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Original Article

Effectiveness of participatory training for the promotion of work-related health and safety among Korean farmers

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Abstract: This study was conducted to explore the effectiveness of participatory training for promoting farmer's health and reducing agricultural work-related injuries. Candidates for this study included 595 farmers in 8 rural villages of South Korea. The one-day course participatory training was administered to 217 (36.5%) farmers and included an action-checklist, a good example presentation, and group discussion. The follow-up visit to participants' houses and farms was performed after 1 to 3 months. A direct interview survey was administered pre- and post-trainings. The total number of proposed action plans for the improvement of working condition was 620. It was observed that 61.5% of action plans (72.2% of short term and 41.3% of long term plans) were completely implemented. In regards to health and safety indices, the proportion of current smokers was reduced from 29.8% to 25.3% in the group that underwent training. The pesticide intoxication was reduced from 16.1% to 4.8% in participants that underwent training. However, the agricultural injury rate was unchanged in both groups. This study reports significant beneficial effects of participatory training in the agriculture sector in Korea.

Key words: Agricultural workers' diseases, Farmers, Education, Accidents, Occupational

Introduction

Agriculture is one of the most hazardous occupation sectors. Many farmers suffer from occupational injuries and illnesses. Farmers encounter many work-related risks. These include: ergonomic hazard, use of dangerous machines and vehicles, and agricultural chemicals such as pesticides[1)]. Many studies have tried to effectively intervene on agricultural injury, prevent agricultural work related diseases, and improve the working environment in individual agricultural enterprises[2–8)]. These studies include educational interventions, financial incentives, banning highly toxic pesticides, legislation for safety devices on agro-machines. The review of 25 farm safety interventions published in 2000 found little evidence that farm safety programs have been effective. While some studies have been able to report at least temporary changes in knowledge, attitudes, and behavior, none have shown a sustained decrease in injuries or illnesses[3)]. The result of meta-analysis about effectiveness of interventions in preventing injuries in agriculture in 2008 also showed that educational intervention did not have any injury reducing effects[4)].

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Education programs for safety and health are an essential part of interventions for improvement of farmer's working lives. However, conventional education has limitations when the purpose of education is not a simple transfer of knowledge, but is aimed at changing one's behavior or inducing some kind of action. Reflecting this problem, participatory approaches are increasingly applied for primary prevention in various local situations[9–14]. The first key step for the success of intervention programs to promote the health and safety of farmers is to ensure that the farmers themselves are aware of the problem. It is also important that the farmers themselves participate actively in the planning, execution, and evaluation of actual intervention techniques. Several researchers have performed participatory research as a solution for this critical issue[15–17]. Among these, participatory action oriented training (PAOT) is a unique training method that includes a checklist exercise to learn the work environment improvement principle, sharing best practices using visual media, and group discussion. There were numerous reports pointing out the roles of participatory training in facilitating workplace improvements that increase safety and reduce health risks[18–24]. PAOT has been introduced in Korea since 2003, and is mainly applied to the improvement of working environment for the prevention of musculoskeletal disease[25]. PAOT also has been applied to hospital workers and the urban poor in Korea, but wasn't applied to the agricultural sector until 2007[26].

Although participatory training appears to be a promising measure for improving workers' health and safety in various industrial sectors, its effectiveness in an agricultural setting has not been fully investigated. Furthermore, it has not been applied and investigated in a rural Korean community. Therefore, we conducted a study to explore the effects of PAOT for promoting farmer health and reducing agricultural work related injuries among Korean farmers.

Subjects and Methods

Study subjects

Candidates for this study included all farmers in 8 rural villages of the Kyungbook province in South Korea during the years 2007 to 2011. After applying the exclusion criteria, a total of 595 farmers were included in the study. Persons who were not directly engaged in growing crops or animal production were excluded. These 8 villages were included in the 'safe farm project'. The safe farm project was designed to reduce agricultural work-related injuries and illnesses and was supported by the Rural Development Administration, a Korean governmental agency. It included 1) pre- and post-intervention interview surveys 2) medical health screening 3) health and safety education 4) Exercise programs for muscle strengthening 5) provide supporting equipment including personal protective equipment.

