ผลของโปรแกรมส่งเสริมความรอบรู้ด้านสุขภาพต่อพฤติกรรมการป้องกันการแพ้พิษสารเคมีกำจัดศัตรูพืชในเกษตรกร อำเภอองครักษ์ จังหวัดนครนายก

Effects of Health Literacy Promoting Program on Pesticide Poisoning Prevention Behaviors among Agricultural Workers, Ongkharak District, Nakhon Nayok Province

นิพนธ์ต้นฉบับ

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วารสารไทยเภสัชศาสตร์และวิทยาการสุขภาพ 2565;17(4):317-325.

Original Article

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บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาผลของโปรแกรมเสริมความรอบรู้ด้านสุขภาพต่อความรอบรู้ด้านสุขภาพและพฤติกรรมการป้องกันการแพ้พิษสารเคมีกำจัดศัตรูพืชในเกษตรกร **วิธีการศึกษา:** ในการวิจัยกึ่งทดลองนี้ กลุ่มตัวอย่างเป็นเกษตรกรผู้ปลูกข้าวและไม้ดอกไม้ประดับ อ.องครักษ์ จ.นครนายก จำนวน 60 คน แบ่งเป็นกลุ่มทดลองซึ่งร่วมโปรแกรมเสริมความรอบรู้ฯ และกลุ่มเปรียบเทียบได้รับคู่มือป้องกันการแพ้พิษสารเคมี กลุ่มละ 30 คน โปรแกรมเสริมความรอบรู้ฯ มี 6 กิจกรรม และติดตามกระตุ้นทางออนไลน์และเยี่ยมบ้านเกษตรกร 4 ครั้ง ประเมินความรอบรู้ด้านสุขภาพและพฤติกรรมการป้องกันการแพ้พิษสารเคมีกำจัดศัตรูพืช ที่ก่อนโปรแกรม และที่สัปดาห์ที่ 8 (หลังโปรแกรม) และ 12 (ติดตามผล) ทดสอบความแตกต่างของคะแนนความรอบรู้และคะแนนพฤติกรรมระหว่างสองกลุ่มที่ก่อนโปรแกรม หลังโปรแกรม และตอนติดตาม โดยใช้ Independent t-test และ repeated measure analysis of variance **ผลการศึกษา:** กลุ่มทดลองมีค่าเฉลี่ยคะแนนความรอบรู้ด้านสุขภาพที่สูงขึ้นและสูงกว่ากลุ่มเปรียบเทียบทั้งตอนหลังโปรแกรม และตอนติดตามผลอย่างมีนัยสำคัญทางสถิติ (*P*-value < 0.05) กลุ่มทดลองมีค่าเฉลี่ยคะแนนพฤติกรรมการป้องกันการแพ้พิษสารเคมีสูงกว่ากลุ่มเปรียบเทียบทั้งตอนหลังโปรแกรม และตอนติดตามผลอย่างมีนัยสำคัญทางสถิติ (*P*-value < 0.05) **สรุป:** โปรแกรมส่งเสริมความรอบรู้ด้านสุขภาพสามารถเพิ่มคะแนนความรอบรู้ด้านสุขภาพและคะแนนพฤติกรรมการป้องกันการแพ้พิษสารเคมีกำจัดศัตรูพืชต่างจากการให้ความรู้แบบให้อ่านคู่มือด้วยตนเองในบรรดาเกษตรกรผู้ปลูกข้าวและไม้ดอกไม้ประดับ

คำสำคัญ: พฤติกรรมการป้องกันการแพ้พิษสารเคมีกำจัดศัตรูพืช, ความรอบรู้ด้านสุขภาพ, เกษตรกร, เกษตรกรผู้ปลูกข้าว, เกษตรกรผู้ปลูกไม้ดอกไม้ประดับ

