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Occupational safety and health interventions to protect young workers from hazardous work – A scoping review

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ABSTRACT

Occupational injury rates are higher among young people when compared to older age groups.
Objective: Identifying preventive occupational safety and health interventions that aim at protecting young workers from hazards at work while considering their ongoing physical and mental maturation.
Methods: We ran a sensitive search strategy in twelve electronic databases to locate studies. Two review authors independently screened titles and abstracts, and later full texts for eligibility. One person extracted the details of studies and another checked for errors. Data were analyzed in an iterative process.
Results: We included 39 studies. Three studies evaluated environmental interventions, 29 evaluated behavioral, one evaluated clinical and six combined more than one type of intervention. Developmental characteristics of young workers that could contribute to risk were addressed in 13 studies. Thirty-five studies were from high income countries, one was from an upper middle-income country and three were from lower middle- income countries. We found no studies from low income countries.
Conclusions: There is a dearth of evidence when it comes to evaluating interventions in low and lower middle income countries and adapting interventions developed in high income countries to the needs of low and middle income ones. A higher and more integrated participation of young workers themselves, parents and other key social actors such as policy makers, employers and occupational safety and health regulators is required to optimally protect young workers. We recommend developing and evaluating interventions that specifically address the risks that youth face at work due to their ongoing developmental process. Further we need systematic reviews of the interventions identified in this review such as for young workers in the service sector.

1. Introduction

In the period 2012–2016 there were 218 million of children in employment, a measure that comprises both child labour and permitted forms of employment for children of legal working age. Out of these, 152 million were in child labour. Nine out of every ten children in child labour were in Africa, Asia and the Pacific regions. In absolute numbers: 72 million in Africa, 62 million in Asia and the Pacific, 11 million in the Americas, 6 million in Europe and Central Asia and 1 million in the Arab States. Even though the numbers have fallen during the period from 2012 to 2016, there were still 42.5 million adolescents from 12 to 14 and 36.5 million from 15 to 17 years old at work, 52% of the total population engaged in child labour (International Labour Office, 2017).

According to International Labour Organization (ILO) Convention 138, (International Labour Organization, 1973) in countries where economy and means of education are insufficiently developed, children from 12 to 14 years old are allowed to perform light work, as long as this does not jeopardize their health or safety, or hinder their education, or vocational training. In other countries where means of education and economy is well developed, children are allowed to do light work at a

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slightly older age (13–15). Convention 138 also sets that the minimum age for admission to employment must not be less than the age at which the school obligation ceases, or in any case, at 15 years for developed countries and 14 years for developing countries.

ILO Convention 182 establishes the worst forms of child labour that should be prohibited (International Labour Organization & Inter-Parliamentary Union, 2002). Hazardous work is defined as any work activity engaged in by children that, by its nature or the circumstances in which it is carried out, is likely to harm or jeopardise their health, safety or morals (International Labour Organization, 2011). All persons under the age of 18 are considered children by Convention 182 (International Labour Organization & Inter-Parliamentary Union, 2002). Here, we only refer to hazardous work that would not come under ILO Convention 182 and thus would not be prohibited.

Thus, in general and based on ILO Conventions 138 and 182, nearly 79 million young people from 12 up to 17 years of age could be considered adolescents of legal working age in permitted forms of employment, if there were no risks at work for them, or if they were well-trained and well-protected from work hazards (International Labour Organization, 2017).

The World Health Organization defines adolescents as people between 10 and 19 years old (World Health Organization, 2014). However, there are variations in terminology when defining working adolescents. For example the term 'young workers' has been used by researchers to include adolescents under the age of 18 but who are of legal working age in permitted forms of employment, as well as people under 24 or under 30 years old (Breslin et al., 2005). This definition leads to an overlap between adolescent workers under 18 years old and those recognized as adult workers (age 18 or older). Also, the Organisation for Economic Co-operation and Development defines young people as those under the age of 15 (Organisation for Economic Co-operation and Development, 2017) and the working population as those between ages 15 and 64 (Organisation for Economic Co-operation and Development, 2017). The United Kingdom allows children as young as 13 to work part time (United Kingdom Government, 2017).

Consequently, we applied the term 'young workers" in this review to denote anyone from the first day aged 12 to a day before becoming 18 years old (see table 1).

Occupational injury rates are higher among young people when compared to older age groups but fatality rates are lower (Salminen, 2004; Santana et al., 2012). This means that even though their probability to die is lower, they run a higher risk of suffering permanent impairment. According to the workers' compensation claim data in the USA, the proportion of injured young workers with a permanent impairment varies widely from 3.4% to 40%, thus hindering some or all future work and other societal contributions (Breslin et al., 2003, 2007) This higher injury risk could be partially attributed to physiological changes during pubertal development such as neurohormonal shifts (Sudhinaraset and Blum, 2010).

Physical factors such as rapid growth can make joints and ligaments less flexible (Marshfield Clinic Research Foundation, 2018) and may lead young people to handle equipment more clumsily, or their smaller size may place them at a greater risk of injury while handling material and equipment designed to suit adult anthropometric dimensions. Neurological and physical maturation as well as social contexts together or separately could explain the higher risk of injury and other negative outcomes in young people's work environment (Sudhinaraset and Blum, 2010).

Then there are other factors that may contribute to increased risks for younger workers such as inadequate training and inadequate supervision as well as the fact that young workers are usually engaged in more physically demanding and dangerous work because those types of jobs are often the only available options for them (Breslin et al., 2005; Salminen, 2004).

A systematic review of young worker's risk for occupational injury found consistent evidence of workplace factors such as time pressure

Table 1
Overview of developmental stages of adolescents and their potential implications for health and safety interventions.

Type of developmental characteristics	Basis		Description of changes	Potential contribution to higher risk at work	Implications to develop OSH interventions
Physical	BIOLOGICAL: physiologic neurohormonal shifts	Circadian rhythms	Shift to more nocturnal wakefulness	Not enough hours of sleep, produces less alertness during daytime.	Setting a threshold of daily work hours (fewer hours).Prohibiting late night work hours.
		Physical growth	Rapid linear growth	Given the rapid linear growth, joint instability predisposes to injury, specially to injuries to ligaments and bone growth plates. Clumsiness.	Adapting tools and working surfaces. Designing less physically demanding work and lower loads.
Cognitive		Neuromaturation	Mainly, in pre-frontal cortex associated with emotional response and reactivity. Development of abstract reasoning.	Proclivity for thrill-seeking and high-intensity feelings: greater frustration, less tolerance, increased reactivity, rebelliousness and impulsivity. Lack or minor understanding and awareness of risks. Lack of adult decision-making skills.	OSH training providing hands on instructions to develop skills for avoiding work accidents as well as work diseases should consider teens' neuromaturation.Safety education to provide information about accidents prevention should consider teens' neuromaturation. Designing less complex work task and ensuring safety measures.
Social	Social values		Needs for affiliation, achievement, independence, etc.	Clothing (loose or tattered) and hair styles to look fashionable; multitasking with electronic devices; high stress for managing time for work, family, school or other responsibilities. Desire to do a good job and be seen as a competent worker.	To ensure safety measures and close supervision. Designing special work organizational measures to avoid psychosocial impacts.
	Economics		Needs of economic independence	Chronic fatigue (combining school / work / other responsibilities).	
	Legal guarantees		Lack of full recognition as workers	Lack of training or the appropriate one, abuses in salary or in the number of working hours, etc.	

Legend: OSH = Occupational safety and health.

increasing injury risk (Breslin et al., 2005). This review finding points to generic risk factors increasing work injury at any age. That is, unsafe working conditions, lack of safety training, and in adequate supervision contribute to injury risk regardless of age. However, young worker researchers point to studies of cognitive and musculoskeletal differences as teens are maturing that may pose unique risks for teen workers, though there are too few occupational safety and health (OSH) – specifc studies to provide clear evidence of their relative contribution to generic risk factors (Institute of Medicine and National Research Council, 1998; Breslin and Smith, 2010). It is likely that ill health or injury in young workers set in motion a cycle of negative impacts on their developmental process, cause disability, and may affect full participation in working and social life in the future (Sudhinaraset and Blum, 2010).