Among a total number of eligible subjects of 595, there were 217 (36.5%) farmers that participated in the training (Fig. 1). PAOT participants were recruited voluntarily. After explaining the purpose and method of the participatory training, all subjects were requested to indicate whether or not to attend to the training. The village leaders confirmed the intention of individuals to participate in training. Farmers with inappropriate physical condition to look around villages were politely proposed not to participate. Those included disabled and farmers older than age of 80. For male farmers, among 276 candidates, there were 129 (46.7%) participants. For female farmers, among 319 candidates, there were 88 (27.6%) participants. PAOT were carried out 10 times during years of 2007 to 2011. They were done once in six villages. Two villages in which there were more than 30 participants had PAOT twice. The average number of participants per training was 21.7 (min 17, max 27). All subjects were asked to agree to the academic use of the study result by filling out a consent form. The ethical issues of the study were approved by the Institutional Review Board of Soonchunhyang University Gumi hospital (SCHGM-2016-18).

Participatory training

The PAOT workshop was run over 8 h. It was scheduled by 1) opening and orientation, 2) the checklist exercise during the farm visit, 3) three technical sessions, which shared good examples using visual media, 4) guidance on implementing improvement, 5) improvement action planning and presentation. The checklist used in PAOT was developed through a review of related references and a collection of examples of good agricultural improvements to produce a concrete action plan. It consisted of 30 items of agricultural health and safety principles which can categorized into six groups. It included most of the agricultural health and safety risks and also included personal health-related practice aspects. Six categories were 1) material storage and handling 2) work station and tools 3) machine safety 4) physical, chemical environment 5) working schedule and resting and 6) basic safety management. The three technical sessions included presentations about basic principles and good example photos, group discussion, and presentation of group discussion results[23, 24]. In first technical session, principles and good example photos related

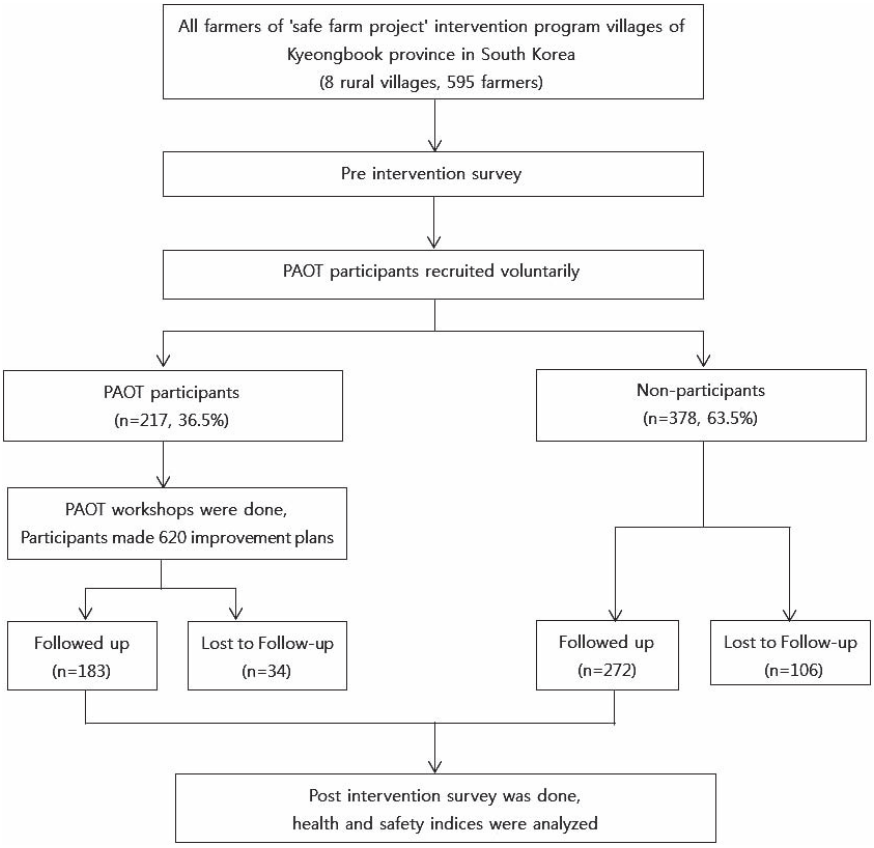

Fig. 1. Flow diagram of the study design.

to category 'material storage and handling' and 'work station and tools' were provided. Contents belonging to 'machine safety' and 'physical, chemical environment' categories were covered in second technical session. Those of 'working schedule and resting' and 'basic safety management' were provided in third session.