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Abstract

Objective: To examine effects of health literacy promoting program on health literacy and pesticide poisoning prevention behaviors among agricultural workers. **Method:** In this quasi-experimental study, participants were 60 agricultural workers of rice and garden plant growers in Ongkharak district, Nakhonnayok province. Thirteen participants attended the health literacy training for pesticide poisoning prevention (test group) while the other 30 participants received a handbook on pesticide poisoning prevention. The health literacy training had 6 activities and 4 follow-up visits. Participants were assessed on health literacy and behavior of pesticide poisoning prevention before the raining, at week 8 post-training, and week 12 (follow-up). Differences in health literacy and the behavior between the two groups before and after the training, and at follow-up were tested using independent t test and repeated measure analysis of variance. **Results:** The mean score of health literacy of test group the intervention group was significantly increased and higher than that of the control group both after the training and at follow-up (*P*-value < 0.05). In addition, the mean score of the behavior of the test group was significantly increased and higher than that of the control group both after the training and at follow-up (*P*-value < 0.05). **Conclusion:** Health literacy training program increased the scores of health literacy and behavior of pesticide poisoning prevention when compared with the handbook on pesticide poisoning prevention among agricultural workers of rice and garden plant growers.

Keywords: pesticide poisoning prevention behaviors, health literacy, agricultural workers, rice growers, garden plant growers

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Introduction

Agricultural workers are exposed with various factors detrimental to health in their work. Exposure to pesticide in particular is of a great concern with a variety of exposure routes including skin, gastrointestinal tract, and respiratory system during dilution, mixing, and spraying.[1] Pesticides cause acute and chronic illnesses.[2] According to the epidemiology report of the Office of Epidemiology, Ministry of Public Health of Thailand, illnesses related to occupation and environment have been increasing from 14.47 per 100,000 populations in 2016 to 16.81 per 100,000 populations in 2017.[3] Measures for preventing pesticide exposure and toxicity have been issued at the policy and practice levels. At the policy level, the Hazardous Substance Act (B.E. 2535) controls the import and registration of chemicals including pesticides. However, the Act does not control the distribution of pesticides to the agricultural workers after the purchase. As a result, the actual use of pesticides has not been adequately controlled for safety, and the overuse and poisoning have been increasing.[4] According to occupational health policy, the service for occupational health has been provided by the occupational health clinic for agricultural workers at community level.[5] The clinic help strengthened health promotion and disease prevention among agricultural workers by primary care settings in their community. However, since this kind of service is not a major indicator of public health quality accreditation[6], this official measure could not be fully reliable and other measures such health promotion on behavioral change to prevent pesticide poisoning among agricultural workers are needed. It has been known that health literacy is associated with and predictive of poisoning prevention behavior of agricultural workers where those with health literacy had proper pesticide poisoning prevention behavior.[7,8]

In Nakhonnayok province, 44.56% of the population were agricultural workers.[9] Most agricultural workers grow rice and garden plants which need a lot of pesticides. Therefore, these workers have long been exposed to pesticides and experienced the pesticide poisoning.[10] Various factors relating to pesticide poisoning have been known including worker's behaviors, work types, and environmental factors. For worker factors, agricultural workers in Nakhonnayok province had inappropriate behaviors while mixing and spraying, and after spraying the pesticides. This included inappropriate use of personal protection gears and devices. The inappropriate behaviors were found to be associated with the pesticide poisoning with statistical significance.[11,12] Based on these personal worker's factors, measures at individual person's level have been tried which included knowledge provision[13,14], and belief modification to promote behavior appropriate for preventing pesticide prevention.[15,16] These health modification measures are however problematic in sustainability among the agricultural workers.

With the unreliable benefit of traditional health behavior modification measures, more reliable ones are needed for these agricultural workers. In improving personal worker factor to sustain the pesticide poisoning prevention behavior, the promotion of health literacy has been a promising measure.[17-19] Health literacy could help build proper health behavior.[17-19] Based on Nutbeam's concept, health literacy consists of basic or functional literacy level (health information access and cognition), interactive literacy level (communication skill and self-management skill), and critical literacy level (media literacy and decision-making skill).