As this population of workers is under the internationally accepted working age for all types of work ($\geq$18 years old), work that may be dangerous for their health and safety (International Labour Organization, 1973), the policies, and the resulting interventions addressing health and safety often fall outside the standard legal OSH contexts. These workers' health and safety issues might instead get classed under social welfare or child welfare. This can make implementing relevant welfare policies and interventions at work difficult. At the same time, OSH professionals may also miss addressing these young workers as they are not visible at regular workplaces or because they are not recognized as a working population (Beyer, 2012; International Labour Organization, 2011.

The classification of countries by income to which we refer in this study is based on the income groups according to 2016 gross national income per capita, calculated using the World Bank Atlas method (World Bank, 2018). The groups are: low income countries (LIC), lower middle income countries (LMIC), upper middle income countries (UMIC), and high income countries (HIC).

Due to the number of young people, as well as the large proportion of informal employment that prevails in LIC and LMIC in comparison to HIC, young workers in LIC and LMIC are even more vulnerable. These countries often have problems implementing labour laws, leaving a significant number of workers outside their scope and in need of protection (Meknassi, 2010). Additionally, young workers may often get little or no training or supervision, receive low or no payment, very little job security, and may lack knowledge of labour rights. Their jobs are often at non-traditional worksites (for example in houses or on the streets) or in industries or activities with high OSH risks such as agriculture, construction, or mining (Alberto, 2017; International Labour Organization & Inter-Parliamentary Union, 2002; Meknassi, 2010; Pieters, 2013; United States - General Accounting Office, 1991). However, this lack of guarantees for vulnerable groups of workers such as young people or children or migrants, are also present in HIC (Rauscher et al., 2016).

OSH research relevant to young workers has been noted to focus 80% of the time on the description of harmful exposures (Sandbox Project, 2016). Such research has been useful but knowing what conditions and agents are dangerous is not enough *per se*. We need to focus on the special developmental characteristics of young workers in synergy with those hazards to develop effective preventive interventions. Documenting the key role that unsafe work conditions have on injury risk among youth has been essential in prevention efforts for the vulnerable population. However, more recent conceptions of OSH include workplace safety climate and culture (Guldenmund, 2000). Given that workplace safety climate and culture include social and cognitive elements, they maybe perceived differently among young workers. Also, the increasing knowledge regarding how the teen brain develops and how they react differently to toxic exposures suggests that unique vulnerability factors for young workers continue to be a useful research focus (Institute of Medicine and National Research Council, 1998; Sudhinaraset and Blum, 2010), and may facilitate more tailored intervention for youth.

This conclusion is supported by a systematic review, which reported that there is a lack of relevant, good quality studies about how developmental factors do or do not pose additional risks for work-related injuries among adolescents (Breslin et al., 2005). This gap in the literature on the role of physical, mental and social development in work injury risk, is a reasonable rationale for the focus on assessing the extent to which preventive interventions consider these developmental challenges faced by young workers.

We undertook a scoping review of all preventive OSH interventions aimed at protecting young workers. This will help identify what is currently known about ways to prevent injury in young workers and what gaps exist in this knowledge. Furthermore, we hope that we can find what interventions if any are feasible for protecting young workers in LIC and LMIC, where the bulk of young workers live and where such strategies are needed the most. However, evaluating the effectiveness of these interventions is beyond the scope of this review and should be the next step.

2. Objective

To identify available preventive OSH intervention studies that aim to improve the health or safety of young workers and identify how they consider their ongoing physical and mental maturation.

3. Methods

We used accepted methodology for this type of research (Arksey and O'Malley, 2005; Levac et al., 2010) and used an iterative process to define the research questions and the inclusion criteria, and to collate, summarize and report the results. A subject expert helped us refine definitions, as is the norm in systematic and scoping reviews. The methodological quality (risk of bias) of included studies was not assessed because it was beyond the objectives of this scoping review.

3.1. Criteria for considering studies for this review

We restricted our search and inclusion to studies published after 1990 because the 1989 enactment of the rights of the child (United Nations, 1989) about freedom from exploitation and right of education could have underpinned OSH interventions around the world (Hesketh et al., 2006) and studies before that would not be applicable to the world today. Studies in any language and of any publication status were included.

3.1.1. Population

We included studies conducted with workers aged 12 or older but younger than 18 years old as the main population of interest or as a subgroup within the study; or that included workplaces or communities employing young workers. Young workers were the target population who had to benefit from the intervention, but the change for them could be mediated by another population targeted by the intervention, for instance parents, whole families, employers, supervisors, teachers, other community members, whole community or healthcare providers. Nonetheless the aim of interventions should be to improve OSH of the young workers.

3.1.2. Interventions

We included all empirical studies that described and evaluated an active purposeful change in hazardous work-related exposures aimed at protecting health or ensuring safety in young workers. We define hazardous work-related exposures as all the agents or situations to which the worker is exposed during work and which have the potential to cause occupational accidents or diseases. We included all studies with an OSH intervention primarily aimed to reduce harm to young workers. This could be achieved via reduction of a hazardous work-related exposure or by any other measure.

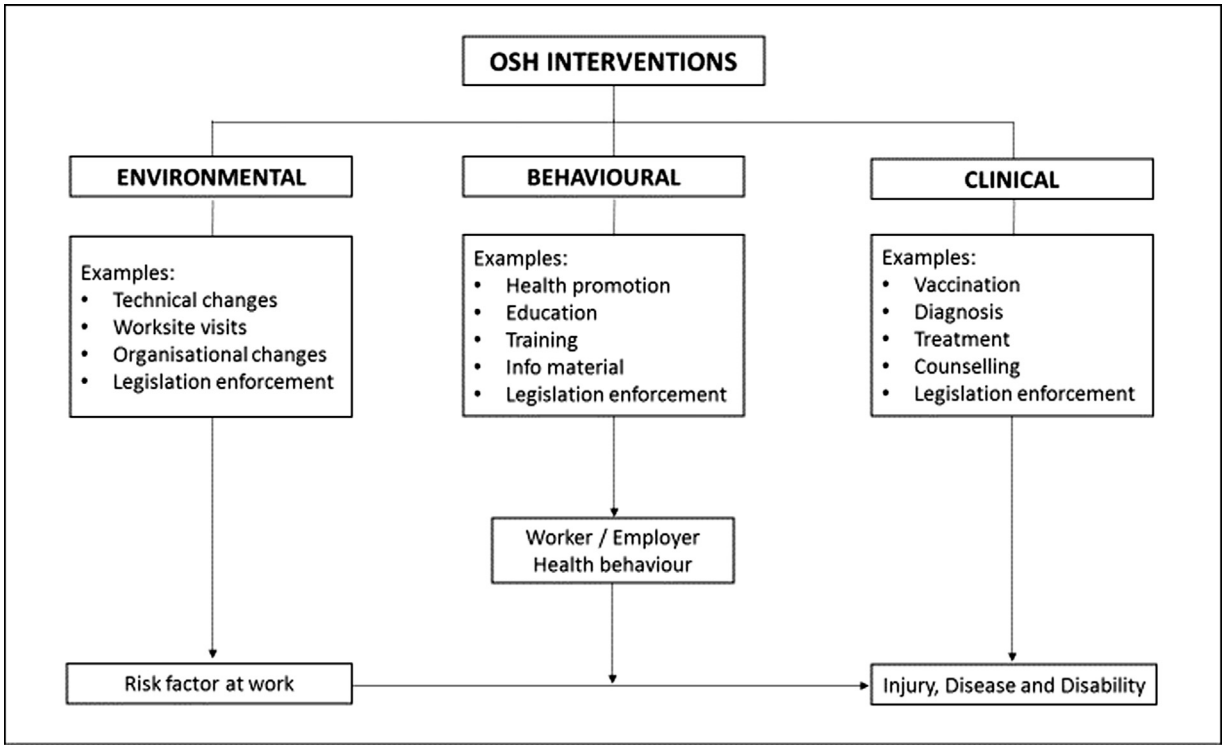


Fig. 1. Adapted from: Model of primary preventive occupational health interventions (Verbeek and Ivanov, 2013).

3.1.3. Outcomes

Eligible interventions had to attempt to change the work environment of young workers; to change attitudes, beliefs or behaviors in or about the work of youth and; measure clinical outcomes as any indicator of individual ill health (see Fig. 1). The included studies could have evaluated a primary preventive occupational health intervention using either quantitative or qualitative outcomes. We had expected study clinical outcomes to include adverse health effects such as symptoms, injuries or disability; intervention feasibility measured as participation rates or participant satisfaction; and environmental outcomes such as technical or organizational changes to decrease or eliminate hazardous exposures.

