1987, Mayhew & Quinlan 1997). Small business owners may first need to be convinced that there is a risk, and that the intervention is possible and credible, before they will invest their time and resources into it.

Conclusion

The systematic review of qualitative evidence used a general meta-synthesis approach and a consensus process (8,53) to answer the question: "How do workplace parties understand and enact processes related to OHS?"

From an initial pool of 33 relevant articles, 20 proceeded to quality assessment and partial data extraction. Four studies were found to be of high quality, 10 of medium quality and six of low quality. The 14 medium and high quality studies proceeded to data extraction and synthesis.

The themes identified draw attention to the conditions in which small businesses operate and their OHS needs, as follows:

- Small businesses lack knowledge of OHS rules and approaches. The reasons include poor training standards, regulations exemptions and lack of inspection surveillance.
- Small businesses lack formal OHS systems and resources. The reasons are: their size precludes formal systems, owners don't see themselves as responsible for worker health, owners focus on immediate business needs rather than health, and owners attend to health needs without formal systems.
- Information, policies and legislation do not always fit small business realities. This is because OHS information can be unclear, norms of social relations in small firms might not fit with policy requirements, and contractual arrangements in certain sectors might not be adequately captured in law.
- Small business parties can downplay risks or not use workplace health information. This is because certain sectors avoid outside "interference" with work practices, risk management interferes with work practices, or economic needs of the business prevent a focus on OHS adherence.
- Small businesses workers can under-recognize and over-tolerate hazards. This is because workers and employers work side-by-side, workplace social relationships play a key role in work relations, and workers can align their own success with that of the business.
- Owners and workers see workplace risk as something to be individually navigated by workers. The reasons are: cultures of independence and autonomy and over-estimations of personal control.

- Workplace injury is particularly disruptive to small firms that rely on each employee. An injury can also upset the social relations that are important to small business functioning, and can lead owners to re-evaluate the value of the injured worker.

We note additional issues not present in any one theme:

- Small businesses are heterogeneous. They can have particular OHS needs depending on their sector. With the opening of new economic arenas, small businesses are establishing a presence in sectors such as software and high technology. Attention needs to be paid to small business needs in the context of international business relations.
- In order to gain a comprehensive understanding of small business OHS, research programs need to consider small business understandings and practices at the level of the individual, workplace, culture and social structures. Small business interventions require information to be presented in an accessible, relevant way, and to realistically consider pre-conditions for optimal work safety, such as cost considerations. In addition, risk awareness and cohesive work relations might enhance intervention success.

4.3 Combined synthesis from qualitative and quantitative studies

This section describes the combined synthesis of the findings from the systematic reviews of qualitative and quantitative literature on work and health in small businesses.

There are various models for integrating qualitative and quantitative findings in systematic reviews (10,54-56). This review used a parallel design that focused on similarity and complementarity. That is, the entire research team provided a coherent design and scope for the review, and methodologically specialized teams reviewed and synthesized findings related to two review questions. This model was used to enhance methodological sensitivity.

What lessons can be drawn from the relationship between the qualitative and quantitative findings on work and health in small business? We identify five issues: the contexts of interventions, tailoring of interventions, complexity of intervention designs, relevance of business size and methodological issues. Finally, we comment on the parallel design we used for this mixed method systematic review.

Interventions, contexts and tailoring

Both the quantitative literature (intervention effectiveness) and qualitative literature (OHS understandings and processes) direct attention to the relevance of context and tailoring for OHS prevention and interventions.

The qualitative literature highlights the relevance of *legislative context*. Some sizes of small businesses across jurisdictions are exempt from some aspects of OHS legislation. For instance, Ontario firms with 20 or fewer employees are mostly exempt from the requirement to have a joint health and safety committee. In the qualitative review, studies noted similar exemptions in Australia (Mayhew 1997), Germany (Wulfhorst 1996), and the United Kingdom (Walters 1987). As a result, some small business employers may have lacked knowledge about OHS responsibilities as they were not required to be aware of and address OHS risks as larger firms were.

Both literatures identify the relevance of *social norms in small businesses*. Many of the qualitative studies showed how employer and worker understandings about the nature and attribution of risks shaped OHS practices. For instance, some studies identified how small business workplace parties viewed risk as a phenomenon to be individually navigated (Eakin 1992, Eakin et al. 2001, Holmes et al. 1999, Mayhew & Quinlan 1997, Niewohner et al. 2004, Walters 1998). Others focused on how personal working relationships in small businesses affected workers' views of the dangerousness of tasks and their willingness to confront hazards (Aragon et al. 2001, Eakin 1992, Eakin & MacEachen 1998). Two quantitative papers (Lazovich et al. 2002, Rasmussen et al. 2003) also focused on social norms. These studies included an interactive problem-solving component where people met to discuss solutions to OHS problems. In addition, attitudes and beliefs were identified as a leading indicator in the quantitative studies. Two studies included components that focused on perceived barriers to personal protective equipment or safety procedures (Torp 2008, Rasmussen et al. 2003) and one focused on worker confidence in engaging in safety practices. Overall, social norms about the dangerousness of risks and how to respond to them were important aspects of risk avoidance, prevention and management.

The relevance of *sectoral context* is clear across the qualitative and quantitative literatures in the disparate occupational health concerns of different kinds of small businesses. Although some OHS issues can be addressed cross-sectorally (e.g. Wells et al.), the studies also indicated a need to tailor interventions to industry sectors, and to differences within sectors. For instance, internationally-oriented biotechnology businesses were profitable and able to sub-contract the processing of hazardous materials. Their staff were well-trained in laboratory safety procedures through their education (Corneliussen, 2005). In these firms, clear documentation of OHS compliance was the main concern. Another example was construction

businesses, which have complex series of subcontracting relationships that create workers with different contracts within a workplace and blur the areas of OHS responsibility of employers and employees (Mayhew & Quinlan 1997). Therefore identifying the OHS jurisdiction and responsibility was a prime concern. A final example is small lithographic printing firms that could not afford to eliminate chemical exposures through automation, and required solutions such as local exhaust controls (Crouch et al. 1999). The primary OHS concern in these firms was the adoption of engineering controls that were effective yet affordable. These examples show that interventions require consideration of sector as well as special needs related to workplace size.

While sensitivity to sector is important, the literature also indicates that a broad intervention model cannot necessarily be applied to all settings, even within a single sector. As a case in point, we compare interventions in three farming studies, in the United Kingdom, Nicaragua and Denmark.

The United Kingdom farming intervention (Walters 1998) involved a trade union initiative to provide agricultural workers with a form of support on OHS matters through regional health and safety representatives. This initiative was an attempt to replicate a system of representation for farm workers in Sweden. The researchers observed many facilitators and barriers to this initiative. They found that safety representatives needed not only to understand farm hazards and safety standards, but also required particular social skills to interact with farmers and gain their trust. They observed that the insular culture on farms and the close, participative employment relationships between workers and farmers led workers to be resistant to "outside" OHS representation. The authors surmise that, as the farm industry has the lowest trade union density in the U.K., an intervention based on a union model that is focused on separate concerns for workers and employers may not be well suited to local culture of farming.

The Nicaragua faming intervention (Aragon et al. 2001) involved educational programs to small-scale farmers. The programs focused on toxic pesticide risk awareness and risk management strategies. This study showed that although farmers had been educated about risks and avoidance, they did not change their behaviour. This study drew attention to the layers of beliefs that affected interventions. Although farmers knew that the education programs were intended to help them, they did not use this knowledge because they had greater faith in the (scientifically ineffective) "home-made" strategies of their forefathers and an overriding concern with crop pest management. The authors draw attention to the need for interventions to consider specific national and local characteristics, including the language and format of interventions and cultural factors that may affect the usefulness of OHS training programs.

The Danish farming intervention (Rasmussen et al. 2003) did not appear to encounter the level of barriers of insularity and cultural beliefs as described above. This intervention was, by comparison, comprehensive and required participants to engage fully in the study. Farmers participated in a safety walk-through with a farm safety specialist and received a written report with recommendations about improvements. All adults at the farm took part in a one-day course run by occupational health physicians and psychologists. At this course, farmers and farm staff were educated about risk factors. They participated in focus group discussions about accidents, how they occurred, how they might have been avoided, and why people behaved as they did. This study found a moderate intervention effect.

Overall, the literature draws attention to the impact of the businesses' context on OHS practice. It shows the need to tailor interventions to the needs of particular sectors, but also to differences within a sector or across jurisdictions.

Complexity of intervention designs

The qualitative and the quantitative literatures draw attention to the complexity of work processes and workplace social relationships and the difficulty of creating change by intervening on one factor alone. The qualitative literature identifies how knowledge provision alone is insufficient for change. It suggests that attention needs to be paid, for example, to how the knowledge is conveyed and its direct relevance to the firms' size and sector (Niewohner et al. 2004, Eakin 1992, Walters 1987). The studies also draw attention to ways that cost constraints (Wulfhorst et al. 1996, Aragon et al. 2001), poor workplace social relations (Niewohner et al. 2004, Eakin & MacEachen 1998), and uncertainty about OHS responsibility (Mayhew& Quinlan 1997, Walters 1987) might undermine full intervention implementation. The culture of the industry sector might also pose a barrier to adopting interventions. Some sectors such as farming can be insular and disinterested in "outside" advice (Aragon et al. 2001, Walters 1998), although safety culture in an industry can vary from region to region.

Four studies in the quantitative literature included multi-component interventions. The authors drew attention to the need to address multiple issues such as engineering arrangements, staff training, social marketing and safety audits. An exception to the need for multi-component interventions might be particular engineering interventions (e.g. Crouch et al.) that do not require practice and behaviour changes in the workplace. Some interventions focused on the specific needs of each business (Lazovich et al.2002) and on a train-the-trainer approach rather than on offering prescriptive OHS suggestions (Wells et al. 1997). One study was also sensitive to the cost feasibility of engineering interventions and offered solutions that were fiscally manageable (Crouch et al. 1999).

Overall, these literatures suggest that small business OHS change and improvements require a focus on a series of *interrelated* factors.

The relevance of business size across sectors

Although we have argued above that interventions need to consider the specific sectors and contexts, we also find that business size (smallness) is pertinent across sectors. The qualitative literature explains how social relations in small businesses are characterized by relatively informal and non-hierarchal relations that develop due to the close work proximity of employers and workers. The "we-they" dichotomies that can be present in large, bureaucratically-organized firms are less likely to exist in small businesses because employers and workers tend to work alongside and to mix roles with one another (Aragon et al. 2001, Eakin 1992). This social proximity, in turn, affects how workers appraise and respond to OHS risks and how employers manage injury following an accident (Eakin & MacEachen 1998, Walters 1998). The qualitative literature highlights the relevance of work relationships in small businesses and how these relations influence the continuum of health understandings and behaviours. The qualitative literature also identifies ways that small firms lack systematic OHS knowledge, OHS systems, and are not subject to the same labour inspection scrutiny as large firms (Aragon et al. 2001, Eakin et el. 2003, Mayhew & Quinlan 1997, Walters 1987).

