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Interventions for preventing injuries in the agricultural industry (Review)

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Interventions for preventing injuries in the agricultural industry.
Cochrane Database of Systematic Reviews 2008, Issue 1. Art. No.: CD006398.
DOI: 10.1002/14651858.CD006398.pub2.

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TABLE OF CONTENTS

[Intervention Review]

Interventions for preventing injuries in the agricultural industry

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Editorial group: Cochrane Injuries Group.
Publication status and date: Edited (no change to conclusions), published in Issue 3, 2009.
Review content assessed as up-to-date: 31 October 2007.

Citation: Rautiainen R, Lehtola MM, Day LM, Schonstein E, Suutarinen J, Salminen S, Verbeek JH. Interventions for preventing injuries in the agricultural industry. *Cochrane Database of Systematic Reviews* 2008, Issue 1. Art. No.: CD006398. DOI: 10.1002/14651858.CD006398.pub2.

ABSTRACT

Background

Agriculture is more hazardous than most other industries. Many strategies have been introduced to reduce injuries in the field, yet the effectiveness of different interventions on occupational injuries still remains unclear.

Objectives

This review aims to determine the effectiveness of interventions to prevent occupational injuries among workers in the agricultural industry compared to no interventions or to alternative interventions.

Search methods

Cochrane Central Register of Controlled Trials, Cochrane Injuries Group's specialised register, MEDLINE, EMBASE, PsychINFO, OSH-ROM (including NIOSHTIC and HSELINE) databases were searched up to June 2006. Reference lists of selected articles, relevant reviews and additional topic related databases and web sites were also searched. The searches were not restricted by language or publication status.

Selection criteria

Randomised controlled trials, cluster-randomised controlled trials, prospective cohort studies with a concurrent control group, and interrupted time series studies assessing any type of intervention aiming to prevent fatal or non-fatal injuries among workers in agriculture.

Data collection and analysis

Two reviewers conducted data extraction and study quality assessment independently. Rate ratios of randomised controlled trials were calculated and the effect sizes were combined in a meta-analysis. Interrupted time series studies were reanalysed and each of them studied for having an immediate and a progressive effect.

Main results

Five randomised controlled trials (RCTs) with 11,565 participants and three interrupted time series studies (ITSs) with 26.3 data points on average met the criteria.

For educational interventions aiming at reducing injury rates among adults the pooled rate ratio after recalculation from effect sizes in three RCTs was 1.02 (95% CI 0.87 to 1.20). For educational interventions aiming at children the pooled rate ratio for injury rates in two RCTs was 1.27 (95% CI 0.51 to 3.16).

One ITS study that evaluated the effect of an intervention that included financial incentives decreased the injury level immediately after the intervention with an effect size of -2.68 (95% CI -3.80 to -1.56) but did not have a significant effect on the injury trend over time with an effect size of -0.22 (95% CI -0.47 to 0.03).

One ITS study that evaluated the effect of legislation to ban Endosulfan pesticide on fatal pesticide poisonings increased the level of poisonings immediately after the introduction with an effect size of 2.20 (95% CI 0.97 to 3.43) but led to decrease in the trend of poisonings over time with an effect size of -2.15 (95% CI -2.64 to -1.66).

One ITS study documented four different regulations aiming to increase the use of rollover protective structures (ROPS) on tractors and their effect on injuries and fatal injuries. The introduction of two different pieces of legislation requiring ROPS on new tractors sold after a certain date was associated with a decrease of fatal injuries over the long term (effect size -0.93 95% CI -1.82 to -0.03). Otherwise the introduction of legislation was associated with an increase of injury rates. Introduction of legislation requiring ROPS on all tractors, old tractors included, was not associated with a decrease but with an increase of injuries and fatal injuries over the long term.

Authors' conclusions

The selected studies provided no evidence that educational interventions are effective in decreasing injury rates among agricultural workers. Financial incentives could reduce injury rates. Legislation to ban pesticides could be effective. Legislation expanding the use of safety devices (ROPS) on new tractors was associated with a decrease in fatal injuries.

PLAIN LANGUAGE SUMMARY

Interventions for preventing injuries in the agricultural industry

Occupational injury rates among farmers are high. Many prevention programs and laws have been introduced as injury control strategies in this field, but the effectiveness of many of these strategies in reducing injuries is still unknown.

A systematic literature search was conducted to find studies on interventions to reduce occupational injuries in agriculture. Eight studies were found from over 8600 references. The quality of the relevant studies was assessed and their results extracted. Randomised controlled trial data were combined across studies in a meta-analysis. Interrupted time series studies were reanalysed to assess if there was a change in the level or trend of injuries associated with the intervention.

Five randomised controlled trials with 11,565 participants and one interrupted time series study with 14 measurement points used combinations of various educational interventions and financial incentives. Two of these studies concentrated on injury prevention among children or adolescents and the rest dealt with injury prevention among adults. The effect of legislation was evaluated in two interrupted time series studies with on average 32.5 measurement points. One study evaluated regulations to prevent tractor rollover injuries in Sweden and another study evaluated regulation to reduce fatal pesticide poisonings in Sri Lanka.

The methodological quality was rated as less than high for all included studies.

The studies provided no evidence that the educational interventions had an injury reducing effect. However, insurance premium discounts as a financial incentive decreased injuries claims in one study. Specific legislative mandates expanding the use of Rollover Protective Structures (ROPS) on tractors were not associated with a reduction of injuries in one study. Legislation to ban Endosulfan pesticides was associated with a reduction in fatal poisonings in the long term in another study.

BACKGROUND

About half of the world's labour force (1.3 billion workers) work in agriculture. The agricultural population is distributed as follows: Asia (76%), Central America and Caribbean (1.3%), Europe (2.2%), Middle East and North Africa (3.8%), North America (0.2%), Oceania (0.2%), South America (2.0%), and Sub-Saharan Africa (14%) (WRI 2006). While the political, economic, climatic, and working conditions vary, agriculture consistently ranks among the most hazardous industries along with mining and construction (Myers 1998).

Agricultural injuries are quite well documented in industrialised countries, but less so in developing countries. An estimated 170,000 farm workers are killed each year and millions more are either seriously injured in workplace accidents or poisoned with pesticides and other agrichemicals. It is likely that under reporting is common and the actual numbers are even higher (ILO 2002).

Available evidence clearly shows that agriculture is a hazardous industry and effective intervention strategies are needed to prevent injuries. Although a wide range of interventions has been developed, their effectiveness is not well understood. A review of 25 farm safety interventions found little evidence that farm safety programs have been effective (DeRoo 2000). While some studies were able to report at least temporary changes in knowledge, attitudes, and behaviours, none showed sustained decrease in injuries or illnesses. Multifaceted programs appeared most successful. Most reports had methodological weaknesses. Some efforts have been made to document the effectiveness of agricultural safety and health programs, but a systematic review is needed to include the most current studies and to keep this information updated.

Description of the intervention

Many different intervention approaches have been developed. One way to categorise them is the "Three E's of Safety": Engineering, Education and Enforcement (Murphy 1992). Haddon's Matrix provides another useful framework for injury investigation and prevention (Haddon 1980). Based on these frameworks we categorised interventions in the following four categories: engineering/technology, education/behaviour change, legislation/enforcement, and multi-faceted interventions using more than one basic approach. Engineering/technology interventions include developing standards for guarding moving machinery parts, improving the design of tools, and replacing hazardous structures with safer ones. Education/behaviour change include voluntary worker training programs (Abend 1998), farm safety day camps for children (Buchan 1993), farm safety fairs (Reed 1994) and community-oriented programs (Hawk 1995). Legislation/enforcement includes implementing new regulations to require Rollover Protective Structures (ROPS) on tractors (Reynolds 2000). Incentive programs do not fit well under these categories, but we include them in the category of education/behaviour change. Examples include offering financial incentives for installing safety devices (Stone 2003), government funding for safety improvements (Lundqvist 1996) and insurance incentives (Rautiainen 2005). Multi-faceted interventions may include combinations of approaches, such as farm inspections with safety courses (Carstensen 1998), best management practice programs (Legault 2000) and multifaceted programs including health evaluation, workplace hazard evaluation and education (Donham 2006).

Why it is important to do this review

There is no single best approach which has yet emerged and therefore all interventions aimed at preventing occupational injuries were included in this review.

OBJECTIVES

To determine the effectiveness of interventions to prevent occupational injuries among workers in the agricultural industry.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) and cluster-randomised controlled trials (cRCTs) irrespective of language of publication.
We expected that the availability of RCTs would be limited due to the infrequency of RCT experiments in the agricultural safety field. Interventions in this field differ from medical clinical interventions in that agricultural interventions are not often implemented at the individual level. For example new equipment or safety engineering controls may be applied at the farm or community level involving multiple workers at the same time. This makes individual randomisation impossible. In principle, this can be overcome by randomisation at the farm or community levels as in a cluster-randomised trial. However, as the level of aggregation increases, the effectiveness of randomisation decreases. For some interventions, randomisation is not feasible. For example, introduction of new regulations that affect an entire jurisdiction are difficult to randomise.
We included the following non-randomised study designs in our review: prospective cohort studies with a concurrent control group

(CCT) and interrupted time series (ITS) studies. Prospective cohort studies are feasible to perform, particularly when the intervention is carried out at the group level, while still providing reasonable validity. We have defined prospective cohort studies as ones in which the study protocol was conceived before the data-collection started and data on the outcome were collected concurrently before and after the intervention at the same moments in time for the intervention and the control group. Injury studies are often based on routinely collected administrative data from insurance or governmental sources which can be used for interrupted time series design. In many cases, the data are collected independently of interventions over longer periods of time which provides reasonable validity. If there were at least three data-points before and three data-points after the intervention we included these study designs as interrupted time series (EPOC 2006).

