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The impact of training on safety performance in agriculture: A scoping review

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Abstract. The aim of the study was to analyse the effectiveness of occupational health and safety (OHS) training methods on safety behaviour of farmers and agricultural workers based on literature results. The scoping review intends to find out the main gaps in teaching methodology influencing safety performance of employers and employees in agriculture. A systematic search of literature with help of predefined search strings (agriculture, education, effectiveness, farmer, farm worker, intervention, safety, training) in two literature databases (Scopus, EBSCO) was carried out. It was analysed, how effectively different training methods improved safety awareness and performance of farmers, students and employees. The strength of the evidence on training's effectiveness was assessed for existence of control or comparison group, pre- and post-testing, follow-up testing, statistical significance testing, clear methodology description and thorough study overview were presented.
In the primary literature research, 276 articles were identified. A total of 224 articles were left after the exclusion of redundant publications. After the abstracts' screening 52 publications met the eligibility criteria. After the full text screening by two independent researchers additionally 33 studies were excluded, and in total 19 studies entered into the data charting process. The articles were assessed as medium (n = 8) and high (n = 8) in terms of strength of evidence. According to the review results, the training methods used in the agricultural sector have shown as effective due to the safety awareness and risk behavior among the trainees improved, but new OHS knowledge after training need to be engaged and regularly updated.

Key words: effectiveness of training, occupational health, safety behavior, training methods.

INTRODUCTION

Training is a common intervention method to improve awareness of OHS among employees and employers. Training is a key element for effective OHS management through high safety awareness and exemplary risk behaviour among farmers and agricultural workers. Only the systematic, forethoughtful and effective OHS training programs can improve safety behaviour in farms and prevent occupational injuries, deaths and occupational diseases. Albeit, smart and effective risk management is important above all for an entrepreneur, saving money and increasing farm productivity.

According to the International Labour Organization (ILO), at least 170,000 agricultural workers are killed in occupational accidents each year, and millions of agricultural workers are seriously injured in occupational accidents, often involving agricultural machinery and livestock (ILO, 2023).

Agricultural sector is divided into three sub-sectors: crop and animal production (CAP), forestry and fishery. Based on the Estonian Labour Inspectorate (ELI) database, 1,446 accidents were registered in the Estonian agricultural sector in the period 2014–2021, whereas from which 84.7% of them in CAP sub-sector. Therefore, although it is important to conduct safety training in the entire agricultural sector, while special attention must be paid to the CAP sub-sector.

According to previous research results (2009–2012), young people, who recently entered to working life and did not get OHS training by the end of their education, had twice as many work-related injuries over two years, compared to those who passed OHS training and were aware in safety behaviour (Boini et al., 2017). An evaluation of the impact of the OHS learning module (2018) on the safety attitudes of students showed that after three weeks of teaching the safety module had a statistically significant positive impact on safety attitudes (Nathai-Balkissoon, 2018). So, the development of an effective and field specific OHS training standard for agricultural managers and employees could help to avoid occupational injuries.

Cecchini et al. (2017) analysed the risk behavior of agricultural workers based on age and education and found that employees who have worked for more years have stronger negative attitudes toward safety than those who have worked for fewer years. It is widely recognized that the involvement of workers in safety training and use of different tools and methods plays a pivotal role in promoting safe work behaviour in the agricultural sector. Previous studies have proven that visual tools and features in training material is rewarding and can increase employee engagement levels (Caffaro et al., 2020). Use of game-based safety training in agriculture increased the operators' skills and safety knowledge (Vigoroso et al., 2021). Despite this, agricultural safety training is still carried out through traditional and conventional methods such as lectures and classroom activities, where trainers use displays, brochures, and posters to integrate their oral explanation (Dierdorff & Surface, 2008). Also, widely used online ergonomics training is needed to develop and focus on user-related outcomes and design-related targets, and with high in the technical and accessibility aspects. However, collaboration between OHS authorities, the scientific community and end-users is needed to compile evidence-based and systematic programs for farmers and farm workers. (Zerguine et al., 2023).

The purpose of this study is to find out the effective methods for conducting safety training in the agriculture sector based on the literature review and to find factors that influence employees to apply the knowledge gained in their daily work.

MATERIALS AND METHODS

Inclusion criteria and search strategy

A literature review was carried out to analyse OHS training impact on safety behaviour of farmers and agricultural workers. The literature search for the scoping review was carried out in January – February 2023. Recording, selection of sources of

evidence, data charting, critical appraisal of evidence and synthesis of results were performed according to the criteria of the PRISMA statement for scoping reviews (Tricco et al., 2018).