The quantitative literature also shows the need to consider small business size when conducting interventions. An engineering intervention study (Crouch et al. 1999) emphasized the need for interventions that were affordable to small businesses. A train-the-trainer intervention study (Wells et al. 1997) across industry sectors found that the effect was greater in small businesses with more employees. These results may reflect the possibility that the differential effect of the intervention might have to do with whether a train-the-trainer model is a good fit with the smallest businesses. The problems small firms experience with OHS implementation were found in the qualitative literature. Eakin et al. (2003) found that the social relations of small firms were at odds with the imperative of government return-to-work policy. Other studies found that small firms did not fully implement OHS training (Niewohner et al. 2004, Wulfhorst et al. 1996, Aragon et al. 2001, Walters 1987). These studies showed that OHS training or tools did not suit the day-to-day realities of small business work life and that workers' attempts to implement OHS could be rendered ineffective by their work environment. For instance, although hairdressers learned that wearing gloves protected against chemical exposure, they "economized" with gloves by turning them inside out and re-using them (Wulfhorst et al. 1996). Therefore, the degree of resources available to small business workers might affect protection behaviours.

The quantitative literature also drew attention to the impact of size on intervention design and the ability to detect effects. One study (Lazovich et al. 2002) concluded that in order to specify effect sizes that are meaningful for health, consideration needs to be taken into the feasibility of sample sizes. To detect more robust intervention effects, more small businesses are required, but the ability and effort to recruit extra small firms would be a challenge. Other studies (Rasmussen et al., 2003) drew attention to the complex interplay of numerous environmental and individual risk factors that lead to an accident. The need to include many small businesses in order to have sufficient sample size also increases the possible variance among businesses. Therefore any study of small businesses poses specific challenges to intervention studies. However, as noted in the Results section, the intervention studies also show that it is indeed possible to conduct well-designed intervention studies in small businesses.

5.0 Discussion

This section provides a discussion of the quality of the scientific literature that met our relevance criteria, and future work recommended in the field. We also reflect on strengths and weaknesses of this systematic review, and recommendations for future reviews.

5.1 Quality of the scientific literature

Quantitative literature (intervention effectiveness)

As described above, high quality small business intervention studies do exist and are possible. However, more attention needs to be focused the methodological quality of these interventions. To develop standards for intervention research in small business settings, a conference or series of workshops could be convened with stakeholders.

To advance the quality of evaluation of small business interventions, and to shift the level of quantitative evidence from moderate to strong, further research should include several methodological features shown in Table 9 and described below.

We found that many low quality studies did not include a concurrent control group, which is necessary to evaluate effectiveness. If they did have a control group, randomization of control and intervention groups was least likely to be included in low quality studies. (One possible advantage of studying interventions in small business rather than in large firms is that the potential for contamination of the control group may be lower. Because small businesses are relatively independent, interventions can be carried out in physically distinct locations without concern that employees in the control group will be exposed to the intervention.)

The intervention studies could also be improved by increasing the number of small businesses recruited. In only one high quality study (Lazovich et al. 2002) did we find an explicit sample size (i.e. the number of small businesses). In some research areas such as engineering control evaluation, it is common to use a case study approach to determine effectiveness. However, this leads to studies that focus on just one or a few firms. Given that the effectiveness of engineering controls can decrease over time due to logistical and behavioural factors, interventions could be enhanced by including multiple firms and evaluating effects over longer periods of time. This approach to assessing engineering controls by recruiting many small businesses was shown in the study by Lazovich et al.

Studies could be improved by having a duration of at least four to 12 months so that longer-term effectiveness and sustainability can be assessed. Also, covariates and confounders should be measured and adjusted for using

multivariable statistical models. This is critical when using a non-randomized study design.

Qualitative literature (OHS understandings and processes)

The methodological limitations of qualitative studies were poor rationales for sampling approaches and inadequate descriptions of data collection. These omissions prevented them from being considered high quality. These studies also failed to examine and explain variance and gaps in findings and generally lacked sufficient evidence. There was overall little reflection about how data collection procedures might have shaped the findings. The medium quality studies were often clearly written and organized, but they were limited to descriptive accounts and for the most part did not extend their analyses to consider how findings were produced in certain contexts.

The high quality studies provided carefully detailed descriptions of findings that were well-supported by the data. They provided a clear link between the study rationale, analytic approach and findings. Nuance and contradictions were considered and used to explain interrelationships between the data and the context in which they occurred.

Future studies should provide greater detail about study sampling and data gathering processes to help readers understand how findings are produced. They might include analyses of legislative, economic or political contexts as they shape the behaviour of small businesses. Although word length limitations in peer-reviewed journals prevent extended descriptions, we note that the high quality papers were able to provide detail appropriately and succinctly. Attention to these features would move the methodological quality of studies beyond "descriptive" (describing a range of responses, but not explaining how and why a situation is happening) to explanatory (understanding how behaviours and processes occur as they do).

Future qualitative studies of work and health in small businesses might focus on several under-researched areas. We note that some of the studies included small business samples but did not engage analytically with the issue of "smallness." That is, the authors did not discuss the issue of how study results were produced as a result of the size of the firm rather than, for instance, the firm's sector or other attributes.

Only two studies (Andersen et al. 2007, Eakin et al. 2003) that proceeded to data extraction focused on the topic of return to work, and so there was insufficient evidence to constitute a theme. We recommend that more studies be conducted on return to work and disability management in small businesses. Also, only one study focused on the newer high technology firms in the small business sector. More research is needed on the OHS needs of these firms.

5.2 Issues in conducting systematic reviews

This section discusses issues in conducting systematic reviews that emerged during this review and that warrant further discussion. We share these issues in order to improve systematic review methodology.

Quantitative research

We strongly encourage small businesses and their safety partners to systematically evaluate any intervention that they implement. Guides are available to help (e.g. Robson et al 2001) (47). If funding and support are not provided for evaluations, then future review efforts on this topic will provide little additional guidance. We found that few studies used similar outcome measures, making it a challenge to integrate findings. While some diversity in specific measures is inevitable, the study of wood dust control (Lazovich et al.2002) provides a good example of the use of outcome measures from multiple domains (workplace exposure, behaviour and attitude).

Intervention and outcome specification

Although we did identify previous work that proposed a categorization system for types of interventions and outcomes (59), we found them to be too general. Developing meaningful categories to communicate findings will continue to be a challenge in systematic reviews of OHS. At least one issue is important to note with intervention specification. Intervention components were often combined with each other, which prevented the identification of component-specific effects. Four of the five studies that included training found positive effects across the different outcome domains. However, they could not be grouped together in an intervention category because they included additional intervention components.

Methodological and statistical improvements to the literature

Statistical analyses are helpful to ascertain whether differences between groups are simply due to chance. However, heterogeneity in the types of statistical procedures used made quality assessment and evidence synthesis on this review difficult or impossible.

Qualitative research

The quality of quality assessment

Systematic reviews of qualitative literature are an emergent field. Given this fact, and based on our experience, we advise using only experienced qualitative methodologists to assess and synthesize qualitative literature. Quality assessment is a particular challenge for reviews of qualitative literature because these studies are not amenable to checklists of study validity and reliability for assessing methodological quality (60). Skilled judgment is required to assess the disciplinary traditions of the study authors, the theoretical orientation of the study, and the suitability of the study method and analysis approach.

Varied qualitative designs

There is some controversy among qualitative systematic reviewers about the strengths and weaknesses of reviews that include studies with a variety of different and contrasting design; for instance, ethnography and phenomenology. We chose to be open to all designs and found this was an effective approach. The variety of studies and theoretical perspectives created a "layered" understanding of the issue at hand. For instance, we were able to synthesize findings about the relevance and role of culture, social structures and policies, workplace social relations, and descriptions of workplace hazards, work processes, and workplace party beliefs and attitudes.

What counts as qualitative

Decisions need to be made about what counts as a qualitative design. We reviewed studies that self-identified as "qualitative," but they did not use any recognizable qualitative methods. This occurred with several participatory studies identified in this review. These studies used interview formats for parts of the research, but ultimately measured results quantitatively (e.g. by frequency of behaviours improved). To be included in a systematic review of qualitative literature, either qualitative or mixed method studies should have qualitative findings that are analyzed independently and can "stand alone" from the quantitative data and its analysis. To be recognized as qualitative, there must be qualitative data collection (e.g. interviews, focus groups, documents) and some qualitative analysis of these data (e.g. thematic analysis, content analysis).

5.3 Strengths, limitations, next steps and reflections

Strengths

A strength of this review is that we were able to identify points of comparison and complementarity between the quantitative and qualitative literatures. This allowed for a broad understanding of small business OHS that was not constrained by methodological or disciplinary boundaries. We were able to examine interventions and their attributes that contributed to adequate designs. We were also able to consider the contexts in which interventions and risk appraisal occurred. For instance, the results showed how health understandings and practices within firms might be shaped by social relationships, local cultures, and broader legislative and policy structures.

The study team included researchers with varied disciplinary backgrounds and specialized methodological expertise (e.g. expertise in ergonomics, epidemiology, industrial hygiene, sociology, psychology, social work). Several reviewers had research experience in small workplaces. We believe this broad expertise contributed to the internal validity of our review.

To be as comprehensive as possible, we searched the peer-reviewed literature in several electronic databases, and the reference lists of relevant studies. We also contacted external experts to request potentially relevant published articles. These steps helped ensure that we reviewed as much relevant literature as possible.

The review teams also used a process of interchanging the pair of reviewers at each phase to improve the quality and independence at quality assessment and at data extraction.

We engaged stakeholders throughout the review. This consultation helped to establish of the scope and foci of the review. For instance, decisions were made about the definition of "small" for small businesses, and about the usefulness of conducting a partial data extraction on all studies relevant to our topic.

Limitations and next steps

There were several limitations of this review. One was that the quantitative part focused only on intervention studies in small businesses and not on other types of studies. Another was that the review included only peer-reviewed literature and not the "grey literature." Finally the inclusion criteria limited the focus to small firms with clearly defined samples of 100 or fewer employees.

Next steps for future systematic reviews:

- Review the observational quantitative literature that examines small business safety climate and OHS safety processes, especially those that examine differences between small businesses.
- Include grey literature for intervention studies that have not been published in peer-reviewed journals, but could inform small business OHS.
- The review was limited to articles published in English, French and German. It is possible that articles in other languages might have provided relevant evidence that could have been used to answer the review question.
- Broaden inclusion criteria. We restricted inclusion to small businesses with 100 employees or fewer, and excluded studies that did not specify business size. If a review included all studies self-defined as "small" and did not require specification of employee numbers as ours did, a broader range of studies might be captured.

Reflections on integrating qualitative and quantitative methods

The process of the review

We find that our model of parallel reviews of qualitative and quantitative literature has advantages and disadvantages. A clear advantage of this strategy is the finely tuned treatment we were able to give to the quality assessment and evidence synthesis using specialized methodological groups. This design allowed for sensitive and optimum data extraction. Although separate sub-teams conducted the quality assessment, data extraction and evidence synthesis, the study team as a whole was coherent and communicated closely. The entire team met every two weeks to discuss progress and results. The identification of literature, study design and methods synthesis was a full-team effort. We were able to achieve independent qualitative and quantitative syntheses of the small business literature, and also to pursue a strategy of synthesis of complementarity and comparison depending on the synthesis findings and their relevance to this issue. These include observations about small business contexts, size, sectors and methodological considerations when examining OHS.

Qualitative and quantitative reviews have dissimilar study paces, and this can affect the ability of sub-team members to compare processes and findings at different stages. At the start of the review, quantitative reviewers require more time to work out definitions (e.g. outcomes) but at the conclusion they can quickly tabulate the results. In contrast, qualitative reviews begin easily with broad and open-ended research questions, but require extensive input at the conclusion to develop themes and analyses of findings. Because of these methodological process differences, the paces of the qualitative and quantitative teams were uneven. However, the reviews began and ended at the same time, and the mixed method design allowed for sub-team independence of processes relating to quality assessment and synthesis.