We based our conclusions only on studies that use one of the study designs described above (RCT, cRCT, CCT, ITS). In the protocol we anticipated that we could also use lower quality intervention studies, including before-after studies without a control group, retrospective cohort studies and case-reference studies. Since we found a reasonable number of studies meeting our primary criteria, and due to the difficulties in comparing results from various studies with different designs we subsequently excluded studies that did not meet RCT, cRTC, CCT or ITS criteria.

Types of participants

This review focused on studies of agricultural industry workers in establishments primarily engaged in growing crops and animal production. We accepted studies where the population could be classified under the International Standard Industry Classification (ISIC) (UNSD 2006) codes A011-A015, which include agricultural workers growing non-perennial crops (such as rice, vegetables, sugar cane), or perennial crops (such as fruits, beverage crops, spices), and animal production (such as cattle, horses, sheep), and mixed farming of crops and animals. If needed, we considered further inclusion criteria by considering the participants work location, work activity or degree of participation in work as described in Table 1. In cases where the intervention was not strictly limited to agricultural workers (such as pesticide regulation at society level), we included studies where the majority of the population would likely meet the inclusion criteria.

Studies were excluded if the (majority of) participants did not work in the agricultural industry according to the exclusion criteria described in Table 1.

Types of interventions

Interventions deliberately applied to decrease the rate or severity of injuries were included. The interventions involved engineering/technology, education/behaviour change (includes incentives), legislation/enforcement, or multifaceted programs. The interventions were administered at the national, regional, organisational, community or individual level.

Types of outcome measures

Primary outcomes

We included trials which measured both fatal and non-fatal occupational injuries. There is some variation in the definitions for occupational injury. We used the following modified definition used in The Injury Chartbook by the World Health Organization (Baker 1984; Peden 2002): Occupational injury is a body lesion at the organic level, resulting from acute exposure to energy in the work environment (mechanical, thermal, electrical, chemical or radiant) in amounts that exceed the threshold of physiological tolerance. In some cases (e.g. drowning, strangulation, freezing), the injury results from an insufficiency of a vital element. We considered all reports of injuries including self-reports. Data sources, such as workers' compensation, have specific definitions, while surveys based on self-report rely on the worker's perception of injury. We included studies where the injury outcome was defined in a way that is reasonably consistent with the WHO definition. Our interpretation of the WHO definition included intentional injuries in the work environment.

We excluded occupational diseases as described by authorities in the jurisdiction where the study was conducted. We also excluded leisure injury and off-farm employment injury. We also excluded studies with only intermediary outcomes such as risk, hazard, adoption of safety changes, awareness, and behaviour.

As an operational definition, we included studies where the primary outcome was "injury", and the definition was in line with the WHO definition. We included subsets of the general injury definition, such as brain injury or agricultural machinery-related injury. We excluded studies where the primary outcome was a musculoskeletal disorder, in which the cause is not due to acute exposure to energy, such as in back pain, cumulative trauma, carpal tunnel syndrome or tendonitis.

Search methods for identification of studies

The searches were not restricted by language or publication status.

Electronic searches

We searched the following electronic databases:

- Cochrane Central Register of Controlled Trials,
- Cochrane Injuries Group's specialised register,
- MEDLINE (1966 to present),
- EMBASE (1988 to present),
- PsychINFO (1983 to present),
- OSH-ROM (including NIOSHTIC and HSELINE).

All databases were searched up to June 2006.
In addition, we looked on the following agriculture-specific databases:

- Agricola,
- Agris,
- ASABE,
- Cinhal,
- NLM Locator Plus,
- Pedro,
- Science Citation Index / Web of Science,

and websites:

- Safetylit,
- Scopus,
- Econlit.

The search strategy is described in Appendix 1.

Data collection and analysis

Selection of studies

The selection of studies was conducted by two authors (ML and RR) independently, applying the inclusion and exclusion criteria. Any disagreement about the inclusion of studies was followed by a discussion until consensus was reached between the two reviewers. In case of disagreement, a third party (LD) decided. Authors (RR) were excluded from evaluating their own studies (ML and ES evaluated the studies by RR). If the title and abstract provided sufficient information to decide that the criteria for selection were not satisfied, the study was excluded. Full articles of the remaining studies were then examined by the two reviewers in order to decide which studies met the selection criteria. We contacted authors directly if it was not clear whether the study met the selection criteria (Pekkarinen 2006). The reasons for exclusion were documented. Applicable articles in languages other than English were reviewed by a native speaker (Russian and Norwegian).

Data extraction and management

Data were extracted independently by two authors (ML and RR). A data extraction form was designed and used to standardise the process. Since there was no disagreement, third author (LD) was not involved in data extraction. If possible, outcomes were recalculated as number of injuries per 100 person-years to enable meta-analysis. Authors (RR) were excluded from extracting data from their own studies (ML and ES extracted data from the studies by RR).
The form was constructed to enable two reviewers to extract the following data from the articles:

1. Study design: RCT, cRCT, CCT or ITS.
2. Participants: number, type of agricultural work, age, gender, ethnicity.
3. Intervention: primary approach of the intervention being engineering/technology, education/behaviour change (including incentives), legislation/enforcement, or multi-faceted approach; intervention is aimed at societal, industry sector, workplace, community, farm family, or individual worker level, content of intervention, intervention in control group.
4. Outcome: primary (and secondary) outcomes, methods used to assess outcome measures, duration of follow-up.
5. Setting: setting in which the intervention was carried out: culture, political system, country, legislative factors, level of mechanisation.

Assessment of risk of bias in included studies

The quality of the included studies was independently assessed by two reviewers (ML and RR). Authors were excluded from assessing their own studies (ML and ES assessed the studies by RR). We used the Downs and Black quality checklist that is capable of assessing both randomised and non-randomised studies (Downs 1998). We used the scale on internal validity from the checklist to rank studies based on their quality. Any disagreement about the quality assessment of studies was followed by a discussion until consensus was reached between the two reviewers. Since there was no persistent disagreement, the third author (LD) was not involved in the quality assessment. For ITS studies we were going to use the quality criteria as developed by the EPOC review group (EPOC 2006). However, during the review process we found an alternative method for calculating comparable and reliable effect sizes for the ITS studies and therefore used the quality criteria as developed by Ramsay (Ramsay 2003) that combines EPOC criteria with the classification of threats to validity identified by Campbell and Stanley (Campbell 1966); eight quality criteria questions answered by DONE, NOT CLEAR or NOT DONE.

Measures of treatment effect

The reported effect measures were extracted from all included studies. The intervention effect for RCTs and cRCTs was calculated as a rate ratio: rate (number of injuries per 100 person-years) in the intervention group divided by the rate in the control group. Effect sizes were combined across studies using natural logarithms of the rate ratios and applying the generic inverse variance method. The standard error of the effect size was calculated as (1/A+1/C), where A is the number of injuries in the intervention group and C is the number of injuries in the control group. These methods are described in the Cochrane Collaboration Handbook (Higgins 2005). The number of annual working hours varies by country and has decreased over time. One person-year is commonly defined as 2000 hours in USA and 1600 hours in Europe (Spangenberg 2002). We used 1600 working hours for injury rate calculations for two European studies (Pekkarinen 1994; Rasmussen 2003). In the Lee 2004 study we calculated the injury rate assuming that each individual contributed one person-year (2000 h) of working time.

In order to obtain comparable and reliable effect size measures from included ITS studies, we extracted data from original papers and reanalysed the data according to recommended methods for ITS designs (Ramsay 2001; Ramsay 2003; Vidanapathirana 2005). These methods utilise a segmented time series regression analysis to estimate the effect of an intervention while taking into account secular time trends and any autocorrelation between individual observations. First order autoregressive time series model was fitted to the data from each study using a modification of the parameterisation (Ramsay 2001). The model was defined as follows:

Y= ß0+ ß1(time)+ ß2 (time-p) I(time > p) + ß3 I(time > p) + E, E~ N(0, s2)

For time = from 1 to T, where p is the time of the start of the intervention, I(time≥p) is a function which takes the value 1 if time is p or later and zero otherwise, and where the errors E are assumed to follow a first order autoregressive process (AR1).

The parameters ß have the following interpretation:

ß1 is the pre-intervention slope.

ß2 is the difference between post and pre-intervention slopes.

ß3 is the change in level at the beginning of the intervention period, meaning that it is the difference between the observed level at the first intervention time point and that predicted by the pre-intervention time trend.

Statistical analyses were performed using Stata 9.2 for Windows (StataCorp LP, College Station, Tx USA).

Observation data over time were extracted from tables of the original studies (Springfeldt 1993a) or directly from authors (Rautiainen 2005; Roberts 2003). Outcomes of these studies were not re-scaled into injuries per 100 person-years, since the studies had different interventions and outcomes, which could not be combined for comparison.

Reanalysis with autoregressive modelling made it possible to estimate regression coefficients corresponding to two standardised effect sizes for each study: i) change in level and ii) change in slope of the regression lines before and after the intervention (Ramsay 2003). The ß parameters in the above regression model were estimated using the Prais-Winstein first order autocorrelation version of generalised least squares (GLS) regression, as implemented in the STATA software package (version 9.2). A change in the level was defined as the difference between the observed level at the first intervention time point and that predicted by the pre-intervention time trend. A change in the slope was defined as the difference between post- and pre-intervention slopes. The change in the level stands for an immediate intervention effect and a change in slope for a sustained effect of the intervention. A negative change in the level or slope represents an intervention effect in terms of a reduction in injuries.

Data were standardised by dividing the outcome and standard error by the pre-intervention standard deviation as recommended by Ramsay 2001 and put into RevMan as effect sizes and standard errors (using the generic inverse variance method).

