ORIGINAL ARTICLE

EFFECTS OF AN EDUCATIONAL INTERVENTION ON KNOWLEDGE AND SAFETY PRACTICES IN PESTICIDE HANDLING AMONG FARMERS IN SAMARAHAN, SARAWAK

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ABSTRACT

Poor safety practices in pesticide handling contribute to the severe consequences of cases of pesticide poisoning globally. The objective of this study was to determine the effectiveness of an educational intervention to improve the knowledge and safety practices in pesticide handling among farmers in Samarahan, Sarawak. A quasi-experimental study was conducted involving an interventional (n= 50) and a control group (n = 50). A self-administered questionnaire was used to collect baseline information on participants' knowledge and practices in pesticide handling. Participants in the interventional group underwent a five-month interventional programme consisting of four modules on the importance of understanding pesticides label, short and long-term effects of pesticides, routes of entry into the body and symptoms manifested upon exposure, safety usage, storage and disposal methods and practices. The control group were not exposed to any intervention. All the participants were reassessed at one- and fifth-month post-intervention using a validated self-administered questionnaire. Data were analysed using repeated measure analysis of variance to measure the effect of intervention between the groups. No significant difference was observed in the baseline based on gender and age distribution between both groups. Participants from the interventional group recorded a significant improvement in the mean knowledge and safety practices scores in the first month and fifth months compared to the baseline values. Meanwhile, no significant improvement in both outcomes was detected in the control group throughout the three assessments. These findings revealed that locally tailored educational intervention is effective in improving the knowledge level and safety practices of farmers in pesticide handling. Hence, these findings can be used by local authorities to develop an effective intervention for pesticide users in Sarawak and other states in Malaysia in reducing the risk of pesticide exposure.

Keywords: *Farmers, pesticide poisoning, educational intervention, safety practices, knowledge*

INTRODUCTION

The current world population of 7.2 billion indicates the importance and the challenges of sufficient food production to fulfil daily needs[1]. In order to secure and enhance the productivity of plantations, organophosphate (OP) pesticides are commonly used insecticides among farmers worldwide. Nevertheless, organophosphate pesticide exposure among farmers is one of the most significant occupational hazards[2]. Although pesticides are used in developed and developing countries, cases of acute and chronic organophosphate pesticide poisoning contribute significantly to morbidity and mortality rates, especially in developing countries[3]. These severe consequences stem from the higher and poor usage of organophosphate pesticides along with inadequate maintenance of protective equipment[4]. Other important predisposing factors include lower safety precaution practices, poor labelling, washing facilities, insufficient enforcement, low literacy, safety knowledge, inappropriate storing and handling, low perceived risk and susceptibility and the lack of laws and regulations on the use of pesticides[5].

Studies have shown that farmers were not following the basic pesticide safety measures due to the low perceived risk of unsafe use of pesticides[6,7]. These findings reflect farmers' poor knowledge regarding organophosphate pesticides, perceived susceptibility, risk, severity and the lack of cue to action to protect themselves from organophosphate pesticide poisoning[7]. Thus, increasing knowledge and perceived benefit of pesticide safety were positively related to the higher usage of personal protective equipment and safe handling of pesticides[5].

Malaysia is well-known as one of the major producers of agricultural products in South East Asia. Meanwhile, in Sarawak, Samarahan is the main agricultural area for the production of agricultural commodities[8]. Hence, the use of organophosphate pesticides among farmers in Samarahan is widely employed to safeguard crops from pests[8]. Nevertheless, such extensive use of organophosphate pesticides may result in severe health issues. This is further exacerbated as there is no specific policy or law to safeguard farmers on the usage of organophosphate pesticides except policies on the amount of certain pesticide residual allowed in food.

Previous studies highlighted that most agricultural workers did not seek medical screening or monitoring for OP poisoning due to the low awareness towards pesticide poisoning, lack of government support and allocation in the pesticide screening programmes, and lack of accurate data on pesticide poisoning[8,9]. The Department of Agriculture (DOA) only focus on farm products in terms of OP levels for the safety of consumers. Hence, farmers are the neglected group that has to face the occupation hazard in their daily lives. Thus, this study attempts to investigate a locally tailored educational intervention to improve the knowledge and safety practices among farmers in pesticide handling in Samarahan.

