

Global Safety Evidence Centre

Occupational safety and health interventions: The state of the evidence





Evidence Review

Technical report

Preface

This research has been funded by Lloyds Register Foundation, with the aim of supporting the Foundation's plans to establish a Global Safety Evidence Centre. For more information on the Centre, please visit: *Irfoundation.org.uk/news/research-support-for-theestablishment-of-a-global-safety-evidence-centre*

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Abstract

Background

Occupational incidents, accidents, injuries, ill health and fatalities can be reduced through occupational safety and health (OSH) interventions. The effectiveness of these interventions can be evaluated through research studies, with different methods and data providing different degrees of evidence of effectiveness. Reviews compile and analyse findings from multiple research studies and, by bringing together findings from multiple studies, can be used to compare interventions and better understand evidence about the effectiveness of interventions. However, existing reviews of studies of OSH interventions are limited and vary in quality.

Aims

To review existing reviews of OSH interventions in order to provide a comprehensive summary of the evidence regarding effectiveness of OSH interventions and to describe the quality of that evidence.

Methods and approach

We conducted a systematic literature review of reviews of OSH interventions studies published from 2015 onward, following on from a previous systematic review. Searches were run in PubMed, Scopus, EBSCOhost (Academic Source Complete), Embase, and Web of Science Core Collection. A total of 53 review articles met our inclusion criteria and were included in this review. Data were extracted in line with the study aims and synthesised via a thematic analysis approach.

Findings

We identified two main themes. The first is the quality of the evidence base, and the second is the quality of the reviews themselves. The primary studies included within reviews were often of poor quality, lacking objective measures and theories of change, and, as such, contributed to a sparse and heterogenous evidence base. Moreover, the reviews themselves varied widely in quality. Methodologies varied in how robust they were and often lacked clear definitions of safety. The quality appraisal tools used by authors also varied.

Discussion

The findings from this review indicate that, despite some high-quality reviews, the evidence base remains limited and varied in quality and that further research is needed to provide a robust evidence base. To support such an evidence base, underpinning work could seek to establish standardised definitions and measures, further explore appropriate methods to appraise evidence and study quality within this field, and encourage theoretical frameworks and theories of change for OSH interventions.





Summary

Harm in the workplace can be reduced in various ways, including through the implementation of OSH interventions. Understanding which interventions are effective, and how they can be evaluated, can be understood through rigorous research studies. Studies on workplace safety interventions have been the focus of multiple reviews. However, the reviews that use systematic approaches are limited in number and scope, and they vary in quality. This report describes a systematic review of reviews which aims to provide an up-to-date account of the existing evidence base for the effectiveness of OSH interventions and explore what the quality of evidence underpinning these interventions is.

To conduct this review of reviews, we ran searches in five databases (PubMed, Scopus, EBSCOhost (Academic Source Complete), Embase, and Web of Science Core Collection). These searches yielded 4,304 articles, with 2,147 unique records following removal of duplicates. The results were screened and selected by the research team according to a predefined inclusion criteria. A final set of 53 review articles were selected for thematic analysis.

The included reviews varied in their specific study design, but were most commonly systematic reviews. The reviews were conducted across a range of geographic settings, with the primary studies seen to cover Asia, Africa, North America, South America, Europe, and Australia. The context of the primary studies also varied, from generic occupational settings, to more specific industries and exposures. All included primary studies discussed at least one type of intervention, with some focusing on a specific intervention, and others reviewing multiple. The interventions identified can be broadly categorised as: educational and training interventions (n=12); exposure reduction, prevention and protective equipment (n=12); technology and engineering interventions (n=4); health and well-being interventions (n=3); safety culture and attitudes interventions (n=3); organisational and management interventions (n=2); communication, social and other interventions (e.g. scent interventions) (n=5); and, finally, reviews which covered mixed or multiple interventions (n=12). We also identified 16 critical appraisal tools utilised within the reviews.

Through our analysis of the reviews, we identified two main themes: (1) the strength of the evidence base; and (2) the quality of the reviews themselves. First, the primary studies included within reviews were often poor in quality, and many did not use objective measures of safety or test a theory of change within their work. Generally, the evidence base appears to be sparse and heterogeneous in nature, which can make drawing definitive conclusions challenging. Second, there was a broad diversity in terms of the quality of the reviews being conducted in this area. Some of the reviews did not robustly assess the quality of the evidence in the primary studies, which may limit their utility in drawing conclusions regarding outcomes. The tools used to appraise evidence also varied, and this variability highlighted that there was no general consensus on how to appraise evidence in this field. This is compounded by the lack of a clear understanding of how safety and related concepts are defined.

The findings from this review indicate that both the reviews and the primary studies are of varying quality and robustness, and that the evidence base is sparse and heterogeneous. Some studies focused on potential measures, such as safety knowledge, without addressing their impact on objective outcomes, such as injuries, fatalities and so on. Therefore, further research is needed to consider and establish a robust link between these indicators of safety and long-term OSH outcomes. Additionally, it may not always be possible to evaluate the impact of an intervention if injuries and accidents have not been adequately recorded or tracked over time to enable exploration of intervention impacts. The inconsistency or lack of definitions utilised further complicates efforts to synthesise and compare findings. Despite some high-quality reviews, the evidence base does remain limited and varied in quality. Further research could address these challenges, in particular to establish key outcome measures, clarify terminology definitions, refine methods to appraise the quality of the evidence within this field, and consider the utility of adopting appropriate theoretical frameworks and theories of change.

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Abbreviations

AACODS	Authority, Accuracy, Coverage, Objectivity, Date and Significance
AGREE-II	Appraisal of Guidelines for Research & Evaluation Instrument II
AMSTAR	A Measurement Tool to Assess Systematic Reviews
ASQ	Average Study Quality
AXIS	Appraisal tool for cross-sectional studies
CASP	Critical Appraisal Skills Program
CB Nanotool	Control banding Nanotool
COPERSH	Centre for Occupational Public Environmental Research in Safety and Health (Australia)
EPHPP	Effective Public Health Practice Project
EPOC	Effective Practice and Organisation of Care
EQUATOR	Enhancing the Quality and Transparency of Health Research
GRADE	Grading of Recommendations Assessment, Development and Evaluation
LRF	Lloyd's Register Foundation (UK)
MINORS	Methodological Index for Non-Randomized Studies
NIOSH	National Institute of Occupational Safety and Health (UK)
NOS	Newcastle-Ottawa Quality Assessment Scale
OHS	occupational health and safety
OSH	occupational safety and health
PPE	personal protective equipment
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RoB	risk of bias
ROBINS-I	Risk of Bias in Non-randomised Studies – of Interventions
ROBIS	Risk of Bias in Systematic Reviews
RQ	review question
SBU	Statens beredning för medicinsk och social utvärdering (Swedish Council on Health Technology Assessment)
SSCI	Social Sciences Citation Index
STROBE	Strengthening the reporting of observational studies in epidemiology
VR	virtual reality

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1. Introduction

1.1. Background

Global estimates show that between 1.9 million (1) and 2.78 million (2) people die every year due to exposure to risk factors in the workplace. Further to this, the 2017 Global Estimates of Occupational Accidents and Work-Related Illness report showed that there are more than 380,000 fatal occupational accidents each year (3). OSH, and the associated work-related burden of disease and injury, is a global priority with relevance to several of the UN Sustainable Development Goals 2030 (4). While there has been significant progress and advancement in some areas across OSH (5), for example a fall in work-related accidents (both fatal and non-fatal) at the European Union level due to improvements in prevention and other developments (1,5,6), there are still ongoing challenges. These include country variation, risk factors associated with shifts in the workforce and the nature of work, and lack of progress related to some traditional OSH risks (e.g. exposure to chemical and biological agents, noise, and extreme temperatures) (6).

Workplace harms, including occupational accidents and injuries, can be reduced in various ways, including through the implementation of OSH interventions. OSH interventions can broadly be defined as 'actions or activities performed with the stated aim of improving the safety or health of employees in the workplace' (7). These interventions can include several components and can vary in design (8). For example, they may include a combination of monitoring, changing work practices, and/or educational interventions. They could be initiated at work, by an employer or the employees, or externally to the workplace with the aim of improving worker safety and health (8).

Conducting reviews in this field presents particular challenges. OSH is a cross-cutting issue relevant to multiple economic sectors and workplaces, requiring analysis and interventions that are tailored to various contexts. As a result, primary studies require a range of methodologies adapted to these different settings, which can make it challenging to draw systematic comparisons across diverse studies and data. Nonetheless, a RAND Corporation assessment conducted in 2017 for the National Institute of Occupational Safety and Health (NIOSH) found that systematic reviews were feasible for OSH topics, but that the standard methods would require adaptation due to challenges with data and methods (9). Thanks to the efforts of groups like Cochrane Work (10), significant progress has been made in improving the quality and rigour of reviews on OSH. Nevertheless, the quality of available reviews still varies.

In 2022, Dyreborg and colleagues published a systematic review of safety interventions for the prevention of accidents at work (8). The authors found that even though multiple reviews of evaluations of safety interventions have been published, reviews that use systematic approaches are limited in number, are often not up to date or comprehensive, and vary in quality (8). Other studies confirmed this finding, describing the challenges that people face in assessing the quality and reliability of research evidence in OSH (11). To our knowledge, no review since Dyreborg et al.'s work has sought to collate new reviews of OSH interventions to offer a comprehensive overview of the current landscape.

Evidence

1.2. The context of this review

LRF is seeking to establish and run a Global Safety Evidence Centre to support the use of evidence to improve the safety of life and property. This initiative draws inspiration from the UK's What Works network, a government initiative designed to improve public services by promoting evidence-based decision making, where centres focus on evaluating and disseminating research to inform policy and practice across various sectors, such as education, health, and policing (12). As part of this, RAND Europe has been supporting LRF in their plans by providing research support.

Reflecting on the current evidence base and LRF's work, we undertook a systematic review of reviews to map the existing evidence base for OSH interventions and explore the quality of evidence of the underpinning studies.

2. Methodology

2.1. Aim and review questions

To contribute to and provide an up-to-date assessment of the existing body of evidence, we conducted a systematic review of reviews of primary studies evaluating the effectiveness of OSH interventions. For this review purpose, we defined OSH interventions broadly as 'actions or activities performed with the stated aim of improving the safety or health of employees in the workplace' (7). The aims of this review were to identify and understand what existing reviews (and reviews of reviews) of OSH interventions exist, and to describe the quality of evidence that they report, seeking to answer the following review questions (RQs):

- **RQ1:** What evidence reviews of occupational safety and health interventions addressing the safety and health of workers in different industries exist?
- RQ2: What is the quality of evidence underpinning these reviews?

2.2. Overview of the methods

This review builds on the previous systematic review published in 2022 by Dyreborg and colleagues (8) discussed earlier. The objective of their review was to assess the effectiveness of safety interventions in preventing accidents at work and then compare the effects. Their inclusion criteria took a broad approach to categorising safety interventions, and the authors did not restrict scope to any one industry. As their last search was conducted in July 2015, our review covers literature published from 2015 onwards.

To conduct the review, we took the following approach: (1) structured searches of academic databases; (2) study selection and screening results; and (3) data extraction and analysis. These steps are outlined in more detail below.





2.3. Search approach and strategy

For this review, we ran searches in PubMed, Scopus, EBSCOhost (Academic Source Complete), Embase, and Web of Science Core Collection. We selected these databases in consultation with topic and search experts in order to capture records across relevant disciplines and journals, reflecting the interdisciplinary nature of OSH.