Previous studies suggest that health literacy could improve protective health behavior.[17-20] In this present study, three components or levels of health literacy were applied for health behavior improvement program. These three components included functional literacy level, interactive literacy level, and critical literacy level. We expected the study participants to gain capacity and skill to access health information, to analyze the information, to evaluate their situation and to decide how to manage their situation. Ultimately, these agricultural workers of the rice field and garden plants were expected to perform behaviors appropriate for preventing pesticide' poisoning. We aimed to compare the effects of health literacy program (test) with no such program (control). Specifically, this study aimed to compare mean scores of health literacy in pesticide's poisoning prevention before and after the health literacy program within each of the test and control groups, and the mean scores between the two groups after the program. We also aimed to compare the mean scores of pesticide's poisoning prevention behavior before and after the health literacy program within each of the test and control groups, and the mean scores between the two groups after the program.

Methods

In this quasi-experimental research, the outcomes were measured before the 7-week program, after the 7-week program (week 8), and at follow-up (week 12). Study population 735 agricultural workers who were rice growers and garden plant growers in 8 sub-districts of Ongkharak district, Nakhonnayok province, in 2021. Study sample was workers who met the inclusion and exclusion criteria. To be eligible, they had to be 18 – 60 years of age, were able to read and write in Thai language, worked in the process of mixing and/or spraying the pesticide for at least 6 months, and were willing to participate in the study. Those who had problems with hearing, speaking or sight, and those who had participated in any training in pesticide poisoning prevention were excluded.

For sample size estimation, power analysis based on effect size was used.[21] A large effect size of 0.8 from a previous similar study comparing health literacy program with control in pesticide's poisoning prevention behavior in a province in the north-east of Thailand was used.[22] With a type

I error of 5% and a power of 80%, a sample size of 17 participants per group was required.[21] However, with a relatively long experimental period of 12 weeks, an additional 50% of participants were required to compensate for a high attrition rate. Finally, a sample size of 30 participants per group was required for the expected normal distribution of the data.[23]

Of the 8 sub-districts of Ongkharak district, the sub-district of Klongyai was randomly selected to be in the test group and the sub-district of Buengsan to be in the control group. Subsequently, 30 participants were randomly selected from Klongyai sub-district registry and another 30 participants from Buengsan sub-district registry.

Participant protection

The study protocol was approved by the Ethics Committee for Human Study of Srinakharinwirot University (Approval number: SWUEC-503/2563E). With voluntary and anonymous nature of the study, participants could participate at their will and could withdraw from the study at any time. Data of their identity and outcomes were kept secret and the results were presented as a summary not individual participant's information.

Research instruments

The instruments included the health literacy program to improve pesticide's poisoning prevention behavior[17] and the questionnaire on health literacy and health behavior in preventing pesticide's poisoning. The whole questionnaire was developed by the researcher based on literature. Content validity was tested by three nursing faculty members including one specialized in teaching, and the other two in community nursing. The questionnaire was also tested for internal consistency reliability using 30 individuals with characteristics comparable to the study participants.

For the questionnaire, the **first part** collected data of the participant's demographic characteristics including age, gender, education level, duration of pesticide use in years, and length of pesticide spraying each time in minutes.

The **second part** evaluated the participant their health literacy in preventing pesticide's poisoning. In this 6-section health literacy questionnaire, the first section asked about knowledge and understanding about pesticide using 15 questions with a total score of 15 points. With a yes-no response format, this section had an acceptable internal consistency reliability with a Kuder-Richardson coefficient of 0.71. The second to sixth sections asked about health information including 2^{nd}-access to health information and health service relating to pesticide exposure (7 questions), 3^{rd}-communication skill for more competence in pesticide poisoning prevention (5 questions), 4^{th}-self-assessment on the illnesses related to pesticide poisoning (7 questions), 5^{th}-media and information literacy about pesticide information presentation and advertisement (4 questions), and 6^{th}-decision-making skill to choose measures to prevent pesticide poisoning (5 questions). The response format for the 2^{nd} to 6^{th} sections was a 3-point rating scale ranging from 2-always practice, 1-practice sometimes, and 0-never practice for positive statements and with the opposite direction for negative statements. As a result, the total scores of these sections were 14, 8 ,14, 8 and 10 points, respectively. Internal consistency reliability of the 2^{nd} to 6^{th} sections of health literacy was acceptable with Cronbach's alpha coefficients of 0.78, 0.70, 0.71, 0.96, and 0.78, respectively.

