Original Research Article

Quasi-Experimental Study on Pesticide Usage among Farm Workers in Rural South India: A Methodology Paper

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Abstract

Synthetic pesticides are commonly used in agriculture to manage pests and protect crop yields. However, improper handling and use of these chemicals pose significant risks to farm workers, leading to health hazards and even fatalities. This methodology paper outlines a project aimed at assessing the awareness, attitude, and practices of farm workers regarding the safe usage of pesticides in rural south India and to evaluate the effectiveness of an educational intervention designed to improve safety. A quasi-experimental pre and post-test will be used to evaluate the knowledge, attitude of farm workers and their practice of handling pesticides in their daily life following an educational intervention for a period of 6 months. The study will involve a baseline assessment through questionnaires, followed by the development and implementation of an educational intervention through a targeted educational module tailored to the identified knowledge and practice gaps. The module will then be implemented in workshops, and its effectiveness will be measured through pre- and post-intervention assessments. The ultimate goal is to promote safer pesticide handling practices and improve farm workers' overall awareness and attitudes toward pesticide safety. This paper describes the methodology in detail and submits results of the pilot study conducted using the developed questionnaire.

Keywords: pesticide safety, educational intervention, farm workers, rural south India

Introduction

The extensive use of synthetic pesticides in agriculture has helped reduce crop losses and improve productivity; however, it also poses significant health and environmental risks, particularly for farm workers who handle these chemicals. Accidental pesticide poisoning is a major public health concern, especially in southern and southeastern Asia, where fatalities related to pesticide exposure remain alarmingly high[1,2]. In Tamil Nadu alone, 1,648 deaths due to accidental intake of pesticides were reported in 2021[3].

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The lack of knowledge about safe pesticide handling practices, improper storage, and incorrect disposal methods contribute to these health risks[4,5]. Therefore, increasing awareness and promoting safer handling practices among farm workers is critical. This study aims to assess the current levels of awareness and practices related to pesticide safety in rural Tamil Nadu and to evaluate the effectiveness of an educational intervention in improving these practices.

Synthetic pesticides play a crucial role in agricultural practices, helping to control pests and prevent crop damage. However, the unintentional acute pesticide poisoning among farm workers is a grave concern in southern and southeastern Asian countries[6,7]. Tamil Nadu has reported alarming statistics regarding pesticide-related fatalities, indicating the urgent need for improving the knowledge and practices surrounding pesticide usage among farmers[8]. Enhancing awareness and safe practices is essential to preventing such incidents.

Aim

To improve awareness, practices, and attitudes toward the safe usage of pesticides among farm workers in rural Tamil Nadu through an educational intervention.

Objectives

1. Assess the knowledge, attitudes, and practices (KAP) regarding the safe handling of pesticides among farm workers.
2. Create an educational module based on the identified knowledge gaps and unsafe handling practices.
3. Provide an educational intervention aimed at improving knowledge, attitudes, and practices related to safe pesticide handling and storage.
4. Measure the effectiveness of the educational intervention post-intervention, particularly changes in knowledge, attitudes, and practices after six months.

Methodology

Study Design: This is a community-based, quasi-experimental study which wasconducted to assess the knowledge, attitude, and practice (KAP) regarding the safe use of pesticides among farm workers in rural Tamil Nadu. The study is divided into two phases: a pre-intervention baseline assessment followed by an educational intervention, with subsequent evaluations to measure the impact of the intervention.

Study Setting: The study was conducted in the K.V. Kuppam block under the Rural Unit for Health and Social Affairs (RUHSA). The K.V. Kuppam block is a 100% rural block, selected for its predominantly agrarian population, who are regularly exposed to chemical pesticides in their work. The K V Kuppam block is divided into 18 peripheral service units (PSUs) for provision of primary health services to the community. Each PSU caters to a population of about 7000 and helps in reaching out to the people in the entire block. There are about 108 villages and hamlets in the entire block and the study was conducted in 10 randomly selected villages from the block.

Participant Recruitment

Sampling Frame: A list of farm workers and aides who use pesticides was generated from 10 randomly selected villages in the K.V. Kuppam block. Participants were selected through a stratified random sampling technique. A preliminary meeting was scheduled with the Block Development Officer and Agricultural Extension Officer (AEO) to discuss the project objectives and ensure their support for community engagement. A list of farmers and farm workers was generated from the pesticide procurement records of local pesticide shops, as well as community informants. Eligible participants are those who spray, mix, or store pesticides in their farming activities. From each of the 10 selected villages, 20 participants were randomly selected, leading to a total of 200 participants.