The trainer in the PAOT workshop was called the 'facilitator'. A workshop was operated by three to four facilitators who previously trained in the facilitator training course. They were occupational physicians, nurses, and industrial hygienists. At the end of the PAOT workshop, participants were requested to establish their own action plan for improving the health and safety conditions of their house and workplace. They wrote their action plans on paper, and then presented it to their neighborhood. If a husband and wife participated simultaneously, they were requested to establish an action plan together. Follow-up visit of participant's houses and farms was performed after 1 to 3 months.

Pre- and post-survey

The direct interview survey was administered pre- and post-PAOT. The pre-survey was performed 2–3 months before the PAOT workshop. The post-survey was performed 1–2 yr later. Both the pre- and post-survey used the same questionnaire, which was developed by the Rural Development Administration of Korea. Trained interviewers visited the villages of participants. The survey was done by direct interview method. Relevant socio-demographic variables were investigated at the pre-intervention survey, including information on gender, age, level of education, and main agricultural products. The primary study outcomes were defined as the improvement of following indices; health-related behaviors including exercise pattern, smoking status, alcohol consumption, pesticide intoxication, agricultural injury, and musculoskeletal symptoms.

Smoking status was categorized as non-smoker, ex-smoker, and current smoker. Alcohol consumption was divided into a dichotomous variable. If a subject drinks alcohol more than 2–4 times per months, he or she was categorized as consumer. Pesticide intoxication was investigated by the question 'Within the past year, have you quit your work or received medical treatment due to agricultural pesticide poisoning symptoms?'. Agricultural injury

Table 1. Pre-intervention survey results of PAOT participants and non-participants

	PAOT participants		Non-participants		Total		*p*-value[a]
	n=217	36.5%	n=378	63.5%	n=595	100.0%	
Age group							0.000
Below 40	42	19.4%	46	12.2%	88	14.8%	
50	81	37.3%	84	22.2%	165	27.7%	
60	81	37.3%	141	37.3%	222	37.3%	
Above 70	13	6.0%	107	28.3%	120	20.2%	
Sex							0.000
Male	129	59.4%	147	38.9%	276	46.4%	
Female	88	40.6%	231	61.1%	319	53.6%	
Main farm products							0.025
Rice	47	21.8%	110	30.0%	157	26.9%	
Vegetables	61	28.2%	116	31.6%	177	30.4%	
Fruits	102	47.2%	137	37.3%	239	41.0%	
Others	6	2.8%	4	1.1%	10	1.7%	
Education							0.000
None	18	8.8%	69	19.3%	87	14.7%	
Elementary school	98	47.8%	208	58.1%	306	51.6%	
Middle school	46	22.4%	54	15.1%	100	16.9%	
High school	40	19.5%	21	5.9%	61	14.3%	
University	3	1.5%	6	1.7%	9	2.5%	
Regular exercise							0.269
No	160	74.1%	292	78.1%	452	76.6%	
Yes	56	25.9%	82	21.9%	138	23.4%	
Smoking status							0.005
Non-smoking	115	53.7%	246	66.8%	361	62.0%	
Ex-smoking	35	16.4%	49	13.3%	84	16.4%	
Current smoking	64	29.9%	73	19.8%	137	29.9%	
Alcohol consumption							0.000
No	105	48.4%	270	71.4%	375	63.0%	
Yes	112	51.6%	108	28.6%	220	37.0%	
Pesticide intoxication							0.211
No	176	85.0%	313	88.7%	489	87.3%	
Yes	31	15.0%	40	11.3%	71	12.7%	
Agricultural injury							0.287
No	189	87.1%	317	83.9%	506	85.0%	
Yes	28	12.9%	61	16.1%	89	15.0%	
Musculoskeletal symptom							
Neck	43	19.8%	86	22.8%	129	21.7%	0.403
Shoulder	88	40.6%	174	46.0%	262	44.0%	0.195
Arm	64	29.5%	108	28.6%	172	28.9%	0.811
Hand	56	25.8%	109	28.8%	165	27.7%	0.427
Lower back	119	54.8%	212	56.1%	331	55.6%	0.768
Knee, leg	93	42.9%	197	52.1%	290	48.7%	0.030