A keyword search was conducted using the search terms 'farmer OR farm AND worker' OR 'agriculture' AND 'safety AND training OR education' AND 'effectiveness' AND 'intervention' to identify relevant articles. Studies had to meet the following criteria to be included in the review: (i) the focus must be on research articles on OHS training, (ii) the year of publication of the article must not be before 2000, (iii) the study results have published in English, (iv) the study participants had to be agricultural workers or students, (v) studies must be focusing on training, (vi) study design must be comparison of the baseline and after training results or comparison group and (vii) full text of the article must be available. The relevant articles were searched for in Scopus and EBSCO database. The review included articles reporting investigations conducted in any geographical area. Obtained reviews, abstracts and keywords were screened for eligibility and articles not meeting the criteria were excluded. The articles not meeting the criteria were excluded. Transparency of the article selection strategy has shown in the Table 1.

Table 1. Table showing search strategy

Exclusion criteria	Number of studies excluded		Number of relevant studies
	Scopus	EBSCO	
Selected based on review, abstract and keywords	66	210	276
Excluded based on article type	18	36	48 + 174
Excluded based on year of publication of the article	1	15	47 + 159
Excluded based on studies not English	3	34	44 + 125
Excluded based on studies focusing other ergonomic workstation not relating to agriculture	9	62	35 + 63
Excluded based on studies not focusing on training	11	35	24 + 28
Excluded based on studies not relevant to the design	7	8	17 + 20
Excluded based on full text availability	5	2	12 + 18
Excluded duplicates	0	11	12 + 7
Potential studies to be included in the review	12	7	19

In total from 276 articles calculated as relevant for analysis, and finally 19 studies selected for scoping review. Of these 19 studies, a number of six studies focused on training of different focus groups as migrant workers, youth, older farmers (4–6, 9, 11, 17 in Table 2), eight on pesticide safety (2, 7, 8, 12, 14, 15, 16, 19 in Table 2), five accident and injury prevention among farmers (1, 3, 10, 13, 18 in Table 2). The methods have used most often is safety curriculums, educational packages, seminars with slides and communication and checklists/self-audits.

In most cases, the selection criteria could be established in the database search. However, in some cases, the search results included articles that did not address training, intervention, or agriculture, or were inappropriate in design. In addition, it was difficult to follow the criteria when the sample was large, as it was necessary to review all articles retrieved from the search engine to identify suitable articles.

Table 2. Characteristics of included studies

	Author	Year	Groups	Participants' number		Methods to compare the results	Intervention and control group difference (*p*)	Pre- and posttest difference (**p*)	Rating
				Intervention group	Comparison group				
1	Vela Acosta et al.,	2009	G – Work safety curriculum C – No training	G – 18	C – 31	Pearson's test	0.03	0.001–0.02	Very high
2	Arcury et al.,[c]	2009	G – Pesticide curriculum C – Nutrition curriculum as control group	G – 65	C – 50	Two-sample *t*-test Wilcoxon rank-sum test Chi-square Fisher's exact test	Knowledge 0.0085–0.83 Behaviors 0.0783–0.98 Pest management 0.81	Knowledge 0.035–1 Behaviors 0.078–0.79 Pest management 0.19	High
3	Carruth et al.,	2010	G – Train of trainers program C – No training	G – 27	C – 16	Paired *t*-test	0.03–0.18	-	High
4	Forst et al.,	2004	G1 – PPE for use Promotor involvement Training G2 – PPE for use Promotor involvement C – PPE for use	G1 – 256 G2 – 298	C – 149	*ANCOVA*	G1 vs C 0.03 G1+G2 vs C 0.0004	< 0.0001	High
5	Jinnah et al.,	2014	G1 – Parent led training G2 – Staff led training C – No training	G1 – 47 G2 – 53	C – 51	ANCOVA Cohen's d Chi-square	G1 vs G2+C 0.02	0.001–0.05	High
6	McCallum et al.,	2022	G1 – Farm Dinner Theatre G2 – Educational Packages	G1 – 553 G2 – 317	-	ANOVA Post hoc	-	< 0.05 – < 0.01	High
7	Sam et al.,	2008	G – Pesticide safety training material	G – 74	-	Kruskal-Wallis Friedmann	-	< 0.001	High
8	Vela Acosta et al.,[e]	2005	G – Training C – No training	G – 77	C – 75	ANCOVA	0.0001	0.00002–0.007	High
9	Caffaro et al.,[a]	2020	G – Training	G – 20	-	Wilcoxon	-	< 0.0001	Medium

Table 2 (continued)

