Research Article

Study on awareness regarding hazards of organophosphorus poisoning among agricultural workers who are at risk of exposure to organophosphate pesticides in Kurnool District, Andhra Pradesh

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ABSTRACT

Background: Agricultural workers are at high risk of exposure to organophosphate pesticides (OPs). Farmers are using OPs frequently without having any safe handling practices. Improving their knowledge and perception regarding organophosphate poisoning can give rise to a drastic reduction in morbidity and mortality due to OP poisoning. **Objectives:** The objectives of this study were (i) to assess the awareness about hazards of organophosphorus poisoning, (ii) to educate about the protective measures while handling pesticides, and (iii) to educate about first aid measures after accidental exposure to pesticides. **Materials and Methods:** A community-based longitudinal study was carried out from September 1, 2015, to January 31, 2016, among agricultural workers using pesticides in their farm of seven villages of Kurnool District. All study subjects were interviewed using a pre-tested semi-structured questionnaire. Health education was given in two sessions with a gap of 2 weeks using audiovisual aids, posters, and flip charts. Each session lasted for 3 h in each village. Post-test was conducted 1 week after the last session. **Results:** A total of 230 subjects were using pesticides in their farm. Their knowledge levels regarding route of entry through contact 0%, inhalation 20 (8.69%) and ingestion 74 (32.17%) respectively in baseline study; which significantly improved to 82 (35.65%), 132 (57.39%) and 230 (100%) respectively in Post-test. Before educational intervention 52% were aware about usage of personal protective equipment during application of pesticides which was significantly improved to 100% in post-test. In pre and Post-test the habit of storage of partially used and un used pesticide tins in households were 28% & 0% respectively. Awareness about the proper disposal of empty tins was (0) less in baseline study which increased significantly to (76%) after educational intervention. **Conclusions:** Overall awareness of agricultural workers regarding usage and toxicity of OPs was inadequate, which was significantly improved after health education. Frequent educational sessions are needed to improve their awareness regarding safe handling procedures.

KEY WORDS: Organophosphate Poisoning; Exposure; Agricultural Workers; Preventive Measures; Knowledge; Awareness

INTRODUCTION

Agriculture is vital to the Indian economy, where farmers' health is the nation's health. Agriculture contributes to 25% of gross domestic product. Agriculture sector constitutes 54.6% of the total workforce in India.[1] The UN Food and Agriculture Organization estimates that, in developing countries, pests, weeds, and disease destroy about 40% of crops, while they are still in the fields and 6–7% of crops after the harvest.[2] The increasing demand for agricultural products and the resultant commercialization of agriculture have induced a rising use of agricultural chemicals in India. Uttar Pradesh, Maharashtra, Andhra Pradesh, Punjab, and Haryana are the states that account for 70% of total pesticide consumption in India.[2] Andhra Pradesh and Telangana account for 24%

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of all the pesticide used in the country.[3] Organophosphate pesticides (OPs) are the most widely used and sold insecticides, which are predominately used to control pests in agricultural settings.[4] However, If not applied them without having any safe handling procedures, they can cause adverse health effects and environmental pollution, which are sometimes irreversible. Exposure of agricultural workers to pesticides is a public health problem worldwide. Acute pesticide poisoning accounts for significant morbidity and mortality worldwide, especially in developing countries. Around 1–5 million cases of pesticide poisoning are estimated annually among agricultural workers, most of them happen in developing countries.[5]

OP poisoning can occur due to intentional or unintentional; both are common in agricultural workers. Intentional due to easy availability of organophosphates to farmers and which is a common approach for committing suicides, attributing to the significant cause of morbidity and mortality in India. Unintentional exposure to these chemicals while spraying due to direct contact as they don't use personal protective equipment, lack of awareness regarding proper use of protective equipment and precautions while using hazardous substances and proper maintenance of its application equipment.

Farmers are also exposed indirectly drift from neighboring fields or by contact with pesticide residues on the crop or soil, which is often underestimated. The dermal and inhalation routes of entry are typically the most common routes of farmers' exposure to pesticides. Dermal exposure during usual pesticide handling takes place in body areas that remain uncovered by protective clothing, such as the face and hands. Farmers' exposure to pesticides can be reduced through less use of pesticides and the correct use of the appropriate type of personal protective equipment in all stages of pesticide handling.