PAOT: Participatory Action Oriented Training
[a] χ^2 test

was investigated by the question 'Within the past year, have you ever quit your work for at least half a day due to injury related to agricultural work?'. Musculoskeletal symptom were surveyed using the questionnaire of the Korean Occupational Safety and Health Agency (Kosha code H-30-2008) which was translated and revised from the questionnaire of the National Institute of Occupational Safety and Health of the USA (NIOSH). Neck, shoulder, hand, arm, lower back, and knee-leg pain were investigated respectively. We adopted the NIOSH criteria 2 for musculoskeletal symptom complaints. It needs 1) pain that lasts more than a week or pain that occurs more often

Table 2. Proposed action plans by PAOT action checklist items

Action checklist items	No of proposed action plan	%
I. Material storage and handling	145 (23.4%)	
1. Keep transport ways wide, even	9	1.5%
2. Use cart, hand trucks	6	1.0%
3. Use motor vehicle, lift, hoist, conveyers	7	1.1%
4. Provide home for tools, multi-level shelves for storage	122	19.7%
5. Minimize height difference for heavy lifting	1	0.2%
II. Work station and tools	18 (2.9%)	
6. Adjust working height at elbow height	7	1.1%
7. Use stable ladder or height adjustable table	4	0.6%
8. Avoid over-bending or squatting using device	0	0.0%
9. Use specially designed tools	6	1.0%
10. Provide adjustable chair with back rest	1	0.2%
III. Machine safety	56 (9.0%)	
11. Purchase safe machine and maintain properly	34	5.5%
12. Attach proper sign and guards	3	0.5%
13. Design guards at rotating parts	2	0.3%
14. Attach labels and signs with color easy to read	9	1.5%
15. Secure electric safety	8	1.3%
IV. Physical, chemical environment	141 (22.7%)	
16. Avoid heavy sunlight exposure	7	1.1%
17. Make safe storage place for pesticide	89	14.4%
18. Collect empty pesticide bottle and agricultural wastage	13	2.1%
19. Use personal protectives	30	4.8%
20. Provide good ventilation and illumination	2	0.3%
V. Working schedule and resting	154 (24.8%)	
21. Frequent short break and stretching	19	3.1%
22. Make place and time for exercise	27	4.4%
23. Avoid heavy drinking and malnutrition	13	2.1%
24. Make regular job off day	42	6.8%
25. Divide household work	44	7.1%
26. Design resting place near to workplace	9	1.5%
VI. Basic safety management	106 (17.1%)	
27. Maintain good dental hygiene	0	0.0%
28. Prepare emergency kit and fire extinguisher	14	2.3%
29. Write agricultural diary and pesticide records	30	4.8%
30. Join together community activity for cleaning	14	2.3%
Others	48 (7.7%)	
total	620 (100.0%)	

than once a month, and 2) severity of pain must more than 'moderate'.

Statistical analysis

Continuous variables are listed with means and standard deviation, and categorical variables as frequencies and percentages. The mean of each measure was compared using the *t*-test. The differences in the categorical variables were assessed using the chi-square test. The McNemar chi square test was used for the comparison of categorical outcome variables between pre- and post-survey results. The statistical significance of the difference between PAOT participants and non-participants was tested using repeated measures ANOVA. Values of $p<0.05$ (two-tailed) were considered statistically significant. Statistical analyses were undertaken using SPSS 14 for Windows.

Results

We compared the pre-intervention survey results of PAOT participants to non-participants. The portion of participants in the age group below 40 yr of age was 19.4% in

Table 3. Follow up results of implementation of action plan

Rural Community	PAOT participants	No. of Followed Up (%)	No. of action plans			Implemented action plans		
			Short term	Long term	Total	Short term	Long term	Total
A (n=71)	17	16 (94.1%)	27	5	32	12 (44.4%)	1 (20.0%)	13 (40.6%)
B (n=56)	21	17 (81.0%)	48	29	77	37 (77.1%)	12 (41.4%)	49 (63.6%)
C (n=76)	40	17 (42.5%)	24	17	41	12 (50.0%)	2 (11.8%)	14 (34.1%)
D (n=92)	27	22 (81.5%)	65	40	105	51 (78.5%)	15 (37.5%)	66 (62.9%)
E (n=67)	50	43 (86.0%)	79	43	122	61 (77.2%)	26 (60.5%)	87 (71.3%)
F (n=103)	24	18 (75.0%)	45	11	56	43 (95.6%)	3 (27.3%)	46 (82.1%)
G (n=58)	19	16 (84.2%)	39	27	66	20 (51.3%)	12 (44.4%)	32 (48.5%)
H (n=72)	19	0 (0.0%)	—	—	—	—	—	—
Total (N=595)	217	149 (68.7%)	327	172	499	236 (72.2%)	71 (41.3%)	307 (61.5%)