3.2. Search methods for identification of studies

We developed a sensitive (Lefebvre et al., 2011) search strategy to obtain all relevant studies. We included terms for population, intervention and outcomes in the search string. We also included additional sensitive OSH terms to widen the scope and number of articles retrieved with the disadvantage of increasing the number of false-positive hits (Verbeek and van Dijk, 2006). The search was developed for Medline and adapted to other databases (see Appendix A). The following databases were searched applying a time limitation from January 1990 to September 2016: Medline, EMBASE, NIOSHTIC 2, Cochrane Library databases (CDSR, CENTRAL, DARE, HTA, EED), CINAHL, the Journal articles database hosted on the webpages of the Institute of Work & Health-Canada, BAuA Library, and Science Direct.

Study authors were contacted and the references of included studies screened to find unpublished studies. Two authors screened titles and abstracts, and later full texts, independently for eligibility. We discussed discrepancies to reach consensus or involved a third author.

3.3. Data extraction and management

One author extracted data using a standardized form and another checked for errors. Extracted data were: study design, location, author and year of publication, target population, intervention participants, type of intervention, type of outcome, and any special considerations undertaken for young workers in the intervention. We categorised study locations according to the World Bank's classification of countries by income into low, lower middle, upper middle, and high-income countries.

We tabulated data in Excel and analysed it in discussion with all team members (both method and content experts) to develop a comprehensive framework of interventions. Data were analysed in an iterative process to refine the intervention categories until consensus was reached.

We adapted a previous classification model of primary preventive occupational health interventions (see Fig. 1). (Verbeek and Ivanov, 2013) Interventions were thus set under three broad categories: (1) environmental – those taking away risk factors in the environment, (2) behavioural – those trying to modify health related behavior, or (3) clinical – interventions usually administered by health care professionals, for example, vaccinations.

4. Results

We retrieved a total of 5555 references from electronic databases and 111 from reference lists and author contacts. After removing duplicates, we screened 4271 titles and abstracts. Based on titles and abstracts we could already exclude 4131 papers as irrelevant to our review. For the remaining 140 we obtained full texts to assess their inclusion. Of these 140, we included 39 studies (reported in 42 papers) that fulfilled our inclusion criteria and excluded 98 studies (see Fig. 2). From these 98, we could not locate a full text report for 17 papers (see Appendix B for details) to date and so these have been excluded. The other reasons for exclusion were either that they reported no intervention, the intervention was not an OSH intervention, the participants were adults, or the article did not report an evaluation component.

Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) flow diagram was used to map out the number of records identified, included and excluded, as well as reasons for

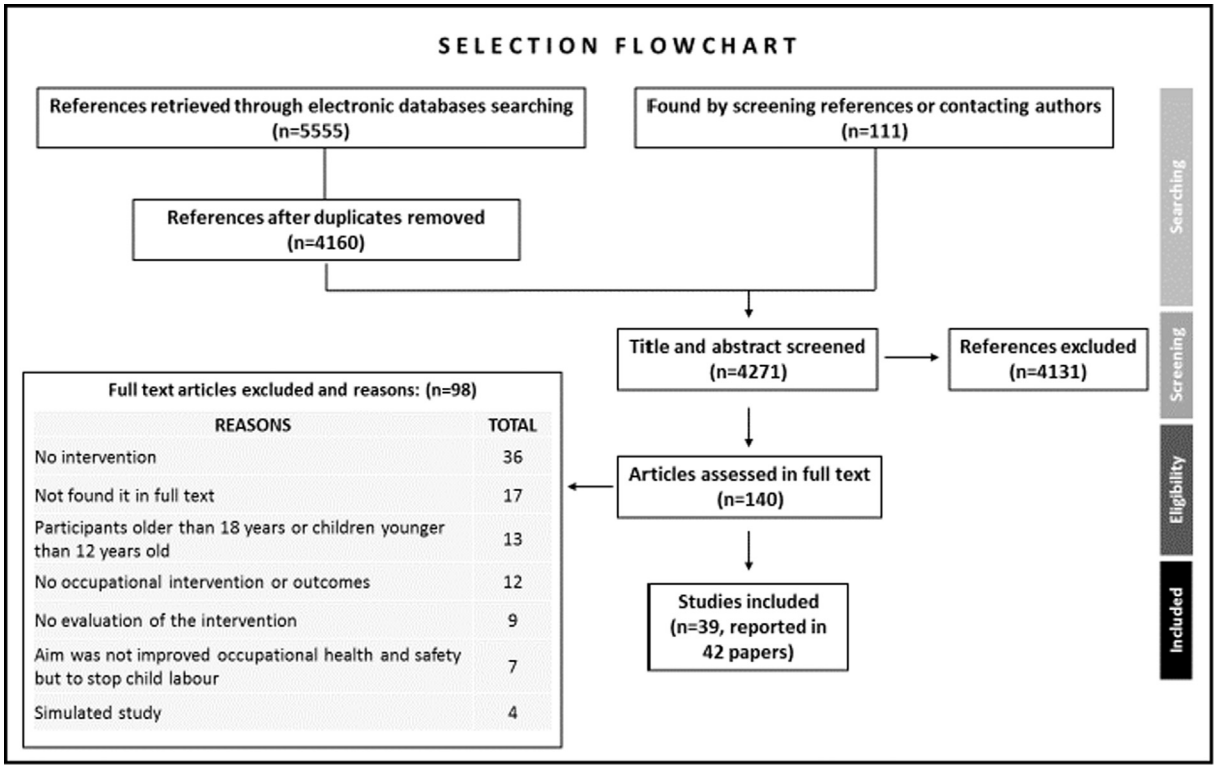


Fig. 2. PRISMA study flow chart (Moher et al., 2009).

exclusions (Moher et al., 2009).

4.1. Map of the available research literature on OSH interventions

We present a map of all interventions we found to provide a quick, proportional and schematic impression of the available research literature and types of interventions tested to date. We used an adaptation of the model of primary preventive occupational health interventions (Verbeek and Ivanov, 2013) to decide on intervention categorization for each study. Studies that included more than one category of OSH interventions (multicategory) were listed in all the categories they included (Fig. 3).

When grouped according to the type of intervention, behavioral interventions were studied most often (n = 29), followed by environmental interventions (n = 3). A clinical intervention was assessed in one study only, while a combination of intervention types was assessed in six studies (see Fig. 3). Thirty-five out of 39 included studies were undertaken in HIC, one in UMIC (see Table 3 and Appendix C for the Bingol study) and three in LMIC (see Table 3 and Appendix C for studies by Das, Carothers and, Bayer). There were no studies from any LIC.

4.2. Description of included studies

Studies were fairly recent with the oldest publication originating from 1997 and the latest from 2016. Studies originate largely from the United States of America (USA) (n = 33) with only few studies from other countries.

Most studies were conducted in the agricultural sector (n = 20). Other sectors covered were services (including grocery stores, restaurants, hairdressing and others), manufacturing (including carpet weaving, carpentry, furniture industries and others) and construction. Behavioral interventions were often based on the trans-theoretical model of behavior change (Prochaska and Velicer, 1997). This model has been one of the most influential in the field of health psychology to understand and predict health-related behaviour because it considers intentional behavior change as a dynamic process of five stages rather than a sudden event.

Participants were: (a) the target population i.e. the young workers (under 18 years) themselves (n = 26) or, (b) intermediaries such as community organizations (n = 2), whole families (n = 1), parents, employers, supervisors, other caregivers or teachers (n = 10).