The Springfeldt study included four different moments in time in which legislation was introduced: 1959 (Springfeldt 1993a), 1965 (Springfeldt 1993b), 1970 (Springfeldt 1993c) and 1981(Springfeldt 1993d). We analysed the data in such a way that the respective time series extended from 1957-1964, 1960-1969, 1966-1975, and 1974-1990.

Unit of analysis issues

The primary unit of analysis was the agricultural worker. In the case of cRCTs where the clustering effect was not taken into account (Pekkarinen 1994) we calculated the 'effective sample size' by dividing the original sample size with the design effect as described in the Cochrane Collaboration Handbook (Higgins 2005). Design effect is 1+(m-1)r, where m is the average cluster size and r is the intracluster correlation coefficient. The calculations of the design effect were based on a fairly large assumed intra-cluster correlation of 0.10. We based this assumption by analogy on studies about implementation research (Campbell 2001).

Lee 2004 had already done tests at the individual and cluster level, and no significant clustering effect was revealed, so design effect calculations were not undertaken for this review.

Dealing with missing data

We requested missing data from authors and received it in all but two cases (Gadomski 2006; Lee 2004).

Data synthesis

Results were pooled for educational intervention studies with similar interventions, participants and outcomes. Those studies with child or adolescent participants were separated from studies with adult participants. For comparing the similarity, we constructed Table 2 which describes the interventions in greater detail. Meta-analysis was performed using the generic inverse variance method. The outcomes were entered into RevMan as effect sizes and their standard errors. To facilitate the interpretation we converted the effect sizes and their confidence intervals back into rate ratios.

Since we could extract data from all studies for meta-analysis, a qualitative synthesis using levels of evidence was not needed.

Studies were considered homogeneous when I^2 was below 50%.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

Results of the search

A total of 8616 references were retrieved and reviewed: 7822 references from the main sources (electronic databases), and 794 references from other sources (topic-related databases and websites). From these references, 122 were selected for detailed review of the journal articles. The reference lists of these selected articles were also checked and 10 new references were identified for a total of 132 references.

Included studies

The detailed reading resulted in a total of 8 included studies in this review: 3 RCT (Gadomski 2006; Rasmussen 2003; Rautiainen 2004), 2 cRCT (Lee 2004; Pekkarinen 1994) and 3 ITS studies (Rautiainen 2005; Roberts 2003; Springfeldt 1993a). From the 132 studies selected for the detailed review, 7 could not be retrieved after intensive searching. After rechecking these missing titles it did not appear that we missed any important studies.

Three of the above mentioned studies were from the USA (Gadomski 2006; Lee 2004; Rautiainen 2004), two from Finland (Pekkarinen 1994; Rautiainen 2005), one from Denmark (Rasmussen 2003), one from Sweden (Springfeldt 1993a) and one from Sri Lanka (Roberts 2003). All studies were published between 1993 and 2006 and the interventions were carried out during 1959-2003.

Two of the studies (Gadomski 2006; Lee 2004) looked at injury prevention among children or adolescents. The rest were dealing with injury prevention among adults and one (Pekkarinen 1994) had only male reindeer herders as study participants.

All RCTs included a combination of educational interventions (primary approach of the interventions being education/behaviour change, including incentives). These studies are summarised in Table 2, which has four intervention subcategories:

1. Occupational health and safety (OHS) professionals involved in the intervention, e.g. farm safety checks, health checks or safety courses;
2. Non-OHS professionals, including other participants, involved in the intervention, e.g. farm visits or group discussions;
3. Written information, e.g. booklets, guides, mailings, written reports, booster interventions;
4. Financial incentives, e.g. travel expenses reimbursed or money paid to a participating farm.

One study (Lee 2004) combined all four above mentioned elements; (1) interactive training, contact with community nurse, (2) national conventions, phone contact, local agribusinesses, (3) instruction guides, "Treasure chest", quarterly mailings, free Personal Protective Equipment (PPE), (4) training travel reimbursement and money for community nurse involvement.

Two studies (Rasmussen 2003; Rautiainen 2004) combined three of the elements. Rasmussen 2003 combined (1) farm safety checks, safety course, (2) group discussion, presentation by a seriously injured farmer and (3) written reports of the farm safety checks and material to those not able to participate in the course. Rautiainen 2004 used (1) annual health screenings, on-farm safety reviews, informational meetings, (2) other farmers participating in informational meetings and (4) paid money each year to participating farm.

One study (Gadomski 2006) combined two of the elements; (2) farm safety visit by a lay educator and (3) booklets and booster interventions.

Two studies (Lee 2004; Pekkarinen 1994) had two intervention groups and a control group. Lee 2004 used quite similar intervention elements for both intervention groups (standard and enhanced group). Pekkarinen 1994 used (1) medical health examinations performed by occupational health personnel for one intervention group and (2 & 3) leaders of districts receiving letters for the other intervention group.

One ITS study (Rautiainen 2005) was based solely on incentives (education/behaviour), studying how insurance discounts affect injury claims. Another study (Roberts 2003) evaluated pesticide regulations (legislation/enforcement) to determine whether Endosulfan ban decreased fatal poisonings. Springfeldt 1993a evaluated the effect of regulations requiring safety devices (technical measures) on tractors. This study included four regulation interventions regarding rollover protection structures (ROPS) in Sweden: interventions in 1959 (Springfeldt 1993a) and 1970 (Springfeldt 1993c) were requirements concerning ROPS and safety cabs in new tractors respectively and interventions in 1965 (Springfeldt 1993b) and 1983 (Springfeldt 1993d) were requirements concerning ROPS and safety cabs in tractors used for occupational work respectively.

Roberts 2003 addressed pesticide poisonings in a developing country. It was not possible to determine from the paper what proportions of the poisoning deaths were unintentional and work-related. We based our assessment on data that were gathered from a district that is known to be primarily inhabited by farmers. Farmers commonly have access to pesticides and their risk of (potentially work-related) suicide by pesticide ingestion may be greater than the risk in non-agricultural populations. This study was included, since the injury criteria were fulfilled and there were no restrictions in our protocol concerning "work-related suicide".

Excluded studies

Most excluded studies were excluded because they did not have the required study design. Studies meeting all criteria except having injury as an outcome are listed in the table entitled "Characteristics of excluded studies", a total of 13 articles. These were studies from which it appeared only after reading the full text that they did not meet the outcome criteria of measuring injuries.

One study (Pekkarinen 2006) met all the criteria, except those relating to the intervention. The aim of the intervention, which resulted as a consequence of Finland joining European Union, was to improve hygiene regulations by requiring the use of slaughter houses if the meat was going to be marketed commercially. This indirectly had an additional effect on injuries, but the aim of the regulation change was to protect the consumer, not the worker.

The results of Springfeldt 1993a were also published by Springfeldt 1998 and Thorson 1999. We took the results from Springfeldt 1993a. The results of Rasmussen 2003 have also been reported in an article by Carstensen 2001. We used Rasmussen 2003 as the original article.

Risk of bias in included studies

None of the studies attempted to blind study subjects, which is difficult to accomplish in these types of studies. Nonetheless the absence of blinding is a potential source of bias. Only one study (Gadomski 2006) reported blinding those who measured the outcome. Other issues decreasing internal validity scores included no compliance, randomisation was unclear (all studies belong to category B of the Cochrane's allocation concealment criteria) and no adequate adjustment for confounding.

The maximum internal validity score of the RCTs was 8 out of 13 points (Gadomski 2006; Rasmussen 2003; Rautiainen 2004) and the minimum score 5 out of 13 points (Lee 2004; Pekkarinen 1994). The highest score for external validity was 2 out of 3 points (Gadomski 2006; Pekkarinen 1994) and the lowest 1 out of 3 points (Lee 2004; Rasmussen 2003; Rautiainen 2004). For the reporting quality, two studies (Gadomski 2006; Rasmussen 2003) had the high score of 9 out of 10 points, other two studies (Lee 2004; Pekkarinen 1994) 8 out of 10 points and one study (Rautiainen 2004) had 7 out of maximum 10 points. The scoring results are presented in Table 3.

The quality of the three ITS studies were rated as follows: Rautiainen 2005 received 5 out of maximum 8 points (63%) and the other two studies (Roberts 2003; Springfeldt 1993a) received only 3 points (38%) out of the maximum. The most common problems were: the authors did not use appropriate time series techniques for analysis, no reasons were given for the number of data points or their spacing, and the shape of the intervention effect was not pre-specified.

Effects of interventions

Effectiveness of educational interventions on injuries

Randomised controlled trials

Two RCT studies (Lee 2004; Pekkarinen 1994) had two intervention groups and a control group. Only one of the interventions groups was selected for the meta-analysis. We chose the more extensive intervention for the analysis: enhanced intervention group for the Lee 2004 study and medical examinations for the Pekkarinen 1994 study.

In these RCTs there was no evidence that educational interventions had an injury-reducing effect.

Meta-analysis of three RCT studies (Pekkarinen 1994; Rasmussen 2003; Rautiainen 2004) aiming to reduce injuries among adults showed no evidence for an effect on injuries (effect size 0.02, 95% CI -0.14 to 0.18; converted rate ratio 1.02, 95% CI 0.87 to 1.20). The narrow 95% confidence interval indicates that a more positive or more negative outcome is not very likely for these kinds of educational interventions. Studies were also statistically homogeneous, so they could be combined for meta-analysis (I^2 0%).

The two RCTs (Lee 2004; Gadomski 2006) aiming to reduce injuries among children/adolescents did not show a significant effect size either. However, they were very heterogeneous (I^2 91.8%) due to the fact that one study had a significant effect in favour of the control group. No potential reasons for this were offered by the authors of the original article. The following result was obtained when we converted the effect size back to rate ratio: 1.27 (95% CI 0.51 to 3.16).