A characteristic of our mixed method synthesis approach is that the studies did not inform each other *during* the synthesis process. That is, findings from the qualitative studies did not direct the quantitative team to focus more strongly on matching elements during data extraction, and vice versa. Our approach preserved the "natural" findings and emphases of the original studies.

The full-team approach to the title, abstract and full article review may have complicated the process. We believe the quantitative and quantitative researchers' respective lack of specialized with the others' disciplines and methods led to an over-inclusion of studies to the specialized sub-teams before quality assessment. The subsequent screening of inappropriate studies may have added time to the process. However, this whole-team approach served an indirect purpose—it united the systematic review team, and helped

to develop the relationships and a common vocabulary that are critical to a mixed method review.

The effect of method on findings

We observe that the relevant qualitative and the quantitative literatures had different foci. The qualitative literature focused strongly on *problems* with OHS in small businesses. They often explained how and why OHS practices do not operate smoothly or as expected by policy-makers and interveners. In contrast, the quantitative papers generally described intervention *effectiveness*. Although not all aspects of interventions had the desired effect, the authors found that the interventions had some impact and that the findings led the way to future, improved study designs and interventions.

6.0 Messages

Health and safety professionals and policy-makers should consider the unique features of small businesses that affect their approaches to health and safety:

- Cultures of independence and autonomy orient small businesses to focus on health and safety as an *individual worker* issue, rather than a workplace issue.
- They are often subject to different or fewer legislative requirements than large firms, and their range of activities does not always "fit" with broader, standardized information, policies and legislation.
- These firms are particularly disrupted by workplace injury because of their reliance on few employees.

Improving OHS in small businesses requires:

- support for understanding OHS rules and approaches.
- occupational health support that accommodates personal working relationships and economic constraints in small firms.
- occupational health support that considers the lack of formal OHS systems and resources.
- finely tailored workplace health and safety support that considers issues related to size (e.g. affordability, informal task division) and particularities of sector.

Two types of OHS prevention activities that have emerging evidence to support them are:

- a combination of training and safety audits.
- a combination of engineering, plus training, safety audits and motivational components.

Although stronger levels of evidence are required to make recommendations, these interventions most frequently prompted positive changes in safety-related attitudes and beliefs and workplace parties should be aware of them.

7.0 References

(1) Industry Canada. Small business research and policy: key small business statistics - July 2005. How many businesses appear and disappear each year? [updated 2005 Jul 7; cited 2008 Aug 11]. Available from: http://www.ic.gc.ca/epic/site/sbrp-rppe.nsf/en/rd01227e.html. 2005. Ref Type: Generic

(2) Lentz TJ, Wenzl TB. Small businesses with high fatality rates: assessment of hazards and their prevention. Journal of Occupational and Environmental Hygiene. 2006 January; 3(2):D8-D14.

(3) National Institute for Occupational Safety and Health. Identifying High-Risk Small Business Industries: The Basis for Preventing Occupational Injury, Illness, and Fatality. Cicinnati, OH: NIOSH Special Hazard Review; 1999.

(4) Antonsson AB. Small companies. 1997; 466-77.

(5) Lamm F. A research design for Occupational Health and Safety in the small business sector. 1997.

(6) Champoux D, J.-P. Occupational health and safety management in small size enterprises: An overview of the situation and avenues for intervention and research. Safety Science. 2003; 41(4):301-18.

(7) Lentz T, Sieber W, Jones J, Piacitelli G, and Catlett LR. Surveillance of safety and health programs and needs in small U.S. businesses. Applied Occupational & Environmental Hygiene 2001; 16(11):1016-21.

(8) Workplace Safety & Insurance Board. Employers: small business services. [cited 2008 Aug 11]. Available from: http://www.wsib.on.ca/wsib/wsibsite.nsf/public/EmployersSBS . 2008. Ref Type: Generic

(9) Snijders T, Bosker R. Multilevel analysis: an introduction to basic and advanced multilevel modeling. Thousand Oaks, CA: Sage Publications; 1999.

(10) Spencer L, Ritchie J, Lewis J, Dillon L. Quality in qualitative evaluation: a framework for assessing research evidence. London: National Centre for Social Research; 2003.

(11) Slavin RE. Best evidence synthesis: an intelligent alternative to meta-analysis. Journal of Clinical Epidemiology. 1995; 48(1):9-18.

(12) Franche RL, Cullen K, Clarke J, MacEachen E, Frank J, Sinclair S, et al. Workplace-based return-to-work interventions: a systematic review of the quantitative and qualitative literature. IWH Report, 2004 Jun 10.

(13) Côté P, Cassidy JD, Carroll L, Frank JW, Bombardier C. A systematic review of the prognosis of acute whiplash and a new conceptual framework to synthesize the literature. Spine. 2001; 26(19):E445-E458.

(14) Noblit GW, Hare RD. Meta-Ethnography: Synthesizing Qualitative Studies. 9-87. Ref Type: Generic

(15) Campbell R, Pound P, Pope C, Britten N, Pill R, Morgan M, et al. Evaluating meta-ethnography: a synthesis of qualitative research on lay experiences of diabetes and diabetes care. Social Science & Medicine. 2003 Feb; 56(4):671-84.

(16) Dixon-Woods M, Agarwal S, Young B, Jones D, Sutton A. Integrative approaches to qualitative and quantitative evidence. NHS Health Development Agency; 2004.

(17) Scherer RF, Daniel J. Complaint resolution by OSHA in small and large manufacturing firms. Journal of Small Business Management 1993; 31(1):73-82.

(18) Niskanen J, H. Ways to promote a noise control programme. Scandinavian Audiology. 2001; 30:174-6.

(19) Baars S, Hafemann H, Kopsel H, and Reinelt J. Occupational-medical care in car repair shops in Lower Saxony. [German]. Arbeitsmedizin Sozialmedizin Umweltmedizin. 2003; 38(6):342-7.

(20) Sohn H, Lee S, Lee C-U. The effect on workers' knowledge, attitudes and behavior of a group health care program for small-sized plants in Pusan, Korea. Journal of Occupational Health. 1998; 40(3):236-9.

(21) Walker DR. Health and safety management in small enterprises: An effective low cost approach. Safety Science 2004;42(1):69-83.

(22) Raffi G, Giacomini C, Mattioli S. Two experiences on education and training in dry-cleaners. Safety Science. 1995; 20(2-3):305-10.

(23) Krungkraiwong S, Itani T, Amornratanapaichit R. Promotion of a healthy work life at small enterprises in Thailand by participatory methods. Industrial Health. 2006; 44(1):108-11.

(24) Houston K, Atkinson R, Macdonald E, O'Connor ME. A multi-disciplinary approach to assessing health promotion, occupational health and health and safety in the workplace. International Journal of Health Promotion & Education. 1999; 37(3):101-9.

(25) Mayhew CC. The impact of an intensive mailed OHS information campaign on small business cabinetmakers. Journal of Occupational Health & Safety - Australia & New Zealand. 1999; 15(1):47-52.

(26) Pearse W. Club zero: Implementing OHSMS in small to medium fabricated metal product companies. Journal of Occupational Health & Safety - Australia & New Zealand. 2002; 18(4):347-56.

(27) Lingard H. The effect of first aid training on objective safety behaviour in Australian small business construction firms. Construction Management & Economics. 2001; 19(6):611-8.

(28) Sheehy J, Cooper T, O'Brien DM. Control of asbestos exposure during brake drum service. Applied Industrial Hygiene. 1989; 4(12):313-9.

(29) Tuskes PM. Potential hazards in small business - A gap in OSHA protection. Applied Industrial Hygiene. 1988; 3(2):55-7.

(30) Waugh R, L. Sense of sound. Australian Deafness Council project. Journal of Occupational Health & Safety - Australia & New Zealand. 1990; 6(5):399-401.

(31) Earnest G, Ewers L, Ruder A, Petersen M, Kovein RJ. An evaluation of retrofit engineering control interventions to reduce perchloroethylene exposures in commercial dry-cleaning shops. Applied Occupational & Environmental Hygiene. 2002; 17(2):104-11.

(32) Martyny J, Buchan R, Keefe T, Blehm KD. Impact of an OSHA onsite consultation program with an educational component on small businesses in Colorado. Applied Industrial Hygiene. 1988;3(6):12-4.

(33) Fine A, Ward M, Burr M, Tudor-Smith C, Kingdon A. Health promotion in small workplaces: A feasibility study. Health Education Journal. 2004; 63(4):334-46.

(34) Akande A. Coping with entrepreneurial stress: A Nigerian case study. Leadership & Organization Development Journal. 1992; 13(2):27-32.

(35) Dugdill L, Kavanagh C, Barlow J, Nevin I, Platt G. The development and uptake of health and safety interventions aimed at small businesses. Health Education Journal. 2000; 59(2):157-65.

(36) Fishwick T. Human factors in small and medium sized enterprises - some safety problems and solutions. Loss Prevention Bulletin[Rugby]. 2005; Apr.

(37) Hetzel C, Flach T, Weber A, and Schian HM. [Problems of implementing integration management at company level in small and medium-sized enterprises]. [German]. Gesundheitswesen. 2006; 68(5):303-8.

(38) Johansson J, Johansson B. Work environment functions in small enterprises in Sweden. Applied Ergonomics. 1992; 23(2):91-4.

(39) Lingard H. The effect of first aid training on Australian construction workers' occupational health and safety motivation and risk control behavior. Journal of Safety Research. 2002; 33(2):209-30.

(40) Cochrane Manual. 2005. http://www.cochrane.org/admin/manual.html

(41) Paterson B, Turnbull J, Aitken I. An evaluation of a training course in the short-term management of violence. Nurse Education Today. 1992 Oct; 12(5):368-75.

(42) Sandelowski M, Voils CI, Barroso J. Comparability work and the management of difference in research synthesis studies. Social Science & Medicine. 2007 Jan; 64(1):236-47.

(43) Hawker S, Payne S, Kerr C, Hardey M, Powell J. Appraising the evidence: reviewing disparate data systematically. Qualitative Health Research. 2002 Nov 1; 12(9):1284-99.

(44) Harden A, Thomas J. Methodological issues in combining diverse study types in systematic reviews. International Journal of Social Research Methodology. 2005 Jul; 8(3):257-71.

(45) Mays N, Pope C, Popay J. Systematically reviewing qualitative and quantitative evidence to inform management and policy-making in the health field. Journal of Health Services Research & Policy. 2005 Jul; 10 Suppl 1:6-20.

(46) Goldsmith MR, Bankhead CR, Austoker J. Synthesizing quantitative and qualitative research in evidence-based patient information. Journal of Epidemiology and Community Health. 2007; 61:262-70.

(47) Robson LS, Shannon HS, Goldenhar LM, Hale AR. Guide to evaluating the effectiveness of strategies for preventing work injuries. How to show whether a safety intervention really works. Cincinnati: OH: Department of Health and Human Services; Centers for Disease Control and Prevention; National Institute for Occupational Safety and Health; Institute for Work & Health; 2001.

(48) Verbeek J, van der Weide W, van Dijk FJ. Early occupational health management of patients with back pain: a randomized controlled trial. Spine. 2002; 27(17):1844-51.

(49) Eakin JM, Mykhalovskiy E. Reframing the evaluation of qualitative health research: reflections on a review of appraisal guidelines in the health sciences. Journal of Evaluation in Clinical Practice. 2003 May; 9(2):187-94.

(50) Popay J, Roen K. Using evidence from diverse research designs. London: Social Care Institute for Excellence; 2003.

(51) Seale C. Quality in qualitative research. In: Seale C, Gobo G, Gubrium JF, Silverman D, editors. Qualitative research practice. Thousand Oaks, CA: Sage; 2004. p. 409-19.