The **third part** evaluated the behavior of preventing pesticide's poisoning. The response format was a 3-point rating scale ranging from 2-always practice, 1-practice sometimes, and 0-never practice for positive statements, and with the opposite direction for negative statement. The total score was 48 points. Internal consistency reliability of the questions was acceptable with a Cronbach's alpha coefficient of 0.83.

Study and data collection procedure

Once approved by the ethics committee, prospective participants were invited to participate in this 12-week experiment as follows. In the first week, the researcher contacted the official community leaders, unofficial community leaders, health volunteers, sub-district health promoting hospital personnel, agricultural office officers, and related personnel for permission and study co-ordination. Eligible participants in both groups were asked to complete the questionnaire of the health literacy and behavior in preventing pesticide's poisoning described previously.

In the second week, participants in the test group attended the in-person class of the health literacy promoting program with strict Covid-19 prevention measures of sanitation and social distancing. Thirty participants in the test group were divided into 3 groups of 10 participants each for practical group activities.

In the 1st week, the researchers, officers of the district agriculture promoting office, and officers of the sub-district health promoting hospitals were planned together on the training. In the 2nd week, 6 activities were carried out in 3 days. Activities 1, 4 and 5 were conducted by the researcher and officers of the sub-district health promoting hospitals while activities 2, 3 and 6 by the researcher and officers of the district agricultural promoting office. The six activities were as follows. In the first activity, participants were provided with content of pesticide's poisoning and its prevention using printed learning materials and videos. Participants were also trained to identify signs and symptoms of pesticide poisoning using body map. Visual and touching inspections for poisoning signs and symptoms were trained. This activity took about 90 minutes. In the second activity, health information access skill was trained by the officers of the district agricultural office using various online and non-online information sources. The content included pesticides, selection of pesticides proper for different plants, the Good Agricultural Practice, organic agriculture, and health related information. Individual participants had a chance to search information. This activity took about 60 minutes.

The third activity aimed at building competency in pesticide poisoning prevention. Participants were trained to identify labels of pesticides products, pesticide's generic name, WHO toxicity level, recommended pesticide dosage, and restricted interval time. They were also trained to use the application created by the Department of agriculture (DOA) to search for pesticide information. They also shared experience in complying with the Good Agricultural Practice. The activity took 60 minutes. The fourth activity allowed the participants to reduce the risk of pesticide poisoning. They were trained for self-assessment of pesticide-related illnesses, and self-protection on the pesticide use. They also participated in discussion and sharing about problems, obstacles, and solutions in preventing pesticide's poisoning. They also participated in activity to improve environment for the better prevention of pesticide poisoning. For example, they were trained to identify spots with the risk of pesticide poisoning such as safe storage of pesticides, and safe disposing spot in the household and community. For the community, community map for safe disposing spot was introduced to the participants. They were encouraged to improve their community environment to prevent pesticide poisoning. The activity took 60 minutes.

In the fifth activity, participants were trained to analyze the media and information for better prevention of pesticide poisoning using educational video. After video viewing, they were encouraged to discuss and share their opinions about the impact of pesticide on health problem, how to prevent and solve such problems in their own community living context. This activity took 60 minutes.

In the sixth activity, the last activity, participants were trained to choose solutions to prevention pesticide poisoning. They were instructed to role-play spraying the colored, fake pesticide with no protective gears or apparels, and encouraged to discuss about the solutions. They were also introduced to biologicals alternative pesticides such as Beauveria bassiana fungi, metarhizium spp. fungi, and Trichoderma harzianum fungi. After demonstration, each participant had the chance to prepare biologicals pesticide. This activity took 90 minutes.