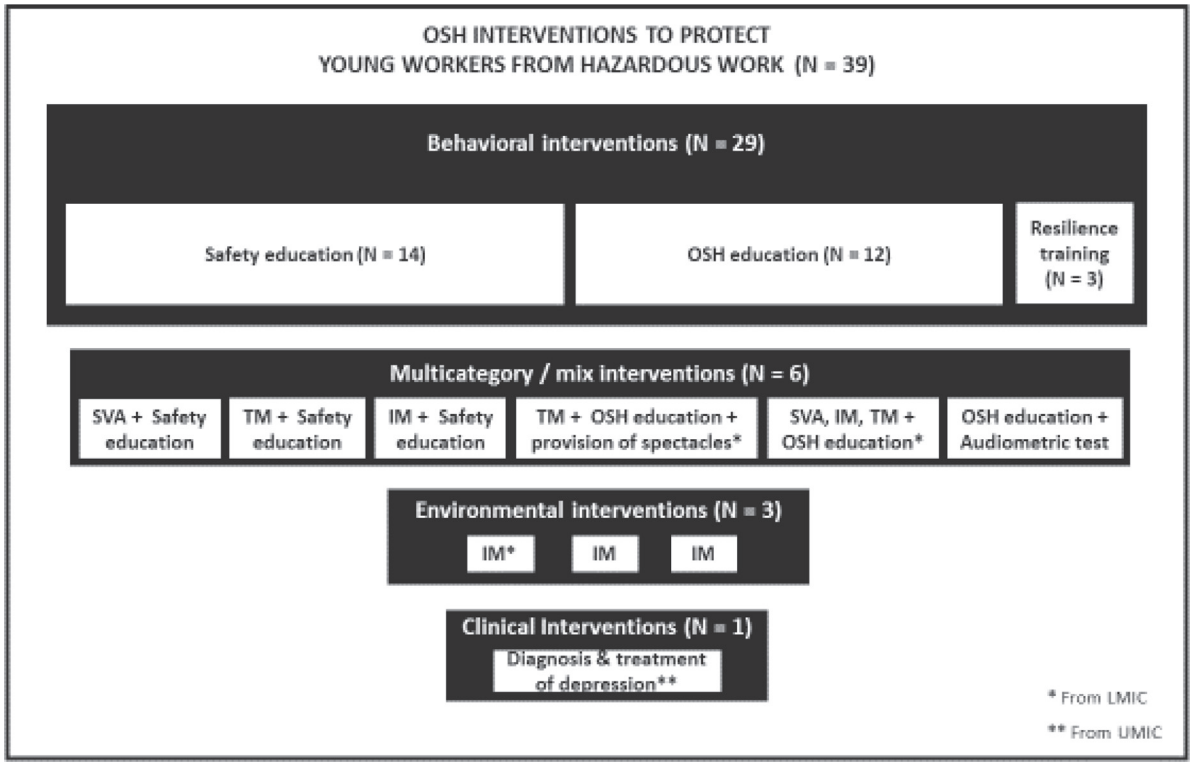
The ages of the young workers included in the studies were varied. While some studies included all children from 4 to 18 years old, others focused on adolescents of age 14 to < 18 years, and still others included children and adults as a group together.

Behavioral outcomes were most frequent (n = 34). Environmental outcomes were the next most common (n = 20). Twelve studies measured health or injury outcomes. Other outcomes were: participants' satisfaction; attendance-participation; perceptions and opinions; features of the programs (curriculum characteristics); resources and support for implementation; self-esteem and leadership self-concept; instrument validation; and integrity of intervention implementation.

None of the included studies reported on adverse or unintended effects of interventions.

A third of the studies were cross-sectional in design (n = 13), followed by cluster-randomised trials (n = 8), mixed methods (n = 5), controlled before and after (n = 4), qualitative (n = 4), uncontrolled before and after (n = 2) and one each of ecological study, case report and randomised controlled trial (see Appendix D).

Developmental characteristics of young workers that could contribute to risk at work, such as lesser ability to assess risks due to ongoing brain development or clumsiness and decreased flexibility due to rapid linear growth or the emotional need for getting approval from their peers, were addressed in 13 studies. These same developmental factors were taken into account during the design or implementation of the intervention. However, none of these studies elaborated on how they implemented theory in their interventions and therefore the approach used was shallow and ambiguous in most of them (see Table 2).



Legends: IM = Implementation Measures; OSH = Occupational Safety and Health; SVA = Standards of Voluntary Application; TM = Technical Measures;

Fig. 3. Map of available research literature on OSH interventions for young workers. Legends: IM = Implementation Measures; OSH = Occupational Safety and Health; SVA = Standards of Voluntary Application; TM = Technical Measures;

4.3. Types of interventions

4.3.1. Environmental

Three studies evaluated implementation measures, specifically: legislation and enforcement against child labour through active community surveillance (n = 1) and, legislation and enforcement of work permits (n = 2). The first of these studies was conducted in Ghana, a LMIC in Africa, whereas the other two were conducted in HIC (see Table 3, Table 4 and Appendix C).

4.3.2. Behavioral

Behavioral interventions mostly consisted of safety education (n = 14). They tried preventing acute negative health impacts through, for example, farm safety day camps for children or safety training with quick response codes (QR codes) linked to videos. Twenty five studies were from USA, three from a USA-Canada collaboration and one from Sweden, all of which are HIC settings.

Other studies evaluated OSH education (n = 12) to protect young workers from chronic and acute hazardous exposures at work. These educational campaigns consisted of: home visits to provide information to parents for assigning farm chores appropriate to the child's age and developmental stage; adding an OSH curriculum at school to enhance adolescent knowledge, attitudes, and beliefs about addressing hazard recognition, injury prevention strategies, child labour laws and communication skills needed to discuss work-related safety concerns; education to prevent hearing loss; and training to wear personal protective equipment. All of these studies were from HIC (USA). Safety education is different from OSH education because the latter covers strategies to prevent accidents as well as diseases. Safety education on the other hand focuses only on acute hazardous exposures that could produce immediate lethal or non-lethal injuries and as such would not need repetitive exposure. Young workers could be healthy and not safe and vice versa.

Three studies evaluated resilience training whereby young workers were trained to recognize the risks and strengths of emerging adulthood. The goal was to learn how to master new roles and responsibilities, whereas resilience refers to the adaptations young workers make and the personal and social resources they develop through that process (see Table 4).

4.3.3. Clinical

The only clinical intervention tested in young workers was the diagnosis and treatment of depression and it was undertaken in Turkey, which is an UMIC setting (see Table 4).

4.3.4. Multiple interventions (Multicategory)

Some studies evaluated environmental and behavioral interventions implemented together (n = 4). Environmental interventions consisted of: (a) legal regulation measures or standards of voluntary application, for example the North American Guidelines for Children's Agricultural Tasks, or the implementation of a Code of Conduct; (b) technical measures like changing a cutter tool and improving working facilities and; (c) implementation measures such as worksite visits to monitor working conditions and legislation enforcement of work permits. Behavioral interventions consisted of safety education (n = 3) and OSH education (n = 1). Three of these studies came from USA (HIC) and one from Egypt (LMIC).

One study evaluated behavioral and clinical interventions together. The package of OSH education consisted of health promotion on ways to manage or prevent hearing loss in the agricultural sector (behavioural intervention) and a hearing screening program using audiometric tests (clinical intervention). This study was from Australia (HIC).

Finally, one study evaluated a set of environmental, behavioral and clinical OSH interventions: the improvement of working facilities; the

Table 2
Studies considering young workers' developmental characteristics that could contribute to risk at work.

Study ID	Study location	Intervention category	Occupational Sector	How the study addressed developmental characteristics that could contribute to risk in young workers	Types of developmental characteristics considered		
					Physical	Mental	Social
Marlenga 2002	USA &Canada	Behavioral	Agriculture	Through the design of materials and the training content.	✓	✓	✓
Pickett 2003	USA &Canada	Behavioral		Through the design of materials and the training content.	✓	✓	
Reed 2004	USA	Behavioral		Through specific methods for teaching/training.		✓	
Gadomski 2006	USA	Behavioral		Through the design of materials and the training content.	✓	✓	✓
Asti 2011	USA	Multicategory: environmental & behavioral		Through the design of materials and the training content.	✓	✓	
Stoneman 2014	USA	Behavioral		Including a video about teenage brain development.		✓	
Stoddard 2005	USA	Behavioral	Services	Based on predictive factors of teen smoking to design the intervention.		✓	✓
Bennett 2010	USA	Behavioral		Through the design of materials and the training content.			✓
Carothers 2010	Egypt	Multicategory: environmental & behavioral		Improving mathematics and literacy skills for making work safer. Setting minimum standards for children's work.		✓	✓
Broome 2011	USA	Behavioral		Through the design of materials and the training content.			✓
Petree 2012	USA	Behavioral		Through the design of training activities and its measures.			✓
Delp 2005	USA	Behavioral	Services & manufacturing/ construction/forestry	Designing the intervention to develop psychological youth empowerment.		✓	✓
Zierold 2006	USA	Multicategory: environmental& behavioral		Demanding basic social protection conditions, to grant work permits.			✓

Legend: USA = United States of America.

implementation of functional literacy classes, awareness campaigns, training of community health volunteers and house-to-house health education and; the provision of spectacles to correct visual pathologies that make the work difficult. It was undertaken in India (LMIC) (see Table 3 and Table 4).