8.0 References in full data extraction and evidence synthesis

(1) Andersen L, Kines P, Hasle P. Owner attitudes and self reported behavior towards modified work after occupational injury absence in small enterprises: a qualitative study. Journal of Occupational Rehabilitation. 2007; 17(1):107-21.

(2) Aragon A, Aragon C, Thorn A. Pests, peasants, and pesticides on the Northern Nicaraguan Pacific Plain. International Journal of Occupational & Environmental Health. 2001; 7(4):295-302.

(3) Corneliussen F. The impact of regulations on firms: a case study of the biotech industry. Law & Policy. 2005; 27(3):429-49.

(4) Crouch K, M.G. The control of press cleaning solvent vapors in a small lithographic printing establishment. Applied Occupational & Environmental Hygiene. 1999; 14(5):329-38.

(5) Eakin JM. Leaving it up to the workers: sociological perspective on the management of health and safety in small workplaces. International Journal of Health Services 1992; 22(4):689-704.

(6) Eakin J, Cava M, Smith TF. From theory to practice: a determinants approach to workplace health promotion in small businesses. Health Promotion Practice. 2001 Apr; 2(2):172-81.

(7) Eakin JM, MacEachen E. Health and the social relations of work: a study of the health-related experiences of employees in small workplaces. Sociology of Health and Illness. 1998; 20(6):896-914.

(8) Eakin J, MacEachen E, and Clarke J. 'Playing it smart' with return to work: small workplace experience under Ontario's policy of self-reliance and early return. Policy and Practice in Health and Safety. 2003; 1(2):19-41.

(9) Holmes N, Lingard H, Yesilyurt Z, De Munk F. An exploratory study of meanings of risk control for long term and acute effect occupational health and safety risks in small business construction firms. Journal of Safety Research. 1999; 30(4):251-61.

(10) Lazovich D, Parker D, Brosseau L, Milton F, Dugan S, Pan W, et al. Effectiveness of a worksite intervention to reduce an occupational exposure: the Minnesota wood dust study. American Journal of Public Health. 2002; 92(9):1498-505.

(11) Mayhew C, Quinlan M. Subcontracting and occupational health and safety in the residential building industry. Industrial Relations Journal. 1997; 28(3):192.

(12) Niewohner J, Cox P, Gerrard S, Pidgeon N. Evaluating the efficacy of a mental models approach for improving occupational chemical risk protection. Risk Analysis. 2004; 24(2):349-61.

(13) Rasmussen K, Carstensen O, Lauritsen J, Glasscock D, Hansen O, and Jensen U. Prevention of farm injuries in Denmark. Scandinavian Journal of Work Environment and Health. 2003; 29(4):288-96.

(14) Shain M, Eakin J, Suurvali H, and Currie A. Small business owners and the management of employees with problems: A descriptive study. Employee Assistance Quarterly. 1998; 14(1):1-21.

(15) Torp S. How a health and safety management training program may improve the working environment in small- and medium-sized companies. Journal of Occupational and Environmental Medicine. 2008 Mar; 50(3):263-71.

(16) Walters D. Health and safety and trade union workplace organisation - a case study in the printing industry. Industrial Relations Journal. 1987; 40-9.

(17) Walters D. Employee representation on health and safety in small enterprises. Employee Relations. 1998; 20(2):164-79.

(18) Wells M, Stokols D, McMahan S, Clitheroe C. Evaluation of a worksite injury and illness prevention program: do the effects of the REACH OUT training program reach the employees? Journal of Occupational Health Psychology. 1997; 2(1):25-34.

(19) Wulfhorst B, Schobel K, and Schwanitz HJ. Prevention of work related skin diseases in hairdressers: First results. [German]. Prävention und Rehabilitation. 1996; 8(1):22-8.

Appendices

Appendix A

Stakeholder meeting participants (initial meeting)

Kiran Kapoor	Industrial Accident Prevention Association
Sandra Miller	Ontario Safety Service Alliance
Enzo Garritano	Construction Safety Association of Ontario
Paul Goggan	Canadian Auto Workers
Michael Lottamoza	Ministry of Labour
Starly Catli	Workplace Safety and Insurance Board (WSIB)
Norma Akinbiyi	Workplace Safety and Insurance Board (WSIB)
Robert Dean	Workplace Safety and Insurance Board (WSIB)
Reimar Gaertner	Workplace Safety and Insurance Board (WSIB)

Appendix B

Search terms

Database: Ovid MEDLINE(R) <1950 to June Week 2 2007>
Search Strategy:

---

1 Occupational Health/ (16722)
2 exp occupational diseases/ (87639)
3 exp occupational exposure/ (34349)
4 exp Accidents, Occupational/ (14956)
5 occupational injur$.mp. (1059)
6 occupational illness$.mp. (242)
7 (occupation$ adj2 health$ adj2 safe$).mp. (717)
8 OHS program$.mp. (8)
9 OSH program$.mp. (4)
10 OHS.mp. (456)
11 OSH.mp. (111)
12 Safety/ (23830)
13 exp Health/ (171850)
14 exp Health Services/ (1080972)
15 (health$ adj3 safe$).mp. (9937)
16 (health adj3 risk$).mp. (13925)
17 (injur$ adj3 risk$).mp. (5824)
18 (disabilit$ adj3 risk$).mp. (829)
19 (illness$ adj3 risk$).mp. (1416)
20 (occupation$ adj3 risk$).mp. (3827)
21 Risk Assessment/ (78761)
22 health risk assessment?.mp. (653)
23 injury risk assessment?.mp. (12)
24 (disability adj3 risk assessment?).mp. (3)
25 (illness adj3 risk assessment?).mp. (3)
26 occupational risk assessment?.mp. (21)
27 Risk Factors/ (317163)
28 health risk factor?.mp. (307)
29 injury risk factor?.mp. (87)
30 disability risk factor?.mp. (18)
31 illness risk factor?.mp. (22)
32 occupational risk factor?.mp. (499)
33 Workers' Compensation/ (5603)
34 workplace safety.mp. (150)
35 workplace health.mp. (248)
36 ("workplace safety" adj1 "insurance board").mp. (5)
37 WSIB.mp. (6)
38 workplace accident$.mp. (58)
39 (quality of life adj3 work$).mp. (322)
40 exp Work Capacity Evaluation/ (4168)

41 work capacity.mp. (6594)
42 work limitation?.mp. (77)
43 workplace injur$.mp. (141)
44 work injur$.mp. (239)
45 compensation claim$.mp. (590)
46 compensation cost$.mp. (121)
47 (compensation adj3 duration?).mp. (42)
48 time los$.mp. (636)
49 lost time.mp. (290)
50 lost workday?.mp. (112)
51 lost-workday?.mp. (112)
52 time-los$.mp. (636)
53 return to work.mp. (3290)
54 return-to-work.mp. (3290)
55 exp "cost of illness"/ (9222)
56 (cost$ adj3 injur$).mp. (624)
57 (cost$ adj3 disabilit$).mp. (434)
58 wage-replacement.mp. (23)
59 wage replacement.mp. (23)
60 (work related adj3 health).mp. (181)
61 (work related adj3 injur$).mp. (798)
62 (work related adj3 disabilit$).mp. (94)
63 (work related adj3 illness$).mp. (171)
64 (work-related adj3 health).mp. (181)
65 (work-related adj3 injur$).mp. (798)
66 (work-related adj3 disabilit$).mp. (94)
67 (work-related adj3 illness$).mp. (171)
68 time on benefit.mp. (1)
69 time-on-benefit.mp. (1)
70 re-employment.mp. (83)
71 reemployment.mp. (70)
72 (modif$ adj3 work$).mp. (851)
73 (modif$ adj3 job$).mp. (84)
74 (job adj3 adapt$).mp. (27)
75 Sick Leave/ (1672)
76 absenteeism/ (5509)
77 presenteeism.mp. (73)
78 Efficiency/ (9106)
79 productivity.mp. (13973)
80 near miss$.mp. (634)
81 (critical adj3 injur$).mp. (505)
82 ((severe or severity) adj3 injur$).mp. (23268)
83 fatalit$.mp. (10731)
84 labo?r relation$.mp. (289)
85 inspection?.mp. (15261)
86 lead$ indicator?.mp. (47)

87 (safety adj2 climate).mp. (91)
88 (safety adj2 culture).mp. (295)
89 "number of inspection?".mp. (6)
90 training.mp. (152558)
91 Education/ (14161)
92 exp Musculoskeletal Diseases/ (617319)
93 musculoskeletal.mp. (23679)
94 MSD?.mp. (1174)
95 ((perceived or perception) adj2 risk?).mp. (2582)
96 safe$ behavio?r?.mp. (299)
97 enforc$.mp. (9539)
98 complian$.mp. (77483)
99 regulat$.mp. (892055)
100 Dust/ (14509)
101 fume?.mp. (2435)
102 Air Pollutants, Occupational/ (10558)
103 Inhalation Exposure/ (2755)
104 exp Smoke/ (9884)
105 mist$.mp. (14653)
106 gas.mp. (158085)
107 (gasses or gases).mp. (23969)
108 Gas Poisoning/ (573)
109 vapo?r?.mp. (13027)
110 Electromagnetic Fields/ (9649)
111 Radiation, Ionizing/ (4005)
112 exp Noise/ (14828)
113 Vibration/ (13258)
114 Hand-Arm Vibration Syndrome/ (9)
115 Temperature/ (136554)
116 Pressure/ (44624)
117 micro?organism?.mp. (36008)
118 exp Viruses/ (463354)
119 exp Bacteria/ (798991)
120 exp Fungi/ (219644)
121 Parasites.mp. (32216)
122 Allergens/ (23515)
123 commitment.mp. (19226)
124 (fire? adj3 protect$).mp. (155)
125 personal protective equipment.mp. (545)
126 safe$ practice?.mp. (737)
127 Head Protective Devices/ (1660)
128 hard hat?.mp. (18)
129 Gloves, Protective/ (1031)
130 Eye Protective Devices/ (1156)
131 safety shoe?.mp. (14)
132 safety boot?.mp. (4)

133 steel-toe? shoe?.mp. (1)
134 steel-toe? boot?.mp. (1)
135 Ear Protective Devices/ (744)
136 hearing protection.mp. (312)
137 Accidental Falls/pc [Prevention & Control] (2491)
138 Respiratory Protective Devices/ (1156)
139 respiratory protection.mp. (375)
140 exp Housekeeping/ (2588)
141 safety inspection?.mp. (58)
142 guard?.mp. (3162)
143 crane training.mp. (0)
144 defensive driving.mp. (10)
145 education/ and (work$ or occupation$ or job$ or industrial).mp. (2343)
146 energy control?.mp. (58)
147 engineering control?.mp. (331)
148 equipment training.mp. (37)
149 ergonomic.mp. (2147)
150 Human Engineering/ (6668)
151 face protection.mp. (29)
152 foot protection.mp. (12)
153 forklift training.mp. (2)
154 hand protection.mp. (66)
155 hazard communication?.mp. (88)
156 hazardous material? training.mp. (5)
157 (health and safety training).mp. (178)
158 heat shield$.mp. (27)
159 heat protection.mp. (42)
160 job hazard analysis.mp. (5)
161 lockout?.mp. (335)
162 tagout?.mp. (10)
163 machine guard$.mp. (10)
164 manual lift$.mp. (114)
165 material? handling.mp. (295)
166 mechanical lift$.mp. (36)
167 radiation safety.mp. (699)
168 Stress/ (34777)
169 stress management.mp. (1519)
170 or/1-169 (4895700)
171 (small$ adj3 business$).mp. (415)
172 (small$ adj3 firm?).mp. (282)
173 (small$ adj3 workplace?).mp. (54)
174 (small$ adj3 enterprise?).mp. (157)
175 (small$ adj3 organization$).mp. (257)
176 (small$ adj3 organisation$).mp. (24)
177 (small$ adj3 company).mp. (52)
178 (small$ adj3 companies).mp. (176)