Farmers' knowledge of pesticide use, as well as their perceptions concerning risks and safety, plays a crucial role in safe spraying operations in farms. We have encountered many OP poisoning cases in our causality who are not practicing any safe handling procedures and not aware of any first aid measures. Hence, we took up this study to assess the awareness about hazards of organophosphorus poisoning, to educate about the protective measures while handling pesticides, and to educate about first aid measures after accidental exposure to pesticides.

MATERIALS AND METHODS

Study Design

This was a community-based longitudinal study.

Study Period

The study duration was from September 1, 2015, to January 31, 2016.

Study Area

The study was conducted in Dinnedevarapadu, Mamidalapadu, Munagalapadu, Masamasjid, Kallur, Peddapadu, and Venkayapalle.

Study Subjects

Agricultural workers in seven villages who were using pesticides on their farm were selected for the study.

Sampling Method

All agricultural workers residing in these seven villages who have given informed consent were taken.

Type of Intervention

Health education was given by personal and group interviews using audiovisual aids, posters, and flip charts.

Ethical Issues

Ethical clearance was taken from the college Ethical Committee of Kurnool Medical College before starting the study properly. The purpose of the study was explained to all study subjects in their local language, and informed consent was taken.

Sample Size

The sample size was estimated According to a study done in Kuttanad, 78 percent of the pesticide applicators had reported adverse health effects due to pesticide spraying[6]. ($P = 78\%$, 20% allowable error and 95% confidence interval). This amounted to a total of 113 subjects. 230 study subjects were enrolled in the present study.

Inclusion Criteria

All agricultural workers in seven villages who have given informed consent and who are at risk of exposure to OPs were included in the study.

Exclusion Criteria

Farmers who were not at risk of exposure to OPs and who were not willing to participate in the study were excluded from the study.

Data Collection

All the agricultural workers residing in these seven villages were briefed about the study and written informed consent was obtained from each participant before the interview. All eligible study subjects were interviewed using a pre-tested semi-structured questionnaire to know their awareness regarding hazards of OP poisoning in agriculture fields, and

preventive measures before and during spray operations and first aid measures are taken immediately after accidental exposure. Data were collected by personal interview. Health education was given in two sessions with a gap of 2 weeks using audiovisual aids, posters, and flip charts. Each session lasted for 3 h in each village. During the intervention, the participants in seven villages were active and participated in all processes of the intervention, including listening, discussing, interacting, or explaining their experiences in using OPs. Post-test was conducted 1 week after the last session. This study helps to change the behavior of farmers, particularly to reduce OP exposure both at the workplace and at home.

Statistical Analysis

The analysis was performed with Epi-Info 7.2.2.2 version. Chi-square test was applied as a statistical test of significance. $P < 0.05$ was considered to be statistically significant.

RESULTS

A total of 230 subjects were included in this study, of which 108 (46.9%) were males and 122 (53.1%) were females [Figure 1]. Age ranges from 21 to 67. Their mean age was 37.5 ± 9.29 years. All of them are using pesticides on their farm. Table 1 shows the distribution of study subjects over age in groups of 10 years each. More number of study subjects enrolled in the age group of 31–40 years holding a total of 85 members which accounts for 36.96% of the total. Age group >40 years holds 78 (33.91%) members.