Theoretical and Conceptual Framework

The health belief model (HBM) as shown in Figure 1, is a psychological health behaviour change model developed to explain and predict health-related behaviours, particularly regarding the uptake of health services[10]. The HBM suggests that people's beliefs about health problems, perceived benefits of action and barriers to action, and self-efficacy explain engagement in health-promoting behaviour[10]. The HMB model consists of five key constructs: perceived barrier, perceived susceptibility, perceived severity, self-efficacy and perceived benefit of the health-related behaviour[11]. Given the importance of these HBM domains and their relevance to individuals' behaviour and practices, the constructs were used to design the educational intervention in improving the safety practices in pesticide handling among farmers in the Samarahan division.

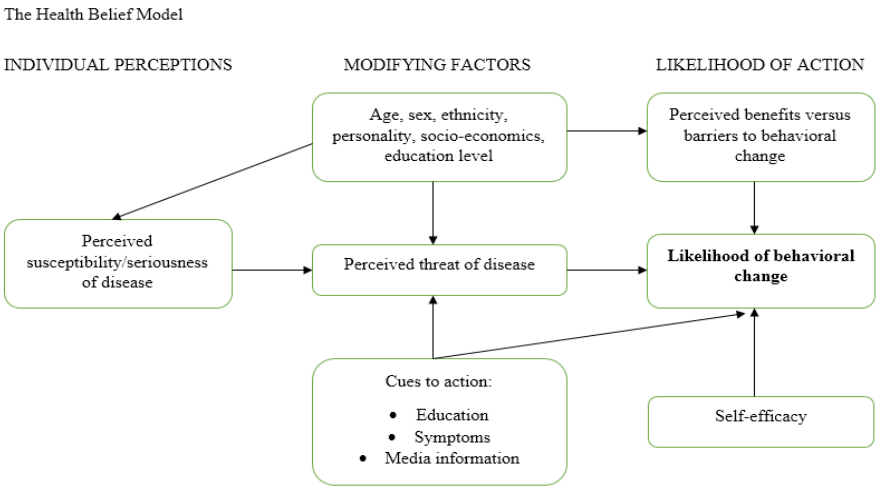

Figure 1: Health Belief Model
Source: Health Belief Model adapted from Harrison et al. (1992)

In terms of the conceptual framework, the dependent variables comprise farmers' knowledge and safety pesticide handling practices while the independent variables are the intervention and control groups, as well as farmers' sociodemographic characteristics.

METHODS

Study Area and Study Design
A quasi-experimental study was conducted among selected farmers in Samarahan divisions in Sarawak. The study comprised pre and post-test designs among an equal number of participants that were not randomly selected. The flow of the study is shown in Figure 1.

Study Population and Sampling Method
The study population consisted of full-time farmers in Samarahan who are actively using organophosphate pesticides for their crop management. The research sampling frame was the list of full-time farmers obtained from the DOA, Samarahan. A multistage sampling method was applied in which all participants in both control and intervention groups were matched according to their age and gender to reduce potential bias. The sample size was calculated using an online sample size calculator with the alpha set at 0.05, a power of 80%, a 95% confidence interval and an enrolment ratio of 1:1. The mean (SD) value for the knowledge score of the control and intervention groups was adopted from the study by Sam et al.[12]. The calculated sample size for each group was 41 participants, which was then increased to 50 participants per group based on an expected 20% dropout. Therefore, the total number of participants required for the study was 100 individuals.