179 (small$ adj3 plant?).mp. (779)
180 (small$ adj3 factory).mp. (33)
181 (small$ adj3 factories).mp. (60)
182 (small$ adj3 office?).mp. (100)
183 (small$ adj3 owner? adj2 operat$).mp. (2)
184 (small$ adj3 independent$ adj1 operat$).mp. (4)
185 (small$ adj3 famil$ adj4 business$).mp. (2)
186 (small$ adj1 unit?).mp. (457)
187 (small$ adj3 project?).mp. (246)
188 (small$ adj10 non-government$ organi#ation?).mp. (2)
189 (small$ adj10 nongovernment$ organi#ation?).mp. (1)
190 (small$ adj3 NGO?).mp. (4)
191 (small$ adj2 volunt$).mp. (93)
192 small$.mp. and exp Organizations, Nonprofit/ (181)
193 (small$ adj3 (non-profit$ or nonprofit$)).mp. (14)
194 (small$ adj5 work$ environment?).mp. (9)
195 (small$ adj3 work$).mp. (1422)
196 SME.mp. (366)
197 SMEs.mp. (107)
198 (micro adj3 business$).mp. (2)
199 (micro adj3 firm?).mp. (1)
200 (micro adj3 workplace?).mp. (2)
201 (micro adj3 enterprise?).mp. (13)
202 (micro adj3 organization$).mp. (34)
203 (micro adj3 organisations$).mp. (1)
204 (micro adj3 company).mp. (3)
205 (micro adj3 companies).mp. (1)
206 (micro adj3 plant?).mp. (98)
207 (micro adj3 factory).mp. (0)
208 (micro adj3 factories).mp. (0)
209 (micro adj3 office?).mp. (3)
210 (micro adj3 owner? adj2 operat$).mp. (0)
211 (micro adj3 independent$ adj1 operat$).mp. (0)
212 (micro adj3 famil$ adj4 business$).mp. (0)
213 (micro adj1 unit?).mp. (34)
214 (micro adj3 project?).mp. (5)
215 (micro adj10 non-government$ organi#ation?).mp. (0)
216 (micro adj10 nongovernment$ organi#ation?).mp. (0)
217 (micro adj3 NGO?).mp. (0)
218 (micro adj2 volunt$).mp. (1)
219 micro.mp. and exp Organizations, Nonprofit/ (7)
220 (micro adj3 (non-profit$ or nonprofit$)).mp. (0)
221 (micro adj5 work$ environment?).mp. (3)
222 (micro adj3 work$).mp. (52)
223 or/171-222 (5192)
224 170 and 223 (2630)

225 limit 224 to (english or french or german or polish or portuguese or spanish) (2443)
226 limit 225 to humans (1620)

Appendix C

Content experts

Name	Country	E-Mail Address
Joan Eakin	Canada	joan.eakin@utoronto.ca
Peter Hasle	Denmark	phs@ami.dk
Felicity Lamm	Australia	f.lamm@auckland.ac.nz
John Mendeloff	US	jmen@birch.gspia.pitt.edu
Kaj Frick	Sweden	kaj.frick@ali.se
Claire Mayhew	Australia	clairemayhew@bigpond.com

Appendix D

Quality assessment questions: Quantitative studies

The quality assessment will be conducted on the studies that remain following the exclusion step. The quality assessment process involves a review of the full article to determine if the article should continue to the data extraction step of the review.

Quality assessment 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.

Q1. Should this study continue to quality assessment?

This is to provide an additional layer of "quality control" to ensure that articles have been appropriately assigned.

a) Yes

b) No, indicate why

i. Is this a peer-reviewed study (including in press or accepted for publication)?
ii. Does this study focus analytically on 'small' businesses?
iii. Does this study include outcomes or findings regarding OHS, behaviour, exposure, cognition, and/or work organization?
iv. Is this a conceptual article with no empirical data (e.g., opinion/editorial pieces, theoretical papers, narrative reviews, commentaries)?
v. For studies with quantitative and/or mixed methods, is this an intervention study?

Design and Objectives

Q2. What was the intervention type? (choose only one answer)

Please select the most appropriate type of intervention as defined below. If the intervention includes more than one of the following types, please select all that apply. Please indicate the specific intervention strategy(ies) in the text box beside each option.

a) Engineering Solution

An intervention with a goal of physically eliminating/reducing the hazard at the source through redesign, automation or other means. Also, engineering solutions tend to require limited input from the worker. An example would be installing ventilation to reduce hydrocarbon exposure. Also, mechanical lifts will be considered an engineering solution because they change the nature of the hazard

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 (PPE)

Interventions that provide employees with equipment such as wrist guards, eye glasses, etc. These interventions rely on the correct use of the equipment by the employees as the hazards remain and these interventions are barriers.

d) Engineering solution PLUS another type of intervention

Interventions that include both an engineering control described in (a) plus an administration or PPE component.

e) Reported in another study

f) Other; Please specify

Q3. Were concurrent comparison groups/units/workstations used? (choose only one answer)

A comparison group is important to document and account for the potential effects of unexpected external 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/workplaces; *statistically generated references created for comparison do not constitute a control*.

a) Yes; single referent

One comparison group was used against which the intervention's effect was evaluated.

b) Yes; multiple referents

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/Unit

No concurrent comparison groups were used in the study.

e) Reported in another study

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.

d) Reported in another study

Q5. Was there a follow-up 3 or more months after the implementation of the intervention?

In the literature, effects for some interventions do not appear until about 2 months into the intervention. Also, because some types of interventions decrease in effectiveness over time, evaluation immediately after the implementation may over estimate the effect.

a) Yes
b) Unclear
c) No
d) Reported in another study

Q6. Was an 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.

a) Yes
b) Unclear
c) No
d) Reported in another article

Q7. Was the intervention allocation random?

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

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

b) Unclear
c) No
d) Reported in another article

Q8. 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
d) Reported in another article

Level of Recruitment

Q9. 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/job title**
b) **Department/supervisors/workstations**
c) **Organizations/workplace**
d) **Unclear**
e) **Not Described**
f) **Reported in another article**

Q10. Was recruitment rate reported?

Greater rate of participation (or recruitment) reduces non-response bias. Reporting a recruitment rate would require indicating the number of eligible participants from the study population that refused to participate in the study. Acquiring and reporting this type of information is a notable methodological step, so reporting the rate is of methodological value. Also, since the threshold at which low recruitment rate leads to significant bias is not clear, and may differ by type of study design, we will collect the recruitment information in the data extraction stage.

a) **Yes**
b) **Unclear**
c) **No**
d) **Reported in another article**

Q11. 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 description of pre-intervention characteristics allows us to identify any important pre-intervention characteristics that could potentially confound the relationship between the intervention and the outcome.

a) **Employees/workers**

Individual level information – for example years on job

b) **Department/supervisors/workstation**

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**
f) **Reported in another article**

Q12. Did they report evaluating any differences across groups at pre-intervention? (if yes, then check all that apply)

If a RCT, confirm whether the characteristics of the group are similar. If not a RCT, than there should be a statement as to the significance. 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/workstations**
c) **Organizations/workplace**
d) **Unclear**
e) **Not Reported**
f) **Reported in another article**

Q13. Was attrition rate reported?

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. Reporting this type of information is a notable methodological step, so reporting the rate is of methodological value. Also, since the threshold at which high attrition rate leads to significant bias is not clear, and may differ by type of study design, we will collect the attrition information in the data extraction stage.

a) **Yes**
b) **Unclear**
c) **No**
d) **Reported in another article**

Q14. Did they report checking for 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) **Not Reported**
f) **Reported in another article**

Intervention

Q15. Was the intervention described? (choose only one answer)

Inadequate description of the nature of the intervention and its subcomponents makes it impossible to replicate 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

Not enough information is provided, intervention process is not clearly described.

c) No

The intervention process is not described.

d) Reported in another article

The intervention process is described in another article.

Q16. Was the process by which the intervention was selected/developed described?

Studies that have explicitly used tools such as the Precede-Proceed model to assess needs and engage workplace parties increase the likelihood of a relevant, sustainable intervention being implemented, i.e. involvement of stakeholders/communities. A description of why a particular intervention was chosen compared to other options will also count as a rationale for intervention selection.

a) Yes
b) Unclear
c) No
d) Reported in another article

Intensity of the Intervention

Q17. 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. 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
d) Reported in another article

Q18. Was contamination between groups/units/workstations assessed or accounted for?

Contamination can occur when the interventions assigned to participants in one group are also used by some or all members of the other groups. This can introduce bias in the results if comparison groups; for example, have been exposed to some of the interventions intended for the study group, unbeknownst to the researchers. This is an issue particularly when a study uses controls from the same workplace as the intervention group.

a) Yes
b) Unclear
c) No
d) Reported in another article

Outcomes of the Intervention

Q19. Was information on exposure sources ascertained pre- AND post intervention?

Changes in exposure sources during the intervention is a key threat to internal validity for an intervention. For example, if the study were sampling air borne hydrocarbons before and after installing a hood, did they assess the use of solvents pre- and post-intervention?

a) Yes
b) Unclear
c) No
d) Reported in another article

Q20. What 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/biological monitoring

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) Observational

For example, auditing, 3rd party observation reports, etc.

g) Exposure sampling

For example, air sampling.

h) Reported in another article
i) Other; Pleas specify:

Please describe in comment box.

Q21. Were measurement properties of outcomes described or cited (e.g., reliability, validity, standard categories)?

The validity of the outcome is the degree to which a measure accurately represents the construct of interest. This is often demonstrated by showing that the measure is associated with other measures of the same construct (construct validity) or known sequelae of the construct (concurrent validity). Reliability refers to the degree of consistency of the measure, either over time or between raters (e.g., interrater reliability of an audit tool).

A clear operational definition of the outcome should be provided (e.g., timing, frequency of measurement), so that results may be properly interpreted, and the study could be replicated in another population. Outcomes should be measured using reliable and valid instruments.

- For administrative outcomes, this may include standard classification codes for injury (i.e. ICD-9 codes). For exposure sampling outcomes, this may include e.g., running blanks for air sampling. Also, there are many standard

protocols established by for example NIOSH to measure various materials. Use of standard protocols enhance measurement validity and replicability. These recommended practices have been developed to achieve recommended sensitivity and specificity. If deviation from standard protocol is mentioned, an explanation why the deviation occurred is needed.

a) Yes
b) Unclear
c) No
d) Reported in another article

Additional Outcome questions – for studies which include engineering/exposure solutions.

Q1 E. What type of sampling exposure assessment occurred? (check all that apply)

Area sampling is useful to examine the basic efficacy of the engineering intervention. Personal sampling is preferred because it is more correlated with risk of a health event than area sampling. Personal sampling also incorporates human variability that occurs with exposure. For this question, biological sampling (e.g., expired carbon monoxide) would be considered personal sampling.

a) Area sampling
b) Personal sampling
c) Task based sampling
d) Unclear
e) Reported in another article

Analysis

Q22. Were the statistical analyses appropriate to the study design?

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.

a) Yes
Statistical methods are described sufficiently, and the methods used were appropriate and properly applied.
b) Unclear
c) No

Q23. Was consideration given to power to detect intervention effect(s)?