Interrupted time series studies

In one ITS study (Rautiainen 2005) there was evidence that incentives have an immediate injury-reducing effect. This study based solely on incentives (insurance premium discount program) had a significant immediate effect decreasing the number of injuries (effect size -2.68, 95% CI -3.80 to -1.56). After the intervention, there was no further decrease - no significant progressive effect (effect size -0.22, 95% CI -0.47 to 0.03). See Table 4.

Effectiveness of legislative interventions on injuries

Legislation banning Endosulfan pesticide

In one ITS study (Roberts 2003) there was evidence that an Endosulfan ban had a progressive effect of reducing injuries (poisoning deaths). This study had an increasing injury rate over time as indicated by the positive pre-intervention slope (Table 4). The immediate effect was also significantly positive, meaning that the number of injuries still increased right after the intervention (effect size 2.20, 95% CI 0.97 to 3.43). However, there was a significant progressive effect of reducing the number of injuries (effect size -2.15, 95% CI -2.64 to -1.66).

Legislation requiring technical measures on tractors

We pooled the effect sizes of the introduction of legislation in the ITS study of Springfeldt 1993a. To prevent including the same data twice in the meta-analysis, we combined the introduction of legislation requiring ROPS for new tractors in 1959 (Springfeldt

1993a) and requiring safety cabins for new tractors in 1970 (Springfeldt 1993c) on the one hand and for ROPS on all tractors in 1965 (Springfeldt 1993b) and for cabins on all tractors in 1981(Springfeldt 1993d) on the other hand. To be able to do so, we had to accept that there were only 2 measurement points before the first intervention in 1959.

Technical measures in new tractors

In the meta-analysis of the Springfeldt 1993a and Springfeldt 1993c studies, the introduction of legislation requiring ROPS or Safety Cabins on new tractors had a significant immediate and progressive effect of increasing all injuries. However, there was a non-significant immediate and a significant progressive effect of reducing fatal injuries with respective effect sizes of -0.90 (95% CI -3.38 to 1.58) and -0.93 (95% CI -1.82 to -0.03).

Technical measures for all tractors

In the meta-analysis of the Springfeldt 1993b and Springfeldt 1993d studies, the introduction of legislation requiring ROPS or Safety Cabins on all tractors did not have a significant immediate effect of reducing injuries. Furthermore, the trend in time showed an increase both for all (effect size 0.21, 95% CI: 0.00 to 0.41) and for fatal injuries (effect sizes 0.33, 95% CI 0.15 to 0.50).

DISCUSSION

Summary of main results

We found no evidence to suggest that educational interventions had an injury-reducing effect. In one study the introduction of insurance discounts reduced the level but not the trend of injuries. In another study a legislative ban of Endosulfan improved the trend of pesticide poisonings but was not associated with a change in poisonings in the short term. In yet another study, legally mandatory technical improvements on tractors showed only one favourable outcome out of a total of 16 outcomes of injury reduction.

Overall completeness and applicability of evidence

We had expected to find three main categories of interventions: technical or engineering interventions, educational or behavioural interventions and legislative or enforcement related interventions. We found interventions in all three categories but most in the educational and legislative domain.

We did not find any interventions in which engineering interventions were evaluated as such. This might be due to the technical nature of the interventions. In such cases it is easily assumed that interventions do work, for example technical measures to reduce noise levels or introducing safety belts in cars. The improvement in the design of machines, environment, and systems has been proposed as being preferable to attempts to change people's safety attitudes or behaviour (Heidt 1984). However, it can still be difficult to get these technical measures implemented. Therefore, evaluation of the implementation of such technical interventions is needed.

For educational interventions we found a wide array of implementation strategies involving training by occupational health and safety professionals and peers (farmers and family members) and more or less extensive information packages.

Legislation was evaluated using an ITS design for two particular issues: technical requirements for tractors, and a ban of the pesticide Endosulfan. Many other safety topics in agriculture such as pesticide distribution and use, worker health and safety training, and safety for agricultural equipment (such as power take-off guards) have been regulated by law (Cordes 1991). It would be informative to have evaluations from these measures as well. The ITS design, though not very powerful and liable to biases, seems to best fit these types of questions. In many cases ITSs and administrative data are presented without statistical analyses where the authors conclude only by visual observation whether there is an impact of the intervention. In addition, there is almost always an overall downward trend of injury-rates which makes it difficult to ascribe changes over time to the intervention. Therefore, we think it is necessary to reanalyse ITS studies using a standard approach of calculating changes in level and changes in trend, taking into account the auto-correlation of the data. It also remains difficult to consider the introduction of legislation as an interruption of the time-series at one distinct point in time. Before the introduction, there will be societal debate and pressure to comply with the legal requirements and after the introduction it will depend on the enforcement of implementation. This kind of information is often lacking in ITS studies.

Ninety percent of the farming population lives in Asia and Sub-Saharan Africa. However, all but one of the studies we found were based on data from industrialised countries (Roberts 2003). The evidence on interventions that we found is probably not applicable in developing countries as the setting is so different (in particular the level of mechanisation).

Educational interventions

The educational interventions in the included studies would be expected to show at least some effect as they were comprised of various combinations of different elements and engaged study subjects in different ways. However, the effect sizes were small and not statistically significant. As a result of the meta-analysis the 95% confidence interval around the effect size was rather narrow and this makes a bigger or smaller effect size very unlikely. Only the study that included financial incentives showed an effect on injury

rates (Rautiainen 2005). This was, however, based on a weak time-series design and it is possible that farmers underreported injuries due to the financial incentives.
Our negative findings are consistent with other studies on the impact of educational interventions alone on injury outcomes among other populations (Duperrex 2007). Apparently educational interventions are not strong enough to bring about change, unless combined with other behavioural incentives such as financial benefit or legislative requirements. It is also possible that the effectiveness of educational interventions is dependent on contextual factors such as the financial or organisational state of the farm (Suutarinen 2004). Furthermore, educational intervention trials may suffer from biases favouring control due to non-blinded design, leaking of intervention into the control group and better awareness and willingness to report outcomes among intervention subjects.

Pesticides ban

Pesticides constitute a serious health hazard to farmers especially in developing countries. From our review, it becomes clear that measures to decrease these risks have been seldom evaluated. The included time series showed some evidence that banning of a pesticide does not lead to illegal and more dangerous use but that it can have a favourable effect on poisoning fatalities.

Legislation requiring technical measures

The Swedish study on ROPS (Springfeldt 1993a) is frequently cited as strong evidence of the effectiveness of ROPS (Reynolds 2000). The effect on the time series of injury rates appears clear as legislation has been implemented in several cases, the percentage of tractors with ROPS has increased and the number of injuries and fatalities has decreased. However the changes in the level and trend of the injury rate and the rate of fatalities following four specific legislative measures were contradictory with some increasing and some decreasing. One explanation could be that there is no interruptive effect of legislation but only a gradual effect. By the end of the study period nearly 100% of tractors had ROPS.
It is interesting to note that the fatalities reduced to near zero quite early, much before the ROPS percentage reached full compliance. The Springfeldt 1993a study provides annual proportions of tractors equipped with ROPS. This proportion shows a gradual steady increase, which indicates that the enforcement of the legislation may not have been immediate, but gradual over time.
Another limitation of the study is that there were only two time points before the first ROPS legislation came into force in 1959 making it difficult to evaluate the data. Yet this initial legislation may have been the most important, having resulted in the steady increase in the percentage of tractors with ROPS (simultaneously decreasing injury rates), particularly in the early years of the observation period.

Quality of the evidence

It is important to note that at least some of the included studies used a randomised controlled study design. It is often argued that this is difficult or impossible to apply in occupational health settings but apparently it is less difficult than thought. However, it remains difficult to perform high quality studies as blinding of participants and of providers is virtually impossible in educational interventions. None of the included studies scored more than 70% of the possible score on the quality checklists. However, compared to the quality of evidence included in previous reviews, there is notable improvement in the quality of studies being produced (DeRoo 2000).

Potential biases in the review process

We did a very sensitive search and tracked all possible references from other studies. In addition, we searched topic-related databases and websites for grey literature. We therefore feel confident that we have found all possible studies that met our inclusion criteria.
We succeeded well in excluding language bias from our review as we had all the foreign language abstracts read and interpreted by persons with appropriate language skills.
Since we had a mixture of positive and negative results we assume that publication bias has not influenced the results of this review.

Agreements and disagreements with other studies or reviews

Several other reviews have summarised the effectiveness of interventions to prevent childhood farm injuries (Hartling 2004; Reed 2000). One did not draw any conclusions due to the lack of methodological rigor of the included studies (Reed 2000). The other review concluded that educational programmes increased knowledge but that the effect on injury rates was unknown. Since then two RCTs became available which were both included in our review.
There are also two reviews on general farm safety interventions (DeRoo 2000; McCurdy 2000). Both used less strict inclusion criteria regarding study design and outcome than we did. Both concluded that the available evidence is not of high enough quality to draw general conclusions. Since then several RCTs and ITS studies have become available which are included in this review.
There is one specific review on educational interventions in agricultural safety settings that concludes that there is no evidence available on educational interventions in agriculture (Murphy 1996). Our review fills this knowledge gap.
Another review on interventions to reduce pesticide poisoning concluded that exposure had been reduced but that there was a lack of evidence whether concomitant poisonings had decreased (Keifer 2000). Most studies had evaluated the use of personal

protective equipment under laboratory conditions and not under real working conditions. Our review adds one study that evaluated legislation and no studies that evaluated other measures under field conditions.

In general, it can be concluded that this review addresses many of the previously identified gaps in knowledge in this area. This is because the quality and number of studies in the research area have increased considerably in the past ten years.