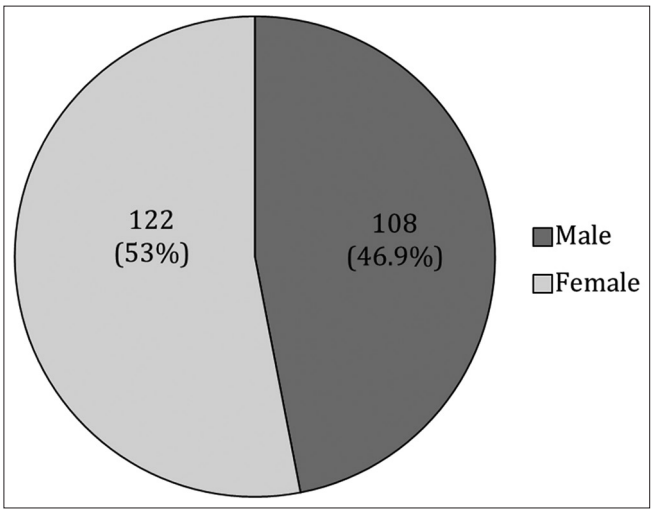

Figure 1: Distribution of study subjects by sex

Table 1: Age distribution of study subjects

Age group (years)	Total (%)
21–30	67 (29.13)
31–40	85 (36.96)
>40	78 (33.91)
Total	230 (100)

Before giving health education, nearly 33% were aware of modes of poisoning, which is improved to 100% after health education [Table 2]. With respect to knowledge of the entry route of pesticides into the human body, response given through contact, inhalation, and ingestion was 0, 21 (9.13%), and 54 (23.48%), respectively, which was significantly improved to 82 (35.65%), 132 (57.39%), and 230 (100%), respectively, in post-test [Table 3].

Knowledge about the use of protective measures of gloves, shoes, goggles, and mask was 79 (34.3%), 37 (16.08%), 15 (6%), and 53 (23%), respectively, and it is improved to 100% after educational intervention. Only 52% were aware of using any protective measures, which is significantly increased to 100% after health education [Table 4].

Initially, all the study subjects were unaware about changing clothes and cleaning of the body immediately after exposure to OP poisoning. Awareness levels significantly increased to 167 (72%) after the intervention. After OP poisoning, only 41 (17%) agricultural workers respond to take patient immediately to the hospital (government/private), 61 (26%) workers told that to take them to Risk Management Plan (RMP), and 128 (55%) farmer 's had misconceptions in first aid measures. After health education, nearly 199 (86%) were aware to take them to the hospital immediately after exposure. Taking them to RMP reduced to 13% (31). After education, all the misconceptions about first aid measures to farmer's were ruled out [Table 5].

Nearly 65 (28%) respondents stored the pesticide tins along with households. After educational intervention, none of them want to store the pesticide tins along with households. Nearly 142 (61%) subjects told that pesticide tins were stored separately and only 23 (10%) members reported that pesticide tins were stored in the field itself. The awareness levels increased significantly to 168 (73%) and 62 (26.9%), respectively [Table 6].

Regarding disposal of empty pesticide tins, nearly 103 (44.7%) members disposed them in the field itself, thrown them in to the dust bins 50 (21.3%), buried 33 (14.3%), sell them to workers by 14 (6%), use them for storing foods by 20 (8%) members, and thrown them to open places by 9 (3.9%), and only one person reported that they are using them in the bathroom after cleaning. Nobody was aware about that the empty tins must be disfigured immediately after using them and then buried. After education, 175 (76.08%) were aware of the proper disposal of empty pesticide tins [Table 7].

DISCUSSION

Knowledge of the route of entry of pesticides into the body is probably the first best line of defense. In the present study, nearly 33% were aware of the mode of poisoning: In that, awareness through the entry route of pesticides through inhalation and ingestion was 21 (9.13%) and 54 (23.48%), respectively, which

Table 2: Awareness of modes of pesticide poisoning

Awareness	Pre-test number (%)	Post-test number (%)	χ^2 value	*P* value
Yes	75 (32.61)	230 (100)	230.7638	0.00
No	155 (67.39)	0 (0)		
Total	230	230		

Table 3: Awareness on different modes of poisoning

Modes	Pre-test (%)	Post-test (%)	χ^2 value: (corrected)	*P* value
Inhalation	21 (9.13)	132 (57.39)	120.66	0.00
Ingestion	54 (23.48)	230 (100)	281.84	0.00
Contact	0 (0)	82 (35.65)	97.36	0.00