The power of a statistical test is the probability that the test will reject a false null hypothesis (that it will not make a Type II error). Generally as sample sizes increases, the chances of a Type II error decrease. Power analysis can either be before (*a priori*) or after (*post hoc*) data is collected. A priori power analysis is conducted prior to the conducting of research and is typically used to determine an appropriate sample size to achieve adequate power. Post-hoc power analysis is

conducted after a study has been conducted and uses the obtained sample size and effect size to determine what the power was in the study. Although there are no formal standards for power, most researchers who assess the power of their tests use 0.80 as a standard for adequacy. Consideration to power to detect intervention effects can be formal (i.e., power calculations) or informal (e.g., guidelines). A typical rule of thumb is having at least 10 observations for each predictor in the regression analysis. If there are a limited number of observations in an intervention study that found no statistically significant effect of the intervention, this is problematic because it is unclear whether the intervention had no effect, or that there was insufficient power to detect the effect.

a) Yes, a priori consideration only
b) Yes, post hoc consideration only
c) Both a priori and post hoc calculation
d) Unclear
e) No

Q24. Were any effect modifiers/confoundersassessed in the analyses?

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. For multiple workplace studies, organizational variables such as presence of a Health and Safety Committee should be included. It is extremely important to measure potential confounders as they could mask or exaggerate any associations that may be present in a given study.

a) Yes
b) Unsure
c) No

Q25. 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, eliminating 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

Q26. Should this reference proceed to data extraction? Why? And if not, why not?

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(e.g. Study did not have enough participants to minimize the play of chance, Design was not adequate to answer question about the outcome, Contamination between groups was a problem). If certain issues led you to recommend that it not proceed to data extraction then please note these in the space provided.

a) Yes

b) No (specify why)

Appendix E

Quality assessment questions: Qualitative studies

(Adapted from Spencer, L., Ritchie, J., Lewis, J., Dillon, L. Quality in qualitative evaluation: a framework for assessing research evidence. National Centre for Social Research, Chief Government Social Researcher's Office. August 2003.)

Methods: Design and Objectives

Q1. How defensible is the research design?

Questions for consideration in evaluation and reviewer commentary:

Is there a discussion of how the overall research strategy was designed to meet the aims of the study?

Is there a discussion of rationale for study design?

Is there a convincing argument for different features of research design (e.g. reasons given for different components or stages of research; purpose of particular methods or data sources, multiple methods, time frames etc.)

Are different features of design/data sources evident in findings presented?

Is there a discussion of limitations of research design and their implications for the study evidence?

Q2. How well defended is the sample design/target selection of cases?

Questions for consideration in evaluation and reviewer commentary:

Is there a description of study locations/areas and how/why these were chosen?

Is the population of interest described, and how sample selection relates to it explained (e.g. typical, extreme case, diverse constituencies etc.)?

Do authors provide a rationale for basis of selection of target sample/settings/ documents, basis for inclusions and exclusions, discussion or sample size/number of cases/setting selected etc.)?

Is there a discussion of how sample/selections allowed required comparisons to be made?

Q3. Sample composition/case inclusion - how well is the eventual coverage described?

Questions for consideration in evaluation and reviewer commentary:

Is a detailed profile of achieved sample/case coverage provided?

How do the authors attempt to maximize inclusion (e.g. language matching or translation; specialized recruitment; organized transportation for group attendance)?

Do the authors discuss any missing coverage in achieved samples/cases and implications for study evidence (e.g. through comparison of target and achieved samples, comparison with population etc.)?

Do authors identify and document reasons for non-participation among sample approached/non-inclusion of selected cases/documents?

Do authors discuss access and methods of approach and how these might have affected participation/coverage?

Q4. How well was the data collection carried out?

Questions for consideration in evaluation and reviewer commentary:

Do authors discuss:

- who conducted data collection
- procedures/documents used for collection/recording
- checks on origin/status/authorship of documents

Was there audio or video recording of interviews/discussions/conversations (if not recorded, were justifiable reasons given)?

Do authors describe conventions for taking field notes (e.g. to identify what form of observations were required/to distinguish description from researcher commentary/analysis)?

Do authors discuss how fieldwork methods or settings may have influenced data collected?

Do authors demonstrate, through portrayal and use of data, that depth, detail and richness were achieved in collection?

Q5. How well has the approach to and formulation of the analysis been conveyed?

Questions for consideration in evaluation and reviewer commentary:

Do authors describe the form of original data (e.g. use of verbatim transcripts, observation or interview notes, documents)?

Is there a clear rationale for choice of data management method/tool/package?

Do authors provide evidence of how descriptive analytic categories, classes, labels etc. have been generated and used (i.e. either through explicit discussion or portrayal in the commentary)?

Is there discussion, with examples, of how any constructed analytic concepts/typologies etc. have been devised and applied?

Methods (Analysis)

Q6. Contexts of data sources - how well are they retained and portrayed?

Questions for consideration in evaluation and reviewer commentary:

Do authors describe the background or historical developments and social/organizational characteristics of study sites or settings?

Are participants' perspectives/observations placed in personal context (e.g. use of case studies/vignettes/individual profiles, textual extracts annotated with details of contributors)?

Is there explanation of origins/history of written documents?

Do authors use data management methods that preserve context (i.e. facilitate within case description and analysis)?

Q7. How well has diversity of perspective and content been explored in analysis?

Questions for consideration in evaluation and reviewer commentary:

Do authors discuss how their sample design/case selection contributes to generating diversity?

Do authors describe and illuminate diversity/multiple perspectives/alternative positions in the evidence displayed?

Is there evidence of attention to negative cases, outliers or exceptions?

Are typologies/models or variation derived and discussed?

Do authors examine or provide informed speculation to explain opposing or differing positions?

Do authors identify patterns of association/linkages with divergent positions/groups?

Q8. How well has detail, depth and complexity (i.e. richness) of the data been conveyed?

Questions for consideration in evaluation and reviewer commentary:

Do authors use and explore contributors' terms, concepts and meanings?

Do authors unpack and portrayal of nuance/subtlety/intricacy within data?

Do authors discuss explicit and implicit explanations?

Are underlying factors/influences detected and discussed?

Do authors identifiy and discuss patterns of association/conceptual linkages within data?

Are textual extracts/observations used to illuminate the findings?

Q9. How clear are the links between data, interpretation and conclusions - i.e. how well can the routes to any conclusions be seen?

Questions for consideration in evaluation and reviewer commentary:

Are there clear conceptual links between analytic commentary and presentation of original data (i.e. commentary and cited data relate; there is an analytic context to cited data, not simply repeated description?

Is there discussion of how/why particular interpretation/significance is assigned to specific aspects of data - with illustrative extracts of original data?

Do authors discuss of how explanations/theories/conclusions were derived - and how they relate to interpretations and content of original data (i.e. how warranted)?

Are alternative explanations explored?

Are negative cases displayed, and do authors identify how they lie outside main proposition/theory/hypothesis etc.; or how proposition etc. revised to include them?

Reporting

Q10. How clear and coherent is the reporting?

Questions for consideration in evaluation and reviewer commentary:

Is reporting and discussion linked to the aims of study/research questions?

Does the reporting provide a narrative/story or clearly constructed thematic account?

Does the report have structure and signposting that usefully guide the reader through the commentary?

Does the discussion/report section provide accessible information for the intended target audience(s)?

Are the key messages highlighted or summarized?

Reflexivity & Neutrality

Q11. How clear are the assumptions/theoretical perspectives/values that shaped the form and output of the study?

Questions for consideration in evaluation and reviewer commentary:

Is there discussion/evidence of the main assumptions/hypotheses/theoretical ideas on which the evaluation was based and how these affected the form, coverage or output of the evaluation (the assumption here is that no research is undertaken without some underlying assumptions or theoretical ideas)?

Is there discussion/evidence of the ideological perspectives/values/philosophies of research team and their impact on the methodological or substantive content of the evaluation (again, may not be explicitly stated)?

Is there evidence of openness to new/alternative ways of viewing subject/theories/assumptions (.e.g. discussion of learning/concepts/constructions that have emerged from the data; refinement restatement of hypotheses/theories in light of emergent findings; evidence that alternative claims have been examined)?

Is there discussion of how error or bias may have arisen in design/data collection/analysis and how addressed, if at all?

Do authors reflect on the impact of the research on the research process?

Ethics

Q12. What evidence is there of attention to ethical issues?

Questions for consideration in evaluation and reviewer commentary:

Are researchers evidently thoughtful/sensitive about their research context and participants?

Do authors document how their research was presented in study settings/to participants (including, where relevant, any possible consequences of taking part)?

Do authors document consent procedures and information provided to participants?

Is there any discussion of confidentiality of data and procedures for protecting it?

How was anonymity of participants/sources protected?

Were there any stated measures to offer information/advice/services etc. at the end of study (i.e. where participation exposed the need for these)?

Do the authors discuss potential harm or difficulty through participation, and how it might be avoided?

Auditability

Q13. How adequately has the research process been documented?

Questions for consideration in evaluation and reviewer commentary:

Do authors discuss strengths and weaknesses of data sources and methods?

Do authors document changes made to study design and reasons for doing so; and consider implications?

Do authors document changes in sample coverage/data collection/analytic approach and reasons for doing so; and consider implications?

Are main study documents reproduced (e.g. letters of approach, topic guides, observation templates, data management frameworks etc.)?

Findings

Q14. How credible are the findings?

Questions for consideration in evaluation and reviewer commentary:

Findings/conclusions are supported by data/study evidence (i.e. the reader can see how the researcher arrived at his/her conclusions; the "building blocks" of analysis and interpretation are evident)

Findings/conclusions "make sense"/have a coherent logic

Findings/conclusions are resonant with other knowledge and experience (this might include peer or member review)

Use of corroborating evidence to support or refine findings (i.e. other data sources have been used to examine phenomena; other research evidence has been evaluated; see also Q14)

Q15. How has knowledge/understanding of SB and OHS been extended by the research?

Questions for consideration in evaluation and reviewer commentary:

Does the literature review (where appropriate) summarize knowledge to date/key issues raised by previous research?

Are the aims and design of study set in the context of existing knowledge/understanding; identifies new areas for investigation (for example, in relation to intervention, strategy, program or substantive theory)?

Is there credible/clear discussion of how findings have contributed to knowledge and understanding (e.g. the intervention, strategy, program or theory being reviewed); might be applied to new policy developments, practice or theory?

Are findings presented or conceptualized in way that offers new insights/alternative ways of thinking?

Do authors discuss the limits of their evidence and what remains unknown/unclear or what further information research is needed?

Q16. How well does the study address its original aims and purpose?

Questions for consideration in evaluation and reviewer commentary:

Is there a clear statement of study aims and objectives; reasons for any changes in objectives?

Are findings clearly linked to the purposes of the study - and to the intervention, strategy or program being studied?

Is the summary or conclusions directed towards aims of study?

Is there a discussion of limitations of study in meeting aims (e.g. are there limitations because of restricted access to study settings or participants, gaps in the sample coverage, missed or unresolved areas of questioning; incomplete analysis?)?

Q17. Scope for drawing wider inference abut SB OHS - how well is this explained?

Questions for consideration in evaluation and reviewer commentary:

Do authors discuss what can be generalized to wider population from which sample is drawn/case selection has been made?

Is there a detailed description of the context in which the study was conducted to allow applicability to other settings/contextual generalities to be assessed?

Do authors discuss how hypotheses/propositions/findings may relate to wider theory; is there consideration of rival explanations?

Do authors supply evidence to support claims for wider inference(either from study or from corroborating sources)?