In weeks 3 to 7, online follow-ups by the researchers to promote more skill of health literacy were made with 4 follow-up visits for each individual participant. Participants were asked about problems and obstacles in applying health literacy skills in preventing pesticide poisoning. They were also provided with more advice on searching through online sources for information about pesticide products, selection of pesticides proper for given plants, self-assessment on poisoning risk and actual poisoning, improvement on agricultural environment for better prevention of poisoning, and the use of biological pesticides. All encouragements were to promote more access to information, advice, self-assessment on pesticide poisoning prevention, analysis of media and information, solution decision making, and behavior to prevent pesticide poisoning. In weeks 8 and 12, health literacy and behavior of pesticide poisoning prevention were re-assessed.

For participants in the control group, were also treated similarly to those in the test group but with no health literacy training program but only a handbook on pesticide poisoning prevention at week 2 for self-learning. Like those in the test group, they were assessed on health literacy and behavior of pesticide poisoning prevention before the training program, and at weeks 8 and 12.

Data analysis

Descriptive statistics including frequency with percentage were used to present demographic characteristics and mean with standard deviation (SD) to present study variables. Differences in demographic characteristics were tested using Pearson's chi-square test or Fisher's exact test, as appropriate. Differences in mean scores of health literacy and behavior variables at each time point were tested using independent t test or Mann-Whitney U test, as appropriate. For each study variable (i.e., individual health literacy components and behavior variables), differences between the test and control groups over the three time points were tested using repeated measure analysis of variance (repeated measure ANOVA). Statistical significance was set at a type I error of 5%. All statistical analyses were performed using software program SPSS version 22.

Results

Of the 60 participants, 30 in each group, the majority were women, 40 years old or older, and with primary school education (Table 1). For duration of pesticide use, half of participants in the test group and about two-thirds of those in the control group had been using for at least 10 years. The majority sprayed the pesticide not more than 120 minutes at a time. No statistical significance was found in any characteristics (Table 1).

Table 1 Demographic characteristics of the participants (N = 60).

Characteristics	N (%) by group				*P*-value*
	Test group (n = 30)		Control group (n = 30)		
Gender					0.573
Men	8	26.7	10	33.3	
Women	22	73.3	20	67.6	
Age (years)					0.559
< 40	7	23.3	9	30.0	
≥ 40	23	76.7	21	70.0	
Education level					0.793
Primary school	18	60.0	17	56.7	
High school or higher	12	40.0	13	43.3	
Duration of pesticide use (years)					0.296
< 10	15	50	11	36.7	
≥ 10	15	50	19	63.3	
Length of pesticide spraying each time (minutes)					0.136
≤ 120	25	83.3	20	66.7	
≥ 121	5	16.7	10	33.3	

* Chi-square test.

At week 8 (i.e., after the health literacy training program), mean score of each of the six components of health literacy (i.e., knowledge and understanding about pesticide, health information and health service access, communication skill for more competence in pesticide poisoning prevention, self-management skill for pesticide poisoning prevention, media literacy in pesticide information presentation and advertisement, and decision-making skill in choosing to prevent poisoning) in the test group was significantly higher than that before the training program (*P*-value < 0.05) (Table 2). Similarly, at week 12 (i.e., follow-up), mean score of each of the six components of health literacy was significantly higher than that before the program (*P*-value < 0.05). However, no differences of all men scores at week 8 and week 12 were found. For the control group, only knowledge and understanding about pesticide at week 12 was significantly higher than that at week 8 (*P*-value 0.015) (Table 2).

Table 2 Health literacy scores of the two groups at three time points (N = 60).