Inclusion Criteria:

Adults (18+ years) who are farm workers and use chemical pesticides.

Permanent residents of the K.V. Kuppam block.

Those who have lived in the area for at least one year.

Consent to participate in the study.

Exclusion Criteria:

Adults with mental disabilities that impair comprehension.

Sample Size Calculation:

For the pretest evaluating baseline knowledge, attitude and practice – Based on previous studies reporting a 42% awareness level of pesticide safety among Indian farmers, a sample size of 147 participants was calculated assuming 8% margin of error. Considering a 25% non-response rate, a minimum of 183 participants were needed for the study. It was decided to recruit 200 participants (20 from each village from the 10 randomly selected villages) for this study. The formula used for calculation of the sample size using the above prevalence (or proportion of people with awareness of use pesticide use) was:

$n=p(1-p)(Z/E)^2$,

where n = sample size required, p = proportion of the event in the population, Z = values from standard normal distribution reflecting the confidence level that were used (usually Z value for 95% confidence interval is 1.96) and E is the desired margin of margin of error.

For the post-test evaluation of effectiveness of educational intervention – For the assessment of the effectiveness of the educational intervention aimed at improving knowledge regarding safe pesticide usage, a sample size calculation was performed to determine the number of participants needed to achieve sufficient statistical power. The primary outcome measure is the improvement in knowledge level, which we anticipate was reflected as a 20% increase from the baseline knowledge level of 48.3% as determined by pretest results. The sample size required for showing the effectiveness of the educational intervention was 210 assuming a 20% improvement of baseline knowledge. It was calculated as follows -

Sample Size

$$n = \left(\frac{Z_{1-\alpha/2} + Z_{1-\beta}}{ES} \right)^2$$

The sample size required for the study can be calculated using the formula:

Where:

$Z1-\alpha/2$ is the z-value for the desired confidence level (for a 95% confidence level, this is typically 1.96).

$Z1-\beta$ is the z-value for the desired power (for 80% power, this is typically 0.84).

$$ES = \frac{|p_1 - p_2|}{\sqrt{p(1-p)}}$$

ES is the effect size, calculated as:

Where:

p1 is the proportion of participants with adequate knowledge before the intervention (baseline level).

p2 is the proportion of participants with adequate knowledge after the intervention (baseline level + 20% increase).

p is the average of p and p2.

Calculating Parameters

Baseline Knowledge Level: p=0.483 (from the pretest study results)

Expected Post-Intervention Knowledge Level: p2 =20% of p1 = 1.2*0.483 = 0.5796

Average Proportion p: (p1+p2)/2 = (0.483+0.5796/2= 0.5313

Effect Size Calculation: using the formula for effect size and substituting the values, ES = 0.097/0.499 = 0.194

Sample size : The required sample size using the above formula with a 20% improvement in outcomes is calculated as follows -

For a 95% confidence level $Z1-\alpha/2=1.96$

For an 80% power $Z1-\beta=0.84$

Sample Size = $(2.8/0.194)^2$ = 208.3. We took 210 as the final sample size to have enough power to show the effectiveness of the educational intervention by at least 20% from baseline.

Data Collection Tools

Questionnaire: The questionnaire was modified from standardized KAP instruments in the literature was adapted from a study done by Rostami F et al[9]

among Iranian farm workers. The questionnaire had a content validity ratio (CVR) and content validity index (CVI) as 75% and 79% in the study. The Cronbach alpha for the knowledge attitude and practice questions were found to be 0.70, 0.71, and 0.79 respectively. The English questionnaire was translated into Tamil and back translated into English by two independent members to verify for the meaning and context and was discussed among the community health workers to check for the correctness of colloquial language to make it comprehensible among the local population. Few modifications were made after the pilot study based on the farmer's suggestions.

Questionnaire had 5 sections –

Section 1 Sociodemographic details

Section 2 Questions on farming practices of the community

Section 3 Knowledge of the farmers on safe pesticide usage

Section 4 Attitude of the farmers on safe pesticide usage

Section 5 Practice of the farmers on safe pesticide usage

The questionnaire will assess:

- Knowledge of pesticide safety
- Attitudes toward safe pesticide handling
- Practices related to pesticide usage

The questionnaire was administered by trained research assistants. Depending on literacy levels, it was either be self-administered or delivered through an interview.