Do authors discuss limits on drawing wider inference (e.g., re-examination of sample and any missing constituencies; analysis of restrictions of study settings for drawing wider inference)?

Appendix F

Partial data extraction form: Quantitative and qualitative studies

Business Description

A1. Jurisdiction

Provide the jurisdiction where the study was carried out (i.e., country, city, regional/provincial etc.). Type "NP" if jurisdiction not provided.

Country	Enter country when study was completed.
City	Enter city where study was completed.
Other	(E.g. regional, multinational etc.)

A2. Business Characteristics

Provide characteristics of the businesses represented in study sample.

Business Size	If exact # given, enter business size.
Size Range:	☐ < =5 ☐ 6-20 ☐ 21-50 ☐ 51-100
Business Age:	☐ < 6 mth ☐ 6-12 mth ☐ 1-2 yrs ☐ 2-5 yrs ☐ 5-10 yrs ☐ > 10 yrs ☐ Not Stated
Unionized?:	☐ Yes ☐ No ☐ Not Stated

A3. Occupation(s) of Sample[1]

Select occupations included in study sample.

☐	**00**	**Not stated**
	A	**Management Occupations**
☐	A0	Senior Management Occupations
☐	A1	Specialist Managers
☐	A2	Managers in Retail Trade, Food and Accommodation Services
☐	A3	Other Managers n.e.c.
	B	**Business, Finance and Administrative Occupations**
☐	B0	Professional Occupations in Business and Finance
☐	B1	Finance and Insurance Administration Occupations
☐	B2	Secretaries
☐	B3	Administrative and Regulatory Occupations
☐	B4	Clerical Supervisors
☐	B5	Clerical Occupations
	C	**Natural and Applied Sciences and Related Occupations**
☐	C0	Professional Occupations in Natural and Applied Sciences
☐	C1	Technical Occupations Related to Natural and Applied Sciences
	D	**Health Occupations**
☐	D0	Professional Occupations in Health
☐	D1	Nurse Supervisors and Registered Nurses
☐	D2	Technical and Related Occupations in Health
☐	D3	Assisting Occupations in Support of Health Services

[1] *Occupation categorization as per National Occupational Classification for Statistics (NOC-S) 2006 (2-digit major occ grouping)*

A3. Occupation(s) of Sample[1]

Select occupations included in study sample.

	E	**Occupations in Social Science, Education, Government Service and Religion**
☐	E0	Judges, Lawyers, Psychologists, Social Workers, Ministers of Religion, and Policy and Program Officers
☐	E1	Teachers and Professors
☐	E2	Paralegals, Social Services Workers and Occupations in Education and Religion, n.e.c.
	F	**Occupations in Art, Culture, Recreation and Sport**
☐	F0	Professional Occupations in Art and Culture
☐	F1	Technical Occupations in Art, Culture, Recreation and Sport
	G	**Sales and Service Occupations**
☐	G0	Sales and Service Supervisors
☐	G1	Wholesale, Technical, Insurance, Real Estate Sales Specialists, and Retail, Wholesale and Grain Buyers
☐	G2	Retail Salespersons and Sales Clerks
☐	G3	Cashiers
☐	G4	Chefs and Cooks
☐	G5	Occupations in Food and Beverage Service
☐	G6	Occupations in Protective Services
☐	G7	Occupations in Travel and Accommodation Including Attendants in Recreation and Sport
☐	G8	Childcare and Home Support Workers
☐	G9	Sales and Service Occupations n.e.c.

A3. Occupation(s) of Sample[1]

Select occupations included in study sample.

	H	**Trades, Transport and Equipment Operators and Related Occupations**
☐	H0	Contractors and Supervisors in Trades and Transportation
☐	H1	Construction Trades
☐	H2	Stationary Engineers, Power Station Operators and Electrical Trades and Telecommunications Occupations
☐	H3	Machinists, Metal Forming, Shaping and Erecting Occupations
☐	H4	Mechanics
☐	H5	Other Trades n.e.c.
☐	H6	Heavy Equipment and Crane Operators Including Drillers
☐	H7	Transportation Equipment Operators and Related Workers, Excluding Labourers
☐	H8	Trades Helpers, Construction and Transportation Labourers and Related Occupations
	I	**Occupations Unique to Primary Industry**
☐	I0	Occupations Unique to Agriculture Excluding Labourers
☐	I1	Occupations Unique to Forestry Operations, Mining, Oil and Gas Extraction and Fishing, Excluding Labourers
☐	I2	Primary Production Labourers
	J	**Occupations Unique to Processing, Manufacturing and Utilities**
☐	J0	Supervisors in Manufacturing
☐	J1	Machine Operators in Manufacturing
☐	J2	Assemblers in Manufacturing
☐	J3	Labourers in Processing, Manufacturing and Utilities

A4. Business Sector/Types[2]:

Select the industry sector(s) and sub-sector(s) represented in study sample.

☐	**00**	**Not stated**
☐	**11**	**Agriculture, Forestry, Fishing and Hunting**
☐	111	Crop Production
☐	112	Animal Production
☐	113	Forestry and Logging
☐	114	Fishing, Hunting and Trapping
☐	115	Support Activities for Agriculture and Forestry
☐	**21**	**Mining**
☐	211	Oil and Gas Extraction
☐	212	Mining (except Oil and Gas)
☐	213	Support Activities for Mining
☐	**22**	**Utilities**
☐	221	Utilities (Electric, Gas, Nuclear, Fossil, Water, Sewage)
☐	**23**	**Construction**
☐	236	Construction of Buildings
☐	237	Heavy and Civil Engineering Construction
☐	238	Specialty Trade Contractors

[2] *Industry sector categorization as per NAICS 2007 (2-digit)*

*Not Applicable (N/A) - Industry not applicable to study; ᴴMulti-Sectoral – study cites multiple sectors in sample (3 or more sectors, or stated as multi-sectors within article); ᵀNot Reported (N/R) - Industry not provided in paper.

A4. Business Sector/Types[2]:

Select the industry sector(s) and sub-sector(s) represented in study sample.

- ☐ **31-33 Manufacturing**
  - ☐ 311 Food Manufacturing
  - ☐ 312 Beverage and Tobacco Product Manufacturing
  - ☐ 313 Textile Mills
  - ☐ 314 Textile Product Mills
  - ☐ 315 Apparel Manufacturing
  - ☐ 316 Leather and Allied Product Manufacturing
  - ☐ 321 Wood Product Manufacturing
  - ☐ 322 Paper Manufacturing
  - ☐ 323 Printing and Related Support Activities
  - ☐ 324 Petroleum and Coal Products Manufacturing
  - ☐ 325 Chemical Manufacturing
  - ☐ 326 Plastics and Rubber Products Manufacturing
  - ☐ 327 Nonmetallic Mineral Product Manufacturing
  - ☐ 331 Primary Metal Manufacturing
  - ☐ 332 Fabricated Metal Product Manufacturing
  - ☐ 333 Machinery Manufacturing
  - ☐ 334 Computer and Electronic Product Manufacturing
  - ☐ 335 Electrical Equipment, Appliance, and Component Manufacturing
  - ☐ 336 Transportation Equipment Manufacturing
  - ☐ 337 Furniture and Related Product Manufacturing
  - ☐ 339 Miscellaneous Manufacturing

A4. Business Sector/Types[2]:

Select the industry sector(s) and sub-sector(s) represented in study sample.

- ☐ **42 Wholesale Trade**
  - ☐ 423 Merchant Wholesalers, Durable Goods
  - ☐ 424 Merchant Wholesalers, Nondurable Goods
  - ☐ 425 Wholesale Electronic Markets and Agents and Brokers

- ☐ **44-45 Retail Trade**
  - ☐ 441 Motor Vehicle and Parts Dealers
  - ☐ 442 Furniture and Home Furnishings Stores
  - ☐ 443 Electronics and Appliance Stores
  - ☐ 444 Building Material and Garden Equipment and Supplies Dealers
  - ☐ 445 Food and Beverage Stores
  - ☐ 446 Health and Personal Care Stores
  - ☐ 447 Gasoline Stations
  - ☐ 448 Clothing and Clothing Accessories Stores
  - ☐ 451 Sporting Goods, Hobby, Book, and Music Stores
  - ☐ 452 General Merchandise Stores
  - ☐ 453 Miscellaneous Store Retailers
  - ☐ 454 Nonstore Retailers

- ☐ **48-49 Transportation and Warehousing**
  - ☐ 481 Air Transportation
  - ☐ 482 Rail Transportation
  - ☐ 483 Water Transportation
  - ☐ 484 Truck Transportation
  - ☐ 485 Transit and Ground Passenger Transportation
  - ☐ 486 Pipeline Transportation
  - ☐ 487 Scenic and Sightseeing Transportation
  - ☐ 488 Support Activities for Transportation
  - ☐ 491 Postal Service

A4. Business Sector/Types[2]:

Select the industry sector(s) and sub-sector(s) represented in study sample.

- ☐ 492 Couriers and Messengers
- ☐ 493 Warehousing and Storage

- ☐ **51 Information**
  - ☐ 511 Publishing Industries (except Internet)
  - ☐ 512 Motion Picture and Sound Recording Industries
  - ☐ 515 Broadcasting (except Internet)
  - ☐ 517 Telecommunications
  - ☐ 518 Data Processing, Hosting and Related Services
  - ☐ 519 Other Information Services

- ☐ **52 Finance and Insurance**
  - ☐ 521 Monetary Authorities-Central Bank
  - ☐ 522 Credit Intermediation and Related Activities
  - ☐ 523 Securities, Commodity Contracts, and Other Financial Investments and Related Activities
  - ☐ 524 Insurance Carriers and Related Activities
  - ☐ 525 Funds, Trusts, and Other Financial Vehicles

- ☐ **53 Real Estate and Rental and Leasing**
  - ☐ 531 Real Estate
  - ☐ 532 Rental and Leasing Services
  - ☐ 533 Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)

- ☐ **54 Professional, Scientific, and Technical Services**
  - ☐ 541 Professional, Scientific, and Technical Services

A4. Business Sector/Types[2]:

Select the industry sector(s) and sub-sector(s) represented in study sample.

- ☐ **55 Management of Companies and Enterprises**
  - ☐ 551 Management of Companies and Enterprises
- ☐ **56 Administrative and Support and Waste Management and Remediation Services**
  - ☐ 561 Administrative and Support Services
  - ☐ 562 Waste Management and Remediation Services
- ☐ **61 Educational Services**
  - ☐ 611 Educational Services
- ☐ **62 Health Care and Social Assistance**
  - ☐ 621 Ambulatory Health Care Services
  - ☐ 622 Hospitals
  - ☐ 623 Nursing and Residential Care Facilities
  - ☐ 624 Social Assistance
- ☐ **71 Arts, Entertainment, and Recreation**
  - ☐ 711 Performing Arts, Spectator Sports, and Related Industries
  - ☐ 712 Museums, Historical Sites, and Similar Institutions
  - ☐ 713 Amusement, Gambling, and Recreation Industries
- ☐ **72 Accommodation and Food Services**
  - ☐ 721 Accommodation
  - ☐ 722 Food Services and Drinking Places

A4. Business Sector/Types[2]:

Select the industry sector(s) and sub-sector(s) represented in study sample.