Health literacy	Mean score ± SD by group		*P*-value†
	Test group (n = 30)	Control group (n = 30)	
Knowledge and understanding about pesticide			
Baseline (before the training)	9.03 ± 1.52	9.17 ± 2.02	0.774
Week 8	9.90 ± 1.88 [a]	8.10 ± 2.58	0.003
Week 12 (follow-up)	10.53 ± 1.31[a]	9.33 ± 1.86 [b]	0.005
P-value‡	< 0.001	0.015	
Health information and health service access			
Baseline (before the training)	6.97 ± 3.01	7.80 ± 2.25	0.230
Week 8	10.30 ± 1.68[a]	7.30 ± 1.49	< 0.001
Week 12 (follow-up)	10.60 ± 1.52[a]	7.07 ± 1.34	< 0.001
P-value‡	< 0.001	0.076	
Competence in communication skill for pesticide poisoning prevention			
Baseline (before the training)	4.00±1.95	4.37±2.41	0.520
Week 8	7.37±1.33[a]	4.47±1.89	< 0.001
Week 12 (follow-up)	7.87±1.14[a]	4.20±1.47	< 0.001
P-value‡	< 0.001	0.749	
Self-management to reduce the risk of pesticide poisoning			
Baseline (before the training)	11.90 ± 1.71	11.60 ± 0.97	0.407
Week 8	13.43 ± 1.17[a]	11.27 ± 1.01	< 0.001
Week 12 (follow-up)	13.53 ± 0.78[a]	11.50 ± 0.97	< 0.001
P-value‡	< 0.001	0.266	
Media and information literacy for pesticide information presentation and advertisement			
Baseline (before the training)	4.77 ± 2.30	4.87 ± 2.18	0.863
Week 8	7.30 ± 1.09[a]	4.63 ± 1.63	< 0.001
Week 12 (follow-up)	7.30 ± 1.06[a]	4.87 ± 1.50	< 0.001
P-value‡	< 0.001	0.404	
Decision-making skill to prevent pesticide poisoning			
Baseline (before the training)	5.23 ± 3.00	6.33 ± 2.51	0.129
Week 8	8.67 ± 1.47[a]	5.50 ± 2.37	< 0.001
Week 12 (follow-up)	8.97 ± 1.22[a]	6.20 ± 1.88	< 0.001
P-value‡	< 0.001	0.055	

† Independent t test for comparison between the test and control groups.
‡ Repeated measure ANOVA for within-group comparison at baseline, 8 weeks, and 12 weeks.
[a] Outcome was significantly different from baseline outcome by repeated measure ANOVA post-hoc comparisons (*P*-value < 0.05).
[b] Outcome was significantly different from 8-week outcome by repeated measure ANOVA post-hoc comparisons (*P*-value < 0.05).

For differences between groups, mean scores of each of the six components of health literacy of the two groups at baseline were not different; while at week 8 (i.e., after the training), mean score of each of the six components of health literacy in the test group was significantly higher than that of the control group (*P*-value = 0.003 for knowledge and understanding about pesticide, and < 0.001 for the rest). At week 12 (i.e., follow-up), mean score of each of the six components of health literacy in the test group was significantly higher than that of the control group (*P*-value = 0.005 for knowledge and understanding about pesticide, and < 0.001 for the rest) (Table 2).

Mean behavior scores in the test group increased significantly by 11.87 points from baseline to week 8 (31.90 to 43.77 points), and 12.93 points from baseline to week 12 (31.90 to 44.83 points) (*P*-value < 0.001 for both) (Table 3). In addition, mean behavior scores increased by 1.06 points from week 8 to week 12 (*P*-value < 0.001). No significant changes were found in the control group.

In terms of differences between groups, mean behavior score of the test group was significantly lower than that of the control group (31.90 and 33.93 points, respectively, *P*-value = 0.027). However, mean behavior score of the test group was significantly higher than that of the control group at week 8 (43.77 and 33.63 points, respectively) and week 12 (44.83 and 34.27 points, respectively) (*P*-value < 0.001, for both comparisons) (Table 3).

Table 3 Behavior scores of the two groups at three time points (N = 60).

Behavior score	Mean score ± SD by group		*P*-value†
	Test group (n = 30)	Control group (n = 30)	
Baseline (before the training)	31.90 ± 4.30	33.93 ± 2.24	0.027*
Week 8	43.77 ± 3.16†	33.63 ± 2.40	< 0.001*
Week 12 (follow-up)	44.83 ± 2.55†‡	34.27 ± 2.78	< 0.001*

* Independent t test for comparisons of the two groups.
† *P*-value < 0.001 for mean score at the time point compared with that at baseline, using repeated measure ANOVA post-hoc comparisons.
‡ *P*-value < 0.001 for mean score at the time point compared with that at week 8, using repeated measure ANOVA post-hoc comparisons.