Table 4: Awareness regarding protective measures

Protective measures	Pre-test (%)	Post-test (%)	χ^2 value	*P* value
Gloves	79 (34.35)	230 (100)	221.82	0.00
Shoes	37 (16.09)	230 (100)	329.072	0.00
Goggles	15 (6.52)	230 (100)	399.92	0.00
Mask	53 (23.04)	230 (100)	284.46	0.00
Using any protective measures	119 (51.73)	230 (100)	143.67	0.00

Table 5: Awareness regarding first aid measures after poisoning

First aid measures after poisoning	Pre-test	Post-test	χ^2 value	*P* value
Remove clothes and body cleaning	0 (0)	167 (72)	259.05	<0.001
Take to hospital (government and private)	41 (17)	199 (86)	214.74	<0.001
Take to RMP	61 (26)	31 (13)	11.426	<0.001
Misconceptions in first aid	128 (55)	0 (0)	174.58	<0.001

RMP: Risk Management Plan

Table 6: Storage of pesticide tins

Storage of pesticide tins	Pre-test (%)	Post-test (%)	χ^2 value	*P* value
Storage along with house hold	65 (28.26)	0 (0)	73.38	0.00
Separately	142 (61.74)	168 (73.04)	6.68	0.009
In fields	23 (10)	62 (26.96)	21.95	0.000
Total	230	230		

Table 7: Disposal of empty pesticide tins

Disposal	Pre-test (%)	Post-test (%)	χ^2 value	*P* value
Use for storing food	20 (8.70)	0	18.87	0.000
Use in bathrooms	1 (0.43)	0	0.00	1.000 NS
Thrown into open place	9 (3.91)	0	7.25	0.007
Disposal in fields	103 (44.78)	0	130.15	0.000
Burring	33 (14.35)	31 (13.48)	0.07	0.78 NS
Burring after disfigurement	0 (0)	175 (76.09)	279.23	0.000
Sell them to workers	14 (6.09)	21 (9.13)	1.51	0.218 NS
Thrown into dustbins	50 (21.74)	3 (1.30)	45.12	0.000

NS: Not significant

was significantly improved to 132 (57.39%) and 230 (100%), respectively. Before giving Health education, all the study subjects were not aware that the OP poisoning can occur by just contact initially, this was improved in 82 (35.65%) members after health education and need further improvement. Only 52% were aware of using any protective measures such as gloves

(34.3%), mask (23%), shoes (16.1%), and goggles (6.5%), and this awareness levels significantly improved to 100% after intervention. The present findings indicate that most of the farmers are not aware of the appropriate precautionary measures such as wearing adequate protective devices required to protect themselves from o0rganophosphate poisoning before the educational intervention, and the awareness levels significantly improved after the educational intervention. Repeated sessions are needed to maintain the awareness levels and safe practices of using protective devices. Storing the pesticides near food and commodities results in the potential risk of unintentional exposure. The present study shows that, before giving health education, 28% of respondents stored the pesticide tins at their residence along with households. After educational intervention, none of the respondents wants to store the pesticide tins along with households at their residence. The awareness about the proper disposal of empty tins was zero in baseline study which increased significantly to 76% after the educational intervention. This study showed that almost half of the farmers disposed the empty pesticide tins into the field itself (45%), nearly 22% dumped these containers into dustbin, burying in 33 (14%), used for storing food items after cleaning them 20 (8.7%), sell them to workers by 14 (6%), thrown in to open place by 9 (4%), and one person used in washrooms after cleaning it as a mug. None of them were aware of the appropriate mode of disposal of empty tins, but awareness levels improved to 76% after educational intervention. None of them were aware of the appropriate mode of disposal of empty tins, but awareness levels improved to 76% after educational intervention.