participants and 12.2% in non-participants. The portion of participants in the age group above 70 yr of age was 6.0% in participants and 28.3% in non-participants. Among participants, 59.4% were male, whereas 38.9% were male in non-participants. The younger farmers and more male farmers participated in the PAOT. There were a greater proportion of fruit-cultivating farmers in training participants (47.2%) than non-participants (37.3%). The proportion of rice- (21.8%) and vegetable- cultivating (28.2%) farmers in participants was less than in non-participants (30.0%, 31.6% respectively). PAOT participants were more highly educated than non-participants. There was no significant difference in the proportion of farmers that regularly exercised, but the proportion of current smokers was higher in training participants (29.9%) than non-participants (19.8%). The proportion of alcohol consumers was also higher (51.6%) in training participants than non-participants (28.6%). The proportion of pesticide intoxication and agricultural injury was not different between training participants and non-participants. The proportion of musculoskeletal complaints of the neck, shoulder, arm, hand, lower back, and knee-leg were not significantly different between training participants and non-participants ($p<0.05$) (Table 1).

The number of action plans proposed at the PAOT workshop by the farmers themselves was 620. Table 2 shows the number of action plans according to checklist items. The most frequently proposed action plan was 'Provide home for tools, multi-level shelves for storage' (19.7%), followed by 'Make safe storage place for pesticide' (14.4%). There were no action plans for the items 'Avoid over-bending or squatting using device' and 'Maintain good dental hygiene'. Among the six categories of action checklist, 'working schedule and resting' had the largest number of action plans. Participants had proposed 154 (23.4%) action plans belonging to this category followed by 'material storage and handling' 145 (23.4%), 'physical, chemical environment' 141 (22.7%), 'basic safety management' 106 (17.1%), 'machine safety' 56 (9.0%) and 'work station and tools' 18 (2.9%) (Table 2).

Follow up visits of the farmers houses allowed for confirmation of implementation of the action plans. Among 217 participants, 149 (68.7%) were followed up. It was observed that 61.5% of action plans were completed. The PAOT participating farmers had completed 72.2% of their short term plans and 41.3% of their long term plans. Depending on the rural community, the implementation rate was 34.1% to 82.1% (Table 3).

To evaluate the effect of PAOT, health and safety indices of pre- and post-surveys were compared. The proportion of current smokers was reduced only in PAOT participants. In non-participants, the proportion of smokers was unchanged. However, in participants, it reduced from 29.8% to 25.3%. Proportion of alcohol consumer was increased in non-participants from 27.6% to 34.9%. However, in participants, it remained unchanged. The changes observed in smoking and alcohol consumption were statistically significant between the training participants and non-participants group. The proportion of regularly exercising farmers was slightly increased, but not statistically significant, in both groups. Pesticide intoxication was reduced only in training participants. It reduced from 16.1% to 4.8% in training participants, but remained unchanged in non-participants from 12.9% to 10.5%. Nevertheless, the difference of change between participant and non-participant group was not statistically significant. The agricultural injury rate was unchanged in both groups. Musculoskeletal symptom complaints were reduced in 3 body regions (shoulder, hand, lower back) in training participants. However, in non-participants it reduced in all six

Table 4. Health and safety indices change between participants and non-participants