Discussions and Conclusion

In this quasi-experimental study, agricultural workers growing rice and garden plants were trained in the health literacy program to improve their health literacy and consequently the pesticide poisoning prevention behavior. Three levels of health literacy included functional literacy level (health information and health service access skill and cognitive skills), interactive literacy level (communication skill and self-management skill), and critical literacy level (media literacy skill and decision-making skill).[18,19]

Scores of health literacy in knowledge about pesticide and health information and health service access skill in those who were trained increased significantly after the training and at follow-up when compared with baseline (*P*-value = 0.001) and were also significantly higher than those in the control group after training and at follow-up (*P*-value < 0.001 for all). This could be due to effective learning arrangements. In addition to basic video viewing, their understanding on pesticide poisoning was reviewed and reflected through group activity. They were trained for the actual information searching from various reliable sources including the online ones. They were allowed to choose the searching tools and channels by themselves. Based on Nutbeam's concept of functional literacy level, quality learning management and information provision could allow for better understanding about health risk, better access to health information and health service, and ultimately being able to apply the knowledge and skill for better health management.[19] Our findings are consistent with health literacy training program for agricultural workers growing cassava.[22] Health literacy was promoted by lecture with mobile learning materials, video, group discussion after short video of pesticide poisoning prevention.[22] Our findings are also consistent with that of health literacy enhancement in agricultural worker of corn growing using participatory lecture, questions and opinion sharing about the use of pesticide, contamination prevention measures at mixing, spraying, and after spraying, and demonstration and feedback for pesticide exposure reduction.[24]Our findings are also consistent with the promotion of health literacy in pesticide use in rubber tree plantation workers using lecture with printed materials and video concerning pesticide impact on health, roleplaying activities promoting access to information and news about pesticide and access to occupational health service after the exposure of pesticides.[25] They also found a significant increase in mean scores of health literacy on gaining more knowledge about pesticides, and access to information and health service among agricultural workers after the training. Mean scores of those in the training were also significantly higher than those not participating the training (control group).[25] However, the score of health literacy on gaining more knowledge about pesticides in the control group also increased at follow-up which could be due to the printed manual for pesticide poisoning prevention in agriculture provided by the researchers.

For the interactive literacy level, we found that mean scores of communication skill and self-management skill for pesticide poisoning prevention the test group were significantly higher than those in the control group after the training and at follow-up, and within the test group after the training and at follow-up were significantly higher than those at baseline (*P*-value < 0.001). These health literacy skills were augmented because the participants were exposed with activities to enhance pesticide poisoning prevention by various means as follows. They were trained to identify pesticide product labels, and to use DOA application to search for pesticide information. They also shared experience about problems carrying out tasks of according to the Good Agricultural Practice. They participated in recognizing acute pesticide poisoning, preventing the acute poisoning, an assessing signs and symptoms of the acute poisoning using self-report activities. They also discussed measures for pesticide poisoning prevention. They made a map of their community with spots of a high risk of pesticide contamination identified to that they can improve the environment to prevent pesticide poisoning.

According to Nutbeam, interactive health literacy is a competency for knowledge usage and communication to be able to participate in their own self-care.[20] Learning with sharing, explanation, and free, appropriate interpersonal communication could lead to the competency to health management.[19] This concept is also proved in the study in agricultural workers in cassava plantation where self-management skill was trained by demonstration and actual maneuver on pesticide contamination protective gears and devices.[22]

The concept was also proved in the study of interactive health literacy among agricultural workers of corn growing where the workers were trained in identifying pesticide labels, and were visited at the individual houses on how they applied pesticide contamination prevention and were allowed for opinion sharing.[24] the concept was again proved in the self-management training for rubber tree plantation workers using scenario-based group activity, risk management, and the use of contamination protective gears.[25] Risk assessment and management using the checklist and model workers to share experiences were also used.[25] All of these learning activities resulted in significantly higher post-training scores of pesticide poisoning prevention and its risk reduction management to in those participating the training. Scores of the two aspects of health literacy in those participating the training were also significantly higher than those in the control group.