5. Discussion

5.1. Summary of main results

We located 39 studies that evaluated interventions aimed at protecting young workers. The most common intervention was safety education in agriculture in HIC.

Only one third of the studies addressed the developmental factors that could contribute to risk at work such as by designing their training materials specifically for young age groups. Mental and social developmental characteristics were the most often addressed characteristics and the physical developmental characteristics to a much lesser extent. Only a few interventions tried to adapt the work environment or to address specific health issues in young workers. These interventions also often addressed intermediaries such as parents or employers for increasing the protection of young workers.

5.2. Applicability of the findings to LIC and LMIC

It is evident that LMIC and LIC where results are most needed are underrepresented in the published research as only three of the 39 studies included in this scoping review came from LMIC (Ghana, India and Egypt) and one from an UMIC (Turkey). What is remarkable, is that we found no studies conducted in a LIC.

Most of the included studies were conducted in the USA and in the agricultural sector and it is unclear if their findings also apply to LMIC and LIC as these were largely educational and often the farming communities in LMIC and LIC are not literate (Chua-Kenn, 2016). Possibly, similar interventions could be applied in LIC and LMIC by dedicated members of communities or volunteers where OSH specialists are not available. And the illiteracy challenge in these countries can be managed with training materials specifically designed for low literacy groups. It is also noteworthy that agriculture is an important employment sector for young people all over the world beyond the income classification of countries (International Labour Office, 2017), which means that any interventions in HIC agriculture sector that does not depend on literacy could easily be applied to a LIC context.

Another common factor for young workers worldwide is that many are employed as or by family (69%) (International Labour Office, 2017). Thus interventions focused on family may be effective in LIC context as well as other.

Studies undertaken in Egypt, Ghana and India show that even very basic interventions in LMIC are appreciated, such as: raising awareness of whole communities to the problem of poor OSH for young workers, improved legislation, and interventions for population empowerment like literacy. Once these are in place the broad experience in OSH education accumulated in HIC probably can also be applied in LIC and LMIC.

In summary, there is a dearth of evidence when it comes to evaluating interventions in LMIC, adapting interventions developed in HIC to the needs of LMIC and, evaluating changes in the work environment that accommodate specific developmental characteristics of young workers that could contribute to risk.

5.3. Applicability to young workers

Two studies considered and reported in detail all the developmental characteristics of young workers that could contribute to risk (physical, mental and, social) (see Table 2 and Appendix C for studies by Marlenga and Gadomski). Other studies reported adapting training material to

Table 3
Characteristics of included studies.

Study ID	Study Location	Occupational Sector	Age (in years) of target population	Intervention participants	Intervention category	Study design
Das 1992	India	Carpet weaving	< 20 to 50	Target population	Multicategory: environmental, behavioral & clinical	Cross sectional
Banco 1997	USA	Services	15 to 17	Parents/caregivers, and employers/ supervisors	Multicategory: environmental & behavioral	Controlled before & after
Baker 2001	USA	Agriculture	7 to 13	Target population	Behavioral	Qualitative
Delp 2002	USA	Services & manufacturing	14 to < 18	Target population	Environmental	Mix method
Marlenga 2002	USA & Canada	Agriculture	9 to 14	Parents	Behavioral	Cluster randomised trial
Kidd 2003	USA	Agriculture	14 to 16	Target population	Behavioral	Controlled before & after
Pickett 2003	USA &Canada	Agriculture	7 to 16	Parents	Behavioral	Cross sectional
Lee 2004	USA	Agriculture	12 to 21	Target population	Behavioral	Cluster randomised trial
NIOSH 2004	USA	Agriculture	14 to 17	Target population	Behavioral	Cluster randomised trial
Reed 2004	USA	Agriculture	14 to 15	Target population	Behavioral	Controlled before & after
Delp 2005	USA	Services & construction	14 to 18	Target population	Behavioral	Mix method
Linker 2005	USA	All industries	14 to 18	Target population	Behavioral	Mixed methods
Mc-Callum 2005	USA	Agriculture	8 to 13	Target population	Behavioral	Uncontrolled before & after
Stoddard 2005	USA	Services	15 to 18	Target population	Behavioral	Cluster randomised trial
Zentner 2005	USA &Canada	Agriculture	7 to 16	Parents	Behavioral	Cross sectional
Gadomski 2006	USA	Agriculture	7 to 16	Parents	Behavioral	Cluster randomised trial.
Heaney 2006	USA	Agriculture	14 to 15	Target population	Behavioral	Cross sectional
Reed 2006	USA	Agriculture	14 to 19	Target population	Behavioral	Cross sectional
Zierold 2006	USA	Services, construction, manufacturing, forestry.	14 to 17	Target population	Multicategory: environmental & behavioral	Cross sectional
Runyan 2008	USA	Services	14 to 17	Target population	Behavioral	Cross sectional
Teran 2008	USA	Agriculture	13 to 20	Target population	Behavioral	Controlled before & after
Bennett 2010	USA	Services	16 to 34	Target population	Behavioral	Cross sectional
Carothers 2010	Egypt	Services	< 18	Employers & supervisors	Multicategory: environmental & behavioral	Qualitative
Dal Santo 2010	USA	No reported	14 to 18	Target population	Environmental	Cross sectional
Ashida 2011	USA	Agriculture	7 to 18	Parents/ caregivers, and employers/ supervisors	Behavioral	Qualitative
Asti 2011	USA	Agriculture	7 to 16	Parents/ caregivers, and employers/ supervisors	Multicategory: environmental & behavioral	Cross sectional
Broome 2011	USA	Services	16 to 35	Target population	Behavioral	Cluster randomised trial
Depczynski 2011	Australia	Agriculture	15 to 24	Target population	Multicategory: behavioral & clinical	Ecological
Ehlers 2011	USA	Agriculture	14 to 35	Community organizations	Behavioral	Case study
Petree 2012	USA	Services	16 to 29	Target population	Behavioral	Cluster randomised trial
Zierold 2012	USA	Services	15 to 19	Target population	Behavioral	Qualitative
Bayer 2014	Ghana	Agriculture	5 to 17	Community organizations	Environmental	Mix method
Stoneman 2014	USA	Agriculture	10 to 19	Families	Behavioral	Cluster randomised trial
Rauscher 2015	USA	No reported	14 to 18	Teachers	Behavioral	Cross sectional
Zierold 2015	USA	Services	15 to 19	Target population	Behavioral	Mix method
Bingol 2016	Turkey	Services & manufacturing	14 to 17	Target population	Clinical	Randomised trial
Guerin 2016	USA	All industries	12 to 18	Target population	Behavioral	Cross sectional
Gummesson 2016	Sweden	Carpentry & furniture industry	16 to 19	Target population	Behavioral	Cross sectional
Hard 2016	USA	Agriculture	4 to 18	Parents/caregivers, and employers/ supervisors	Behavioral	Uncontrolled before & after

Legend: USA = United States of America.
Note: Mixed methods is a study with both qualitative and quantitative method components.

Table 4
Interventions and outcomes used in included studies.

