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EFFECTIVENESS OF A SIMPLE EDUCATIONAL TOOL TO PROMOTE SAFE USE OF PESTICIDES AMONG VEGETABLE FARMERS IN NORTHERN INDIA

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ABSTRACT

Aim: The study objective is to assess the effectiveness of an inexpensive and simple educational tool which was developed to provide education to vegetable farmers in India.

Methods: After developing a simple educational tool, its effectiveness was assessed by measuring change in mean scores of knowledge, attitude, practice (KAP) and in-home pesticide safety behaviour in households of farmers. Pictorial and simple to understand educational tool was provided and explained to enrolled farmers in intervention villages whereas no additional information was provided to farmers in control villages. A face to face interview based on a structured questionnaire was performed to collect quantitative data on knowledge, attitude and pesticide use and other practices utilised by the vegetable farmers. In-addition, in-home inspection as a component of pesticide risk behaviours was carried out in both the groups. Improvement in KAP and in-home inspection scores in intervention group was compared to control group at 1 and 3 months post intervention, to demonstrate effectiveness of educational tool.

Results: At baseline, both intervention and control group had low but similar KAP score ($P>.05$). At 1 month and 3 months after baseline, the intervention group was associated with statistically significant increase in knowledge, attitude, and practice scores, as well as significant increase in in-home inspection scores in intervention group.

Conclusion and discussion: We found that a simple, affordable and self-explanatory pictorial educational tool is not only effective in providing knowledge to farmers about safe use of pesticides but also has short to long term impact on improving behaviour for safe use of pesticide, which can help reduce health impact in the community.

Keywords: KAP, Pesticides, Vegetable farmer and Educational tool

1. INTRODUCTION

In recent years, there has been a steep increase in dependence on chemical pesticides which is more common and prominent in developing countries. This has led to widespread availability and hence use of pesticides by farming community, resulting in serious health problems not only to farmers and their families but also to environment [1]. It is estimated that 1.5 million pesticides are being manufactured worldwide per year with a total pesticide market of worth $ 30 billion [2]. On annual production of pesticide, India is number second in terms of its consumption after China [3]. India started its first pesticide production facility in mid of nineteenth century and now is producing more than 85000 metric tons of pesticides per year. The institute of Central Insecticides Board and Registration Committee (CIBRC) has registered more than 145 varieties of pesticides so far [4].

Pesticides exposure has been associated with a large spectrum of morbidity and mortality, ranging from unintentional exposure, accidental consumption, to occupational exposure in industrial settings and farming. [5]. Out of above, occupational exposure and poisoning in farmers is the most common mainly due to ignorance and impractical guidance for use of pesticides among farmers. Most of the safety equipment advised do not work in humid and hot environment, especially in country like India where farmers are not only economically marginalized but also have poor education and little information about health hazards of pesticides exposure [6,7]. Moreover, safety instructions on pesticide containers are difficult to follow, often written in unfamiliar languages, which many farmers are unable to follow [8,9] Since there is no formal or informal advice available to farmers on use of pesticides by either manufacturers or sellers, farmers and their family members run the highest risks of pesticide exposure as they directly come in contact with the pesticides during various processes of its application like mixing, spraying, storage and disposal. Pesticide residues are not only found on farmers, but also in their house holds as they usually carry the residue back to their houses due to wrong practices on use of pesticides. Due to lack of resources and training programs for agricultural community by governments in developing countries, coupled with illiteracy among farming community, there is no way to ensure safe use of pesticides. Hence, pesticide poisoning is a major problem among poor rural populations where men, women, and children all work and live in close proximity along with pets. [10]

In past, there have been several studies and methods proposed to reduce pesticide exposure in farming communities. But all such methods have not been successful due to their expensive nature and non-availability to farmers, especially in rural settings. In 1985, the UN Food and Agricultural Organization (FAO) initiated a voluntary code of conduct, but lack of adequate

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government resources in the developing world has made this code ineffective and thousands of deaths continue even today. Though WHO tried to limit the access to highly toxic pesticides, but this measure has failed in many parts of the world due to illegal trade practices. [6].