Educational Intervention

Based on the findings of the baseline KAP assessment, an educational intervention module was designed. The intervention consist of:

A 20-minute video on the safe handling, storage, and use of pesticides.

A 30-minute demonstration of best practices.

A 20-minute participatory advocacy session to encourage safe pesticide use.

A 30-minute hands-on training at five stations (purchasing, storage, mixing and disposal, spraying, and post-use hygiene).

Pamphlets were also distributed, summarizing key messages from the educational sessions.

Post-Intervention Evaluation

Immediate Post-Test: A post-test was conducted at the end of the educational sessions to assess changes in knowledge and attitudes.

Follow-Up After Six Months: A follow-up assessment will measure changes in pesticide handling practices to evaluate the long-term impact of the intervention.

Methods to Minimize Bias

To ensure consistency, all questionnaires were administered by the same trained research assistants. The educational intervention was delivered to participants from the same community where the pretest was conducted, thus minimizing interviewer bias.

Data Analysis

Descriptive Statistics: The baseline KAP data was analyzed using descriptive statistics, including means, medians, and standard deviations for continuous variables and proportions for categorical variables.

Bivariate Analysis: Chi-square tests were used to assess the association between demographic variables and knowledge, attitudes, and practices. Odds ratios and p-values were calculated to identify significant relationships.

Pre-Post Comparison: Paired t-tests were used to compare mean knowledge and attitude scores before and after the intervention. Changes in practices will be analyzed using proportions.

Timeline of the Study

Participant Recruitment and Baseline Survey: 8 months

Data Analysis of Baseline KAP: 2 months

Development of Educational Module: 2 months

Educational Intervention (Workshops): 8 months

Post-Test and Long-Term Follow-Up: 6 months

Final Data Analysis and Reporting: 2 months

Status of the study and results

The baseline questionnaire was administered to 200 participants , who will be recruited after getting their informed written consent from selected 10 villages in the local community. The results of the baseline data was analysed to model the intervention content and delivered using the methods described earlier. This was followed by an endline intervention among 210 participants from the same local community but selected randomly from those who attend the educational intervention sessions.

The results of the pilot study conducted among 50 farm workers including farm hands, farmers, and persons associated with purchase, storage, handling and disposal of pesticides are presented in this paper. Participants were recruited into the study between Nov 2023 to June 2024. The results are as follows –

The mean age of the participants was 56.72±14.56 years; the median age was 60 years with the minimum age being 30 years and the oldest being 83 years of age. 64% of the participants were males and 28% has no or primary level education.

Table 1: Knowledge of the farmers on safe pesticide usage:

		Yes	No
Knowledge on PPE usage:	Gloves	26 (52%)	24 (48%)
	Workwear	29 (58%)	21 (42%)
	Boots	11 (22%)	39 (78%)
	Face shield	20 (40%)	30 (60%)
	Respiratory protection	7 (14%)	43 (86%)
Knowledge on ways of entry of pesticides into the body:	Hand	21 (42%)	29 (58%)
	Skin	20 (40%)	30 (60%)
	Inhalation	27 (54%)	23 (46%)
	Eyes	28 (56%)	22 (44%)
Correct Knowledge on safe disposal of pesticides		20 (40%)	30 (60%)
Correct Knowledge on storage of pesticides:		18 (36%)	32 (64%)

Table 2: Attitudes of the farmers regarding safe pesticide use

Attitude	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
PPE not required when used in little amount	10(20%)	4(8%)	6(12%)	17(34%)	13(26%)
Pesticide mixing should be done outdoors is important	18(36%)	17(34%)	1(2%)	2(4%)	12(24%)
High quality pesticide are not dangerous	2(4%)	3(6%)	6(12%)	22(44%)	17(34%)
Using pesticide is essential and necessary	17(34%)	18(36%)	3(6%)	9(18%)	3(6%)
Exposurebathing is not required, and changing clothes is enough	18(36%)	7(14%)	2(4%)	18(36%)	5(10%)
Personal protective equipment is important to prevent the body from pesticide	4(8%)	7(14%)	6(12%)	20(40%)	13(26%)
Bathing immediately after using pesticide, decrease poisoning	22(44%)	22(44%)	0(0)	3(6%)	2(4%)
Smoking during pesticide increase pesticide entrance to the body	20(40%)	16(32%)	7(14%)	6(12%)	1(2%)
During use of pesticide drinking and eating is not a problem	8(16%)	2(4%)	5(10%)	18(36%)	17(34%)
Using personal protective equipment is not easy when using pesticide	2(4%)	28(56%)	6(12%)	7(14%)	7(14%)
The sprayer tanks can be washed in a river or waterway without damage	10(20%)	11(22%)	0	19(38%)	10(20%)
Pesticides only have lethal effect on pest	6(12%)	8(16%)	10(20%)	21(42%)	5(10%)