AUTHORS' CONCLUSIONS

Implications for practice

This review did not find evidence supporting the widespread use of educational interventions alone. The widespread use of educational interventions alone can therefore be questioned. However, this is not to indicate that there is not a place for an educational component within a multi-factorial intervention. The use of financial incentives could be effective but should be studied better before more extensive implementation can be recommended. The banning of Endosulfan lowered the rate of fatal pesticide poisonings in one study and should be considered for other countries as well.

Implications for research

RCTs are possible and feasible both at the individual and the farm level. More of these studies are needed for evaluating behavioural interventions and interventions to enhance the implementation of technical interventions. ITS studies using administrative databases are feasible for studying the effects of interventions, particularly those at the society level (including legislation changes). For better understanding the impact of legislation on time series of injury rates, studies are needed on the development and implementation process of safety legislation.

ACKNOWLEDGEMENTS

The source for external support was the Commonwealth of Australia as represented by and acting through the Department of Employment and Workplace Relations (DEWR). The Office of the Australian Safety and Compensation Council (Office of the ASCC) was the direct supporter. The Office of the ASCC resides within the Department and provides policy advice on a range of issues including national OHS and workers compensation matters and standards review, development and implementation. The Office also coordinates DEWR's international role in OHS and workers compensation through intergovernmental agencies such as the OECD and ILO. The Office supports the work of the ASCC and is a recognised source of national research and statistical information relating to OHS and workers compensation.

Merja Jauhiainen, information specialist at the Institute of Occupational Health, Kuopio, Finland, provided expertise and assistance in the development of search criteria. Review Group Coordinator Katharine Ker provided expertise on the development of injury definitions. Trial Search Coordinator Karen Blackhall assisted with the development of search strategy. Doctors Vasiliy V. Vlassov and Arve Lie provided help in assessing the eligibility of the foreign language articles. Dr C.R. Ramsay kindly helped with the assessment of the interrupted time series studies.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Gadomski 2006

Methods	RCT.
Participants	Farm families; 462 Intervention farms and 469 Control farms.
Interventions	1) NAGCAT guideline implementation and booster interventions issued in 2001 in USA. 2) Control group no intervention. Form: education/behaviour (incentives).
Outcomes	Primary: injuries of children per 100 FTEs. Secondary: NAGCAT-related and NAGCAT-preventable injuries, violations of NAGCAT age guidelines (adoption of safety change, behaviour)
Notes	Injury definition: Any condition occurring on the farm that resulted in at least 4 hours of restricted activity or required professional medical treatment

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Lee 2004

Methods	cRCT.
Participants	Students in 123 FFA chapters; 41 chapters in each, Standard, Enhanced, and Control group
Interventions	1) Partners Program implemented in 1998-2000 in USA: training of FFA advisors and student team members, learning material, conventions, news. 2) Second enhanced intervention group: in addition to point 1 this group got more mailings, phone contact with program facilitator, contact opportunity with local public health office with $300 incentive, free PPE supplies. 3) Control group no intervention, except the same national program marketing material as other groups Form: education/behaviour (incentives).
Outcomes	Primary: accidents. Secondary: safety knowledge (awareness).
Notes	Injury definition: Not reported.

Risk of bias

Item	Authors' judgement	Description

Allocation concealment?	Unclear	B - Unclear

Pekkarinen 1994

Methods	cRCT.
Participants	Reindeer herders in 53 herding districts, total n=3324 men; Intervention A had 18 districts n=1157, Intervention B had 17 districts n=1065, Control group had 18 districts n=1102
Interventions	1) Information dissemination by theme letters in 1986 in norhern Finland. 2) Information dissemination during medical examinations conducted in 1986. 3) Control group no intervention, had access to information about the study in the press. Form: education/behaviour (incentives).
Outcomes	Primary: accidents per 1000 working days. Secondary: number of applied preventive measures (adoption of safety change)
Notes	Injury definition: Not clearly reported. Injuries defined broadly as "all accidents", which includes also minor injuries

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Rasmussen 2003

Methods	RCT.
Participants	Farm/worker/farm family; 208 farms, 104 farms in each, Intervention and Control group
Interventions	1) Safety checks in farms, 1-day course issued between Nov 1995 - July 1997 in Denmark. 2) Control group no intervention. Form: education/behaviour (incentives).
Outcomes	Primary: (all) Injuries per 100.000 workhours (risk time adjusted for seasonal variation) Secondary: (all) Injuries per 100.000 work hours (no adjustment), medically treated injuries per 100.000 workhours (seasonal variation adjusted and non-adjusted risk time), time at risk, safety scores (adoption of safety change), PPE use (behaviour)
Notes	Injury definition: A sudden, unintended incident that occurs during the performance or supervision of farm work, and results in personal injury. Those injuries recorded that received professional treatment and accidents resulting in an injury requiring a break from work of less than or, respectively, more than 10 minutes. Minor scrapes and bruises not recorded

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Rautiainen 2004

Methods	RCT.
Participants	Farm/worker/farm family; 169 Intervention farms, 187 Control farms
Interventions	1) Certified Safe Farm program implemented in 1999-2003 in the USA; health screenings, on-farm safety reviews, educational element and incentive of $200 each year. 2) Control group no intervention, but received $75 compensation payment Form: education/behaviour (incentives).
Outcomes	Primary: all injuries per 100 person-years. Secondary: injuries with at least one day disability per 100 person-years, injuries with at least 1 visit for professional care per 100 person- years, injuries requiring hospital care per 100 person-years, injuries resulting in at least $100 costs per 100 person-years, injuries where some costs were covered by insurance per 100 person-years, injury characteristics, costs
Notes	Injury definition: An event that is sudden, unexpected, unintentional, has an external cause, occurs during farm work, and results in bodily harm and some loss of work time, loss of consciousness, or considerable pain or discomfort 85% minimum safety score was required for becoming certified, but lower scoring intervention farms were also included in the analysis

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Rautiainen 2005

Methods	ITS; based on 6 years before and 6 years after intervention.
Participants	Finnish farmers belonging to mandatory MATA insurance system; 224.280 persons in 1990, 109.997 persons in 2003
Interventions	1) Insurance premium discount program issued in July 1997 in Finland; 10% reduction in MATA costs in each claim-free year up to 50% after 5 claim-free years. 2) No control group. Form: education/behaviour (incentives).

Rautiainen 2005 (*Continued)*

Outcomes	Primary: injury insurance claims: injury rate per 10.000 insured persons Secondary: injury claims stratified by disability duration in 7 categories
Notes	Injury definition (MATA): A sudden unexpected forceful event with external cause, which results in bodily damage or an ailment, and which occurs in the course of agricultural work. Occupational diseases and back injuries excluded

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Roberts 2003

Methods	ITS, based on 7 years before and 3 years after intervention.
Participants	Farmers/Society in Anuradhapura district.
Interventions	1) Endosulfan banned in 1998 in Sri Lanka. 2) No control group. Form: legislation/enforcement.
Outcomes	Primary: fatal Endosulfan poisonings. Secondary: hospital admissions related to poisonings, case fatality proportions
Notes	The article did not report whether the poisonings were intentional or unintentional and work-related or non-work related

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Springfeldt 1993a

Methods	ITS*, based on data from 1957 to 1964.
Participants	All farms/workers with tractors.
Interventions	1) ROPS required on new tractors in 1959 in Sweden. 2) No control group. Form: legislation/enforcement.

Outcomes	Primary: annual total rollover injuries per 100.000 farm tractors Secondary: annual fatal rollover injuries per 100.000 farm tractors, annual total and fatal rollover injuries per farm tractors or all tractors, annual total and fatal rollover injuries per 100.000 tractors, annual rollover injuries per 100 million driving hours	
Notes	Injury definition: Not clearly reported (Fatal tractor overturn injury; Non-fatal tractor overturn injury) The number of farmers decreased by 65% between 1951 and 1981	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

Springfeldt 1993b

Methods	ITS*, based on data from 1960 to 1969.	
Participants	All farms/workers with tractors.	
Interventions	1) ROPS required for employee-operated tractors, issued in 1965 in Sweden. 2) No control group. Form: legislation/enforcement.	
Outcomes	Primary: annual total rollover injuries per 100.000 farm tractors Secondary: annual fatal rollover injuries per 100.000 farm tractors, annual total and fatal rollover injuries per farm tractors or all tractors, annual total and fatal rollover injuries per 100.000 tractors, annual rollover injuries per 100 million driving hours	
Notes	Injury definition: Not clearly reported (Fatal tractor overturn injury; Non-fatal tractor overturn injury) The number of farmers decreased by 65% between 1951 and 1981	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

Springfeldt 1993c

Methods	ITS*, based on data from 1966 to 1982.
Participants	All farms/workers with tractors.
Interventions	1) Safety cab required on all new tractors sold since 1970 in Sweden. 2) No control group.

Springfeldt 1993c (*Continued)*

	Form: legislation/enforcement.	
Outcomes	Primary: annual total rollover injuries per 100.000 farm tractors Secondary: annual fatal rollover injuries per 100.000 farm tractors, annual total and fatal rollover injuries per farm tractors or all tractors, annual total and fatal rollover injuries per 100.000 tractors, annual rollover injuries per 100 million driving hours	
Notes	Injury definition: Not clearly reported (Fatal tractor overturn injury; Non-fatal tractor overturn injury)	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

Springfeldt 1993d

Methods	ITS*, based on data from 1974 to 1990.	
Participants	All farms/workers with tractors.	
Interventions	1) Safety cab on all tractors used for occupational work, issued in 1983 in Sweden. 2) No control group. Form: legislation/enforcement.	
Outcomes	Primary: annual total rollover injuries per 100.000 farm tractors Secondary: annual fatal rollover injuries per 100.000 farm tractors, annual total and fatal rollover injuries per farm tractors or all tractors, annual total and fatal rollover injuries per 100.000 tractors, annual rollover injuries per 100 million driving hours	
Notes	Injury definition: Not clearly reported (Fatal tractor overturn injury; Non-fatal tractor overturn injury)	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

*Different parts of the same ITS study used for different interventions.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Cole 2002	No injury outcome.
Forst 2004	No injury outcome.
Glasscock 1997	No injury outcome.
Hawk 1995	No injury outcome.
Jansson 1988	No injury outcome. Also participants were farmer-loggers.
Landsittel 2001	No injury outcome.
Legault 2000	No injury outcome.
Marlenga 2002	No injury outcome.
Myers 2004	No injury outcome.
Myers 2005	No injury outcome.
Pekkarinen 2006	Injury reduction not the primary aim of the intervention. Intervention (Finland joining EU) changed hygiene regulations in meat processing (slaughtering in inspected slaughter houses only) and resulted in indirect changes in reindeer herders' working conditions
Reinhart 1997	No injury outcome.
Stave 2007	No injury outcome.