10	Kidd et al.,	2003	G – Physical or narrative simulations C – No training	G – 373	C – 417	ANCOVA	< 0.0001	< 0.0001	Medium
11	Kilanowski et al.,	2014	G1 – Peer-education safety education programm G2 – Peer-education safety education programm	G1 – 37 G2 – 80	-	Wilcoxon Kruskal-Wallis	-	0.168–0.759	Medium
12	Kobashi et al.,[b]	2021	G – Checklist with pesticide protective habits	G – 100	-	*t*-test	-	< 0.01	Medium
13	Landsittel et al.,[d]	2001	G1 – Self control intervention G2 – Educational programs and activities G3 – Community coalition intervention C1 – Traditionally scheduled safety activities C2 – No training	G1 – 72 G2 – 30 G3 – 41	C1 – 72 C2 – 40	ANOVA	0.02	0.01–0.79	Medium
14	LePrevost et al.,	2014	G – The pesticides and farmworker health toolkit	G – 20	-	Paired *t*-test	-	0.05	Medium
15	Rohlman et al.,	2020	G – Education program	G – 119	-	McNemar	-	< 0.001	Medium
16	Quandt et al.,[c]	2013	G – Training	G – 658	-	McNemar Paired *t*-test	-	< 0.0001–0.0502	Medium
17	Vincent et al.,	2019	G – CROPS curriculum	G – 141	-	*t*-test	-	0.01–0.05	Medium
18	Barrero et al.,[f]	2012	G – Educational program C – No training	G – 60	C – 60	-	-	-	Low
19	Damalas & Koutroubas	2017	G – Training C – No training	-	-	*t*-test Mann-Whitney U Chi square	< 0.0001	-	Low

Notes: [a] Very small sample and questionnaire; [b] The change in pesticide protective behavioral score was significantly associated with the education year; [c] Participants were motivated by a monetary reward; [d] Details concerning analyses on the survey questions used to identify appropriate components are published in another article, that isn't available; [e] The duration of the training is short compared to the content of the training; [f] Fifty-three persons were lost to follow-up and had to be replaced.

Assessment of articles

The following characteristics were assessed for the included articles: intervention structure, participants, methods of comparing results, outcome of intervention and scientific evaluation. In the Table 2 the coding letters are used to label the groups in the observed studies: intervention groups - G and control (or comparison) groups - C. In the case of several intervention or comparison groups, also the sequence number is added (4–6, 11, 13 in Table 2). The intervention groups were the groups where training interventions have implemented. In the most cases the control group (C) didn't get any training (1, 3, 5, 8, 10, 18, 19 in Table 2). Sometimes the comparison groups as controls have used were not always without any activities. For example, the controls were issued PPE and participated in the company's regular safety activities, but did not receive any training, developed for this investigation (2, 4, 13 in Table 2), so we called them as comparison group.

The scientific evaluation

The impact of OHS training in each study were analysed by a qualitative method. The strength of evidence was calculated for each included article based on the presence of the following eligibility criteria: existence of control or comparison group, pre- and post-testing, follow-up testing, statistical significance testing, clear methodology description and thorough study overview were presented. For each characteristic has added one point and maximum score was 5 points. The ratings were divided according to the scores as follows: 1 – very low, 2 – low, 3 – medium, 4 – high and 5 – very high.

RESULTS AND DISCUSSION

This review study analysed the methods and effectiveness of OHS training, carried out among agricultural students, workers or farmers, presented in 19 individual studies. Table 2 briefly describes the training methods, participants, intervention structure and design and outcomes of included studies. The author added the rating scales, assessed by the certain eligibility criteria to follow the best scientific level of carrying out the training study and described above.

The results of the scientific validity assessment by the eligibility criteria showed that only one training study followed very high-quality criteria (1st in Table 2), seven of them followed the high-quality criteria (2–8 in Table 2), nine of them medium and group (9–17 in Table 2). Two articles with low scientific quality (18–19) due to lack of statistical calculations of knowledge differences between the training and control group.

The review shows that, in general, the traditional lecture format is not used to teach safety to agricultural workers unlike Vigoroso et al., results show. Participants and promoters are involved in the development of training materials and practical lessons are also used in the training. When using pesticides, checklists and materials from effective interventions are used. The trainings, which focused on several risk factors at the same time, emphasized explanations and communication, and in some cases, there were attempts to implement the safety module in school curricula. The intervention trainings, which included dangers related to machines, dangerous risk takings and injury experiences, also used video footage of the evenings and the consequences. The Farm Dinner Theater and videotaped theater program are presented as an interesting and effective solution (McCallum et al., 2022). In the other studies, the game-based training

improved the skills and machine safety knowledges among farm workers operators (Vigoroso et al., 2021).