Educating farmers with such measures that utilize local resources available in the area and tailored to local environment needs could be considered as one of the best methods to curb the indiscriminate and harmful use of pesticides [11]. In the past, there have been multiple efforts to educate farmers, by developing various educational and behavior change model for the farming community [12]. These educational interventions like small books, video tapes and recorded lecturers although were meant to educate farmers they seem to be too time consuming and effort oriented [13,14]. The challenge is not only to develop an affordable tool which could identify hazards associated with pesticide use, but it should be self-explanatory like a pictorial tool which needs minimal explanation [15]. In addition, this education tool should also have some utility and must address local issues of farmers effectively addressing workplace pesticide safety [16]

2. MATERIAL AND METHODS

2.1 Study Methodology and Activities

The study design was quasi-experimental where head of family from one farming household is selected for the study. This study was conducted in farming community in outskirts of Delhi, from October 2016 to February 2017. The vegetable farmers were recruited as intervention and control group using purposive sampling method from villages which were similar in their cultivation and farming practices throughout the year. After developing a simple and pictorial educational tool, its effectiveness was assessed by comparing the mean scores of knowledge, attitude, behavior and an assessment of in-home pesticide safety in households of farmers in both the study groups. The research was divided into three phases: preparatory phase, implementation phase and post implementation evaluation phase. A face to face interview based on a structured questionnaire was performed to collect quantitative data on knowledge, attitude and pesticide use practices utilized by the vegetable farmers. In-addition, scores were given on in-home inspection of environment and work activities as a component of pesticide risk behaviors by the study team/researchers at the beginning of study. Changes in scores in intervention group was compared to control group at 1 and 3 months post intervention to demonstrate effectiveness of educational tool.

2.2 Development of educational tool

A simple pictorial educational tool, which is easy to read and understand, was developed during preparatory phase of study. The intention was to capture accurate and useful representations of knowledge in the form of pictures that is easy to comprehend when imparting knowledge on safe use of pesticides to farmers. This was intended to make the process of understanding easier because it is a visual expression. Based on past research studies on the knowledge gaps among farmers for safe use of pesticides in similar farming communities [15] and using guidance and experience of experts in India, an affordable and self-explanatory pictorial educational tool was prepared using help of professional sketch artist, during the month of Jan-Feb 2016. Finally, an educational poster was printed in the form of a wall calendar (educational tool) (fig. 1) so that it could also be made useful for the household throughout the year. Educational tool was prepared in 2 different sizes and posted on intervention village household walls depending on area available and visual aesthetics.

Figure 1: ***Pictures of Educational Tool***

2.3 Sample Size

An earlier study done in India, [14] found an average baseline KAP score of 30.88 +/- 10.33 which improved after imparting education significantly ($P < 0.001$) at first follow-up to 45.03 +/- 9.16 and at second follow-up to 42.9 +/- 9.54. Using information from this study, and in order to

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detect a true difference between the intervention and control groups, the sample size of 25 subjects per group was considered to be sufficient, with power of 90 and confidence level of 95%. However, since we needed to power the study for practice score which is most critical for effectiveness of an educational tool, we needed 40 subjects per arm. Anticipating a 20% dropout, we planned to enrol 50 farmers each from separate intervention and control villages.

2.4 Data Analysis

Descriptive statistics including frequencies and percentages were used for demographic and occupational data. Mean and Standard deviation were used for scoring knowledge, attitude, practice and in-home behavioral changes related to occupational pesticide safety. Chi-square test, t-test, and paired-t test was used to evaluate differences of characteristics between intervention and control groups and to evaluate changes of participant's knowledge, attitude, practices and in-home behavior.

Repeat measure analysis was done for dependent variables and *p*-value was calculated for 95% CI. The proposed study includes one baseline and 2 follow-up data collections. Some outcome variables are continuous, some are dichotomous. The primary goal of data analysis was to quantify and test statistical significance of the effect of the intervention on the outcomes at follow-up 1 and follow-up 2 (as compared to baseline). For continuous outcomes, linear mixed model was constructed, which accounts for repeated measures and which enables evaluation of intervention effects at each follow-up time. For dichotomous outcomes, generalized linear model was constructed. All models were adjusted as appropriate for independent variables which exhibit differences between the control and intervention groups at baseline.