We developed search strings in collaboration with a specialist librarian and topic experts. These strings underwent several rounds of review and testing and were adapted to meet individual database requirements. We provide each of these in Annex A (Search strategies).

2.4. Study selection and inclusion criteria

All titles and abstracts of the articles that resulted from the searches were screened by the research team, against predefined inclusion and exclusion criteria derived from our RQs (see Table 1, below). This process was initially piloted by four members of the research team (JD, AA, KS, GM) on a sample of 100 articles to ensure consistency of criteria. The full screening was undertaken by two members of the research team (AA and KS), with any discrepancies discussed and reviewed by a third (JD).

Table 1: Inclusion and exclusion criteria

2.5. Data extraction and analysis

The full text of all included articles was read by the members of the research team. Data were extracted from each included source in line with the review aims. This was undertaken using the literature review software MAXQDA. Extraction was completed using a standardised, shared coding framework with relevant categories and themes. Elements for this framework included data on the populations and workplace contexts, type of interventions, and outcome(s) being collected and/or measured. Data were also extracted regarding the approach to quality assessment of primary studies and included evidence. The full extraction framework is provided in an annex at the end of this report (see Annex B, Extraction framework). One member of the team (JD) conducted this extraction, with an additional member of the team (AA) reviewing all extracted data and, where necessary, extracting further information.

Following data extraction, the research team conducted thematic analysis and held an internal analysis workshop to bring together the relevant evidence from the review into a cohesive narrative. The coded and extracted data were examined and grouped during a discussion among the members of the research team. Initial patterns across the data were identified, then later grouped together during iterative refinement and finalisation. These themes were then reviewed again to ensure coherence and relevance to the included review literature.

Include	Exclude
Academic reviews (including reviews of reviews, systematic reviews, meta-analyses, and other forms of literature reviews)	Other document types (e.g. primary research, study or review protocols, conference proceedings, news articles, commentaries)
Topic focus: review of studies that evaluated or assessed the effectiveness of an OSH intervention(s) or intervention type(s)	 Sources which: Provide a description of an OSH intervention without reviewing or discussing its effectiveness or outcomes Focus exclusively on occupational medicine interventions, or are solely health-related Are not focused on OSH (i.e. not workplace context/setting) Review the factors contributing to risk of an incident, injury, illness, or accident
Review articles published since 2015	Review articles published before 2015
Written in the English language	Written in a language other than English





3. Findings

3.1. Results of the search

The searches retrieved a total of 4,304 articles. Following the removal of duplicates, 2,147 unique records were screened based on their title and abstracts. This first round of screening removed 2,072 articles which did not meet our inclusion criteria, leaving 75 records which were sought for retrieval for full text-review. A further 22 records were excluded on review of the full text, resulting in 53 review articles which met our inclusion criteria for this review. The PRISMA diagram below illustrates this process.

Figure 1. PRISMA flow diagram



Identification of studies via databases

3.2. Description of included studies

We included 53 reviews from the academic database searches. Full characteristics of each of the included review articles can be found in the Study characteristics table in the annex (see Annex C), but we provide a high-level overview in the following sections.

3.2.1. Study design

All included articles were reviews, but the review type varied. This review includes systematic reviews (n=28), systematic reviews with meta-analysis components (n=9) and scoping reviews (n=7). Others were general literature reviews (n=3), integrative literature reviews (n=2), meta-analyses (n=1), systematic review with a narrative synthesis component (n=1), systematic mappings (n=1), and a review of reviews (n=1). Sample sizes for the reviews, defined here as number of articles included in the review, ranged from 2 included studies to 139, with a median of 24 (though this is approximate, as not all reviews gave precise figures).

3.2.2. Setting

This review includes studies conducted across a range of geographic settings, with the articles included in each review also providing broad geographic coverage. The primary studies within the included reviews cover Asia, Africa, North America, South America, Europe, and Australia (see Annex C for further details).

Regarding industry and setting, some of the included reviews did not specify an industry, simply referring to 'occupational settings' (n=23). Others noted occupational settings with specific qualities or exposures (e.g. asbestos or handling of specific materials/ chemicals) (n=6) or focused on a selection of industries (e.g. highrisk industries) (n=3). Some reviews focused on agricultural settings (n=7) and construction (n=8). Other settings included the dairy industry specifically (n=1), maritime (n=1), offices (n=1), mining and civil engineering (n=1), the electrical industry (n=1), and the meatprocessing industry (n=1).

3.2.3. Populations

Population characteristics also varied, and here we provide the findings based on the type of worker(s) or intervention application. Included reviews focused on workers generally (n=11) and workers exposed to specific factors (e.g. hot environments, chemicals) (n=11). Some focused on farmers and farmworkers (n=2), migrant farmworkers (n=1), agriculture (n=3), and farmers and agricultural workers together (n=1). Others included construction (n=6), workers and employers (n=2), dairy workers (n=1), office workers (n=1), supervisors (n=1), and workers in the meat-processing industry (n=1). There were also studies that focused more on the interventions themselves (rather than a specific population) and therefore did not specify the population (n=12).

3.2.4. Interventions

All included papers discussed at least one type of intervention, with some focusing on a specific intervention or type of intervention and others reviewing multiple interventions or types of intervention. The interventions identified, and how they were reviewed in our included articles, are described in Table 2, below. These are also mapped to each included review in Annex C.

3.2.5. Comparators

Over half of the studies included a comparator (n=32), which refers to a condition against which the effectiveness of an intervention is measured. Comparators included the absence of an intervention, recommended exposure levels vs in-place exposure levels, and the presence of a control group. The inclusion of a comparator depended on the study design (e.g. a pre- and post-intervention design) and the nature of the studies included in the review.



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 Table 2. Intervention categories and examples

Example interventions
 Educational interventions to improve and prevent various aspects related to safety (e.g. awareness of exposure risks and hazards, awareness of OSH, safety literacy) Safety training
 Interventions designed to reduce exposure (to e.g. pesticides) Cooling interventions Noise management systems and approaches
 Digitalisation Virtual reality technology Engineering controls and devices for workers
 Programmes integrating worker health, safety, and wellbeing Interventions promoting healthy lifestyles
 Interventions to improve safety culture Interventions aiming to modify attitudes, behaviours, norms, or structural conditions
 Interventions for supervisors focusing on leadership, supervisor-worker interactions, and injury or disability management
 Safety communication Scent interventions or exposures Social marketing
 Studies that focused on multiple different types of intervention, various similar interventions, or did not specify beyond a broad categorisation (e.g. 'OSH interventions'). Examples include: OSH legislation, inspection activity, and introduction of technical devices Combinations of various interventions, such as regulation, training, and safety campaigns Interventions involving exposure reduction, education and information provision, and testing Mindfulness and sustainability interventions, and management

3.2.6. Outcomes

Most studies reported or included outcome measures in some form (n=44). Many of the included reviews focused on multiple outcome measures (n=31). Some outcomes were objective measures of safety-related outcomes, such as accident, incident and injury rates; health outcomes; hazard exposure; organisational costs; and number of working days lost to injury or ill health. Some outcome measures were subjective, such as behavioural observations and self-reported questionnaires. In many studies, subjective measures were used as proxies for objective safety-related outcome measures. Some measures were of safety-related processes rather than outcomes, including safety knowledge and attitudes, behaviour change, risk perception, hazard awareness, safety motivation, safety culture and climate, and uptake of safety behaviours. The full list of outcomes is provided in the study characteristics table found in Annex C.

3.3. Critical appraisal tools and approaches

In reviewing and extracting data from the included studies, we found that the approaches to critical appraisal and quality assessment taken by the reviews we identified were varied. The tools used by reviews covered different aspects of the studies they reviewed, and there were also different levels of transparency provided regarding the critical appraisal methods used. In order to better understand how these varied approaches might affect the findings that can be drawn from these reviews, we therefore analysed the critical appraisal approaches taken by the reviews themselves.

To do this, we applied a framework developed by Crowe and Sheppard (13), who conducted a review of critical appraisal tools. In their article, they applied the constant comparative method to qualitatively analyse different items from critical appraisal tools and map whether different categories were considered across various



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tools. This provides a framework to map categories included within tools and understand where different approaches may be similar or not. We used this framework to analyse how reviews appraised the evidence they included.

In the rest of this section, we describe that analysis, broken down by the different dimensions of that framework. The dimensions (categories) considered in the framework are:

- Preamble (text; title; abstract)
- Introduction (background; objective)
- Research design (design type; intervention, input and exposure; outcome, output, predictor; bias and others)
- Sampling (sampling method; sample size; sampling protocol)
- Ethical matters (participant; researcher)
- Data collection (collection method; collection protocol)
- Results (analysis, integration, interpretation method; essential analysis; outcome, output, predictor analysis)
- Discussion (interpret; generalise; concluding remarks)

Within the reviews, we identified 16 different critical or quality appraisal tools used by the review authors to assess the quality of the primary articles. The list of tools is provided in Table 3, alongside the number of reviews that used it. The different tools utilised have notably different applications, for example, some tools are used to appraise evidence for a review and others are designed for individual studies. This may reflect the difference in study designs and that there is no agreed approach for how to assess evidence quality within this field. Not all reviews conducted quality assessments. Reasons for this include the study design or the absence of any mention by some authors regarding how the quality of studies was assessed. Some reviews utilised or adapted existing critical appraisal tools, in some cases applying more than one tool, and others developed their own (though, again, not all provided details of these). The critical appraisal tools used are further detailed in the study characteristics table and mapped to each of the included reviews (see Annex C).

Table 3. Critical appraisal tools

Critical appraisal tool	No. of reviews utilising tool
A MeaSurement Tool to Assess systematic Reviews (AMSTAR) (14)	1
American College of Occupational and Environmental Medicine's Practice Guidelines (15)	1
Appraisal of Guidelines for Research & Evaluation Instrument II (AGREE-II) (16)	1
Appraisal tool for cross sectional studies (AXIS) (17)	1
Authority, Accuracy, Coverage, Objectivity, Date, and Significance (AACODS) (29)	1
Average Study Quality (ASQ) score (18)	1
Critical Appraisal Skills Program (CASP) Checklists (19)	1
Downs and Black quality assessment checklist (20)	2
Effective Public Health Practice Project quality assessment tool (EPHPP) (21)	2
Enhancing the QUAlity and Transparency Of health Research (Equator) STROBE initiative (22)	1
Grading of Recommendations Assessment, Development and Evaluation (GRADE) (23)	7
Methodological Index for Non-Randomized Studies (MINORS) (24)	1
Newcastle–Ottawa Quality Assessment Scale (NOS) (25)	1
Seymour et al. adapted methodological quality rating system (26)	1
Swedish Council on Health Technology Assessment (SBU) Modified GRADE approach (27)	1
Tompa et al. methodology (28)	1



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The table below collates the categories and attributes used to appraise study quality across the included reviews. These categories were derived from the Crowe and Sheppard paper (13). The 'number

Table 4. Critical appraisal categories and items identified within tools used in reviews¹

of critical appraisal tools' column refers to the number of critical appraisal tools which included the particular category and item, out of the 16 listed above. These tools are then referenced in the rightmost column.

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1. Table and categories from Crowe and Sheppard (2011) (13).