In all the analysed studies, the effectiveness of the intervention was evaluated by comparing the pre- and post-test results with t-test, Wilcoxon signed-rank test, Kruskal Wallis test, Friedmann test, McNemar test, Mann-Whitney U test, Chi-square test etc. In most cases, the assessment was limited to this. In some cases, a follow-up was also carried out after a longer period, which gave a better insight into the persistence of the effects of the training (Sam et al., 2008; Rohlman et al., 2020).

The target groups of reviewed interventions were mainly migrant workers and youth, but there were also few groups of farm workers in general. The number of participants and duration of trainings were very different - in a large scale from 20 participants up to 933 and from one hour up to whole year lasting trainings.

Some of the studies had mixed methodology and very difficult to understand. In some intervention studies the scientific validity of evaluating the effectiveness of intervention training was questionable. For example, the training on safe pesticide actuation, the use of a checklist as an intervention has been shown to be an effective method and its use was monitored, but clear impact assessment before and after the training wasn't implemented (Kobashi et al., 2021). It is important that the research criteria and effectiveness assessment and explanations are unambiguous.

Physical and narrative simulation intervention have great impact according to the study. According to the study 86% of OHS trained students have improved their safety technique in their farm work, when passed the program. Also, these changes frequently extended to family units (Kidd et al., 2003).

The results of intervention training on tractor safety for youth showed that parent-led group trainings were more effective than staff-led trainings and compared to control groups (Jinnah et al., 2014). At this point, it is important that the parents themselves understand the seriousness of machinery risks and hazards. Among the training methods, parents were shown fear-inducing videos on tractor safety and how a disaster video influence on teenage brain development. The study results showed that 70% of parent-led group participants reported they started using seatbelts on tractors. It should be further investigated whether the parent' trust can be the key of effectiveness of safety behaviour, since only 40% of the participants in the staff-led group reported using seat belts.

Research of Rohlman et al. (2020) also shows that immediately after interventions safety awareness increases, but in some cases as time passes, awareness begins to decline again. This suggests that consistent reminders and follow-up training are necessary.

It is important to develop and focus on user-related outcomes and involve the training participants in their selection of training topics (Caffaro et al., 2020). This ensures that the participants are motivated and that the training topics are relevant. Illustrative material, discussions and real exercises could preferably be used when conducting the training. In some cases, participation in the study was financially compensated (Arcury et al., 2009; Quandt et al., 2013). Token funding motivates participants to devote their time and attention on training and knowledge testing before and after the intervention.

According to the results of the studies, all the training methods used were effective in the agricultural sector, increasing safety awareness and significantly improving risk behaviour in the intervention groups, whereas the results of the pre- and post-tests remained largely unchanged in the comparison groups. At the same time, follow-up tests

showed that over time, employees return back to their pre-intervention behaviour patterns. This may be due to forgetting what has been learned or due to a lack of follow-up control. To avoid this, it is necessary to carry out continuous control over work methods and regular reminder training. At the same time, it seems that the acquisition of safety skills in agriculture is more convenient and faster with the help of practical work methods used in training programs.

CONCLUSIONS

More accidents occur in the agricultural sector than in other industrial sectors each year, and most of them occur in the crop and animal production sub-sector. Conducting trainings is considered an effective method to prevent occupational deaths and injuries.

In the present study we analysed the effectiveness of safety training methods to improve safety behaviour among CAP sub-sector workers based on the literature review. Involving employees, employers and students in safety training plays an important role in promoting safe work behaviour in agriculture.

The keyword search was used for the literature search and an exclusion method was used to decide on the inclusion of articles. During the keyword search, 276 articles were found, of which 19 were marked as suitable during the exclusion process.

In order to evaluate the effectiveness, the included studies used the comparison of the results of the pre- and post-tests and the comparison of the results of the intervention and comparison groups. Various valid tests have used to compare significant change of knowledge and behavior in pre- and post-test samples.

The review revealed that traditional classroom lecture-style trainings are not used in CAP and preference is given to trainings involving participants and practical exercises. Safety training conducted by a parent or using safety games had a significantly greater impact on young people than the same training conducted by an educator using traditional auditory lectures. The results show that safety knowledge after the intervention training usually increases, but as time passes it begins to decrease again. Therefore, it is necessary to organize regular reminder or refreshment safety trainings.

Based on the literature review, it can be shown that participants are more motivated if they receive something in return for their participation. Several of the included studies used financial incentives. In addition, agricultural workers are more inclined to join intervention activities if they have had own contribution in the selection of training topics.

In conclusion, it can be said that training as an intervention is an effective way to raise safety awareness among agricultural employees, employers and students, if employees are involved in the selection of this topic. The training itself is engaging when includes practical exercises and safety knowledge is regularly updated. However, collaboration between OHS authorities, the scientific community and end-users need to complete evidence-based and systematic training programs for farmers and farm workers.

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