2.5 Ethical Consideration

The study protocol was approved according to Chulalongkorn University guidelines for the protection of human subjects. Furthermore, written informed consent was obtained from the farmer participants prior to conducting any study-related procedures and all information collected was kept confidential by using numbers and codes during analysis.

3. RESULTS

3.1 Study Subjects:

The study enrolled 96 study subjects from 4 villages, out of which a total of 90 subjects complete the study and were followed up to completion of study. 44 subjects completed study from intervention villages and 46 subjects completed all study follow up from control villages. Below are the details of study subjects enrolled from each village, who completed entire study duration.

Table 3.1: Study subject's enrollment within study village.

	Village Name (Intervention/ Control)	Frequency	Percent	Cumulative percent
1	Ibrahim Majra (intervention)	39	43.3	43.3
2	Gopalpur Khadana (intervention)	5	5.6	48.9
3	Puthri (control)	24	26.7	75.6
4	Barawad (control)	22	24.4	100
TOTAL		90	100	

3.2 Data Analysis at Baseline

Independent t-test for continuous data on KAP and in-home behaviour scores was used to compare outcome of measurement between control group and intervention group at baseline. Table 3.2 below depicts mean scores on Knowledge, attitude, practice and in-home behaviours before the start of study. Though there were no differences at baseline between study groups, however baseline knowledge score of study subjects was found to be lowest. Out of total possible score of 26, study participants gave correct response to 40% of questions, on an average. This was followed by attitude and practice scores, which ranged between 40-60% of total score at baseline. For in-home assessment, we found an average of 66% correct safe pesticide practices being followed at home, which was similar in both intervention and control groups.

Table 3.2: Total knowledge, attitude, practice and in-home assessment scores by study group at baseline

Total Score	Control (n=46)		Intervention (n=44)		*p*-value
	Mean	SD	Mean	SD	
Knowledge Score	9.9	1.9	10.3	2.5	.426
Attitude Score	85.2	4.0	84.7	3.7	.501
Practice Score	87.9	3.2	87.1	3.4	.594
In home assessment Score	8.0	1.0	7.8	.99	.398

Independent t-test

3.3 Effectiveness of educational tool:

Repeated-measures analysis of variance and multilevel models for knowledge, attitude, practice and in-home assessment for pesticide use was performed and results of intervention effect is

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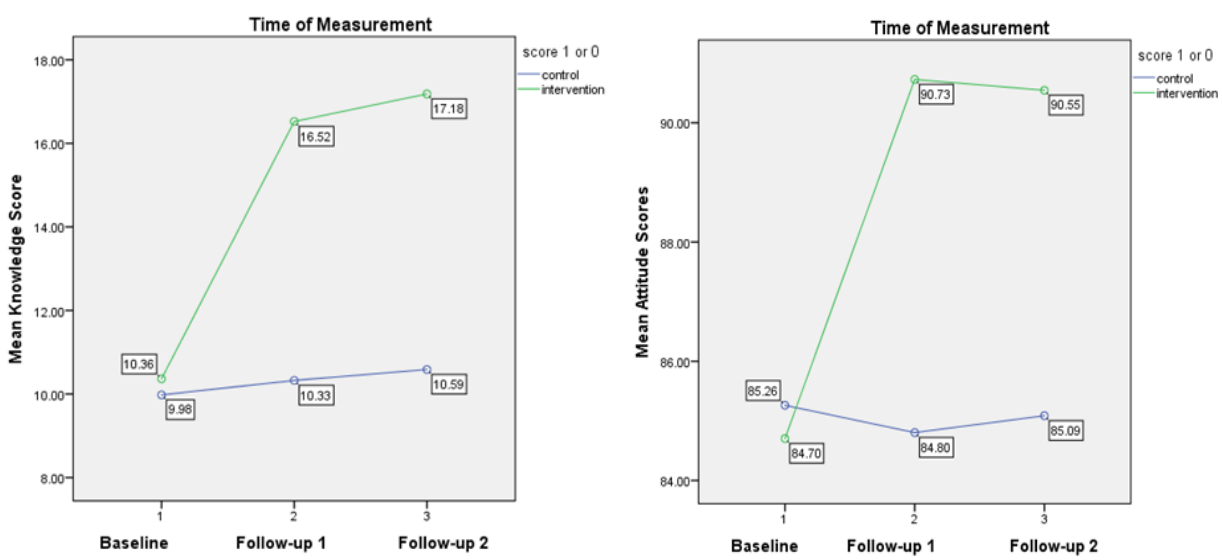
presented in Figure 2 and 3 below. General Linear Model repeated-measures ANOVA was used to assess overall effect of intervention in knowledge of insecticides use. Possible knowledge score was between 0 to 26 points. Overall effectiveness of educational tool was found to have statistically significant effect on knowledge score ($p<0.001$) in repeated- measures analysis of variance (Wilks' Lambda from Multivariate test). We found an overall improvement of 23.8% in knowledge level due to intervention. Similarly, out of total attitude score of 0–135 points, average attitude score in the control group (85.26 points) was found to be similar to attitude score in the intervention group (84.7 points) at baseline. At follow-up 1 (one month after the educational tool intervention) we found that average attitude score of farmers in the intervention group rapidly increased to 90.73 points much higher than attitude score of subjects in the control group. The attitude score in the intervention group was found to be further maintained (90.55) at follow-up 2 (three months after the educational tool intervention). However, there was no change in attitude score from baseline in farmers in the control group of study.