DATA AND ANALYSES

Comparison 1. Educational intervention versus no intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 All injuries adults	3		Effect Size (Fixed, 95% CI)	0.02 [-0.14, 0.18]
2 All injuries children and adolescents	2		Effect Size (Random, 95% CI)	0.24 [-0.67, 1.15]

Comparison 2. Insurance incentive versus no intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Level of injury claims	1		Effect Size (Fixed, 95% CI)	Totals not selected
2 Slope of injury claims	1		Effect Size (Fixed, 95% CI)	Totals not selected

Comparison 3. Pesticide ban versus no intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Level of poisoning deaths	1		Effect Size (Fixed, 95% CI)	Totals not selected
2 Slope of poisoning deaths	1		Effect Size (Fixed, 95% CI)	Totals not selected

Comparison 4. Technical measures in all tractors versus no intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Level of injury rates	2		Effect Size (Fixed, 95% CI)	Subtotals only
1.1 Injuries per 100.000 tractors	2		Effect Size (Fixed, 95% CI)	0.06 [-0.89, 1.01]
1.2 Fatal injuries per 100.000 tractors	2		Effect Size (Fixed, 95% CI)	0.58 [-0.14, 1.30]
2 Slope of injury rates	2		Effect Size (Fixed, 95% CI)	Subtotals only
2.1 Injuries per 100.000 tractors	2		Effect Size (Fixed, 95% CI)	0.21 [0.00, 0.41]
2.2 Fatal injuries per 100.000 tractors	2		Effect Size (Fixed, 95% CI)	0.33 [0.15, 0.50]

Comparison 5. Technical measures in new tractors versus no intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Level of injury rates	2		Effect Size (Fixed, 95% CI)	Subtotals only
1.1 Injuries per 100.000 tractors	2		Effect Size (Fixed, 95% CI)	0.96 [0.23, 1.69]
1.2 Fatal injuries per 100.000 tractors	2		Effect Size (Fixed, 95% CI)	-0.90 [-3.38, 1.58]
2 Slope of injury rate	2		Effect Size (Fixed, 95% CI)	Subtotals only
2.1 Injuries per 100.000 tractors	2		Effect Size (Fixed, 95% CI)	0.57 [0.32, 0.82]
2.2 Fatal injuries per 100.000 tractors	2		Effect Size (Fixed, 95% CI)	-0.93 [-1.82, -0.03]

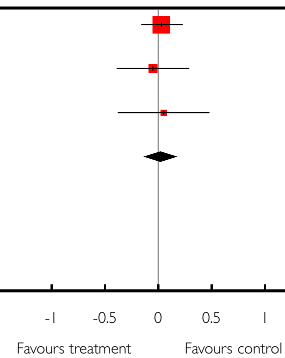
Analysis 1.1. Comparison 1 Educational intervention versus no intervention, Outcome 1 All injuries adults.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 1 Educational intervention versus no intervention

Outcome: 1 All injuries adults

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Weight	Effect Size IV,Fixed,95% CI
Pekkarinen 1994	0.0337 (0.0997)		65.2 %	0.03 [-0.16, 0.23]
Rasmussen 2003	-0.0488 (0.1747)		21.2 %	-0.05 [-0.39, 0.29]
Rautiainen 2004	0.0476 (0.2183)		13.6 %	0.05 [-0.38, 0.48]
Total (95% CI)			**100.0 %**	**0.02 [-0.14, 0.18]**



Heterogeneity: Chi^2 = 0.19, df = 2 (P = 0.91); I^2 =0.0%

Test for overall effect: Z = 0.22 (P = 0.82)

Test for subgroup differences: Not applicable

Analysis 1.2. Comparison 1 Educational intervention versus no intervention, Outcome 2 All injuries children and adolescents.

Review: Interventions for preventing injuries in the agricultural industry

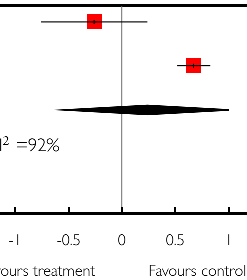
Comparison: 1 Educational intervention versus no intervention

Outcome: 2 All injuries children and adolescents

Study or subgroup	Effect Size (SE)	Effect Size IV,Random,95% CI	Weight	Effect Size IV,Random,95% CI
Gadomski 2006	-0.2578 (0.254)		46.6 %	-0.26 [-0.76, 0.24]
Lee 2004	0.6732 (0.0793)		53.4 %	0.67 [0.52, 0.83]
Total (95% CI)			**100.0 %**	**0.24 [-0.67, 1.15]**

Heterogeneity: $Tau^2 = 0.40$; $Chi^2 = 12.24$, df = 1 (P = 0.00047); $I^2 = 92\%$

Test for overall effect: Z = 0.51 (P = 0.61)



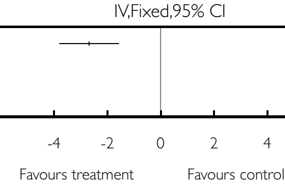
Analysis 2.1. Comparison 2 Insurance incentive versus no intervention, Outcome 1 Level of injury claims.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 2 Insurance incentive versus no intervention

Outcome: 1 Level of injury claims

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Effect Size IV,Fixed,95% CI
Rautiainen 2005	-2.68 (0.57)		-2.68 [-3.80, -1.56]



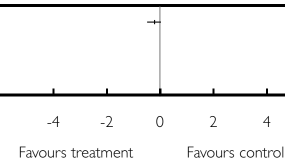
Analysis 2.2. Comparison 2 Insurance incentive versus no intervention, Outcome 2 Slope of injury claims.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 2 Insurance incentive versus no intervention

Outcome: 2 Slope of injury claims

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Effect Size IV,Fixed,95% CI
Rautiainen 2005	-0.22 (0.13)		-0.22 [-0.47, 0.03]



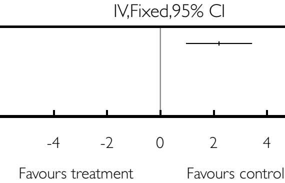
Analysis 3.1. Comparison 3 Pesticide ban versus no intervention, Outcome 1 Level of poisoning deaths.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 3 Pesticide ban versus no intervention

Outcome: 1 Level of poisoning deaths

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Effect Size IV,Fixed,95% CI
Roberts 2003	2.2 (0.63)		2.20 [0.97, 3.43]



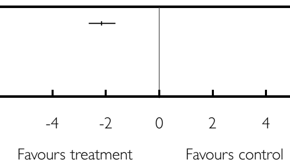
Analysis 3.2. Comparison 3 Pesticide ban versus no intervention, Outcome 2 Slope of poisoning deaths.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 3 Pesticide ban versus no intervention

Outcome: 2 Slope of poisoning deaths

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Effect Size IV,Fixed,95% CI
Roberts 2003	-2.15 (0.25)		-2.15 [-2.64, -1.66]



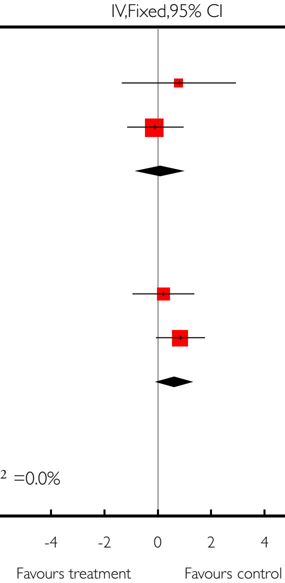
Analysis 4.1. Comparison 4 Technical measures in all tractors versus no intervention, Outcome 1 Level of injury rates.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 4 Technical measures in all tractors versus no intervention

Outcome: 1 Level of injury rates

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Weight	Effect Size IV,Fixed,95% CI
1 Injuries per 100.000 tractors				
Springfeldt 1993b	0.78 (1.09)		19.7 %	0.78 [-1.36, 2.92]
Springfeldt 1993d	-0.12 (0.54)		80.3 %	-0.12 [-1.18, 0.94]
Subtotal (95% CI)			**100.0 %**	**0.06 [-0.89, 1.01]**
Heterogeneity: Chi^2 = 0.55, df = 1 (P = 0.46); I^2 =0.0%				
Test for overall effect: Z = 0.12 (P = 0.91)				
2 Fatal injuries per 100.000 tractors				
Springfeldt 1993b	0.2 (0.59)		38.8 %	0.20 [-0.96, 1.36]
Springfeldt 1993d	0.82 (0.47)		61.2 %	0.82 [-0.10, 1.74]
Subtotal (95% CI)			**100.0 %**	**0.58 [-0.14, 1.30]**
Heterogeneity: Chi^2 = 0.68, df = 1 (P = 0.41); I^2 =0.0%				
Test for overall effect: Z = 1.58 (P = 0.12)				
Test for subgroup differences: Chi^2 = 0.74, df = 1 (P = 0.39), I^2 =0.0%				