Study ID	I N T E R V E N T I O N categories			O U T C O M E S reported			
	Environmental	Behavioral	Clinical	Environmental	Behavioral	Clinical	Others
Das 1992	Technical measures	OSH education	Provision of spectacles	Technical changes	Attitude change	Back pain relief prevalence, number of spectacles provided	Literacy classes attendance
Banco 1997	Technical measures	Safety education	No	No	No	Injuries rate	Satisfaction
Baker 2001	No	Safety education	No	No	Knowledge & behavior change	No	Program's strengths & weaknesses. Number of journal publications
Delp 2002	Implementation measures	No	No	Decrease or elimination of exposure	Knowledge change	No	Opinions
Marlenga 2002	No	Safety education	No	No	Knowledge & behavior change	No	No
Kidd 2003	No	OSH education	No	Technical changes	Behavior change	Injuries prevalence	No
Pickett 2003	No	Safety education	No	Compliance of standards of voluntary application	Knowledge & Behavior change	No	No
Lee 2004	No	OSH education	No	No	Knowledge, attitude & behavior change	Injuries prevalence	Participation, attendance. Self-esteem & leadership self-concept
NIOSH 2004	No	Safety education	No	No	Knowledge, attitude & beliefs change	No	Perceptions
Reed 2004	No	OSH education	No	No	Behavior change	No	Curriculum's characteristics
Delp 2005	No	OSH education	No	Legislative or regulation change	Knowledge & attitude change	No	Opinions. Integrity of intervention's implementation.
Linker 2005	No	OSH education	No	No	Knowledge change	No	Perceptions, opinions
Mc-Callum 2005	No	Safety education	No	No	Knowledge & behavior change	No	No
Stoddard 2005	No	OSH education	No	No	Behavior change	Smoking prevalence	No
Zentner 2005	No	Safety education	No	Technical changes	Behavior change	No	No
Gadomski 2006	No	Safety education	No	Technical changes	Behavior change	Injuries incidence & severity	No
Heaney 2006	No	Safety education	No	No	No	No	Participation
Reed 2006	No	OSH education	No	No	Behavior change	No	No
Zierold 2006	Implementation measures	Safety education	No	No	Knowledge change	Injuries prevalence	No
Runyan 2008	No	OSH education	No	No	Behavior change	No	No
Teran 2008	No	OSH education	No	No	Knowledge, attitude & behavior change	No	Perceptions, opinions
Bennett 2010	No	Resilence training	No	No	Knowledge & behavior change	No	No
Carothers 2010	Standards of voluntary application, implementation measures & technical measures	OSH education	No	Compliance of standards of voluntary application, technical & organizational changes	Knowledge & behavior change	No	No
Dal Santo 2010	Implementation measures	No	No	No	Behavior change	No	No
Ashida 2011	No	Safety education	No	No	Knowledge &behavior change	No	Perceptions, opinions
Asti 2011	Standards of voluntary application	Safety education	No	No	Behavior change	No	No
Broome 2011	No	Resilence training	No	No	Behavior change	No	No
Depczynski 2011	No	OSH education	Audiometric test	Organizational & technical changes	Behavior change	Signs & symptoms prevalence	No

(*continued on next page*)

Table 4 (*continued*)

Study ID	I N T E R V E N T I O N categories			O U T C O M E S reported			
	Environmental	Behavioral	Clinical	Environmental	Behavioral	Clinical	Others
Ehlers 2011	No	OSH education	No	No	No	No	Participation, attendance Self esteem & leadership Self-concept
Petree 2012	No	Resilence training	No	Decrease or elimination of exposure	No	Signs & symptoms prevalence	No
Zierold 2012	No	Safety education	No	No	Beliefs change	Injuries prevalence	Satisfaction
Bayer 2014	Implementation measures	No	No	Decrease or elimination of exposure & organizational changes	Knowledge, attitude & behavior change	No	School attendance
Stoneman 2014	No	Safety education	No	No	Attitude & behavior change	No	No
Rauscher 2015	No	OSH education	No	No	Behavior change	No	Opinions, satisfaction. Resources and support for implementation.
Zierold 2015	No	Safety education	No	Decrease or elimination of exposure	No	Injuries prevalence	Program's characteristics
Bingol 2016	No	No	Diagnosis & treatment of depression	No	Behavior change	Improving symptoms	Depression & demographic indicators of correlation
Guerin 2016	No	OSH education	No	No	Knowledge & skills change	No	Instrument's reliability
Gummesson 2016	No	Safety education	No	No	Knowledge, attitude & behavior change	No	Opinions
Hard 2016	No	Safety education	No	Technical changes	Knowledge & attitude change	No	No

Legend: OSH = Occupational Safety and Health.

the development stage of young workers but from the reports it was not clear how they did this (see Table 2 and Appendix C for studies by Pickett, Reed, Delp, Stoddard, Bennett, Asti, Broome, Petree and, Stoneman). One study identified young workers' illiteracy and poor mathematical skills as their main vulnerability (see Table 2 and Appendix C for Carothers study). The authors found that street vendor children face physical or verbal abuse from customers when they make mathematical mistakes in providing change. This is an interesting finding because it supports the idea that in LMIC improving basic conditions such as literacy skills may also improve OSH conditions for young workers by reducing their social developmental vulnerabilities.

5.4. Limitations of this review

The concept 'young workers' includes a wide range of ages, which hinders finding research specifically addressing workers under 18 years old because they are often only a part of study populations. The biggest challenges in designing a sufficiently sensitive systematic search were the necessity to include a wide variety of terms to catch all possible studies that included workers under 18 years old and applying filters to take out all social or welfare interventions to obtain only the OSH ones.

The period applied for the search strategy (January 1990 – September 2016) is another limitation of this study. Our search was initially developed and run in year 2014 and updated in 2016. Since then many new papers in the field may have been published. In a review of effectiveness of intervention this would be a major limitation. However, for a scoping review that aims to identify the trends and gaps in research in this area, this limits the applicability of our findings to a small extent only. Furthermore, our systematic searches showed that a certain type of study is common – namely those conducted in the USA and in the agricultural sector-, while studies from several sectors such as services and small-scale manufacturing are missing. These are areas where many young workers from LMIC are employed (International Labour Office, 2017). There were also no studies from any of the LIC, where the safety of young workers is likely to be more at risk. Therefore, we did not update the search again in 2017.

We found limited data from 12 studies (see Table 4 and Appendix C for studies by Banco, Bingol, Das, Depczynski, Gadomski, Kidd, Lee, Petree Stoddard and, Zierold) on outcomes of injury or disease incidence or prevalence. We acknowledge that this may reflect a lack of data in general on this worker group. This is partly illegal work settings and employers are unlikely to collect any safety data, but also because if a work is considered not legal by a region's occupational sector this would not feature in any occupational databases and would be difficult to identify. However, we also acknowledge that there are adolescents of legal working age in permitted forms of employment but the data to calculate injury and/or fatality rates continue being limited even for these adolescents.

5.5. Implications for practice

Parents and other key social actors (employers, teachers, supervisors, whole communities, unions) could be instrumental in reinforcing the results of interventions applied only to young workers. Ensuring inclusion of these actors in development and implementation of OSH interventions may be helpful.

Improving basic conditions such as implementing OSH legislation and their appropriate enforcement, sanitation, access to health services and improving literacy in children can probably improve the occupational health of young workers but further research is required to evaluate their impact. Programmes developed for young workers in agriculture in HIC and, behavioral interventions like safety or OSH education in all sectors can probably be used also in LMIC and LIC after adaptation to the specific setting.

We think a greater consideration of the hazards affecting young workers due to their age and their developmental stage by employers and decision makers is needed.

ILO Conventions 138 and 182 have been the global foundation on which to build national regulations for protecting young workers. It is unlikely that health and safety rights of young people at work can be protected when national or regional laws do not reflect the ILO conventions. (Ercelawn and Nauman, 2001) In the absence of regulations and enforcements from authorities there is nothing to hold employers to account and therefore only some employers would voluntarily try to improve safety and health for their young employees. In this situation, the onus perhaps falls on national leaders in LMICs to ensure protection of their young workers and on OSH practitioners to lobby for these legal changes.

Considering that 27% of workers from 5 to 17 years old are in paid employment (International Labour Office, 2017), it is required that employers have an active and mandatory participation in the development and implementation of concrete interventions to protect young workers from hazardous work-related exposures in order to avoid occupational accidents and diseases.

5.6. Implications for research

Intervention studies should strive to demonstrate their effectiveness on key outcomes such as the incidence of injuries or disease, instead of only reporting intermediate results such as a change in knowledge, attitude or behavior.

There is enough available research to undertake a systematic review of the effectiveness of OSH interventions for young workers. There are systematic reviews for this population in agriculture (Hartling et al., 2004; Rautiainen et al., 2008) but not for other occupational sectors. In this scoping review three cluster-randomised trials and one controlled before-after study were located for the services sector such as grocery store and restaurant work. Future systematic reviews evaluating these interventions should also assess the methodological quality of the studies (i.e. their risk of bias) which was beyond the scope of this review. We need studies on effectiveness of clinical and work environment interventions in all other occupational sectors.