Category and items	Description	Number of critical appraisal tools including this item	Relevant critical appraisal tools
	Preamble		
Text	 Sufficient detail others could reproduce Clear, concise writing/table(s)/diagram(s)/figure(s) 	4	(15–18)
Title	1. Includes study design and aims	1	(22)
Abstract	 Key information Balanced and informative 	1	(22)
	Introduction		
Background	 Summary of current knowledge Specific problem addressed and reason(s) for addressing 	3	(18,22,24)
Objective	 Primary objective(s), hypothesis(es), aim(s) Secondary question(s) 	10	(14–20,22,24,29)
	Research design		
Design type	 Research design(s) chosen and why Suitability of research design(s) 	12	(14,15,17–19,21,22,24,26–29)
Intervention, input, exposure	 Precise details of the intervention(s)/input(s)/exposure(s) for each group Main factors that contribute to choice of intervention(s)/input(s)/ exposure(s) Intervention(s)/input(s)/exposure(s) valid and reliable 	14	(15–28)
Outcome, output, predictor	 Clearly define outcome(s)/output(s)/predictor(s) Main factors that contribute to choice of outcome(s)/output(s)/ predictor(s) Outcome(s)/output(s)/predictor(s) valid and reliable 	10	(15–20,22,23,27,28)
Bias and others	 Potential sources of bias, confounding, interactions, effect modifiers, imprecision Sequence generation, group allocation, group balance, and by whom Equivalent treatment of participants/cases/groups 	14	(14,15,17–25,27–29)
	Sampling		
Sampling method	 Method(s) of selecting participants/cases/groups Suitability of sampling method 	10	(16,17,19,20,22–27)
Sample size	 Calculate sample size (statistical, theoretical, practical) Suitability of sample size 	8	(17,20,22–27)
Sampling protocol	 Description and suitability of target/actual/sample population Inclusion and exclusion criteria for participants/cases/groups Recruitment of participants/cases/groups 	14	(15–28)
	Ethical matters		
Participant	 Informed consent, equity Privacy, confidentiality/anonymity 	3	(17–19)
Researcher	 Ethical approval, funding, conflict(s) of interest Subjectivities, relationship(s) with participants/cases 	7	(14–17,19,22,29)
	Data collection		
Collection method	 Method(s) used to collect the data Suitability of collection method(s) 	11	(14,15,17–19,21,23,26–29)



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Category and items	Description	Number of critical appraisal tools including this item	Relevant critical appraisal tools
Collection protocol	 Include date(s), location(s), setting(s), personnel, materials, processes Method(s) to ensure/enhance quality of measurement/instrumentation Manage non-participation, withdrawal, incomplete/lost data 	9	(17–22,24,25,27)
	Results		
Analysis, integration, interpretation method	 Method(s) used to analyse/integrate/interpret primary outcome(s)/ output(s)/ predictor(s) Methods for additional analysis/integration/interpretation (e.g. subgroup analysis) Suitability of analysis/integration/interpretation method(s) 	14	(14,16–28)
Essential analysis	 Flow of participants/cases/groups through each stage of research Demographic and other characteristics of participants/cases/groups Analyse raw data, response rate, non-participation, withdrawal, incomplete/ lost data 	8	(18–23,27,28)
Outcome, output, predictor analysis	 For each outcome/output/predictor, a summary of results and precision Consider benefits, harms, unexpected results, problems, failures Describe outlying data (e.g. diverse cases, adverse effects, minor themes) 	8	(16,17,19,20,22,23,27,28)
	Discussion		
Interpret	 Interpret results in the context of current evidence and objectives Draw inferences consistent with the strength of the data Consider alternative explanations for observed results Account for bias, confounding, interactions, effect modifiers, imprecision 	12	(14–20,22,23,27–29)
Generalise	 Consider overall practical usefulness of the study Discuss the generalisability (external validity) of the study results 	8	(15,16,18,19,22,23,26,27,29)
Concluding remarks	 Highlight study's particular strengths Suggest steps that may improve future results (e.g. limitations) Suggest further studies 	6	(15–17,19,22,29)

As this table demonstrates, there was considerable variation in the items covered by the different critical appraisal tools, with no single tool covering all items identified by Crowe and Sheppard. Notably, some tools were not explicit about the exact categories used to appraise evidence quality but, rather, gave generic titles or did not specify at all. These have been mapped against the Crowe and Sheppard categories where feasible. Further to this, other categories seen within appraisal tools were not covered by the framework above (e.g. stakeholder involvement or peer-review), and the table may miss categories specific to certain study design applications (e.g. appraisal tools for guideline development). We further describe and discuss this quality aspect in the following sections.

3.4. Themes and findings

This section describes the findings and themes emerging from the analysis of the literature included in this review. We identified two main themes: (1) the strength of the evidence base; and (2) the quality of the reviews themselves. The box below presents a highlevel summary of these findings, and we present the detail in the subsequent sections.

3.4.1. Strength of the evidence base

The first theme identified from the included literature is the strength of the evidence base itself. This finding emerged from the findings of the reviews themselves, with the primary studies included often

being poor in quality, as often these studies did not test a theory of change to evaluate the intervention and did not use objective measures of safety. Generally, the evidence base appears to be sparse, due to gaps in the existing evidence base, and it appears to be heterogeneous in nature, which can make drawing definitive conclusions challenging.

Box 1. Findings summary

Theme 1 - Strength of evidence base

 The quality of primary studies included in reviews tends to be poor

- The evidence base is sparse and heterogeneous
- Evaluations rarely use objective measures of safety and test a theory of change

Theme 2 – Quality of reviews

- Broad diversity in terms of the quality of the reviews
- Variation in critical and quality appraisal tools used
- Lack of clarity or clear definition of the term "safety"

The quality of primary studies tends to be poor

Not all the reviews that we consider in this paper discussed the risk of bias (i.e. the possibility of error in method or approach resulting in potential overestimation or underestimation of effect or result) or overall quality of the primary studies that they included. Of those that



did, a clear majority found the methodological strength of the studies they included to be mostly poor (30–39), poor to moderate (8,40– 42), or moderate (43–45) via their quality assessments. Reviewers cited a number of common issues affecting OSH interventions and evaluations, including small sample sizes (30,40,46,47), participant attrition from interventions and subsequent failure to account for this in evaluations (33,48,49), lack of or imperfect randomisation of treatment and control groups (43,46,48,49), failure to blind participants and observers to participants' assignment to treatment or control groups (33,43), insufficient reporting (43,44), use of selfreported outcome measures (30,48), and general problems with confounder control (40,47). Several reviews also noted the likely distorting effects of these validity issues, including inflated effect sizes in evaluations with small or non-random samples or other design flaws (30,35,43,50).

There are some apparent exceptions to this rule. A minority of reviews (seven in total) found study quality to be mostly moderate to high (7,47,51–55). However, it is notable that only two of these seven reviews used the methodology outlined in the *Cochrane Handbook for Systematic Reviews and Interventions* to assess risk of bias (47,54), while the others used a custom quality assessment tool (7,51,52).

The evidence base is sparse and heterogeneous

Major gaps in the evidence base for OSH interventions were a common finding. A number of reviewers noted the general paucity of primary studies on their topic of interest (7,33,37,42,46,47,56–60); some also remarked on the scarcity of high-quality, rigorous studies in particular (42,46). Others expressed their surprise at failing to find any studies whatsoever on particular sub-topics: the authors of (30), for instance, expected but failed to find studies that considered the effect of legislation or engineering interventions on farmers' pesticide exposure, while the authors of (36) could not find any controlled studies that evaluated technical measures to reduce noise levels at the company level. This may reflect the fragmented nature of the OSH field.

The fragmented nature of OSH is also reflected in the heterogeneity of the evidence base (7,8,30,33,34,37,40,41,43,45,48– 51,55,60,61). Reviewers pointed to the considerable diversity of outcome measures (7,33,34,40,43,45,49,50,60), study designs (7,33,34,40,43,45,49,60), intervention types (7,8,34,45,49,60), intervention contexts or settings (7,8), and study participants (8,33) found in the various primary studies included in their reviews. In a number of cases, the heterogeneity of interventions and evaluations was found to preclude meta-analysis, which requires studies to be similar enough to be statistically comparable (33,34,40,41,43 ,45,49,55,60,62). In other cases, reviewers noted the diversity of the evidence base but were, nonetheless, able to conduct metaanalyses of at least some of the primary studies included in their reviews (7,8,37,50,63).

Evaluations rarely use objective measures of safety and test a theory of change

As several reviewers noted (45,46,53,63), relatively few evaluations of OSH interventions considered objective measures of safety, such as injury, accident, or fatality rates. For instance, none of the 16 evaluations of dairy industry OSH interventions reviewed in (46) measured changes in injury or fatality rates; and in (63), only three out of 90 evaluations of OSH training interventions to improve safety performance measured accident or injury rates. Far more commonly measured were outcomes that might be considered intermediate, such as changes in workers' safety knowledge or the workplace safety climate.

A minority of primary studies did measure accident, injury, or fatality rates directly. Ideally, these studies would also have outlined and tested the theory of change underpinning the intervention they were evaluating in order to shed light on the reasons for the intervention's (in)effectiveness. However, as several reviewers noted (30,33,37,48,57), only a small proportion of interventions were based on theory at all. Of those that were, most did not test the intermediate outcomes believed to drive the changes in accident, injury, or fatality rates that they were ultimately aiming for. In (33), for example, 5 out of 15 interventions were based on a theory or model (including the PRECEDE-PROCEED model, Integrated Safety Management Theory, Goal setting theory, and a Health Promotion Model), but only one of the five measured components of the theory before and after the intervention in order to validate the model. Similarly, only around a guarter of the 31 studies considered in (30) reported on an intervention that was based on theory, and only two tested the theory in question.

Summary of review findings

The findings from the included reviews show that 'success' of an intervention (i.e. effectiveness or positive outcomes) vary for a range of reasons, including approach, type of intervention, and context. While there is evidence to support the effectiveness of specific interventions for safety in specific contexts, it is not possible to draw general conclusions about effective cross-sectoral interventions for OSH. Findings for each of the reviews can be found in the study characteristics table (see Annex C); we provide some examples below.

Interventions that focused on safety culture, leadership and behavioural approaches showed some success (43,57). There was also evidence that safety climate practices play a role in safety performance (8,49,65). Educational programmes also showed varying levels of effectiveness in different contexts. For example, educational programmes were effective for enhancing general OSH knowledge for office workers (57) and were seen as 'appropriate' for reducing exposure risks to pesticides for agricultural workers (30,50). Training methods in agricultural settings were found to be effective in raising awareness and improving risk behaviours for farmers and



agricultural workers (52). Another example is the integration of digital technologies for reducing workplace accidents, for which there is some evidence for reduction of accidents (78), and e-training 'shows promise' as an intervention for OSH improvement for businesses and employees (79).

Other examples of interventions included scent interventions, which had a positive impact in some studies on alertness and fatigue mitigation (80). Legislative policies may be effective, with one review finding moderately strong evidence for reducing injuries and fatalities, and for improved compliance (7). Multifaceted interventions, such as multifaceted safety campaigns, offer varying degrees of success (8,37).

In general, the quality of primary studies included within the reviews varied. This often leads to results that are inconclusive or that have a high risk of bias, as indicated by review authors. Many studies recommend further research and note that their findings should be interpreted with caution, due to the methodological and data limitations of the current evidence base.