- ☐ **81 Other Services**
  - ☐ 811 Repair and Maintenance
  - ☐ 812 Personal and Laundry Services
  - ☐ 813 Religious, Grantmaking, Civic, Professional, and Similar Organizations
  - ☐ 814 Private Households
- ☐ **92 Public Administration**
  - ☐ 921 Executive, Legislative, and Other General Government Support
  - ☐ 922 Justice, Public Order, and Safety Activities
  - ☐ 923 Administration of Human Resource Programs
  - ☐ 924 Administration of Environmental Quality Programs
  - ☐ 925 Administration of Housing Programs, Urban Planning, and Community Development
  - ☐ 926 Administration of Economic Programs
  - ☐ 927 Space Research and Technology
  - ☐ 928 National Security and International Affairs

SECTION B: Study Design

B1. Primary study design

☐	Qualitative study	*If qualitative, complete **B2**(for qualitative Team)*
☐	Quantitative study	*If quantitative, complete **B3***
☐	Mixed methods study	*If mixed methods, complete **B2**(qualitative Team)**& B3**(quantitative Team)*
☐	Other (describe)	Enter description of methods used.

B2. Qualitative study method: ***If qualitative, select all study methods that apply:***

- ☐ Interviews
  - ☐ Unstructured (open-ended)
  - ☐ Semi-structured
  - ☐ Structured
- ☐ Focus groups
- ☐ Case study
- ☐ Document review
- ☐ Participant Observation
- ☐ Mixed methods (describe) Enter description of methods used.
- ☐ Other (describe) Enter description of methods used.

B3. Quantitative study method: ***If quantitative select all study methods that apply:***

- ☐ Prospective cohort study
- ☐ Retrospective cohort study
- ☐ Case-control study
- ☐ Cross-sectional study
- ☐ Randomized control trial
- ☐ Non-randomized control trial
- ☐ Pre/post test
- ☐ Time series study with comparison group
- ☐ Time series study without comparison group
- ☐ Other (describe) Enter description of methods used.

B4. Timeframe of study: ***Enter start and end year. Enter 00 in both fields if not stated***

From: Enter 4-digit year **To:** Enter 4-digit year

Section C: OUTCOME TYPE

C1. Sample described clearly ☐ Yes ☐ No

C2. Sampling Strategy

☐	Entire population	
☐	Probability sample	
☐	Convenience sample	
☐	Other (describe)	

Appendix G

Data extraction form: Quantitative studies

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. Name of 1st author and the year of publication.
Write the last name of the first author and the year of publication (Author's last name, yyyy).

2. State the research question(s)/objective(s).
If the research question(s)/objective(s) are well stated then use the exact wording (in quotations) OR if not well stated then use the wording – Appears to say. If more than one objective; then list all objectives. Be clear to only include *the objectives tested* not broader objectives described.

3. 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), individuals (I) for inclusion, or not applicable (NA). 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", "I", or "NA". 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)

4. 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, individuals for exclusion, or not applicable. 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", "I", or "NA".

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

Intervention Characteristics:

5. Describe all intervention in the study.
Please describe all interventions in the study verbatim. If control received an intervention, please describe.

E.g.: I_1 - engineering solution ("installing ventilation to reduce hydrocarbon exposure"); I_2 -administrative technique "job rotation"; I_3 – personal protective equipment ("use of protective eye wear"); C_1 -no engineering solution and no "job rotation"
***Organize your description of interventions according to I_1, I_2, C, I_1C, and I_2C**

6. Describe the process by which the intervention was selected/developed (if any).
Studies that have explicitly used tools such as the Precede-Proceed model to assess needs and engage workplace parties increase the likelihood of a relevant, sustainable intervention being implemented, i.e. involvement of stakeholders/communities. A description of why a particular intervention was chosen compared to other options will also count as a rationale for intervention selection.

7. For studies with non-engineering components, 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" if not provided.
***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).

8. 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:

9. Describe overall study group.
Provide answer in the comment box for each category. Type "NP" in all comment boxes if information is not available in the article.

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

10. Describe the Intervention group(s). Provide answer(s) for each category - enter "NP" in all comment boxes where information is not available in the article. 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=, I_2C=, …)*
Age (mean, SD, range)	*Eg: I_1 =, I_2=, … (or I_1C=, I_2C=, …)*
% female	*Eg: I_1 =, I_2=, … (or I_1C=, I_2C=, …)*
Loss to Follow up (N)	*Eg: I_1 =, I_2=, …(or I_1C=, I_2C=, …)*

11. 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_1C=, I_2C=, …)*
Age (mean, SD, range)	*Eg: C_1 , C_2, …(or I_1C=, I_2C=, …)*
% female	*Eg: C_1 , C_2, …(or I_1C=, I_2C=, …)*
Loss to Follow up (N)	*Eg: C_1 , C_2, …(or I_1C=, I_2C=, …)*

Not applicable (no control group)

Covariate/confounder Questions:

12. 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.

*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)

13. Provide a list of covariates/confounding variables that were controlled for in the final test of the intervention effectiveness. Enter not applicable "NA" if no covariates/confounders were tested in the final analysis.

Outcome Questions:

14. Provide a list of outcome variables used to evaluate intervention effectiveness.
When listing the outcome variable, identify the type of outcome as in the quality assessment stage (i.e., self report, physical exam/biological monitoring, clinical diagnosis, injury/illness reports, observational, exposure sampling, other). Also note the substantive content of the measure. For example, if one of the outcomes was a self report measure, also note what it asked about (e.g., being injured at work).

15. If injury/claim rates were calculated, list the equation(s) (e.g., equation, type of denominator such as employee hours)? Please define the numerator and denominator using the author's language explicitly. If the equation is not explicitly explained, not provided "NP". If injury rates were not calculated, enter not applicable "NA".

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

Temporary employees, contract employees, or floating employees between units
Turnover rate

17. What changes were implemented as a result of the intervention (e.g. tasks, processes, organization)?

Statistical Analysis Questions:

18. Please mark 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". If unclear and do not feel information fits into one of these categories please contact Curtis or comment on this in Q20.

a) ANOVA (ANCOVA)
b) MANOVA (MANCOVA)
c) Linear/Logistic Regression
d) Multilevel Regression (linear or logistic)
e) Survival Regression
f) Poisson Regression
g) Percentage of change
h) Nonparametric tests
i) Nonparametric Matched Test
j) Nonparametric Unmatched Test
k) Other Parametric Matched Test
l) Other Parametric Unmatched Test
m) No Statistical Test
n) Other (please specify)

19. Report for each 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). If multiple outcomes please report information for each outcome. ***Organize your description of interventions according to I_1, I_2, C, I_1C, and I_2C**

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

20. Were additional statistical analyses conducted to increase your confidence in the observed effect? For example, if there was a significant loss to follow-up and/or movement between study arms then an intention-to-treat analysis may be appropriate.

a) **Yes (please describe)**
b) **No**
c) **Not applicable**

21. Remark on the findings or enter information that is unique about the study that may not be adequately captured in the other data extraction questions.

Appendix H

Data extraction form: Qualitative studies

The reviewers will use a data extraction template laid out as follows. Where possible, reviewers should provide page numbers for reference to the original study.
Basic information about the study:
RefMan ID: Provide the number assigned by the library.
Reviewer: Clearly identify the reviewer assigned to this data extraction.
Authors: Use authors' full names if known.
Article reference: Provide full bibliographic citation for the study including title, journal, volume, issue number, date (with month if possible), and page range.
Language: Identify study language.
Translated title: If not English, enter English translation of title.

Section A: Research Question

A1. What is the research question?

Explanation: This section addresses the research question of each study and identifies the study's central focus and specific objective(s). If possible, reviewers should use the exact wording from the article.

Section B: Theoretical perspective

B1. Provide theoretical orientation of study:

a) Description given *or* Unstated/implicit perspective

Explanation: This section identifies both the broad theoretical orientation of the research. Researchers should provide the description given if study author(s) explicitly identify their theoretical stance. If the theoretical orientation is not stated or implicit, the researchers should identify the theoretical paradigm.

Impact of theoretical perspective on method and findings (i.e., strengths, weaknesses, areas for enhancement)

Explanation: It is important for qualitative researchers to identify the ways in which the epistemological assumptions of research (e.g. what questions are asked and why) shape outcomes. In this section, the reviewers should comment on the role that theoretical frameworks play in shaping methodological choices, interpretive approaches, and discussion of findings, and speculate in an informed fashion on ways that the study might have been improved.

Section C: Study method

C1. Impact of method on findings (i.e., strengths, weaknesses, areas for enhancement)

Explanation: As in question B1, researchers should identify the ways in which the method of research (e.g. how data was gathered and analyzed) shape outcomes. In this section, the reviewers should comment on the role that methodological choices such as data collection, documentation, and analysis play in shaping study findings, and speculate in an informed fashion on ways that the study might have been improved.

Section D: Study sample and context

D1. Describe unit of analysis

How many?

Explanation: The unit of analysis is typically individual (workers, managers, SB owners) or firms. "How many" refers to the number of study participants, whether firms or workers.

Describe participants (check all that apply):

a) **Workers (specify role)**

b) **Managers**

c) **Employers**

d) **External resources**

e) **Other (describe)**

Explanation: "External resources" can be key stakeholder/informant interviews, consultations with organizations or groups, etc.

D2. How were they recruited?

Explanation: Reviewers should identify how participants were recruited by study author(s), noting if required whether this information was provided in the study.

D3. Health problems & risks?

Explanation: Which occupational health problems and/or risks were discussed in the study? Reviewers should be as specific as possible given the information provided by the study author(s). Thus, for instance, "chemical exposure" is adequate if that is all the information the study gives, but "exposure to perchloroethylene in dry cleaning workplaces" is preferable.

Section E: Data analysis

E1. Author's description of how analysis proceeded

Explanation: Cut and paste authors' description from article PDF.

E2. Reviewer's comments on analysis scope, depth, integrity

Explanation: In this section, reviewers should offer comments on the quality of the analysis, aiming to provide a general overview.

Section F: Study findings

F1. Summary of study findings (themes and key issues)

Describe how and why study findings are relevant to the present research question: How do SB workplace parties understand and practice OHS?

Explanation: Here reviewers should provide a summary of themes and key issues in study findings, and identify their relevance to the Systematic Review research question.

F2. How does this paper contribute to:

a) **Constant comparison (comparing same construct)**

b) **Refutation (contradictory findings)**

c) **Line of argument (varied findings which, when pulled together, create a story)**

Explanation: This section draws on qualitative metasynthesis literature (e.g. Bondas and Hall 2007; Noblit and Hare 1988) in which the outcome of the broad literature review and evaluation is to accomplish theoretical and/or methodological development combined with the potential for production of new insights and knowledge. In order to accomplish this component successfully, reviewers will likely need to accumulate at least a few studies so that they can evaluate each study's contribution in context. In practice, this will likely mean that reviewers put off filling out this section until they have at least a few studies passing Level 4 quality assessment in order to generate comparisons at the Level 5 data extraction stage. The three suggested contributions are not mutually exclusive, and each study can contain elements of one or more.

Constant comparison, or reciprocal translation, involves the comparison of similar or analogous concepts or findings, which may include continual refinement of a given concept. In this instance, the reviewer aims to identify the shared or comparable features of each study, with the intent to develop a cohesive whole in the final report.

Refutation identifies findings that contradict or conflict with other findings; e.g. Study 1 finds that people report one element is significant while Study 2 finds that people report that it is not. Disparities between studies may not be explicit; however, implied refutation can be drawn out by the reviewer via interpretation, and then the reviewer may attempt to reconcile or account for the conflict.

Line of argument develops a "narrative" through "layering", adding, or "weaving together" various findings. For instance, findings in Study 2 may augment or add a unique dimension or new perspective on the findings in Study 1. Each study contains a set of distinctive characteristics, which are optimally retained during the process of review (that is, reviewers should not seek to artificially homogenize or "flatten" them).