Future OSH interventions for young workers should use appropriate study designs: randomised controlled trials or non-randomised trials with a concurrent control group.

Studies that report design or evaluation of interventions for young workers should clearly report which specific developmental characteristics were addressed and how. It is likely that simply replicating OSH education used for adult workers would not sufficiently address these issues specific to young workers.

Programmes that are either developed in LMIC and LIC or adapted for use in these countries should be evaluated for their effect on injuries and health of young workers. We recommend designing interventions for well-defined or stratified groups of young workers, without mixing them with very young children or with adult workers.

6. Sources of support

6.1. Internal sources

Cochrane Occupational Safety and Health Review Group, Finland. Finnish Institute of Occupational Health, Finland.

6.2. External sources

National Autonomous University of Mexico (UNAM), México. National Council for Science and Technology (CONACYT), México.

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Declarations of interest

The authors involved in this review do not have any conflicts of interest to declare in conjunction with this study.

Appendix A. Example of search strategy in Medline via pubmed.

Population terms	#1	Search((“child work” OR “child labour” OR “children workers” OR “child workers” OR “adolescent work” OR “adolescent workers” OR “teen workers” OR “young worker” OR “young workers” OR “young workforce” OR “youth work” OR “young employees” OR “young employee” OR “child employment” OR “adolescent employment” OR “teen employment” OR “youth employment” OR “young employed” OR “young fishers” OR “domestic work” OR “young miners” OR “teen construction worker” OR “young construction workers” OR “adolescent farmer” OR “young farmers” OR “young farmer” OR “young farm workers” OR “adolescent carriers” OR “young carriers” OR “children carriers” OR “child carriers” OR “child carrier” OR “young restaurant workers” OR “childhood farm” OR “working child” OR “working boys” OR “working children” OR “working youth” OR “working teens” OR “working teenagers” OR “working adolescent” OR “working adolescents”[Title/Abstract])) OR (child participation AND mining[MeSH Terms])
Intervention terms	#2	Search (“prevention and control”[sh] OR effect*[tw] OR control*[tw] OR evaluat*[tw] OR program*[tw] OR prevention*[tw] OR protect*[tw])
Possible outcomes	#3	Search ((((“occupational injury” OR “occupational injuries” OR “occupational accident” OR “occupational accidents” OR “occupational disease” OR “occupational diseases” OR “work injury” OR “work injuries” OR “work accident” OR “work accidents” OR “work disease” OR “work diseases” OR “work-related injury” OR “work-related injuries” OR “work-related accident” OR “work-related disease” OR “work-related diseases” or “wet work”[Title/Abstract])) OR (exposure, occupational OR air pollutants, occupational OR accident, occupational OR accidents, occupational OR asthma, occupational OR asthmas, occupational OR dermatitides, occupational OR dermatitis, occupational OR disease, occupational OR diseases, occupational OR exposures, occupational OR pesticides OR agrochemicals OR blood poisoning OR blood poisonings OR work loads OR work loads, employee OR factor, psychosocial OR factors, psychosocial[MeSH Terms])
Additional sensitive OSH terms	#4	Search (work* OR occupation*OR prevention* OR pain* OR expos* OR protect*[Title/Abstract])
		#1 AND #2 OR #3 OR #4
Time Filter		AND “1990/01/01”[PDAT]:”2016/09/16”[PDAT]

Appendix B. Detail of excluded studies.

Studies excluded because there was no intervention (n = 36)

Al Gamal 2013	ILO 1999	Rubenstein 1999
Beckett 2000	ILO 2013	Schulte 2014
Beyer, 2012	ILO/IPEC 2011a	Sitzman 2002
Breslin 2009	Laberge 2014	Solecki 2002
Brezler 1999	Miller 2004	Sorensen 2004
Coimbra 2014	Neufeld 2002	Tappura 2012
Collins 2002	NIOSH 1999	Tucker 2015
Cooper 2005	ÓConnor 2005	Turte 2012
Fisher 2009	Otañez 2006	van der Molen 2010
Frone 2000	Polanska 2006	Vuong 2007
Grant-Smith 2015	Richter 1991	Woodward-C 2015
Grootaert 1995	Rohlman 2013	Woodward-C 2015

Studies excluded because a full text publication could not be found (n = 17)

Burgus 1997	Knoblock 1998	Reed, 2003
Carrabba 2000	Lucas 1999	Schlesinger 2001
Higgins 2001	Marcolina 2007	Slaunwhite 2010
Huneke 1998	McCallum 2000	Spiewak 2000
Jepsen 2014	Patiroglu 2001	Stephenson 2005
Khumalo 2016	Ramaswamy 2015	

Studies excluded because participants were older than 18 years old or they were exclusively children (n = 13)

Carpenter 2002	McCullagh 2002	Soares 2012
Chan 2016	Pidd 2015	Stuart 2013
Franklin 2002	Schenker 2002	Voaklander 2006
Hyatt-R 2007	Schermann 2008	Williams 2010
Klassen 2000		

Studies excluded because the effectiveness of the intervention was not evaluated (n = 9)

Andersson 2015	Nurture newsletter-summer 2014	Rutkowski 2015
Chin 2010	Nurture newsletter-winter 2014	Schulte 2005
Mayer 2013	Nurture newsletter-spring 2015	Tulane University 2011

Studies excluded because there was no occupational intervention or outcomes (n = 12)

Carter 2011	Howard 2014	Quendler 2009
Coburn 2014	Landmann 2015	Sachedev 2013
Cone 1998	Luseno 2013	Schady 2008
Corsica 1993	Mzung 1999	Uplap 2014

Studies excluded because the aim was not to improve occupational health and safety but to stop child labour (n = 7)

ILO 2004a	Nguyen 2015	Tulane University 2010.
ILO 2004b	Tulane University 2009	Yildirim 2015
Mello 2015		

Studies excluded because they were simulations (n = 4)

Allread 2007	Kotowski 2009a
Fathallah 2016	Kotowski 2009b

Appendix C. Detail of included studies (n = 39).