For critical health literacy, mean scores of media and information literacy and decision-making skills in our study after training in the test group were significantly higher than that before the training. For the between-group difference, mean scores of the test group after the training and follow-up were significantly higher than those in the control group (*P*-value < 0 .001). This could be because the workers participated in sharing opinions toward impact of pesticide shown in the video clip. Their opinions included advantages and disadvantages of pesticide use, and the impact on health of the pesticide. The participated in pesticide mixing and spraying colored liquid with no protective gears but only white gown. They discussed about routes of contamination into the body and the advantages of protective gears and apparels. They also had the chance to have group discussion about solutions or measures for preventing pesticide poisoning, and to prepare alternative biological pesticides. Based on Nutbeam's concept, critical health literacy is the skill for evaluating the health information to decide ad choose proper practice for better health promotion and prevention.[20] Participating in analysis and brain-storming for problem-solving measures could allow for better health outcomes.[19] Our finding is consistent with the training for cassava plantation workers where group discussion on health related media was allowed.[22] Our finding is also consistent with the study in rubber tree plantation workers where they were advised to analyze and evaluate information on pesticide products and advertisements. They were also allowed to make decision to choose appropriate pesticides based on the comparisons of advantages, disadvantages using a brief protocol.[25] A checklist was used to compare advantages and disadvantages of pesticide use as advertised in the media.[25] These activities resulted in scores of media and information literacy after the training significantly higher than that before the training and significantly higher than that of the control group. However, scores of this aspect of health literacy in the test group at follow-up (week 12) were not different from those after the training (week 8). This could be due to no learning activities from weeks 8 to 12.

For the behavior of pesticide poisoning prevention, mean scores of the test group after the training and at follow-up were significantly higher than that at baseline, and were significantly higher than those in the control group (P-value < 0.001). This could be because these agricultural workers were trained with health literacy through various active leaning activities to enhance knowledge, understanding and access to health information and health service in preventing pesticide poisoning, i.e., functional health literacy. The workers shared their opinions in the discussion on case studies and simulated scenarios which enriched their interactive health literacy skill (communication and self-management skills). They were also trained for critical health literacy via media literacy by analyzing various situations from the media and video clips, practicing preventing pesticide poisoning, and preparing appropriate biological pesticides. According to Nutbeam's concept, health literacy us a major factor influencing health behavior. Individuals with the access to, the understanding on, and the proper use of information for decision making could enhance themselves in self-protection behavior.[18,19] The improved pesticide poisoning prevention behavior with the health literacy training in our study is consistent with the training in cassava plantation workers[22], corn growers[24], rubber tree plantation workers.[25] While health literacy training was associated with significant increase in the behavior score over time, and significant higher scores when compared with the control group, those in control group had no such improvement over time. This could be because workers in the control group received only the printed manual to read.

Based on our findings and conduct, continuous follow-up and encouragement on health literacy to prevent pesticide poisoning should be in place when applying the program to practice for the workers. Subsequently, a long-term follow-up should also be in place.

Our study had certain limitations. Even though the health literacy training program offered an active learning process, the context of agricultural workers in rice growing and garden plants limits the generalization to other groups of agricultural workers. Studies in other agricultural workers should be conducted. In addition, qualitative studies and studies with other quantitative health outcomes such as cholinesterase enzyme should be conducted.

In conclusion, health literacy training program applied three levels of health literacy including functional literacy level (health information and health service access skill and cognitive skills), communication skill (communication skill and self-management skill), and critical literacy level (media literacy skill and decision-making skill). The program was effective in improving health literacy and the behavior of preventing pesticide poisoning among agricultural workers in rice and garden plant growing.

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