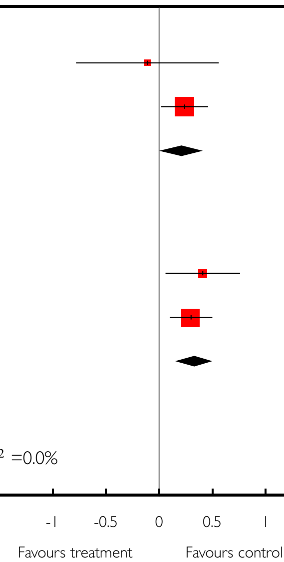
Analysis 4.2. Comparison 4 Technical measures in all tractors versus no intervention, Outcome 2 Slope of injury rates.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 4 Technical measures in all tractors versus no intervention

Outcome: 2 Slope of injury rates

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Weight	Effect Size IV,Fixed,95% CI
1 Injuries per 100.000 tractors				
Springfeldt 1993b	-0.11 (0.34)		9.5 %	-0.11 [-0.78, 0.56]
Springfeldt 1993d	0.24 (0.11)		90.5 %	0.24 [0.02, 0.46]
Subtotal (95% CI)			**100.0 %**	**0.21 [0.00, 0.41]**
Heterogeneity: $Chi^2 = 0.96$, df = 1 (P = 0.33); I^2 =0.0%				
Test for overall effect: Z = 1.98 (P = 0.048)				
2 Fatal injuries per 100.000 tractors				
Springfeldt 1993b	0.41 (0.18)		23.6 %	0.41 [0.06, 0.76]
Springfeldt 1993d	0.3 (0.1)		76.4 %	0.30 [0.10, 0.50]
Subtotal (95% CI)			**100.0 %**	**0.33 [0.15, 0.50]**
Heterogeneity: $Chi^2 = 0.29$, df = 1 (P = 0.59); I^2 =0.0%				
Test for overall effect: Z = 3.73 (P = 0.00019)				
Test for subgroup differences: $Chi^2 = 0.76$, df = 1 (P = 0.38), I^2 =0.0%				



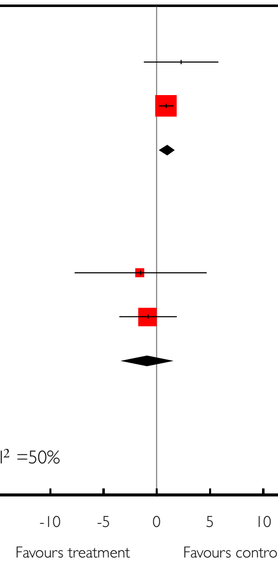
Analysis 5.1. Comparison 5 Technical measures in new tractors versus no intervention, Outcome 1 Level of injury rates.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 5 Technical measures in new tractors versus no intervention

Outcome: 1 Level of injury rates

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Weight	Effect Size IV,Fixed,95% CI
1 Injuries per 100.000 tractors				
Springfeldt 1993a	2.28 (1.77)		4.4 %	2.28 [-1.19, 5.75]
Springfeldt 1993c	0.9 (0.38)		95.6 %	0.90 [0.16, 1.64]
Subtotal (95% CI)			**100.0 %**	**0.96 [0.23, 1.69]**
Heterogeneity: $Chi^2 = 0.58$, df = 1 (P = 0.45); $I^2 = 0.0\%$				
Test for overall effect: Z = 2.59 (P = 0.0097)				
2 Fatal injuries per 100.000 tractors				
Springfeldt 1993a	-1.53 (3.16)		16.0 %	-1.53 [-7.72, 4.66]
Springfeldt 1993c	-0.78 (1.38)		84.0 %	-0.78 [-3.48, 1.92]
Subtotal (95% CI)			**100.0 %**	**-0.90 [-3.38, 1.58]**
Heterogeneity: $Chi^2 = 0.05$, df = 1 (P = 0.83); $I^2 = 0.0\%$				
Test for overall effect: Z = 0.71 (P = 0.48)				
Test for subgroup differences: $Chi^2 = 1.99$, df = 1 (P = 0.16), $I^2 = 50\%$				



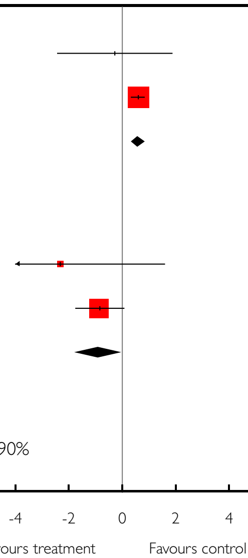
Analysis 5.2. Comparison 5 Technical measures in new tractors versus no intervention, Outcome 2 Slope of injury rate.

Review: Interventions for preventing injuries in the agricultural industry

Comparison: 5 Technical measures in new tractors versus no intervention

Outcome: 2 Slope of injury rate

Study or subgroup	Effect Size (SE)	Effect Size IV,Fixed,95% CI	Weight	Effect Size IV,Fixed,95% CI
1 Injuries per 100.000 tractors				
Springfeldt 1993a	-0.27 (1.1)		1.4 %	-0.27 [-2.43, 1.89]
Springfeldt 1993c	0.58 (0.13)		98.6 %	0.58 [0.33, 0.83]
Subtotal (95% CI)			**100.0 %**	**0.57 [0.32, 0.82]**
Heterogeneity: Chi² = 0.59, df = 1 (P = 0.44); I² =0.0%				
Test for overall effect: Z = 4.40 (P = 0.000011)				
2 Fatal injuries per 100.000 tractors				
Springfeldt 1993a	-2.31 (1.99)		5.3 %	-2.31 [-6.21, 1.59]
Springfeldt 1993c	-0.85 (0.47)		94.7 %	-0.85 [-1.77, 0.07]
Subtotal (95% CI)			**100.0 %**	**-0.93 [-1.82, -0.03]**
Heterogeneity: Chi² = 0.51, df = 1 (P = 0.48); I² =0.0%				
Test for overall effect: Z = 2.03 (P = 0.043)				
Test for subgroup differences: Chi² = 9.90, df = 1 (P = 0.00), I² =90%				



ADDITIONAL TABLES

Table 1. Specific inclusion and exclusion criteria for study participants

Category	Inclusion criteria	Exclusion criteria
Industry	Based on the ISIC classification (UNSD 2006), we will include studies in which the majority of participants belong to the following categories: A 011 Growing of non-perennial crops; A 012 Growing of perennial crops; A 013 Plant propagation; A 014 Animal production; and A 015 Mixed farming	Based on the ISIC classification (UNSD 2006), we will exclude studies in which the majority of participants belong to the following categories: A 016 Support activities to agriculture and post-harvest crop activities; A 017 hunting and trapping; A 02 forestry and logging; A 03 fishing and aquaculture; and non-agricultural industries
Occupation	Based on the ISCO classification (ILO 1987), we will include studies in which the majority of participants belong to the	Based on the ISCO classification (ILO 1987), we will exclude studies in which the majority of participants belong to the fol-

Table 1. Specific inclusion and exclusion criteria for study participants *(Continued)*

	following categories: 611 Market gardeners and crop growers; 612 Market-oriented animal producers and related workers; and 613 Market-oriented crop and animal producers	lowing categories: 614 Forestry and related workers; 615 Fishery workers, hunters and trappers; and non-agricultural occupations
Work location	We will include studies in which the majority of participants work on farms, ranches, stations, dairies, animal feeding operations, and premises where agricultural activities (see ISIC categories listed above) take place, as well as public roads (using farm vehicles) , and other places where agricultural workers conduct agricultural business	We will exclude studies about roadway injuries, when the injury does not involve farm vehicles or equipment
Persons relation to agricultural operation	We will include studies in which participants' relation to agricultural operation is owner/operators or their spouse or immediate family member (including children and seniors, regardless of pay) or manager, hired worker, person working on a farm on a contract basis doing agricultural production work	We will exclude studies which discuss, for instance owners who do not live on the farm and who do not participate in agricultural work
Work activity	We will include studies in which the work activity is agricultural work, and activities arising from work, such as conducting farm business off the farm (marketing commodities, purchasing supplies, transporting farm goods etc.)	We will exclude studies addressing non-agricultural work activities (based on above ISIS codes), such as off-farm employment, operating a non-agricultural business on the farm, or conducting leisure activities on the farm
Degree of participation in the agricultural operations	We will include studies in which the persons participate in agricultural production on a full-time or part-time basis. We will also include studies in which farm family member participants are children or seniors, who live on the farm and are exposed to the farm hazards	We will exclude studies which are dealing with persons who may live on a farm, but do not work on the farm and are not family members of the owner/operator of the farm

Table 2. Educational intervention studies

Study ID	Participants	OHS prof involved	Non-OHS prof inv	Written information	Financial incentive
Gadomski 2006	Farm parents		-One farm visit by lay educator with farming background.	-Booklet of 52 guidelines. -Booster interventions; post-	

Table 2. Educational intervention studies *(Continued)*

				card, calendar, refrigerator magnet	
Lee 2004 A (selected for meta-analysis)	FFA chapters, students	-One interactive 4-hour training of FFA advisers & student team members. -Personal contact with local public health office; community nurse involvement in program activities	-Encouragement to implement program from local agribusinesses. -Opportunity to discuss activities at national FFA conventions. -Bi-weekly phone contact with program facilitator.	-Instruction guides. -"Treasure chest". -Highlight of local health and safety events in national newsletter. -Quarterly mailings of topic-specific guides. -Free PPE supplies.	-Training travel expenses reimbursed. -$300 incentive for community nurse involvement in program activities
Lee 2004 B	FFA chapters, students	-One interactive 4-hour training of FFA advisers & student team members. -One "Refresher" on-site in-person training session on implementation of the program	-Encouragement to implement program from local agribusinesses. -Opportunity to discuss activities at national FFA conventions	-Instruction guides. -"Treasure chest". -Highlight of local health and safety events in national newsletter	-Training travel expenses reimbursed.
Pekkarinen 1994 A (selected for meta-analysis)	Reindeer herders	-Occupational health personnel informed herders during medical examinations about accident prevention; focus on PPE and ergonomics			
Pekkarinen 1994 B	Reindeer herders		-Leaders of the district and contact persons received eight theme letters and were asked to inform herders in their own districts	-Eight "theme" letters during one year describing 34 preventive measures	
Rasmussen 2003	Farms/ farmers	-One-day safety course conducted by OH physician and psychologist. -Farm safety check	-Group discussion, presentation by a seriously injured farmer during the one-day sa-	-Written report from the farm safety check. -Written material and videotapes	

Table 2. Educational intervention studies *(Continued)*

		before and after course conducted by farm safety specialist; duration about half day; verbal feedback & advice	fety course	to those not able to participate in the course.	
Rautiainen 2004	Farms/ farmers	-Annual health screening by trained nurse; one-on-one discussion regarding specific health concerns and proper use of PPE. -Annual on-farm safety review by trained farm safety consultant (local farmer) ; discussion of hazard removal and safe working methods. -Informational meetings and focus groups to discuss aspects of the program	-Other participants in the informational meetings and focus groups		-$200 each year paid to participating intervention farmer.