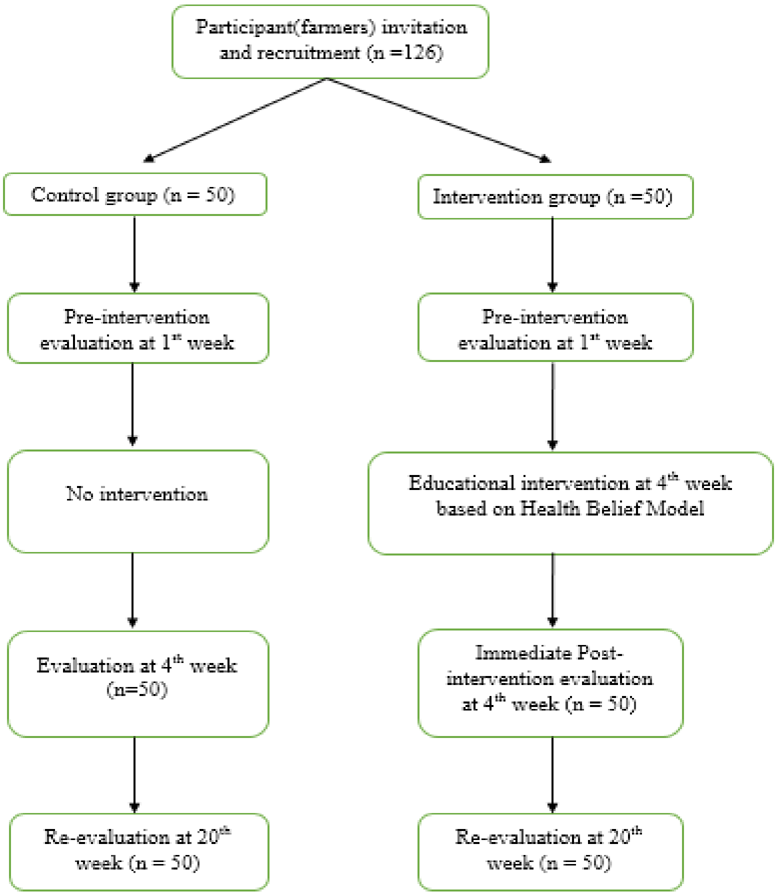

Figure 2: Flow chart of the study

Research Instrument, Data Collection and Intervention Procedures

An interviewer-administered questionnaire was used during the face-to-face interview with the farmers. The questionnaire employed was adopted and validated in Malay[13]. The questionnaire comprised 5 sections: socio-demographic details, knowledge of pesticide handling and toxic symptoms, presence of pesticide residues and portals of entry into the body, usage of the recommended amount of pesticide, the safety of easily available pesticide products, and practices relating to usage, storage and disposal of pesticides. A pilot study was conducted among 20 farmers. Reliability analysis revealed a Cronbach's alpha value ranging from 0.82 to 0.94 for various sections of the questionnaire. These results demonstrated that the questionnaire is reliable with acceptable internal consistency.

Data collection and intervention programmes started from October 2019 until June 2020 upon obtaining participants' written consent and briefing them on the research objectives and procedures. The same questionnaire was used for the pre-test and post-test for both groups.
All the participants were initially assessed to record their scores of perceived susceptibility towards pesticide poisoning, the severity of pesticide poisoning, the benefit of safety practices in handling pesticides, barrier towards safety practices, cue to their action and the self-efficacy level in safety practices. The intervention group was subjected to an educational programme which focused on four modules, the importance of understanding pesticides label, short and long-term effects of pesticides, routes of entry into the body and symptoms manifested upon exposure, safety usage, storage and disposal methods and practices. The intervention was conducted within one month from the date of the pre-intervention evaluation. The researcher was assisted by the staff of the Department of Agriculture of Sarawak. Educational programs were performed in small groups and strengthened by using information technology such as computers, video and audio displays, and brochures.

Data Analysis

All the data collected were analysed using SPSS-Version 24.0. Descriptive statistics were conducted to summarise the participants' socio-demographic profile, baseline knowledge level and safety practices in pesticide handling. Data distribution was assessed by conducting normality tests based on the level of skewness and kurtosis. Mean and standard deviation was presented for normally distributed data, while median and interquartile range was used for non-normally distributed data. Bivariate analyses were performed to compare the farmers' characteristics at baseline either by using chisquare or independent tests depending on the normality results. The total score for knowledge and safety practices was computed based on the number of questions (n = 20 and n = 28) upon allocation a score of 1 for a correct answer and 0 for a wrong answer. The dependent variables were assessed for normality and homogeneity of data distribution and outliers before conducting the repeated measure ANOVA test. Pairwise comparison analyses were performed after correction with the Bonferroni method. Statistical significance was set at $p < 0.05$.

Ethical Consideration

In the initial phase of the research planning, the research proposal was reviewed by the University Malaysia Sarawak (UNIMAS) Medical Ethics Committee and approved accordingly (Ref No: UNIMAS/NC-22.02/04-02 Jld 4 (62). Subsequently, written consent was obtained from each of the participants before they were recruited into the study.

RESULTS

Descriptive analyses

Table 1 depicts the participants' characteristics. Both of the groups were similarly consisting of 33 male and 17 female participants. Most of the participants in both groups were Malays, with corresponding mean ages of 51.2 years ± 13.26 and 50.8 years ±13.40 in the control and intervention groups ($p > 0.05$), respectively. Most participants were married (90.0%) and acquired secondary educational levels (control = 52.0%, intervention = 46.0%). Participants in the control and interventional groups had a mean of 17.2 and 16.0 years of working experience as farmers, respectively.