3.4.2. Quality of the reviews themselves

The second theme that we identified in the literature was a broad diversity in terms of the quality of the reviews being conducted in this area. Limitations within the design of included reviews, such as the absence of clear evidence quality assessments and robust methodologies, may limit the utility of many of these reviews in determining which interventions improve safety. This is compounded by the lack of a clear definition of what safety is. While there were many papers conducted with strong methods, there was a preponderance of reviews which summarised interventions described elsewhere in the literature without making meaningful comparisons between them or evaluating their effectiveness. Some of these were narrative, descriptive or scoping reviews, which understandably did not adopt a systematic approach, but others, which were described as systematic, were lacking in key components, such as a protocol or reporting on evidence quality (64-67).

A total of 18 papers were produced to a high methodological standard, in that they include inclusion/exclusion criteria and details of evidence quality assessment or risk of bias for each paper (7,8,30,31,33,34,36-38,40,41,43-45,50,54,55,68). These were predominantly performed by organisations known for conducting systematic reviews, such as the Cochrane Work Group and Campbell (8,36,37,44,54). However, other included papers were also produced by established university medicine departments or organisations involved in safety research or advocacy, such as the Centre for Occupational Public Environmental Research in Safety and Health (COPERSH), the Monash University Accident Research Centre, and the US-based National Safety Council (34,43,55,68).

Some of the included reviews only partially reported on the quality of evidence but did so in a way that was not systematic or not in the main body of the paper (35,51,53,60). For example, one review referred to an acceptable level of evidence quality in the included studies but did not provide any details of the criteria used to make this assessment (53). Another did not include a quality-of-evidence assessment, but did refer to the quality-of-evidence assessments performed in these papers (almost all of which used GRADE) (23). The authors noted that these assessments 'may be subject to subjective influences of the respective systematic review authors,' although this may be mitigated by the fact that only studies with a low risk-of-bias were included (35).

Other reviews took different approaches. For example, one review of intervention studies across six decades scored the quality of the included studies from one to four based on: the planning of the intervention, the use of a control group, the use of randomisation for the intervention/control and measurements of pre- and postintervention effects. The quality scores were provided per decade and study area, but there was no detailed breakdown of the quality of each study (42). Further, another review performed a risk-ofbias assessment of the five included papers using the Cochrane methodology but did not perform any systematic assessment of quality of evidence. The table of included papers nonetheless commented on factors relating to quality, such as a lack of randomisation, aspects not discussed by the studies or the need for further research (47).

As noted above, most of the included papers provided limited or no information concerning evidence assessment, although some of these did allude to the quality of evidence in general or mention methodological problems identified with individual articles (39,46-49,56,58,59,61-67,69-75). For example, one review described an assessment of quality but provided no specific details, while another referred to 'research quality labelling' but provided no further detail (39,56). Two papers suggested that quality assessment was not possible owing to the papers being scoping reviews (46,75).

Overall, the reviews in this area were found to be of mixed quality, with a range of approaches taken to quality assessment and methodology. A primary challenge with the literature is the number of reviews which lacked either an assessment of quality of evidence or meaningful comparison between interventions. While these reviews may provide a helpful overview of what techniques or interventions are in use, they may be of limited utility for informing safety improvement practices, due to uncertainties in the underlying evidence and the lack of objective measures.

Critical appraisal and quality assessment methodologies

There was a high degree of variation in terms of the tools being used to determine quality of evidence. Some papers used established frameworks, while others used their own methodology/ criteria. For example, some authors used an assessment tool previously developed and used in the Scandinavian Journal of Work, Environment and Health (7). Others calculated the strength of evidence for each article in the review using custom criteria, including the existence of a control/comparison group and statistical significance testing (32). Other articles developed custom criteria based on such factors as study design, presentation of results, randomisation, planning and sample size (42,51,60).

The single most commonly used tool in the included papers was GRADE, a systematic method used to rate the quality and certainty of the evidence used in literature reviews (7.31.32.38). However, there were a plethora of other evidence assessment tools used in the reviewed articles, including the NOS method (55), AGREE-II (40), AMSTAR (40), the Cochrane Quality Criteria Checklist (33), the Downs and Black approach (33,43), the ASQ scoring system (43), the AXIS tool (76), the Quality Assessment Tool for Quantitative Studies (EPHPP) (30,34) and AACODS (68). Overall, there was no consensus about which critical appraisal tools are most appropriate for research on the effectiveness of OSH interventions. The variation in evidence assessment methodologies (and the differences in coverage of categories from the framework) may reflect the broad range of safety topics covered as part of this review and the need, therefore, to adopt different critical appraisal methodologies to assess them. While, ultimately, any appraisal of evidence quality is better than none, a harmonised or consistent approach for such appraisals may help with drawing stronger comparisons and robust conclusions regarding evidence quality. In any event, this lack of consensus on how to assess quality of evidence across the field makes it difficult to draw robust conclusions across the different reviews of the area.

Risk of bias

Risk-of-bias (RoB) assessment was conducted for many papers in the included set, using a range of different methodologies. Most of these papers used RoB tools developed by Cochrane, with the type depending on the review type (e.g. Risk of Bias in Non-randomised Studies – of Interventions (ROBINS-I) for non-randomised interventions, RoB/RoB 2 for randomised interventions, tools developed by Cochrane Effective Practice and Organisation of Care (EPOC) for interrupted time series studies) (8,31,37,38,41,44,47,50,54). Other tools used for risk of bias included ROBIS, produced by the University of Bristol (35); MINORS (32); and the modified Downs and Black method (36).

Definitions

Some of the reviews provided theoretical groundings for how they conceptualised and defined OSH (40,52,67,70,77,78). Only one of the reviews we included provided a concrete definition of safety. As Tawfeeq et al. described: 'Safety is defined clearly by protecting people from physical harm. The boundary between health and safety remains undefined, and these two terms are commonly utilised together to show concern for the physical and mental well-being of the person working' (65). Some definitions were also provided for concepts adjacent to safety. For example, Lee et al. defined occupational safety as an 'emergent property [and] a result of dynamic interactions between work system components', while Zara et al. defined workplace safety as 'associated with active communication to minimize the rate of accidents and improve safety in the workplace' (39,49). Another article provided a circular definition of safety training based on efforts to 'improve safetyrelated outcomes', without qualifying what safety-related outcomes are (34). Dyreborg et al. note that 'there is no general consensus on a definition of safety climate' and that the literature 'has been plagued by conceptual ambiguity', while also suggesting that safety climate is a robust predictor of safety performance (8).

4. Discussion

4.1. Summary of findings

The literature on health and safety at work examined as part of this review is heterogeneous in terms of both content and quality. Many different methodologies were adopted, and they differed by paper, from established tools to criteria developed specially for the study in question. Some papers went into extensive detail about the quality of the evidence and included all of the appropriate methodological elements for the study type. These reviews were mostly performed by established research centres or review groups. However, many reviews lacked specificity about the quality and RoB of the included papers or did not make meaningful comparisons between the interventions reviewed. Further, studies also rarely used objective outcomes of safety or tested a theory of change within their evaluations. The lack of clear definitions of safety also presents challenges for drawing conclusions or comparing outcomes.

4.2. Implications

The findings from this review of reviews indicate that the recent body of evidence on the effectiveness of OSH interventions is highly heterogeneous, mirroring the sector-specific and context-dependent nature of OSH. Primary studies also exhibit varying quality - with differences in study designs, lack of underpinning theory and gaps in the evidence – underscoring the necessity for further research. The reviews of these primary studies are also of varying quality, with only a few of these adopting systematic quality appraisal tools and even fewer assessing the risk of bias of the primary studies. The primary studies, while not our main focus, largely discuss potential proxy outcomes (e.g. safety knowledge and safety culture), without rigorously linking these to objective health and safety outcomes (i.e. number of occupational incidents, accidents, injuries, ill health and fatalities). This lack of a described or verified causal relationship between proxy or process measures and ultimate objective outcomes can be problematic. If such a relationship existed, then the evaluations', and therefore also the reviews', focus on intermediate outcomes would be more robust. The lack of such relationship only further underlines a need for clear theories of change or causal mechanisms for using such measures. Another challenge for outcomes is that injury and accident rates may not be recorded and tracked in an appropriate way that allows for investigation. Injuries and accidents may also need to be tracked for a significant length of time (potentially years) to see whether an intervention has made a difference to incidence rates.

The inconsistency, or absence, of clarity and consensus on definitions regarding safety is worth further discussion, too. A lack of standardisation makes synthesising findings and comparing them challenging. This lack of clarity may also generally hinder understandings and applications of safety within workplaces. Although identifying a definition of safety was not the primary objective of this review, we believe that the absence of clear definitions within the identified articles highlights a broader

vidence

challenge. This stems from the fact that different articles often use the same terms with slightly varying meanings, leading to inconsistencies and potential misunderstandings in the field and making it challenging to make comparisons or robust conclusions. There are also likely to be further variations between different sectors and industries that may require specific adaptations. This underscores the need for research to provide definitions for the terms being used within OSH research. The development and utility of clear outcome measures and improved study quality will be further enabled by clarity of terms.

As we have discussed, the evidence base is limited and of varied quality, and further reviews and study in this field may continue to reflect this. Some of the included reviews were of high quality, but, again, these also face challenges, due to the heterogeneity of the included primary studies. Addressing these challenges will improve the quality of further research, and improve the ability of this research to effectively inform evidence-based interventions and their application in workplaces.

4.3. Recommendations for further research

The following are our recommendations for future OSH researchers, funders, and evidence-based policymakers who are conducting and commissioning studies and reviews on the effectiveness of OSH interventions. These are aimed at improving the overall quality, robustness and replicability of this evidence base, reflecting on the findings and discussion of this review.

1. Better and clearer definitions

Future research should consider developing more precise and universally accepted definitions of the terms used in OSH research, beginning with the definition of safety itself and extending to related concepts, such as safety culture and safety knowledge, as well as then building greater consensus on how to measure different constructs and outcomes. This process could involve engaging with multidisciplinary perspectives to capture the complexity of OSH as it applies to various sectors and environments.

2. Use of models and theories to make causal relations explicit

Researchers and designers of OSH interventions should be encouraged to incorporate well-defined models or theories, such as a theory of change, to guide the design, implementation, and evaluation of interventions. Employing clear theories or models can help elucidate the causal pathways between interventions, process outcomes (such as safety culture), and objective outcomes (such as injuries and fatalities), which it would be helpful to make more explicit in publications of primary studies.

3. Refining quality appraisal tools for OSH research

Researchers conducting reviews should work towards refining and standardising quality appraisal tools specific to OSH research, while being mindful of the potential limitations of the existing primary evidence base. This effort should aim to address the heterogeneity of the evidence landscape, ensuring consistent and reliable assessments of study quality across diverse methodologies and contexts.

4. Addressing evidence gaps.

As new OSH interventions are continually developed and many existing interventions remain unevaluated, research may inevitably lag. Despite this lag, it is important for funders and researchers to persist with primary research on the effectiveness of both new and established interventions within OSH to ensure that practices are grounded in robust evidence.

4.4. Review limitations

This review only included literature published in the English language; therefore there may be other relevant reviews published in other languages that were not retrieved during our search. This was a review of reviews, and thus our findings are dependent on the quality of those reviews, the issues around which we discuss in our findings and discussion section.

The nature of this evidence also introduces challenges when attempting to use a systematic review methodology. The variability and mixed quality of evidence, alongside the range of outcome measures being used across different interventions, can make it difficult to draw meaningful conclusions within a systematic review approach. The range, or lack, of safety definitions also raises complications when categorising and attempting to understand evidence.