	PAOT participants (n=183)					Non-participants (n=272)					*p*-value[b]
	pre		post		*p*-value[a]	pre		post		*p*-value[a]	
Regular exercise					0.174					0.078	0.276
No	135	74.2%	120	69.0%		211	78.7%	193	72.6%		
Yes	47	25.8%	54	31.0%		57	21.3%	73	27.4%		
Smoking status					0.012					0.804	0.007
Non, ex-	127	70.2%	121	74.7%		216	82.4%	201	93.1%		
Current	54	29.8%	41	25.3%		46	17.6%	41	16.9%		
Alcohol consumption					0.144					0.022	0.000
No	90	49.2%	101	55.2%		197	72.4%	177	65.1%		
Yes	93	50.8%	82	44.8%		75	27.6%	95	34.9%		
Pesticide intoxication					0.003					0.418	0.418
No	146	83.9%	158	95.2%		222	87.1%	188	89.5%		
Yes	28	16.1%	8	4.8%		33	12.9%	22	10.5%		
Agricultural injury					0.522					0.100	0.400
No	161	88.0%	156	85.2%		230	84.6%	230	84.6%		
Yes	22	12.0%	27	14.8%		42	15.4%	42	15.4%		
Musculoskeletal symptoms											
Neck	37	20.2%	36	19.7%	0.100	63	23.2%	34	12.5%	0.002	0.437
Shoulder	71	38.8%	49	26.8%	0.007	131	48.2%	77	28.3%	0.000	0.118
Arm	53	29.0%	34	18.6%	0.014	80	29.4%	39	14.3%	0.000	0.526
Hand	50	27.3%	31	16.9%	0.007	87	32.0%	43	15.8%	0.000	0.574
Lower back	101	55.2%	77	42.1%	0.006	162	59.6%	115	42.3%	0.000	0.537
Knee, leg	79	43.2%	64	35.0%	0.086	148	54.4%	107	39.3%	0.000	0.037

[a] McNemar χ^2 test

[b] Repeated Measure of ANOVA between participants and non-participants

body regions ($p<0.05$) (Table 4).

Discussion

The checklist is the most important tool for participation in PAOT. The checklist is called an "Action checklist" in PAOT. It lists low-cost improvements widely applicable to reduce work-related risks in diverse work settings[27]. It outlines the basic principles of ergonomics and occupational hygiene in agricultural fields[18, 24]. In this study, we developed a Korean version of the action checklist for farmers. It was based on the checklist used in the Work Improvement in Neighborhood Development (WIND) training program[28]. The WIND checklist was translated into Korean, and we revised it into 30 items. The farmer's action plans were established on the guide of this checklist. We could classify the farmer's action plan according to items of the action checklist. Action plans of 620 cases were sorted by items of the action checklist. Items which many farmers proposed as action plans were 'Provide home for tools, multi-level shelves for storage' (19.7%), and 'Make safe storage place for pesticide' (14.4%). We could classify the 30 items of action checklist into six categories. It was 'working schedule and resting' category which had the largest number of action plans. A total of 154 (24.8%) action plans belonging to this category were proposed. This is due to reason that because issues of 'working schedule and resting' was not only it does not require much cost or resources to improve, but also because it is an easy-to-implement plan. Categories of 'material storage and handling', 'physical, chemical environment' and 'basic safety management' also had 145 (23.4%), 141 (22.7%), and 106 (17.1%) action plans respectively. On the other hand, 'work station and tools' and 'machine safety' categories had few action plans. They had only 18 (2.9%) and 56 (9.0%) action plans respectively. The checklist items of these categories need to be modified with careful consideration.

It was observed that 61.5% of action plans were implemented 1–3 months after the PAOT workshop. Our data showed that 72.2% of the short-term action plans and 41.3% of long-term action plans were implemented. If we took account into the fact that follow up visits were made just 1–3 months after workshop, it is expected that there were higher implementation rates of improvement. Since PAOT emphasized practical low-cost improvements using

Fig. 2. Examples of improvement: Pesticide storage using a book self, storage for agricultural devices, home for small tools, reflective signs for night safety.

the farmers' own ideas and available local resources, they initially started with small, easy-to-implement improvements. Once farmers are trained in the participatory steps leading to the actual improvements, they can apply the sequential steps in a sustainable way to manage agricultural work-related risks. We can expect that they would expand their scopes to more challenging improvements in a step-wise manner (Fig. 2).

In this study, we observed the effects of PAOT by comparing health and safety indices changes between PAOT participants and non-participants. Decreases in the proportion of current smokers and pesticide intoxication were observed only in the training participants group, which proved the successful effects of PAOT. These decrements were statistically significant as compared to non-participants. As PAOT action plans, many farmers promised to make safe storage places for pesticides and increase the use of personal protective equipment. Many example photos of good, low-cost interventions were presented at the technical session. These photos would influence the thinking of the farmers in regard to pesticide-related safety. This made it possible to reduce experience of pesticide intoxication symptoms among PAOT participants.