Table 1: Participants' Socio-demographic Profile

Characteristics	Control		Intervention		p-value
	n (%)	Mean (SD)	n (%)	Mean (SD)	
Gender					
Male	33 (66.0)		33 (66.0)		
Female	17 (34.0)		17 (34.0)		
Ethnicity					
Malay	47 (94.0)		50 (100.0)		
Chinese	3 (6.0)				
Age (years)		51.2 (13.26)		50.8 (13.40)	0.807
Marital status					
Single	4 (8.0)		4 (8.0)		
Married	45 (90.0)		45 (90.0)		
Widower	1 (2.0)		1 (2.0)		
Highest Education					
None					
Primary	13 (26.0)		12 (24.0)		
Secondary	26 (52.0)		23 (46.0)		
	11 (22.0)		15 (30.0)		

Baseline Knowledge scores and safety practices scores

For the control group, the mean knowledge score was 15.4 ± 2.02 (max = 18.0, min = 10.0), whereas the interventional group had a mean score of 14.7 ± 3.31 (max = 19.0, min = 5.0) for the knowledge on pesticides as shown in Table 2. The overall baseline of the mean knowledge score for both groups was not significantly different. Participants from the control group and intervention group scored a mean of 22.7 ± 3.01 and 22.8 ± 2.99 for perceived susceptibility towards pesticide poisoning, 14.8 ± 1.92 and 15.1 ± 2.09, 35.3 ± 3.77 and 36.5 ± 4.10 for the perceived benefit of action, 28.8 ± 2.78 and 27.8 ± 2.92 for the perceived barrier to safety practices, respectively. Meanwhile, the control group had a mean of 17.2 ± 1.72 for self-efficacy to take safety precautions in preventing pesticide poisoning compared to that of the intervention group at 17.5 ± 1.87.

Table 2 also presents the baseline of the mean score of safety practices for participants of both groups. Participants from the control group had a mean score of 18.5 ± 3.09 on safety practices while participants from the interventional group had a mean score of 18.3 ± 3.76 for the safety practices. There were no significant differences in the baseline of the mean score of safety practices between control and interventional groups

Table 2: Baseline knowledge level of participants in control and interventional groups in safety practices on pesticide handling

	Control (*n* = 50)	Intervention (*n* = 50)	Max, min	*p-value*
Knowledge level				
Mean (SD)	15.4 ± 2.02	14.7 ± 3.31	18,10; 19,5	0.532
				0.585
Safety Practices	18.5 (3.09)	18.3 (3.76)		

Mean differences of knowledge scores and safety practices scores between control and interventional group

Table 3 revealed that there was no significant difference in the mean knowledge score between the two groups at the baseline (0 months). However, there were significant differences between the control and interventional group in 1st month, F (1, 98) = 10.64, p = 0.002, = 0.098 and in 5th month, F (1, 98) = 5.99, p = 0.016, and a = 0.058. The control group did not experience significant changes in their knowledge score

Table 3: Comparison of the knowledge score between the two groups at each point in time.

Time	F Stat. (df)	*p*-value	Effect Size η^2
Knowledge Score			
Pre (0 months)	0.005 (1, 98)	0.944	0.000
Mid (1st month)	10.640 (1,98)	**0.002**	0.098
Post (5th month)	5.993 (1, 98)	**0.016**	0.058

The largest difference in the mean score for the interventional group was the score at the mid (1st month) assessment as compared to the last assessment at the 5th month of intervention as shown in Figure 2. The mean score of perceived severity, benefit, and self-efficacy, perceived susceptibility towards pesticide poisoning increased significantly in the intervention group in the second and third assessments compared to the first assessment. Such changes were not observed in the control group at all the assessment periods. In contrast, a significant reduction was observed in their second and third assessments for the mean score of perceived barriers in safety practices compared to the participants in the control group.