5. Conclusion

This study aimed to identify and understand what existing reviews (and reviews of reviews) of OSH interventions exist and to understand the quality of the evidence that they describe.

We found that the strength of the evidence base is varied, with many primary studies being poor in quality and not using objective measures of safety, and that the reviews themselves also have broad diversity in their quality, with some lacking an assessment of quality of evidence. A lack of clear outcomes and definitions of the term safety may also contribute to this mixed quality. There was also no consensus among the papers around how to critically appraise or review evidence quality within the identified reviews. The critical appraisal tools used across the included reviews varied in nature and coverage. This hinders the ability to draw robust conclusions about the underlying evidence base on the basis of existing reviews. While, ultimately, any appraisal of evidence quality is better than none, a unified or similar approach for conducting appraisals would help with drawing stronger comparisons and robust conclusions regarding evidence quality. The lack of standardisation in definitions, outcomes, and appraisal methods poses challenges in conducting meaningful comparisons and identifying clear conclusions.





Thinking to the future, this report highlights that further research needs to focus on establishing standardised definitions and outcomes in OSH interventions to enhance clarity and consistency across studies. Such research should aim to develop and refine quality appraisal tools that are tailored to the unique challenges of OSH research, ensuring comprehensive evaluations of evidence quality. Additionally, there is a need to promote the integration of theoretical frameworks, such as theories of change, to better understand causal pathways and improve intervention design and evaluation.

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Annex A. Search strategies

A.1. PubMed

Set #	Search Strategy	# of Results
1 Occupational Health & Safety	"occupational safety health"[tab:~1] OR "occupational safety"[tiab] OR "occupational health"[tiab] OR "workplace safety"[tiab] OR "workplace health"[tiab] OR "OSH"[tiab] OR "occupational health safety"[tiab:~1] OR "occupational exposure*"[tiab] OR "occupational injur*"[tiab] OR "OHS" [tiab] OR "occupational accident*"[tiab] OR "occupational risk*"[tiab] OR "job injur*"[tiab] OR "OHS" [tiab] OR "occupational accident*"[tiab] OR "occupational risk*"[tiab] OR "job injur*"[tiab] OR "work injur*"[tiab] OR "workplace injur*"[tiab] OR "job accident*"[tiab] OR "work accident*"[tiab] OR "workplace accident*"[tiab] OR "industrial health"[tiab] OR "employee health"[tiab] OR "employee safety"[tiab] OR "occupational hazard*"[tiab] OR "Occupational Exposure"[Mesh] OR "Occupational Injuries"[Mesh] OR "Accidents, Occupational"[Mesh] OR "Occupational Health"[MAJR]	151,682
2 Interventions	intervention[tiab] OR interventions[tiab] OR intervening[tiab] OR program[tiab] OR programs[tiab] OR programme[tiab] OR programmes[tiab] OR strategy[tiab] OR strategies[tiab] OR practices[tiab] OR initiative*[tiab] OR framework*[tiab]	4,313,091
3* Systematic Reviews	"systematic review"[ti:~3] OR "systematic reviews"[ti:~3] OR ((systematic[tiab] OR scoping[tiab]) AND review[pt]) OR "systemic review*"[ti] OR "systematical review*"[ti] OR "meta analy*"[tiab] OR metaanaly*[tiab] OR metasynthes*[tiab] OR "meta synthes*"[tiab] OR ((systematic[ti] OR scoping[ti] OR metanaly*[ti] OR metasynth*[ti] OR "meta analy*"[ti] OR "meta synth*"[ti] OR evidence[ti] OR Cochrane[ti] OR literature[ti]) AND (review*[ti] OR synthes*[ti] OR map[ti] OR mapping[ti] OR scan[ti])) OR "systematic review"[pt] OR "systematic review"[sb] OR meta- analysis[pt] OR "literature review"[ti:~2] OR "rapid review"[ti:~2] OR "umbrella review"[ti:~2] OR "review of reviews"[ti] OR "evidence review*"[ti] OR "scoping review*"[ti] OR "literature scan*"[ti] OR "Systematic Reviews as Topic"[Mesh] OR "Meta-Analysis as Topic"[MeSH] OR "Review Literature as Topic"[MeSH]	767,780
4	#1 AND #2 AND #3 AND ((2015/1/1:2024/12/31[pdat]) AND (english[Filter]))	1,176

*Adapted from: Salvador-Oliván JA, Marco-Cuenca G, Arquero-Avilés R. Development of an efficient search filter to retrieve systematic reviews from PubMed. J Med Libr Assoc. 2021 Oct 1;109(4):561-574.





A.2. Academic Search Complete

Set #	Search Strategy	# of Results
1 Occupational Health & Safety	(TI "occupational safety" OR AB "occupational safety") OR (TI "occupational health" OR AB "occupational health") OR (TI "workplace safety" OR AB "workplace safety") OR (TI "workplace health" OR AB "workplace health") OR (TI OSH OR AB OSH) OR (TI "occupational exposure*" OR AB "occupational exposure*") OR (TI "occupational injury" OR AB "occupational injury") OR (TI "occupational injuries" OR AB "occupational injuries") OR (TI "occupational accident*" OR AB "occupational accident*") OR (TI "occupational risk*" OR AB "occupational accident*" OR AB "occupational accident*") OR (TI "occupational risk*" OR AB "occupational risk*") OR (TI "job injur*" OR AB "job injur*") OR (TI "work injur*" OR AB "work injur*") OR (TI "workplace injur*" OR AB "workplace injur*") OR (TI "job accident*" OR AB "job accident*") OR (TI "workplace injur*" OR AB "work accident*") OR (TI "workplace accident*" OR AB "workplace accident*") OR (TI "industrial health" OR AB "industrial health") OR (TI "employee health" OR AB "employee health") OR (TI "employee safety" OR AB "employee safety") OR (TI "occupational hazard*" OR AB "occupational hazard*") OR TI(occupational safety W1 health) OR AB(occupational safety W1 health) OR TI(occupational health W1 safety) OR AB(occupational health W1 safety) OR DE "OCCUPATIONAL health services" OR DE "EMPLOYEE health promotion" OR (DE "OCCUPATIONAL exposure") OR (DE "OCCUPATIONAL hazards") OR (DE "WORK-related injuries")	61,790
2 Interventions	(TI intervention OR AB intervention) OR (TI interventions OR AB interventions) OR (TI program OR AB program) OR (TI programs OR AB programs) OR (TI programme OR AB programme) OR (TI programmes OR AB programmes) OR (TI strategy OR AB strategy) OR (TI strategies OR AB strategies) OR (TI practices OR AB practices) OR (TI initiative* OR AB initiative*) OR (TI framework* OR AB framework*)	5,440,172
3* Systematic Reviews	TI "systematic review*" OR TI "systematic reviews" OR TI "systemic review*" OR TI "systematical review*" OR (TI "meta analy*" OR AB "meta analy*") OR (TI metaanaly* OR AB metaanaly*) OR (TI metasynthes* OR AB metasynthes*) OR (TI "meta synthes*" OR AB metasynthes*") OR TI "umbrella review*" OR TI "evidence review*" OR TI "scoping review*" OR TI "literature scan*" OR TI (literature N2 review*) OR AB(literature N2 review*) OR TI (rapid N1 review*) OR TI "review of reviews" OR TI((systematic OR scoping OR metanaly* OR metasynth* OR synthes* OR map OR mapping)) OR AB((systematic OR scoping OR metanaly* OR metasynth* OR "meta analy*" OR "meta synth*" OR evidence OR Cochrane OR literature) N2 (review* OR synthes* OR map OR mapping)) OR AB((systematic OR scoping OR metanaly* OR metasynth* OR "meta analy*" OR "meta synth*" OR evidence OR Cochrane OR literature) N2 (review* OR synthes* OR map OR mapping)) OR AB((systematic OR scoping OR metanaly* OR metasynth* OR "meta analy*" OR "meta synth*" OR evidence OR Cochrane OR literature) N2 (review* OR synthes* OR map OR mapping)) OR AB((systematic OR scoping OR metanaly* OR metasynth* OR "meta analy*" OR "meta synth*" OR evidence OR Cochrane OR literature) N2 (review* OR synthes* OR map OR mapping)) OR DE "META-analysis" OR DE "SYSTEMATIC reviews" OR DE "LITERATURE reviews"	579,994
4	S1 AND S2 AND S3 Limits: 2015-2024; English; Academic Journals	671





A.3. Scopus

Set #	Search Strategy	# of Results
1 Occupational Health & Safety	TITLE-ABS("occupational safety" OR "occupational health" OR "workplace safety" OR "workplace health" OR "OSH" OR "occupational exposure*" OR "occupational injury" OR "occupational injuries" OR "occupational accident*" OR "occupational risk*" OR "job injur*" OR "work injur*" OR "workplace injur*" OR "job accident*" OR "work accident*" OR "workplace accident*" OR "industrial health" OR "employee health" OR "employee safety" OR (occupational safety W/1 health) OR (occupational health W/1 safety) OR "occupational hazard*")	105,923
2 Interventions	TITLE-ABS("intervention" OR "interventions" OR "program" OR "programs" OR "programme" OR "programmes" OR "strategy" OR "strategies" OR "practices" OR initiative* OR framework*)	12,786,945
3* Systematic Reviews	TITLE("systematic review*" OR "systematic reviews" OR "systemic review*" OR "systematical review*" OR "meta analy*" OR metaanaly* OR metasynthes* OR "meta synthes*" OR "umbrella review*" OR "evidence review*" OR "scoping review*" OR "literature scan*" OR (literature W/2 review*) OR (rapid W/1 review*) OR "review of reviews") OR TITLE-ABS((systematic OR scoping OR metanaly* OR metasynth* OR "meta analy*" OR "meta synth*" OR evidence OR Cochrane OR literature) W/1 (review* OR synthes* OR map OR mapping))	1,119,203
4	#1 AND #2 AND #3	1,133

A.4. Web of Science: Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Emerging Sources Citation Index (ESCI)