Study ID	Reference
Das 1992	Das PK, Shukla KP, Ory FG. An occupational health programme for adults and children in the carpet weaving industry, Mirzapur, India: a case study in the informal sector. *Soc Sci Med*. 1992;35(10):1293–302. https://doi.org/10.1016/0277-9536(92)90182-P
Banco 1997	Banco L, Lapidus G, Monopoli J, Zavoski R. The Safe Teen Work Project: a study to reduce cutting injuries among young and inexperienced workers. *Am J Ind Med.* 1997;31(5):619–22.
Baker 2001	Baker AE, Esser NM, Lee BC. A qualitative assessment of children's farm safety day camp programs. *J Agric Saf Health*. 2001;7(2):89–99.
Delp 2002	Delp L, Runyan CW, Brown M, Bowling JM, Jahan SA. Role of work permits in teen workers' experiences. *Am J Ind Med.* 2002;41(6):477–82.
Marlenga 2002	Marlenga B, Pickett W, Berg RL. Evaluation of an enhanced approach to the dissemination of the North American Guidelines for Children's Agricultural Tasks: a randomized controlled trial. *Prev Med.* 2002;35(2):150–9.
Kidd 2003	Kidd P, Reed D, Weaver L, Westneat S, Rayens MK. The transtheoretical model of change in adolescents: implications for injury prevention. *J Safety Res.* 2003;34(3):281–8.
Pickett 2003	Pickett W, Marlenga B, Berg RL. Parental knowledge of child development and the assignment of tractor work to children. *Pediatrics*. 2003;112(1Pt 1):e11-6.
Lee 2004	Lee BC, Westaby JD, Berg RL. Impact of a national rural youth health and safety initiative: results from a randomized controlled trial. *Am J Public Health.* 2004;94(10):1743–9.
NIOSH 2004	CDC - NIOSH Publications and Products – Evaluating Teen Farmworker Education: An Evaluation of a High School ESL Health and Safety Curriculum (2011–113). https://www.cdc.gov/niosh/docs/2011-113/default.html
Reed 2004	Reed DB, Kidd PS. Collaboration between nurses and agricultural teachers to prevent adolescent agricultural injuries: the Agricultural Disability Awareness and Risk Education Model. *Public Health Nurs*. 2004;21(4):323–30.
Delp 2005	Delp L, Brown M, Domenzain A. Fostering youth leadership to address workplace and community environmental health issues: a university-school-community partnership. *Health Promot Pract.* 2005;6(3):270–85.
Linker 2005	Linker D, Miller ME, Freeman KS, Burbacher T. Health and safety awareness for working teens: developing a successful, statewide program for educating teen workers. *Fam Community Health*. 2005;28(3):225–38.
Mc-Callum 2005	McCallum DM, Conaway MB, Drury S, Braune J, Reynolds SJ. Safety-related knowledge and behavior changes in participants of farm safety day camps. *J Agric Saf Health*. 2005;11(1):35–50.
Stoddard 2005	Stoddard AM, Fagan P, Sorensen G, Hunt MK, Frazier L, Girod K. Reducing cigarette smoking among working adolescents: results from the SMART study. *Cancer Causes Control*. 2005;16(10):1159–64.
Zentner 2005	Zentner J, Berg RL, Pickett W, Marlenga B. Do parents' perceptions of risks protect children engaged in farm work? *Prev Med.* 2005;40(6):860–6.
Gadomski 2006	Gadomski A, Ackerman S, Burdick P, Jenkins P. Efficacy of the North American guidelines for children's agricultural tasks in reducing childhood agricultural injuries. *Am J Public Health*. 2006;96(4):722–7. Epub 2006 Feb 28.
Heaney 2006	Heaney CA, Wilkins JR 3rd, Dellinger W, McGonigle H, Elliott M, Bean TL, Jepsen SD. Protecting young workers in agriculture: participation in tractor certification training. *J Agric Saf Health*. 2006;12(3):181–90.
Reed 2006	Reed DB, Browning SR, Westneat SC, Kidd PS. Personal protective equipment use and safety behaviors among farm adolescents: gender differences and predictors of work practices. *J Rural Health*. 2006 Fall;22(4):314–20.
Zierold 2006	Zierold KM, Anderson H. The relationship between work permits, injury, and safety training among working teenagers. *Am J Ind Med.* 2006;49(5):360–6.
Runyan 2008	Runyan CW, Vladutiu CJ, Rauscher KJ, Schulman M. Teen workers' exposures to occupational hazards and use of personal protective equipment. *Am J Ind Med.* 2008;51(10):735–40. doi: https://doi.org//10.1002/ajim.20624.
Teran 2008	Teran S, Strochlic R, Bush D, Baker R, Meyers J. Reaching teen farm workers with health and safety information: an evaluation of a high school ESL curriculum. *J Agric Saf Health*. 2008;14(2):147–62.
Bennett 2010	Bennett JB, Aden CA, Broome K, Mitchell K, Rigdon WD. Team resilience for young restaurant workers: research-to-practice adaptation and assessment. *J Occup Health Psychol.* 2010;15(3):223–36. doi: https://doi.org//10.1037/a0019379.
Carothers 2010	Carothers R, Breslin C, Denomy J, Foad M. Promoting occupational safety and health for working children through microfinance programming. *Int J Occup Environ Health*. 2010;16(2):180–90.
Dal Santo 2010	Dal Santo JA, Bowling JM, Harris TA. Effects of work permits on illegal employment among youth workers: findings of a school-based survey on child labor violations. *Am J Public Health.* 2010;100(4):635–7. doi: https://doi.org//10.2105/AJPH.2009.160812. Epub 2010 Feb 18.
Ashida 2011	Ashida S, Heaney CA, Kmet JM, Wilkins JR 3rd. Using protection motivation theory and formative research to guide an injury prevention intervention: increasing adherence to the North American Guidelines for Children's Agricultural Tasks. *Health Promot Pract.* 2011;12(3):396–405. doi: https://doi.org//10.1177/1524839910362034.
Asti 2011	Asti L, Canan BD, Heaney C, Ashida S, Renick K, Xiang H, Stallones L, Jepsen SD, Crawford JM, Wilkins JR 3rd. Compliance with the North American Guidelines for Children's Agricultural Tasks (NAGCAT) work practice recommendations for youth working with large animals. *J Agromedicine.* 2011;16(3):174–93. doi: https://doi.org//10.1080/1059924X.2011.584044.
Broome 2011	Broome KM, Bennett JB. Reducing heavy alcohol consumption in young restaurant workers. *J Stud Alcohol Drugs*. 2011;72(1):117–24.
Depczynski 20-11	Depczynski J, Challinor K, Fragar L. Changes in the hearing status and noise injury prevention practices of Australian farmers from 1994 to 2008. *J Agromedicine.* 2011;16(2):127–42. doi: https://doi.org//10.1080/1059924X.2011.554770.
Ehlers 2011	Ehlers JJ, Graydon PS. Noise-induced hearing loss in agriculture: creating partnerships to overcome barriers and educate the community on prevention. *Noise Health.* 2011;13(51):142–6. doi: https://doi.org//10.4103/1463-1741.77218.

Petree 2012	Petree RD, Broome KM, Bennett JB. Exploring and reducing stress in young restaurant workers: results of a randomized field trial. *Am J Health Promot.* 2012;26(4):217–24. doi: https://doi.org//10.4278/ajhp.091001-QUAN-321.
Zierold 2012	Zierold KM, Welsh EC, McGeeney TJ. Attitudes of teenagers towards workplace safety training. *J Community Health.* 2012;37(6):1289–95. doi: https://doi.org//10.1007/s10900-012-9570-z.
Bayer 2014	Bayer CN. The effects of child labour monitoring on knowledge, attitude and practices in cocoa growing communities of Ghana. Doctoral Dissertation. 2014. https://digitallibrary.tulane.edu/islandora/object/tulane%3A27805/datastream/PDF/view
Stoneman 2014	Stoneman Z, Jinnah HA, Rains GC. Changing a dangerous rural cultural tradition: a randomized control study of youth as extra riders on tractors. *J Rural Health.* 2014;30(4):388–96. doi: https://doi.org//10.1111/jrh.12073. Epub 2014 May 6.
Rauscher 2015	Rauscher KJ, Casteel C, Bush D, Myers DJ. Factors affecting high school teacher adoption, sustainability, and fidelity to the "Youth@Work: Talking Safety" curriculum. *Am J Ind Med.* 2015;58(12):1288–99. doi: https://doi.org//10.1002/ajim.22497. Epub 2015 Jul 6.
Zierold 2015	Zierold KM. Teen worker safety training: methods used, lessons taught, and time spent. *New Solut.* 2015;25(1):25–41. doi: https://doi.org//10.1177/1048291115569024. Epub 2015 Mar 16.
Bingol 2016	Bingol F, Buzlu S. Effect of the Cognitive-Behavioral Prevention Program on Levels of Depression Symptoms Among Working Adolescents in Turkey. *J Psychosoc Nurs Ment Health Serv.* 2016;54(7):43–51. doi: https://doi.org//10.3928/02793695-20160616-08.
Guerin 2016	Guerin RJ, Okun AH, Kelley P. Development and validation of an assessment tool for a national young worker curriculum. *Am J Ind Med.* 2016;59(11):969–978.
Gummesson 2016	Gummesson K. Effective measures to decrease air contaminants through risk and control visualization – A study of the effective use of QR codes to facilitate safety training. *Saf Sci.* 2016;82:120–128. https://doi.org/10.1016/j.ssci.2015.09.011

Appendix D. Designs of included studies.

Type of study	Characteristics
Qualitative	Study with descriptive results, without numerical data, measurements, nor statistical methods.
Case report	Study reporting numerical data of the activities carried out during an intervention.
Ecological	Study whose unit of observation and analysis is the group and not the individual.
Cross-sectional	Study in which the outcome of the intervention was measured at a single time point, without baseline measurements.
Uncontrolled before and after	Study with pre-test and post-test measurements but without a control group.
Controlled before and after	Study with pre-test and post-test measurements and a control group.
Cluster randomised-trial	Prospective experimental study where the allocation of interventions is done randomly. Randomisation is by clusters, not by individuals.
Randomised control trial	Prospective experimental study where the allocation of interventions is done randomly, individual by individual.
Mixed methods	Study that includes quantitative and qualitative methods

Appendix E. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssci.2018.11.024.

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