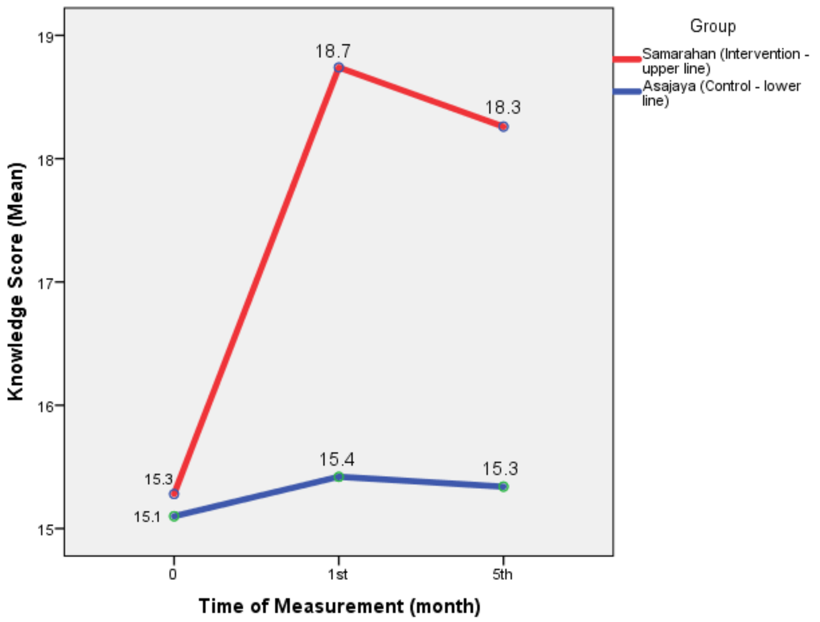

Figure 3: Changes in farmers' knowledge score (mean) by time for control (n = 50) and interventional (n=50) groups.

Table 4 shows that there was no significant difference in the mean safety practices score between the two groups at the baseline (0 months). However, there were significant differences between the control and interventional group in 1st month, F (1, 98) = 0.56, p < 0.001, = 0.006 and 5th month, F (1, 98) = 8.16, p = 0.005, and a = 0.077.

Table 4: Post-hoc comparison of safety practices scores of the two study groups across three different times

Time	Mean Diff	(95% CI)	P value
Safety practices Score			
Control			
Pre vs Mid	-0.5	(-1.3, 0.3)	0.214
Pre vs Post	-0.4	(-1.1, 0.4)	0.350
Mid vs Post	0.1	(-0.5, 0.7)	0.676
Intervention			
Pre vs Mid	-0.4	(-4.9, -3.1)	**< 0.001**
Pre vs Post	-3.6	(-4.5, -2.7)	**< 0.001**
Mid vs Post	0.4	(0.08, 0.8)	**0.017**

The control group recorded significant changes in their safety practices score along the time from baseline to first and from baseline to 5th month of assessment but no significant changes from mid to 5th-month assessment. Meanwhile, the interventional group depicts statistically significant changes in the mean score of safety practices in all three different points and all were statistically significant (Figure 3).

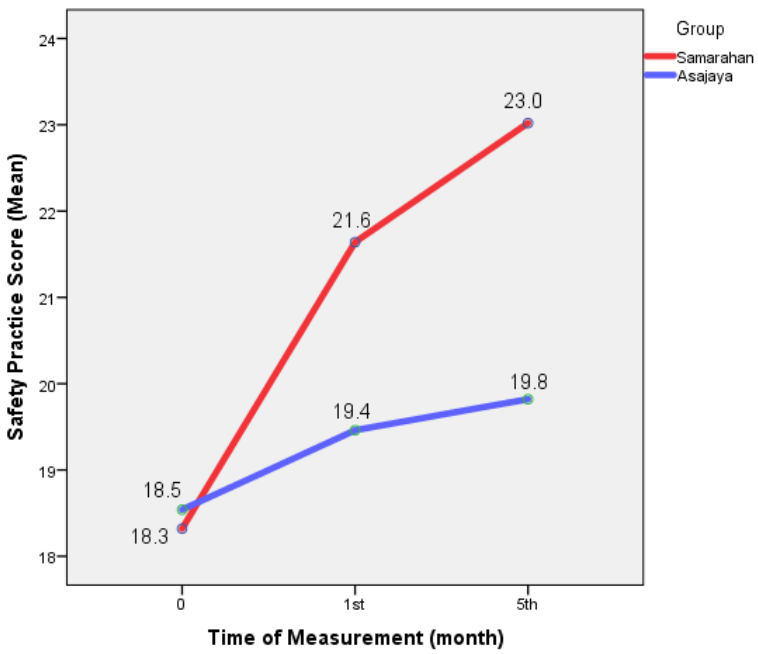

Figure 4: Changes in farmers' safety practice score (mean) by time for control (n = 50) and interventional (n = 50) groups.