Set #	Search Strategy	# of Results
1 Occupational Health & Safety	TI=("occupational safety" OR "occupational health" OR "workplace safety" OR "workplace health" OR "OSH" OR "occupational exposure*" OR "occupational injury" OR "occupational injuries" OR "OHS" OR "occupational accident*" OR "occupational risk*" OR "job injur*" OR "work injur*" OR "workplace injur*" OR "job accident*" OR "work accident*" OR "workplace accident*" OR "industrial health" OR "employee health" OR "employee safety" OR (occupational safety NEAR/1 health) OR (occupational health NEAR/1 safety) OR "occupational hazard*") OR AB=("occupational safety" OR "occupational health" OR "workplace safety" OR "workplace health" OR "occupational injury" OR "occupational hazard*") OR AB=("occupational safety" OR "occupational health" OR "workplace safety" OR "workplace health" OR "occupational injury" OR "occupational injuries" OR "OFH" OR "occupational injury" OR "occupational hazard*") OR AB=("occupational safety" OR "occupational health" OR "workplace safety" OR "workplace health" OR "occupational injury" OR "occupational injuries" OR "OFH" OR "occupational exposure*" OR "occupational injury" OR "workplace accident*" OR "occupational injury" OR "occupational injuries" OR "OFH" OR "occupational accident*" OR "occupational injury" OR "workplace accident*" OR "occupational injury" OR "work injur*" OR "workplace injur*" OR "job accident*" OR "work accident*" OR "work accident*" OR "workplace accident*" OR "industrial health" OR "employee health" OR "occupational safety NEAR/1 health) OR (occupational health NEAR/1 safety) OR "occupational hazard*") OR "occupational health NEAR/1 safety) OR "occupational hazard*")	60,152
2 Interventions	TI=("intervention" OR "interventions" OR "program" OR "programs" OR "programme" OR "programmes" OR "strategy" OR "strategies" OR "practices" OR initiative* OR framework*) OR AB=("intervention" OR "interventions" OR "program" OR "programs" OR "programme" OR "programmes" OR "strategy" OR "strategies" OR "practices" OR initiative* OR framework*)	6,995,201
3* Systematic Reviews	TI=("systematic review*" OR "systematic reviews" OR "systemic review*" OR "systematical review*" OR "meta analy*" OR metaanaly* OR metasynthes* OR "meta synthes*" OR "umbrella review*" OR "evidence review*" OR "scoping review*" OR "literature scan*" OR (literature NEAR/2 review*) OR (rapid NEAR/1 review*) OR "review of reviews") OR TI=((systematic OR scoping OR metanaly* OR metasynth* OR "meta analy*" OR "meta synth*" OR evidence OR Cochrane OR literature) NEAR/1 (review* OR synthes* OR map OR mapping)) OR AB=((systematic OR scoping OR metanaly* OR metasynth* OR "meta analy*" OR "meta synth*" OR evidence OR Cochrane OR literature) NEAR/1 (review* OR synthes* OR map OR mapping)) OR AB=((systematic OR scoping OR metanaly* OR metasynth* OR "meta analy*" OR "meta synth*" OR evidence OR Cochrane OR literature) NEAR/1 (review* OR synthes* OR map OR mapping)) OR KP=("systematic review*")	907,389
4	#1 AND #2 AND #3	912





A.5. Embase

Set #	Search Strategy	# of Results
1 Occupational Health & Safety	'occupational safety':ti,ab OR 'occupational health':ti,ab OR 'workplace safety':ti,ab OR 'workplace health':ti,ab OR 'OSH':ti,ab OR 'occupational exposure*':ti,ab OR 'occupational injury':ti,ab OR 'occupational injuries':ti,ab OR 'occupational accident*':ti,ab OR 'occupational risk*':ti,ab OR 'job injur*':ti,ab OR 'work injur*':ti,ab OR 'workplace injur*':ti,ab OR 'job accident*':ti,ab OR 'work accident*':ti,ab OR 'workplace accident*':ti,ab OR 'industrial health':ti,ab OR 'employee health':ti,ab OR 'employee safety':ti,ab OR (occupational safety NEAR/1 health):ti,ab OR (occupational health NEAR/1 safety):ti,ab OR 'occupational hazard*':ti,ab OR 'occupational health'/exp OR 'occupational hazard'/exp OR 'occupational accident'/exp	321,179
2 Interventions	intervention:ti,ab OR interventions:ti,ab OR program:ti,ab OR programs:ti,ab OR programme:ti,ab OR programmes:ti,ab OR strategy:ti,ab OR strategies:ti,ab OR practices:ti,ab OR initiative*:ti,ab OR framework*:ti,ab	5,467,731
3* Systematic Reviews	'systematic review*':ti OR 'systematic reviews':ti OR 'systemic review*':ti OR 'systematical review*':ti OR 'meta analy*':ti OR metaanaly*:ti OR metasynthes*:ti OR 'meta synthes*':ti OR 'umbrella review*':ti OR 'evidence review*':ti OR 'scoping review*':ti OR 'literature scan*:ti OR (literature NEAR/2 review*):ti OR (rapid NEAR/1 review*):ti OR "review of reviews":ti OR ((systematic OR scoping OR metanaly* OR metasynth* OR 'meta analy*' OR 'meta synth*' OR evidence OR Cochrane OR literature) NEAR/1 (review* OR synthes* OR map OR mapping)):ti OR 'systematic review'/exp	740,255
4	#1 AND #2 AND #3 AND ([article]/lim OR [article in press]/lim OR [review]/lim) AND [english]/lim AND [2015-2024]/py AND [embase]/lim NOT [medline]/lim	412

Annex B. Extraction framework

General information

- Reviewer name
- Date of extraction
- Review paper title
- Author(s)
- Year of publication
- DOI/link

Evidence review scope and objectives

- Review aim/objective(s)/research question(s)
- Type of review (e.g. systematic review, meta-analysis, scoping review)
- Definition of safety (if available)
- Inclusion/exclusion criteria
- Scope of review (number of studies/populations/interventions)
- Population
- Characteristics
- Geographical location
- Workplace/industry/sector
- Interventions
- Types of interventions reviewed (e.g. training programmes, safety protocols)
- Comparator (if applicable) (e.g. different intervention, none or absence of intervention)
- Outcomes (e.g. quality of life, injury rates, health improvements, safety outcome improvements, costs, return to work, worker behaviour)
- Indicators and measurements

Evidence quality

- What is the paper's assessment of quality of evidence?
 - What tool or criteria did the paper use?
 - What were the conclusions/findings on evidence quality?
 - What were the limitations noted by author(s)?



Annex C. Study characteristics table

Table 5. Study characteristics table

Author and year	Study design	Sample size (# of articles included)	Industry/setting	Geography (areas in which studies were conducted)	Population characteristics	Intervention	Comparison (if applicable)	Outcomes	Critical/quality appraisal tool	Summary of review findings
Aburumman et al. 2019	Systematic review	23	Occupational settings	Australia, Canada, China, Denmark, Iran, Poland, the UK, the United States, Sweden	Workers	Workplace interventions to improve safety culture	Primary studies used a mixture of between- subject and within- subject designs	Safety culture, measured by various safety climate/ safety culture scales	Downs and Black checklist, Average Study Quality	The most 'successful' interventions were those related to safety importance, leadership style, and behavioural monitoring. No significant differences in outcomes by level of intervention. Results and findings are inconclusive due to susceptible study design and overall weak methodological quality.
Afshari et al. 2021	Systematic review	31	Agriculture	Australia, Bolivia, Ecuador, Egypt, India, Iran, Nepal, Nicaragua, Sri Lanka, Thailand, the United States	Farmers and farmworkers	Interventions designed to reduce pesticide exposure or poisoning	Mixture of between- subject and within- subject designs	Various, including knowledge/attitudes/ beliefs (such as perception of risk from pesticide exposure), practices/behaviours (such as use of personal protective equipment (PPE)) and objective measures of pesticide exposure (such as pesticide metabolite concentrations in urine)	EPHPP Quality Rating	Majority of studies did not assess the effect of interventions on objective messages, but the results highlight the 'significant effectiveness' of educational programmes.
Akyildiz 2023	Literature review	50	Occupational settings	Not stated	N/a (focus is on hypothesised benefits and risks of technologies)	Digital technologies / digitalisation	N/a	N/a	Not stated	Integration of digital technologies can lead to a 'significant reduction' in workplace accidents, but there are challenges.
Allaouat et al. 2020	Systematic review and meta- analysis (Cochrane)	4	Occupational settings	Italy, Thailand, the United States	Workers who work with lead	Educational interventions aiming to prevent lead exposure and lead poisoning	None (due to within- group study designs)	Blood/urine lead levels, behaviour change, knowledge of the health effects of lead exposure	GRADE	Minimal, low-quality evidence suggests potential reduction in blood lead levels, but some other mixed results. Overall, there may be an effect of interventions, but this is uncertain or inconclusive based on the evidence.
Andersen et al. 2019	Systematic review and meta- analysis	50 peer- reviewed studies, 16 grey literature studies	Occupational settings	Vast majority from the United States	Workers	Various, summarised as: '(i) introduction of OHS [occupational health and safety] legislation, (ii) inspection/enforcement activity, (iii) training, such as improving knowledge, (iv), campaigns, and (v) introduction of technical devices, such as mechanical lifting aids'	Not stated	Many, summarised as 'reduced levels of industrial injuries and fatalities, musculoskeletal disorders, worker complaints, sick leave, and adverse occupational exposures'	SBU Modified GRADE approach	⁴ [M]oderately strong evidence' for improvements related to injuries and compliance with OHS legislation. The review concludes that legislative and regulatory policy may reduce injuries and fatalities and improve compliance.
Ayaz et al. 2022	Systematic review and meta- analysis	38	Agriculture	Africa, Asia, Australia, North America, South America	Agricultural workers	Educational interventions aiming to reduce the risk of pesticide exposure	Mixture of between- subject and within- subject designs	Knowledge, behaviour or risk perception in relation to pesticide exposure	Cochrane for RoB	Findings show that educational interventions are appropriate for reducing pesticide exposure risks for agricultural workers.



Author and year	Study design	Sample size (# of articles included)	Industry/setting	Geography (areas in which studies were conducted)	Population characteristics	Intervention	Comparison (if applicable)	Outcomes	Critical/quality appraisal tool	Summary of review findings
Bakhuys Roozeboom et al. 2021	Systematic review	38	Occupational settings	Not stated	Workers	Interventions that (1) aimed to prevent work-related ill health, accidents and injuries or promote worker health and well-being; and (2) explicitly used the Intervention Mapping protocol	N/a	Fidelity of intervention to the Intervention Mapping protocol, the implementation process, whether interventions were effective or ineffective	Not stated	Participative approaches and implementatio planning are difficult in practice. Conducting 'matrices of change' objectives within an intervention also takes time and is challenging but may pay off.
Barati Jozan et al. 2023	Literature review (with some systematic elements)	25	Occupational settings	Developed countries (Australia, Belgium, Canada, Germany, Japan, Korea, Norway, Spain, the Netherlands, the UK, the United States) and developing countries (China, Turkey)	Workers	Educational interventions aimed at improving workers' occupational safety and health	Mixture of between- subject and within- subject designs	Numerous 'primary outcomes related to occupational safety and health', e.g. time spent sitting, pain reduction, weight loss	Not stated	Analysis shows that e-training has 'enormou promise' in OSH for businesses and employees.
Belackova et al. 2024	Systematic review and meta- analysis (Cochrane)	7	Occupational settings where asbestos is present	France, Switzerland, the Netherlands, the UK	Workers exposed to asbestos	Interventions involving the use of PPE to reduce asbestos exposure	No intervention / no asbestos protection	Reduction in asbestos exposure, reduction in asbestos concentration, adverse effects of PPE on core body temperature	GRADE	Some coveralls may increase body temperature more than others, and some interventions may reduce exposure, but this is dependent on concentration. Studies included do not directly compare, and result were imprecise due to low numbers of participants in included studies.
Caffaro et al. 2018	Scoping review	29	Agriculture	Australia/Indonesia, the United States	Migrant farmworkers	OSH training programmes for migrant farmworkers	Mixture of between- subject and within- subject designs	Safety knowledge, safety attitudes and beliefs, safety behaviours, safety and health outcomes	N/a (scoping review)	Included studies showed varied effect depending on the study design. Training could contribute to 'effective attainment' of OSH information, but more evidence is needed.
Castellani et al. 2024	Systematic review	28	Occupational settings in which workers are exposed to formaldehyde (human and veterinary anatomy, autopsy, histopathology or pathology laboratories, embalming procedures, hospital, operating theatres, aquaculture, textile or foundry industries, industry using 3-D printers, offices and firefighter activities)	Australia, Finland, Germany, Iran, Israel, Italy, Japan, South Korea, Spain, Thailand, the Netherlands, the UAE, the United States	Workers exposed to formaldehyde	Interventions aiming to mitigate formaldehyde exposure in the workplace (including technical strategies, organisational methods, engineering controls, PPE)	None	Percentage reduction in formaldehyde concentration	Newcastle–Ottawa Quality Assessment Scale	Different methods are seen to be helpful in mitigating exposure. The highest reduction was 'obtained in an anatomy laboratory through locally exhausted dissection tables equipped with activated carbon filters'.
Chicas et al. 2020	Systematic review	21	Agriculture, construction, industry, firefighting	Australia, Brazil, China, El Salvador, Guatemala, India, Iran, Korea, Nicaragua, the UK, the United States	Workers who work in hot environments	Cooling interventions (e.g. cooling gear, water dousing)	All between-subject designs	Heat stress (including objective measures, such as heart rate and body temperature as well as subjective measures)	Not stated	Existing evidence indicates that 'using multiple cooling gears along with rest cycles may be the most effective method to reduce heat-related illness'.