Table 3. Methodological validity of the RCT studies

Study ID	Reporting	External validity	Internal validity	Total
Gadomski 2006	9/10	2/3	8/13	19/26
Lee 2004	8/10	1/3	5/13	14/26
Pekkarinen 1994	8/10	2/3	5/13	15/26
Rasmussen 2003	9/10	1/3	8/13	18/26
Rautiainen 2004	7/10	1/3	8/13	16/26

Table 4. Reanalysis results of ITS studies

Study ID	Pre-int Level M (SD)	Change in Level (SE)	Pre-int Slope (SE)	Change in Slope (SE)	Autocorrelation
Rautiainen 2005	51.80 (2.43)	-6.51 (1.39)	0.31 (0.23)	-0.54 (0.32)	-0.54
Roberts 2003	11.14 (10.75)	23.64 (6.78)	4.38 (1.00)	-23.10 (2.69)	-0.34
Springfeldt 1993a injuries	23.17 (3.69)	8.42 (6.56)	-0.79 (3.95)	-1.00 (4.07)	0. 14
Springfeldt 1993a fatalities	16.43 (2.48)	-3.80 (7.84)	3.55 (5.03)	-5.75 (4.94)	-0.75
Springfeldt 1993b injuries	23.28 (4.36)	3.41 (4.77)	-2.62 (1.11)	-0.46 (1.48)	-0.49
Springfeldt 1993b fatalities	9.92 (4.28)	0.84 (2.52)	-2.12 (0.59)	1.76 (0.78)	-0.53
Springfeldt 1993c injuries	12.38 (7.76)	7.00 (2.91)	-4.72 (0.99)	4.47 (0.99)	-0.37
Springfeldt 1993c fatalities	0.023 (1.01)	-0.79 (1.40)	0.53 (0.47)	-0.86 (0.48)	0.02
Springfeldt 1993d injuries	4.47 (1.79)	-0.21 (0.97)	-0.46 (0.12)	0.43 (0.19)	-0.20
Springfeldt 1993d fatalities	1.33 (1.42)	1.16 (0.67)	-0.48 (0.09)	0.43 (0.13)	-0.12

APPENDICES

Appendix 1. Search strategy

Preliminary searches were done in PubMed to define useful terms for the search strategy. We expect that the strategy will have adequate sensitivity and specificity. Our approach to come to a comprehensive search strategy was as follows:

First we devised terms for participants, such as agriculture and farm. The term farm* could not be used since it had a too short body for truncating thus forming hundreds of word variations that PubMed could not detect. That is why most important farm related words were selected to the search strategy: farm, farms, farmer, farmers, farming, "farm worker", "farmworker", "farm workers", “farmworkers”. Ranch is a term commonly used for cattle farms. The word was truncated as ranch* to increase sensitivity and include ranch worker. Dairy, greenhouse, orchard and animal confinement were added to make the search more sensitive. These specific sector terms are sometimes used instead of the generic term, agriculture. Agriculture was truncated as agricultur* to include terms such as agricultural enterprise. Also few terms describing the actual work done by the agricultural workers were added to make the search more sensitive, like “crop production” and “livestock”. The terms were tagged to enhance specificity and to eliminate articles that include the terms just in author names and addresses or unintended contexts, such as “Remuda Ranch Programs for Anorexia & Bulimia, Inc.”.

Next we devised terms for outcome such as injury. Outcome in the search strategy was defined as an injury and the term is truncated as injur* to make it sensitive. The term trauma is often used in clinical settings instead of injury. The term accident is also used, particularly in Europe, to describe an injury and an event leading to injury. Both terms were included. Accident was truncated as accident*. Both terms safety and accident (also as injury term) were included in the strategy. The MeSH term accident should include safety but the search results did not overlap.

Specific terms for the intervention were not included, because we would include any intervention for this review.

For study design we will use two search strategies designed to find RCTs and non-randomised studies respectively. For RCTs we will use the strategy described by Robinson and Dickersin (Robinson 2002) and for non-randomised studies the strategy described by Verbeek (Verbeek 2005).

We used search terms that covered the concepts of ’agricultural work’, ’injury’, ’safety’ and ’study design’ to identify studies in the electronic databases. The search strategy for PubMed is described below. This search strategy was modified to fit the characteristics of the other databases.

#1 agricultur*[tw] OR farm[tw] OR farms[tw] OR farmer*[tw] OR farming[tw] OR “farm worker”[tw] OR “farm workers”[tw] OR “farmworker”[tw] OR “farmworkers”[tw] OR ranch*[tw] OR dairy[tw] OR dairying[tw] OR dairies[tw] OR greenhous*[tw] OR orchard*[tw] OR livestock*[tw] OR “live stock”[tw] OR “live stocks”[tw] OR “animal confinement”[tw] OR “farm animal”[tw] OR “crop production”[tw] OR harvesting[tw] OR horticultur*[tw] OR agronom*[tw] OR “Cattle”[MeSH] OR “Animals, Domestic”[MeSH] OR “Agriculture”[MeSH]

#2 injur*[tw] OR accident*[tw] OR trauma[tw] OR harm*[tw] OR wound*[tw] OR fall[tw] OR falls[tw] OR falling*[tw] OR burn[tw] OR burns[tw] OR poison*[tw] OR fatal*[tw] OR drown*[tw] OR suffocat*[tw] OR lacerat*[tw] OR scald*[tw] OR asphyxia[tw] OR asphyxiate*[tw] OR shoot*[tw] OR shot[tw] OR gunshot[tw] OR “electric shock”[tw] OR “electric shocks”[tw] OR “injuries”[MeSH subheading] OR “Accidents, Occupational”[MeSH] OR “Wounds and Injuries”[MeSH]

#3 safet*[tw] OR prevent*[tw] OR control*[tw] OR risk*[tiab] OR “risk management”[MeSH Term] OR “accident prevention”[MeSH Terms] OR Safety[MeSH] OR “Safety Management”[MeSH] OR “prevention and control”[MeSH Subheading] OR risk[MeSH Term]

#4 = #1 AND #2 AND #3

#5 (randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized controlled trials[mh] OR random allocation[mh] OR double-blind method[mh] OR single-blind method[mh] OR clinical trial[pt] OR clinical trials[mh] OR “clinical trial”[tw] OR ((singl*[tw] OR doubl*[tw] OR trebl*[tw] OR tripl*[tw]) AND (mask*[tw] OR blind*[tw])) OR “latin square”[tw] OR placebos[mh] OR placebo*[tw] OR random*[tw] OR research design[mh:noexp] OR comparative study[mh] OR evaluation studies[mh] OR follow-up studies[mh] OR prospective studies[mh] OR cross-over studies[mh] OR control*[tw] OR prospectiv*[tw] OR volunteer*[tw]) NOT (animal[mh] NOT human[mh])

#6 = #4 AND #5

#7 (effect* [tw] OR control* [tw] OR evaluation* [tw] OR program* [tw]) NOT (animal[mh] NOT human[mh]])

#8 = #4 AND #7

#9 = #6 OR #8

WHAT'S NEW

Last assessed as up-to-date: 31 October 2007.

Date	Event	Description
23 May 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 1, 2007

Review first published: Issue 1, 2008

CONTRIBUTIONS OF AUTHORS

Risto Rautiainen was involved in conceptualising and writing the review.

Marika Lehtola was involved in co-ordinating the project team, designing the search strategy, writing and finalising the review.

Lesley Day, Simo Salminen, Eva Schonstein and Juha Suutarinen gave critical comments on all drafts of the review.

Jos Verbeek did the statistical analysis and commented on all the review drafts and was responsible for the discussion section.

DECLARATIONS OF INTEREST

The authors involved in this review have participated in intervention studies. Authors and co-authors (RR, LD, SS and JS) were excluded from evaluating their own studies or studies of their close colleagues.

SOURCES OF SUPPORT

Internal sources

- Cochrane Occupational Health Field, Finland.
- Finnish Institute of Occupational Health, Finland.

External sources

- The Office of the Australian Safety and Compensation Council of the Commonwealth of Australia, Australia.
- Senior Research Fellowship, Australian National Health and Medical Research Council, Australia.

I N D E X   T E R M S

Medical Subject Headings (MeSH)

*Agriculture; Accident Prevention [*methods]; Accidents, Occupational [*prevention & control]; Adolescent; Randomized Controlled Trials as Topic; Wounds and Injuries [*prevention & control]

MeSH check words

Adult; Child; Humans