DISCUSSION

This study assessed the effectiveness of an educational intervention in enhancing farmers' knowledge and safety practices in the usage and handling of pesticides. Three assessments were conducted at baseline, and first and fifth months after the intervention. While participants in the control group had almost similar mean knowledge and safety practices scores throughout the three assessments, the interventional group demonstrated a significant increment in their mean scores for both outcomes post-intervention. Similar findings were reported by Suratman et al.[14] who found that participants experienced significant improvement in knowledge levels after attending an educational intervention based on the HBM. This finding reflects that locally tailored educational intervention is useful in improving farmers' knowledge levels[14]. Likewise, another study found that educational intervention improved farmers' knowledge of pesticide poisoning and safe handling[15].

Nevertheless, further analyses revealed that farmers' knowledge scores in the intervention group decreased slightly on the third assessment compared to the second assessment. The Ebbinghaus forgetting effect might explain this result, which refers to the ability of the brain to retain memory over time[16]. The second and third assessments were conducted one-month and four-month post-intervention, respectively. In between, the movement control order (MCO) period in Malaysia lasted for three months due to the COVID-19 pandemic. During the MCO, all participants were restricted in their homes except for emergency activities and food purchases during the day. Participants stopped their routine activities, including farming and the application of pesticides. Hence, this may affect the participants' knowledge level in the interventional groups. Notwithstanding, the score at the third assessment for the interventional group remains significantly improved relative to their baseline score.

The educational intervention had a positive impact on participants' perceptions in terms of susceptibility, severity, the barrier to PPE application, the benefit of safety practices, and self-efficacy towards safe pesticide handling. These findings are consistent with previous studies[14,17], thus indicating that the present intervention could serve as a guide and initial step in formulating an effective educational programme to improve farmers' perception towards pesticide poisoning and safety practices. This is because a low level of perceived susceptibility and severity, a high level of perceived barriers with a low level of perceived benefit in safety practices, and a lack of self-efficacy in pesticide handling contributed to cases of pesticide poisoning among farmers[17]. In addition, improving farmers' perceptions of pesticide poisoning will significantly improve their safety practices and behaviour while handling pesticides[18]. Other factors that may affect safety practices such as the availability of personal protective equipment, humid and hot weather in certain countries, and the feasibility of purchasing expensive protective equipment also need to be considered[19,20].

Given the positive association between farmers' behaviour regarding safety practices in pesticide handling and their knowledge and perceptions towards pesticide poisoning[21], the present study investigated if farmers' safety practices were affected by the educational intervention. Participants' mean scores in the intervention group improved significantly relative to the control group. Nonetheless, minimal improvement in self-reported safety practices was detected in the control group, which can be explained by the Hawthorne effect[22]. Participants tend to provide the answers preferred by the researcher upon knowing they are being observed or questioned about actions they ought to have taken[22]. The repeated use of a similar self-reported questionnaire which may become familiar to the participants might also explain this finding.

Despite the significant improvement in the mean scores of participants from the interventional group, a few safety practices were still poorly practised such as the wearing of goggles (6.0%) and a respirator (6.0%). Notably, certain PPE such as chemical-graded respirators and goggles may be unavailable in rural areas, higher costs, and discomfort for farmers under hot and humid weather[20]. Overall, these results indicate that the two research objectives were achieved.

Strength and limitation

This study provides a very practical and feasible approach to conducting a locally tailored educational intervention for farmers based on the HBM aimed at improving farmers' knowledge level and perceptions towards pesticide poisoning and safety practices in pesticide handling. The intervention is cost-effective and can be easily implemented. Besides, this is the first interventional study based on the HBM to be conducted in the Samarahan Division. Thus, this study has exceptional potential in changing the behaviour of farmers towards better safety practices and reducing their exposure to pesticides.

Several limitations in the present study can be digested as opportunities for future research, particularly the use of a self-reported questionnaire for all the assessments and the limited follow-up period. Prospective and longitudinal studies with a longer follow-up may be used to evaluate the long-term impact of the intervention.

CONCLUSION

A locally tailored educational intervention based on the HBM significantly improved farmers' knowledge level and safety practices in pesticide handling. This study demonstrates that a community-based educational intervention is a feasible, comprehensive and effective method for improving the knowledge and safety practices among farmers to reduce short-term exposure to pesticides. Our findings could be a starting point for the local authority, as part of the effort to reduce the incidence of pesticide-related acute and chronic poisoning cases.

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