Author and year	Study design	Sample size (# of articles included)	Industry/setting	Geography (areas in which studies were conducted)	Population characteristics	Intervention	Comparison (if applicable)	Outcomes	Critical/quality appraisal tool	Summary of review findings
Coman et al. 2020	Systematic review	36	Agriculture	Africa (Egypt, Tanzania), Asia (Cambodia, India, Laos, Thailand, Vietnam), Australia, Europe, North/Central America (Canada,the United States, Nicaragua), South America (Bolivia, Brazil, Ecuador)	Farmers	Educational interventions to improve health and/or safety literacy	Mixture of between- subject and within- subject designs	Various, including biomarkers and knowledge/skills	Seymour and coworkers rating system	Interventions that used evidence-based theories, considered cultural and individual factors, used biomarkers as a behaviour- changemeasurement, and that during development included the target community, had the best results regarding behaviour change.
Cooklin et al. 2017	Systematic review	31	Occupational settings	Europe, Japan, North America (the United States and Canada)	Workers and employers	Programmes implementing an integrated approach to worker health, safety and well-being	Mixture of between- subject and within- subject designs	Employee health promotion, employee injury prevention or management, OSH management, psychosocial outcomes, organisational costs	American College ofOccupational and Environmental Medicine Practice Guidelines	Empirical evidence on integrated approaches to OSH are still emerging, but of the evidence that exists indicates that there is some support for these interventions.
Driscoll et al. 2022	Scoping review	19	Dairy industry	Not stated	Workers in the dairy industry	Measures applied to improve worker safety	Mixture of between- subject and within- subject designs	Various, including knowledge/behaviour regarding safe working practices and objective measures of increased safety (e.g. dust/endotoxin concentrations)	N/a (scoping review)	The current literature 'lacks any rigorous evaluation of whether dairy safety interventions are making an impact on injury prevention'. As a result of this, it is not possibleto determine how work-related injuries and deaths can be prevented in this context.
Dyreborg et al. 2022	Systematic review and meta- analysis	100	Occupational settings	Mostly 'western societies, as only few studies came from Africa and Asia'	Workers and employers	Interventions aiming to modify attitudes, behaviours, physiological conditions, climate/norms/ culture, or structural conditions (e.g. changes to legislation, introducing engineering controls)	Mixture of between- subject and within- subject designs	Various: primary outcomes included injuries at work (fatal and non-fatal), number of working days lost due to injury and cases of work disability, and proxies for injury incidence, such as safety behaviours and injury risk factors	Tompa et al. approach	There are greater effects with safetyinterventions directed at the group or organisational level rather than at the individual level.Multifaceted approaches provide moderate to strong effects. Effects are modest for safety climate interventions. There are no effects for physical training methods, and behavioural approaches are less effective.
Eastlake et al. 2016	Systematic review	2	Occupational settings where nanomaterials are handled	Not stated	N/a (study focuses on effectiveness of control banding for safe handling of nanomaterials)	Application of the Control banding (CB) Nanotool in workplaces where engineered nanomaterials were being handled	Recommended exposure control using CB Nanotool compared with the in-place exposure control	Accuracy of exposure control recommended by CB Nanotool	Methodological Index for Non-Randomised Studies (MINORS)	The CB Nanotool recommended the same level of exposure control as an industrial hygienist for 19 out of 32 job activities, a higher level of control for 9 and a lower level of control for 4. Quality of evidence from the existing studies was low, and validation of CB Nanotool strategies is needed.
Febriyanto et al. 2024	Scoping review	16	Maritime	Brazil, Canada, Egypt, Iran, Norway, Romania, Thailand, the UK, the United States	N/a (study focuses on recommendations for noise control on ships)	Various interventions considered, e.g. engineering solutions, use of PPE, noise monitoring	N/a	N/a	Not stated (although scoping review, so N/a)	Various methods for noise control on ships are available and potentially effective.
Hayashi et al. 2023	Scoping review	24	Construction	Australia, China, Europe (Denmark, the Netherlands, the UK)	Workers in the construction industry	Various interventions aiming to improve worker safety or health	Mixture of between- subject and within- subject designs	A variety of subjective and objective outcomes	Not clear which approach was used to assess quality	17 out of 24 interventions reported significant effects, including 5 studies related to occupational safety. The 7 studies that found no effect were all related to occupational health.



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Author and year	Study design	Sample size (# of articles included)	Industry/setting	Geography (areas in which studies were conducted)	Population characteristics	Intervention	Comparison (if applicable)	Outcomes	Critical/quality appraisal tool	Summary of review findings
Hutchinson et al. 2022	Meta- analysis	90	Occupational settings	Canada, China, Columbia, France, Germany, Iran,Israel, Korea, Malaysia, New Zealand, Norway, Portugal, Sweden, Switzerland, the Netherlands, the UK,the United States, Vietnam	High- and low-risk industries	Workplace safety training interventions	Mixture of between- subject and within- subject designs	Safety motivation, knowledge, climate, compliance and participation	Not stated	Safety training improved all the outcomes considered, but effect sizes were very varied. Compared with low-risk industries, high-risk industries generally saw smaller gains in safety performance but larger gains in safety climate and motivation after training.
Jiang et al. 2024	Scoping review	28	Workers generally, with no restrictions, both occupational and non- occupational settings	Belgium, China, Germany, India, Iran, Japan, Korea, Thailand, the United States	N/a (no restrictions)	Scent interventions or exposures (olfactory interventions)	Between-subject designs	Alertness	Not stated	Most of the studies included in the review found that scent interventions had a positive impact on alertness and fatigue mitigation.
Lagoe and Newcomer 2023	Systematic review	11	Occupational settings	Australia, Canada, Iran, the United States	Workers	OSH interventions that used social marketing principles in their design	Mixture of between- subject and within- subject designs	Safety behaviours (e.g. use of PPE or handwashing)	Not stated	The majority of the social marketing interventions considered had 'at least some degree of success' in promoting behaviour change.
Laroche et al. 2020	Systematic review	10	Occupational settings	Australia, South Korea, the UK, the United States	Workers	Interventions using social media to promote healthy lifestyles or the prevention of occupational injuries	Mixture of between- subject and within- subject designs	Various, including objective outcomes (e.g. daily step count as measured by a pedometer) and subjective outcomes (e.g. self-reported overall health)	AGREE-II, R-AMSTAR, CASP checklists	Scarce and poor-quality evidence precludes firm conclusions, but use of social media for OSH promotion is 'promising'.
Lee 2018	Systematic review	12	Occupational settings (a bank, research institutes, government organisations, medical centres, shipbuilding, forestry, universities, IT firms, shoe manufacturers)	Bangladesh, Brazil, Finland, the Netherlands, the UK, the United States	Workers	OSH interventions	Between-subject designs	Economic outcome (cost-effectiveness of intervention)	Not clear	10 out of 12 primary studies found a positive return on investment in OSH interventions.
Lee et al. 2019	Systematic review	19	Occupational settings	Majority in Denmark and the United States	Workers	Various interventions involving safety/health- related communication, safety education, improvement of safety leadership, improvement of physical work environment, and/or improvement of technological aspects of work	Mixture of between- subject and within- subject designs	Safety climate	Not stated	17 out of 19 primary studies found a statistically significant improvement in safety climate. The studies' authors found there was limited to full support for the effectiveness of the various interventions they considered.
Li et al. 2020	Systematic review	33	Occupational settings	Australia, Belgium, Canada, China, Cuba, Denmark, Egypt, Finland, France, Germany, India, Italy, Mexico, Nigeria, the United States, Zimbabwe	Workers	Educational interventions	Mixture of between- subject and within- subject designs	Injury rates	Not stated (only risk of bias)	17 out of 35 studies found a significant reduction in injury rates, but risk of bias in these studies was moderate to high. Interventions in the manufacturing industry tended to be more effective than interventions in the construction sector.





Author and year	Study design	sample size (# of articles included)	Industry/setting	Geography (areas in which studies were conducted)	Population characteristics	Intervention	Comparison (if applicable)	Outcomes	Critical/quality appraisal tool	Summary of review findings
Mir et al. 2022	Systematic review	74	Construction	Not stated	N/a (focus is on developing a construction noise management framework)	Noise management processes	N/a	N/a	Not stated	Review contributes to a 'holistic understanding of the construction noise management process' by proposing a new framework for managing construction noise. Review does not consider findings of primary studies in detail.
Mmereki and Brouwer 2022	Systematic review	32	Construction	Denmark, France, Germany, Italy, Portugal, South Korea, Spain, the Netherlands, the UK, the United States	Construction workers	Use of various methods (e.g. ventilation, PPE) to reduce exposure to contaminants	Not stated	Exposure to harmful contaminants	Not stated	Most of the primary studies included did not evaluate the effectiveness of methods of exposure reduction. Of those that did, several concluded that local exhaust ventilation was effective.
Monroe and Khoza- Shangase 2020	Systematic review	26	Workplace application generally	China, Iran, Jordan,Malaysia, South Africa, South Korea, Spain, the UK, the United States, Turkey	N/a	Hearing conservation programmes	N/a	N/a	Not stated	Review focuses on recent advances in hearing conservation methods, with very little discussion of their effectiveness.
Morata et al. 2024	Systematic review and meta- analysis (Cochrane)	3	Occupational settings	Iran, the United States	Workers exposed to noise	Providing extensive/simple/ no instructions for fit- testing hearing protection devices	Simple/no instructions	Personal (noise) attenuation rating	GRADE	Fit testing accompanied by provision of simple instructions probably does not improve the noise attenuation of hearing protection devices when compared with fit testing without instructions. Fit testing and provision of extensive instructions probably does improve attenuation immediately after fit testing when compared with fit testing with provision of simple instructions.
Mullan et al. 2015	Systematic review	11	Construction	Denmark, FinlandHong Kong, India, Italy, Spain, the United States	Construction workers aged 18+	Various behaviour-change methods (e.g. educational sessions, inspections, games, feedback)	Mixture of between- subject and within- subject designs	Injury rates or uptake of safety behaviours	Downs and Black	Around half of the interventions considered improved injury rates, but very few achieved all of their aims. Longer interventions and interventions offering feedback/ monitoring rather than instruction/ information tended to be more effective. Methodological quality of the studies was generally poor.
Nilsson 2016	Systematic review	3	Agriculture	Canada, New Zealand, the United States	Older workers (aged 55+) in agriculture	Risk assessment and awareness training; use of Rollover Protective Structures to reduce deaths from tractor overturns	None	Various: level of participation in programme, farm safety practices, injury rates, physical hazards, prevalence of Rollover Protective Structures	Not clear which approach used to assess quality	There are very few evaluations of interventions to reduce injuries in older agricultural workers, and the design of the evaluations that do exist is generally poor. No intervention was found to have a clear positive effect.
Ohlander et al. 2020	Systematic review	146	Occupational settings	Majority in Germany, the Netherlands, the United States	Workers exposed to chemical or biological agents	Interventions targeting exposure to chemical or biological agents or aiming to reduce workers risk of related health issues	Mixture of between- subject and within- subject designs	Occupational exposures or health outcomes	Author framework on study design	The number of intervention studies focused on reducing exposure to chemical or biological agents has increased over the past six decades, but remains low. Methodological quality has, similarly, improved, but remains generally poor.
Oluwaseun Odu et al. 2023	Systematic review	7	Offices	Australia, Austria, Denmark, Germany, Iran, Malaysia, the Netherlands, the United States, Turkey	Office workers	Various workplace safety interventions	Between-subject designs	Workplace safety culture practices, knowledge, and attitudes	AXIS tool	Most studies found 'promising results' and were effective in improving OSH knowledge and/or practices.