Figure 2: Mean attitude score for Knowledge (left) and attitude (right) in intervention and control groups at baseline, follow-up 1 and follow-up 2 (unadjusted)



Similarly, we also observed effectiveness of educational tool in not only "improvement in practices score" from baseline, but also in "in-home safe pesticide behavior", as represented in figure 3 below. Out of total "practices score" of 0–108 points at baseline, average "practices score" in the control group (87.96 points) was similar to "practices score" in the intervention group (87.14 points). After subjects in the intervention group received the educational tool, at follow-up 1 (one month after intervention) we found that average

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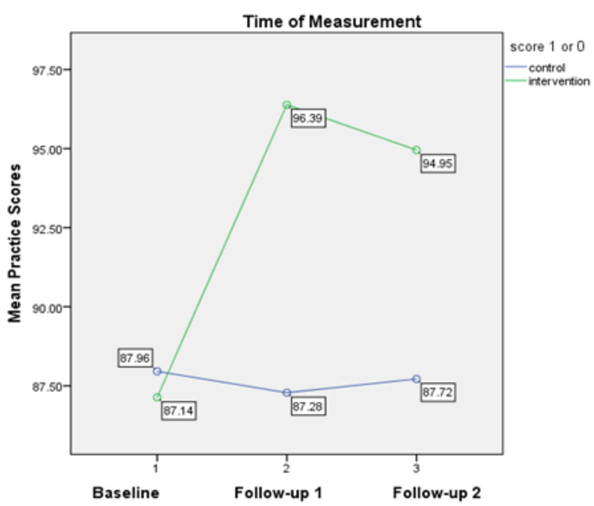
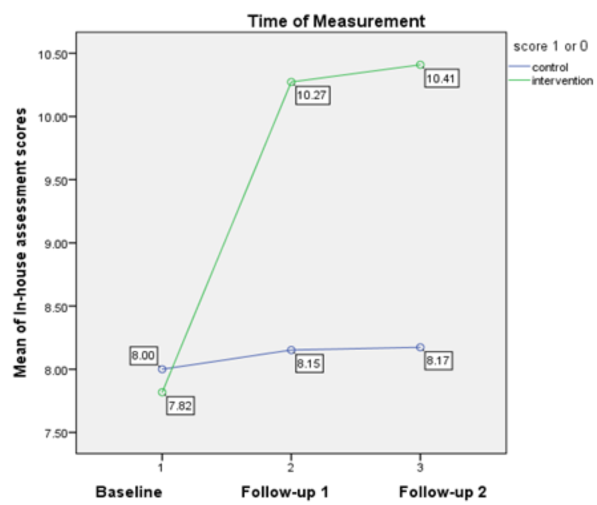
practices score of farmers in the intervention group was rapidly increased to 96.39 points much higher than "practices score" of subjects in the control group (87.28, similar to baseline levels) . At follow-up 2 (three months after intervention), "practice score" in intervention group was maintained at 94.95 points, indicating sustained effect of educational tool intervention even after 3 months. However, there was no change in practice score from baseline in farmers in the control group of study.