Table 3 Practice regarding safe pesticide use

Practice with regard to PPE	Always	Almost	Sometimes	Never
I wear mask when I am using pesticides	24(48%)	10(20%)	9(18%)	7(14%)
I wear gloves when spraying pesticides	19(38%)	7(14%)	10(20%)	14(28%)
I wear glasses when spraying pesticides	6(12%)	2(4%)	9(18%)	33(66%)
I always wear long sleeved shirt when spraying	26(52%)	8(16%)	9(18%)	7(14%)
I always wear foot cover/foot wear	6(12%)	7(14%)	9(18%)	28(56%)

Discussion

Conducting the pilot study and analysing the results provided us with insights and understanding of process of pesticide usage and the reasons for unsafe use, inadequate knowledge and indifferent attitudes at multiple levels which helped us in designing the intervention using methods to target all levels and groups.

We identified the workflow that occurs during the process of pesticide spraying in different settings and scenarios. We found participants were mostly unaware with safe handling and usage of pesticides, specifically use of personal Protective equipment (PPE) like glasses, gloves and footwear. We found that women in the household are also involved in the process of mixing the pesticides, though they don't know the name or the nature of the pesticides and are not involved in purchasing. We also found there were separate farm labourers who were designated for this job. Though all the farm labourers were exposed to pesticides at point in time of spraying not all of them are involved in spraying. So, we could clearly identify four levels involved in safe handling for targeting the contents of the health intervention, i.e., at the level of buying, level of storage and mixing, level of spraying and usage and after use and safe disposal. Each of these levels or steps are manned by different individuals in a family or a community. For example, buying is done by the landowners/farmers who are usually men while mixing and storage are done at the household level which involves women of the household and spraying is done by a separate group for farm labourers each with different levels of exposure, knowledge and understanding. The intervention will be designed keeping all these facts in mind specifically targeting these different stations and levels. We will thus design the intervention which specifically demonstrates the safe use of pesticides at different levels and use techniques like video shows, demonstrations, participatory advocacy and a hands-on training at five stations for reinforcing the safe use of pesticides and reach all types of farm workers and handlers of pesticides.

Conclusion

This study seeks to address the critical gaps in awareness and practice regarding pesticide safety among farm workers in rural Tamil Nadu. This methodology paper outlines a comprehensive plan to assess and improve the awareness and practices of safe pesticide usage among farm workers in rural Tamil Nadu. By implementing a structured educational intervention, this study aims to enhance the knowledge and attitudes of participants, thereby potentially reducing the incidence of pesticide-related health hazards. This paper provides insights to new researchers in this field to help design and implement an effective intervention program for improving awareness and practice of pesticide usage in the community.

Limitations and Strengths

Being a quasi-experimental pre-post study, the individual participants have not been randomised and therefore there may be some inherent biases in gender, age group and socio-economic status. The participants of pretest and post-test are randomly selected at both time points, so this study may not be able to state that the knowledge, attitude and practice (KAP) of the same individuals have changed/ improved; however it reflects a general change in the KAP of the community. Since this a methodology study, it does not provide results from the study but a snapshot of the findings from the pilot study to reveal the trends. This may be helpful for researchers to implement the same in a different setting but they may have difficulty comparing outcomes as this is not

stated within this paper. This study describes in detail about the methods of how the study was conducted and this can be used for successful implementation of an educational intervention program.

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Ethical Clearance: The research study has been approved by the Institutional Review Board (IRB) which includes the scientific and the ethics committees, IRB Mo. 15493 [OTHER] dated 28.06.2023 and further amended to include the interventional module developed after the analysis of pre-test results, dated July 30, 2024.

Conflicts of interest: The authors declare no conflict of interests

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