A study was done by Lekei *et al.*[7] who reported that the knowledge of the routes of absorption included mainly dermal (75.2%) and inhalational (72.7%). About 10% indicated lack of knowledge of any route of absorption. Another study done by Esechi[8] revealed that the percentages of responses given for the same through dermal, nasal, oral, and ocular were 89, 14, 16, and 29, respectively. Sawalha *et al*.[9] showed that the farmers were at risk to effects of pesticides simply because they were not aware of inhalation and dermal absorption as entry points into the body. Esechi[8] showed that only 33% used personal protection equipment (PPE) during pesticide application. A study was done by Damalas and Koutroubas[10] reported that wearing of gloves was found to be the most effective protection against pesticide exposure among Danish greenhouse workers, and the practice reduced dermal exposure among US citrus farmers by 27%. Different studies show that inadequate use of protective gears has been a common practice in India.[11-14] Muñoz-Quezadaa *et al*.[15] showed that nearly 63% of farmers do not wear appropriate protective equipment during pesticide application and are completely contaminated. Meenambigai *et al*.[16] in Tamil Nadu revealed that most of the farmers (93.33%) did not follow any safety measures while undertaking spraying operation. These results are in agreement with the finding of Devi[17] who showed that only very few farm workers used protective clothing during spraying. Unsafe storage of pesticides is common among households in many developing countries where significant associations of poisoning incidence and pesticide storage with households (79%) have been found in a study done by Lekei *et al.,* 2014.[7] Similar kind of results was obtained in a Cambodian study where workers stored pesticides frequently inside their home.[18] A study done by Mohanty *et al*.,[19] South Indian study, showed that about two-thirds of the farmers were found to dispose of the empty pesticide containers indiscriminately and were not aware of safe disposal. Lekei *et al*., 2014,[7] showed the method of disposal of empty pesticide containers included burying ($n = 38$), burning ($n = 33$), dumping on the farm ($n = 25$), selling back to pesticide retailers ($n = 7$), and reuse for household purposes ($n = 8$). According to Sawalha *et al*.,[9] improper dumping of empty pesticide containers such as discarding these into immediate surroundings, into local waste bins, or even burying and reusing it at home can render danger to the environment and the general public. Mohanty *et al*.[19] showed that about two-thirds of the farmers in a study in South India were found that safely dispose of the empty pesticide containers indiscriminately and were not aware of safe disposal.

Strengths

The intervention in this study was specifically targeted that the precautions should be taken before exposure; reduce OP exposure and first-aid measures to be taken immediately after OP exposure. In addition, this study provides a starting point to change the behavior of agricultural workers, particularly to reduce OP exposure both at the workplace and home.

Limitation of the study is that this study is done in seven villages only and could not cover all the villages in the district.

Recommendations

This study recommends a multisectoral approach in trying to combat this problem. Prevention still appears to be the best modality of management.

- Agricultural policies must be formulated to reduce the use of pesticides to the lowest feasible level using accurate diagnosis and advanced knowledge of pest problems; this will reduce the number of agricultural pesticide poisoning and minimize the overall exposure to pesticides at the community level.
- Create clear and specific guidelines and protocols for selection of a pesticide product with minimum impact on the operator and optimization of the procedure of pesticide handling; strictly following the regulations and taking into account the public concerns with reference to pesticide residues in food and drinking water are essential.
- Operative and well-maintained spraying equipment and the necessary precautions at all stages of pesticide handling are essential for reducing farmers' exposure to pesticides.
- Community-based participatory training and education program to farmers in their local language and at relevant educational levels, on the handling and application

of pesticides and on the worker protection standards, are needed at frequent intervals till their knowledge improved to the optimum level.
- Intrinsic motivation, to enhance knowledge and to avoid misconception about the usage of PPE and first aid measures.
- Most of the farmers unaware of the proper disposal of empty tins. Government authorities must, therefore, embrace appropriate measures that may lead to safe disposal management.

CONCLUSIONS

Before health education, only 67% were aware of modes of poisoning, and different modes of poisoning through inhalation and ingestion were 20 (8.69%) and 74 (32.17%), respectively. None of them were aware of the mode of poisoning by mere contact. Using protective measures gloves, shoes, goggles, and mask was 79 (34.3%), 37 (16.08%), 15 (6%), and 53 (23%), respectively. All the participants were unaware about changing of clothes and cleaning the body immediately after exposure to OP poisoning. Overall 55% had misconceptions about first aid measures. Nearly 28% of members stored the pesticide tins along with households. Nobody was aware of the empty tins must disfigure initially and buried, but there is a significant improvement in almost all aspects of knowledge and perceptions about OP exposure in the follow-up assessment after providing the educational intervention.

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