Our data showed that there was no decrease in the agricultural injury rate in either PAOT participants or non-participants. Many previous intervention studies that aimed at reducing agricultural injury also failed to achieve this goal. In a systematic review of interventions in preventing injuries in agriculture, they concluded that the reviewed studies provided no evidence that educational interventions are effective in decreasing the injury rate[3–5]. Lehtola MM *et al.*[4] reviewed 8 studies in preventing injuries in agriculture. They said that "Three randomized controlled trials on educational interventions with adult participants did not indicate any injury-reducing effect, with a rate ratio of 1.02 (95% confidence interval 0.87–1.20), nor did two randomized controlled trials among children (6,895 participants). Financial incentives decreased the injury level immediately after the intervention in one interrupted time-series study. Banning endosulfan pesticide in Sri-Lanka led to a

significant decrease in the trend of poisonings over time. Legislation requiring rollover protective structures on all tractors in Sweden did not produce a reduction in injuries, but the same requirement for new tractors was associated with a decrease in fatal injuries"[4]. For reducing the agricultural injury rate, educational interventions are not adequate to bring about change, unless they are combined with other comprehensive approaches. New interventions to address a multitude of hazards in the farm work environment as well as the management and organization of farm work is needed. The self-reported agricultural injury rate of this study was 15.0%. This means that 15 out of 100 farmers suffered from agricultural work-related injury in one year time. Since it was investigated by subjective interview survey and included minor injuries, the injury rate of this study was likely to be inflated. In the Korean Farmers' Occupational Disease and Injury Survey (KFODIS) conducted in 2009, the estimated agricultural injury rate of Korea was 3.2% for injuries requiring more than 4 d of absence[29].

Musculoskeletal symptoms were improved in all farmers regardless of PAOT participation. The target population of this study was farmers who were already involved in 'safe farm project', which was supported by a Korean governmental agency. This project also provided intervention programs such as health and safety education, provision of work-burden reducing agricultural devices, and a muscle-strengthening exercise program. Therefore, it was assumed that improvement of musculoskeletal symptoms was mainly due to effects of other interventions.

The PAOT methodologies are now widely applied in many counties to improve occupational safety and health and working conditions in various grassroots workplaces. Typical examples of the participatory training program include the Work Improvement in Small Enterprises (WISE) training program designed to assist small enterprises[30–32], and the Work Improvement in Neighborhood Development (WIND) training program with farmers[16, 17, 28]. Participatory training methods were also applied to home workers in the informal economy through the Work Improvement in Self-employed and Home workers (WISH) program, to construction workers through the Work Improvement in Small Construction Sites (WISCON) program[24, 33]. Tsutsumi *et al.*[20] conducted the first randomized controlled study in participatory training. They reported that the participatory intervention for mental health and job performance among blue collar worker had beneficial effects for worker's mental health as well as organizational benefits[20]. Yu *et al.*[21] evaluated the effectiveness of participatory training and didactic training in preventing occupational injuries among frontline workers in China. They reported that the rate of injury in the intervention group reduced significantly, but not in control group. They concluded that participatory training was more effective in reducing occupational injuries than didactic training[21]. Yu *et al.*[19] evaluated the effectiveness of participatory training on musculoskeletal disease prevention among frontline workers in China. They reported that participatory training might be effective to reduce musculoskeletal diseases in the lower extremities, wrist, and finger[19]. However, in the agricultural sector, to our knowledge, there were no controlled studies or comparative studies to demonstrate the effectiveness of participatory training.

The important limitation of this study was that participation in PAOT was not randomly assigned. Farmers arbitrarily volunteered to participate in the training. Therefore, the younger farmers and more male farmers participated in PAOT. Due to the interventional nature of this study, it was almost impossible to have a randomized study design. The lack of longer follow-up data made it impossible to reach any conclusions regarding long-term effects. Future studies should evaluate the long-term effect and cost-effectiveness of PAOT.

Although the study design is not a well-controlled one, this study is the first to demonstrate the significant beneficial effects of participatory training in the agricultural sector. This study therefore demonstrates the effectiveness of participatory training approaches in Korean agricultural health and safety settings, including the reduction of pesticide intoxication and reducing smoking in farmers. Our findings suggest that it is worthwhile to facilitate participatory training to ensure farmers' safety and good health.

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