Similarly, for in-home safe pesticide behavior, we observed an increase in score from 7.82 points at baseline to 10.41 in intervention group at follow-up 1 which was a statistically significant increase compared to subjects in control group who showed no improvement in observed behavior. This increase in score in the intervention group was found to be maintained even at follow-up 2.

Figure 3: Mean score for practice (left) and in-home behaviour (right) in intervention and control groups at baseline, follow-up 1 and follow-up 2 (unadjusted)





As indicated in table 3.3 below, a highly significant positive change in scores was observed due to intervention effects on knowledge, attitude, practice and in-home assessment score in the intervention group as compared to the change in scores in control group.

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Table 3.3: Overall test of intervention effects on knowledge, attitude, practice and in-home assessment score in intervention and control groups at baseline and follow-up 1& follow-up 2 (unadjusted).

Parameter	Type III Sum of Squares	df	Mean Square	F	*p*- value
Knowledge	737.2	2	368.6	220.5	<0.001
Attitude	473.1	2	236.5	45.7	<0.001
Practice	989.4	2	494.7	96.1	<0.001
In-home Assessment	989.4	2	494.7	96.1	<0.001

Test of Within-Subjects Effects in General Linear Model repeated-measures ANOVA

4. DISCUSSION

Pesticides are now being used extensively throughout the world. They play a very important role in meeting not only global food requirements but also other industrial requirements like cotton, jute, tobacco etc. However, these pesticides do have harmful effects on un-protected agricultural workers when they get exposed mainly through contamination of the skin, lungs and the gut. The public health issue of pesticide exposure is further complicated due to unregulated and excessive use of pesticides mainly in developing countries by poor and marginalised farming community, who have no formal knowledge and knowhow to protect them from harmful effects of pesticide use. Exposure to pesticides has been shown to be one of the most important occupational risks among farmers in developing countries by many researchers in past [17, 6, 7]. Misuse of highly toxic and cheap pesticides, coupled with a weak or absent legislative framework for the use of pesticides, is one of the major reasons for the high incidence of pesticide poisoning in developing countries [6]. Poor education levels of the rural farming population, lack of information and training on pesticide safety, poor spraying technology, and inadequate and unaffordable personal protection during pesticide use have been reported to play a major role in the inadvertent exposure to pesticides [18,19].

Elements of unsafe use of pesticides that have been identified in previous studies include erroneous beliefs of farmers about pesticide toxicity, lack of attention to safety precautions during handling, environmental hazards of these chemicals, and information about health ill effects [18,20,21,22,23,8,9]. Extensive use of domestic utensils, broken equipment for measuring and dispensing pesticides and use of bare hands for handling pesticides is often seen in rural settings.

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In view of the above, it becomes very important and imperative that the potential hazards of unsafe pesticide use should be clearly communicated to the farmers along with pesticide use and management practices which are easy to understand and adoptable by the community. In past, many researchers have not only emphasized the need to increase the awareness of farmers about the consequences of unsafe pesticide use but also the importance of communication and education programs aiming to reduction of risk [24,25,26,27]. However, these interventions were resource intensive and need continuous insolvent of farmers. In our current research, we saw a need to develop a self-intuitive educational tool, which could provide basic awareness on adverse health effects and impart knowledge on safe use of pesticides, in the form of a simple pictorial educational tool, along with correct information on some of the prevalent wrong practices used for spraying, storage and destruction of pesticides at home by farmers.

We developed a simple educational tool for the purpose and tested its effectiveness in small vegetable farming community in northern India. We found the tool to be highly effective in not only increasing knowledge, attitude and practice scores but also information being translated into change in behaviour which is confirmed by in-home assessment of safe pesticide use behaviour.

5. CONCLUSION

We found that a simple, affordable and self-explanatory pictorial educational tool can be effective in not only providing knowledge to farmers on safe use of pesticides but also has short to long term impact on improving safe use of pesticide behaviour, which can help reduce health impact in the farming community**.** Through current study, we demonstrated that an inexpensive, self-explanatory and passive education tool can be successful in improving the knowledge, attitude and practice of the farmers for long duration. Successful outcome of this research will motivate pesticide manufacturers to undertake use of inexpensive educational tool in order to promote the safe use of pesticides and minimize occupational hazards to farmers.

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