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Author and year	Study design	Sample size (# of articles included)	Industry/setting	Geography (areas in which studies were conducted)	Population characteristics	Intervention	Comparison (if applicable)	Outcomes	Critical/quality appraisal tool	Summary of review findings
Prasath et al. 2024	Scoping review	22	Occupational settings	Brazil, Canada, Denmark, Germany, India, Iran, Italy, Korea, Spain, Switzerland, Taiwan, the United States, and other studies across Europe, and worldwide	Workers exposed to engineered nanomaterials	Various control measures aiming to reduce exposure to engineered nanomaterials	Not stated	Various, including exposure to engineered nanomaterials and level of risk	Not stated	There is limited evidence for the effectiveness of methods of controlling exposure to engineered nanomaterials in the workplace, but all four of the approaches discussed in the review (substitution controls, engineering methods, PPE, and administrative/ work practices) appear likely to be effective.
Rebelo et al. 2019	Literature review (with some systematic and comparative elements)	7 (of which 2 are conference papers)	Construction	Authors from the Australia, Canada, China, Germany, Puerto Rico, South Korea. Taiwan, theUnited States	N/a	Building Information Modelling	N/a	N/a	Not clear which approach used to assess quality (but notes following PRISMA guidelines)	Building Information Modelling systems have a number of uses and benefits, but adopting them also entails challenges.
Ricci et al. 2016	Systematic review and meta- analysis	28	Occupational settings	Brazil, Denmark, India, Israel, Italy, Norway, Sweden, Taiwan, the Netherlands, the United States	Workers	OSH training interventions	Between-subject designs	OSH knowledge, attitudes, beliefs, behaviours, or health outcomes	N/a	The 28 studies included provided strong evidence for the effect of training on attitudes/beliefs, less strong evidence for an effect on knowledge, some evidence for an effect on behaviour and little evidence for an effect on health.
Shahbaz and Sajjad 2021	Integrative literature review	Not stated	Occupational settings	Not stated	N/a	Mindfulness/sustainability interventions for OSH, as well as management control systems	N/a	N/a	Not stated	Review presents a framework for using mindfulness to enhance OSH, with reference to literature suggesting that mindfulness- based interventions can help organisations improve OSH.
Sinelnikov et al. 2020	Systematic review and narrative synthesis	22	Occupational settings	Australia, Canada, Denmark, Israel, Norway, Sweden, the UK, the United States	Work unit supervisors	Various interventions aimed at supervisors, focusing on ergonomics, leadership, supervisor–worker interactions, injury, or disability management	Mixture of between- subject and within- subject designs	Various, including supervisors' reaction to the intervention, supervisors' safety attitudes, supervisors' safety knowledge and skills, changes in organisational practice and operational procedures, and injury rates	Effective Public Health Practice Project (EPHPP) quality assessment tool	Results must be viewed with caution due to methodological weakness of primary studies, but 'consistent evidence was found for the effectiveness of supervisory training interventions across several outcome measures'.
Strzałkowski et al. 2024	Systematic review	ʻjust over 100'	Mining and civil engineering	Not stated	N/a (discusses potential applications of VR technology for OSH)	VR technology	N/a	N/a	Not stated	Provides a framework for the application of VR technology for improving safety, efficiency and profitability. Also identifies research gaps.
Swanepoel et al. 2023	Systematic review	8 grey literature publications	Occupational settings in which diesel engines are used (e.g. mining)	Not stated	N/a (focus is on the OSH effects of emissions-based maintenance programmes)	Maintenance interventions informed by diesel engines emissions data	Generally none, but one study had a 'control fleet' of diesel engines	Emissions, personal exposure to emissions, fuel consumption, service life, productivity gains	Authority, Accuracy, Coverage, Objectivity, Date and Significance (AACODS) checklist	Productivity gains found (e.g. reduced fuel consumption, reduced worker exposure), but no evidence that emissions-based maintenance improved fleet management.
Tawfeeq et al. 2024	Systematic review	30	Electrical industry	Majority in Asia and Europe	N/a (focus is on safety management practices)	Various (touches on a variety of 'safety management practices', broadly conceived)	Not stated	Various	Not stated	Results showed that safety climate practices play a role in safety performance. Most focus was placed on procedural safety, with relatively little emphasis on human safety.



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Author and year	Study design	Sample size (# of articles included)	Industry/setting	Geography (areas in which studies were conducted)	Population characteristics	Intervention	Comparison (if applicable)	Outcomes	Critical/quality appraisal tool	Summary of review findings
Teufer et al. 2019	Review of reviews	25 systematic reviews	Occupational settings in OECD countries	OECD countries	Employees aged 15+, mixed populations of employed and self- employed workers if >50% employed	Workplace interventions designed to protect against occupational injuries and diseases	Mixture of between- subject and within- subject designs	Prevalence, incidence and severity of occupational diseases, injuries, physical disability symptoms (e.g. pain), sickness absence rates, risk factors for injuries/ diseases	GRADE	Some interventions led to positive results on individual diseases; others did not show any effects or the studies were contradictory.
Tikka et al. 2017	Systematic review and meta- analysis (Cochrane)	29	Occupational settings where workers are exposed to noise	Majority in the United States	Workers exposed to noise	Engineering controls (e.g. putting panels around noise sources), administrative controls (e.g. training sessions), personal hearing protection devices (e.g. earplugs), and hearing surveillance (monitoring workers' hearing)	Mixture of between- subject and within- subject designs	Noise exposure or hearing loss	GRADE	Overall, the effects of hearing loss prevention programmes are not clear. "Better use of hearing protection as part of a programme probably helps but does not fully protect against hearing loss", and improved implementation of protection interventions may provide better protection against noise.
Trask and Linderoth 2023	Systematic mapping review of evidence	24	Construction	Not stated	Construction workers	Interventions aiming to identify and/or mitigate hazards; OSH training	Mixture of between- subject and within- subject designs	Various: most often functionality/feasibility of tools being tested, but also some OSH outcomes (e.g. improved hazard awareness following training)	EQUATOR – STROBE	Most of the included studies provide low to no evidence of improvement conditions or reduction in injury and/or illness among construction workers. More evidence is needed.
Vaher and Merisalu 2023	Scoping review	19	Agriculture	Not stated	Farmers and agricultural workers	Safety training	Mixture of between- subject and within- subject designs	Various, e.g. use of seatbelts in tractors, machine safety skills and knowledge	Author analysis on impact and strength of evidence	Training methods used in the agricultural sector have shown to be effective based on awareness and risk behaviours.
Van der Molen et al. 2018	Systematic review and meta- analysis (Cochrane)	17	Construction	Austria, Belgium, Denmark, Finland, Germany, Italy, Spain, the UK, the United States	Construction workers	Various, including regulations, safety campaigns and training programmes	Mixture of between- subject and within- subject designs	Injuries (fatal or non- fatal), lost working days and behaviour change if reported	GRADE	Regulation alone may or may not be effective for preventing non-fatal and fatal injuries. Regional interventions may not be effective for reducing non-fatal injuries. Multifaceted campaigns (and 'subsidies for replacement of scaffoldings') may be effective in reducing non-fatal injuries. Overall evidence quality was very low.
Van Holland et al. 2015	Systematic review	13	Meat processing industry	Australia, Denmark, New Zealand, the United States	Workers in the meat processing industry	Interventions involving ergonomics programmes, skin protection, or Q fever vaccination	Mixture of between- subject and within- subject designs	Various, including injury rates, perceived discomfort, Q fever incidence, use of measures to prevent eczema, eczema prevalence	GRADE	Limited evidence for the effectiveness for a range of workplace interventions. Also, limited evidence for effectiveness of ergonomic interventions, moderate for a skin protection intervention, but strong for Q fever vaccination.
Vitrano and Micheli 2024	Integrative literature review	84	Occupational settings	Not stated	N/a (paper is a high-level review of how OSH management systems have been/should be evaluated)	Interventions to improve workplace OSH management	N/a	N/a	Not stated	The analysis suggested that there is a need for improvement in understanding the effectiveness of interventions.
Volkmer and Lucas Molitor 2019	Systematic review	5	Agriculture	Not stated	Agricultural workers	Physical interventions and an educational intervention	Mixture of between- subject and within- subject designs	Various, including discomfort rating, disability, injury rate	Not clear which approach used to assess quality	Moderate evidence exists for efficacy of interventions within occupational therapy practice and injury management for agricultural workers. Further research required to improve level of evidence.



Author and year	Study design	Sample size (# of articles included)	Industry/setting	Geography (areas in which studies were conducted)	Population characteristics	Intervention	Comparison (if applicable)	Outcomes	Critical/quality appraisal tool	Summary of review findings
Zainal Abidin 2022	Systematic review	16 (including 8 grey literature publications)	Occupational settings where workers are exposed to ototoxic chemicals	Publications from Australia, Canada, China, European countries, Germany, Nordic countries, the United States, the United States, the United StatesGrey literature 'mainly from developed countries', including European countries, Australia, Canada, New Zealand, the United States	Workers exposed to ototoxic chemicals	Interventions involving exposure reduction, provision of education and information, or clinical testing (review is more focused on describing these different approaches than on evaluating them)	Not stated	Not stated	Not clear which approach used to assess quality	Findings and conclusions show that 'more efforts should be geared toward ototoxicity prevention and management particularly in developing countries'.
Zara et al. 2023	Systematic review	40 (after excluding low-quality publications)	High-risk workplaces (with a focus on the oil and gas industry)	Majority in Malaysia, Nigeria, Norway	Workers in high-risk workplaces	Safety communication on safety commitment	Not stated	'Safety commitment' (undefined)	Not clear which approach used to assess quality	The study emphasises 'the importance of the variables that influence the reduction of accident and injury rates through effective communication and commitment to safety'.
Zong et al. 2024	Systematic review	139	Construction	Majority in China, Hong Kong, the United States	Construction workers	Interventions to monitor, predict and/or alleviate fatigue	Not stated	Various, including fatigue levels and rating of perceived exertion	Not stated	Study focused on and describes interventions to alleviate construction worker fatigue. Study promotes further research and that there are areas needing further investigation to understand challenges for interventions.

