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Factors associated with self-reported symptoms of acute pesticide poisoning among farmers in northwestern Jamaica

Ngqabutho M. Ncube, B.S.[1], **Christopher Fogo, B.Sc.**[2], **Patricia Bessler, MPH**[1], **Curtis M. Jolly, PhD**[3], and **Pauline E. Jolly, PhD, MPH**[1]

[1] Department of Epidemiology, University of Alabama at Birmingham, Birmingham, AL

[2] Westmoreland Health Department, Ministry of Health, Jamaica, West Indies

[3] Department of Agricultural Economics and Rural Sociology, Auburn University, Auburn, AL

Abstract

Pesticide poisoning is a major public health concern in developing countries. We conducted a population survey among farmers in three parishes of northwestern Jamaica to determine the occurrence of acute pesticide poisoning and to identify factors associated with pesticide poisoning. Approximately 16% of 359 farmers who participated in the study reported one or more incidents of acute pesticide poisoning within the last two years. Only 25% of the farmers reported ever receiving training in pesticide handling or safety. The majority (68%) of farmers who reported pesticide poisoning never sought medical attention for poisoning. The factors found to be associated with pesticide poisoning in this study indicate that implementation of specific intervention strategies and education of farmers is needed in order to improve safe handling, use and disposal of pesticides and reduce incidents of acute pesticide poisoning.

Introduction

The safe production and marketing of food is a major step towards food security. However, many farmers put themselves at risk from pesticide poisoning during the production process. This is a major public health concern, especially in developing countries where the most persistent and hazardous pesticides are used by untrained farmers.[1,2] Further, pesticides that are banned, unregistered or suspended in developed countries due to their toxicity and harmful health effects are often exported to developing nations.[2,3] Many of these highly toxic pesticides are applied by people with minimum or no training in safe application or storage of pesticides, and without suitable protective gear.[1,2] Many developing countries do not have effective monitoring systems in place to assess the extent of pesticide poisonings and the majority of cases are unreported.[4] Acute pesticide exposure can lead to death or serious illness. An estimated 99% of human pesticide fatalities occur in developing countries, although these countries account for only 20% to 30% of pesticide use. [5–7] In 1986 the World Health Organization (WHO) estimated that there were about one million cases of pesticide poisoning occurring annually.

Farmers and agricultural workers face chronic health effects from chronic exposure to pesticides.[8] Chronic exposure can increase the risk of developmental and reproductive disorders, immune system disruption, endocrine disruption, impaired nervous system function and development of certain cancers.[5] There is a high risk of exposure to toxic

Corresponding author: Pauline E. Jolly, PhD, MPH, Professor, Department of Epidemiology, School of Public Health, University of Alabama at Birmingham, Ryals Building, Room 217, Birmingham, Alabama 35294-0022, Tel: 205 934 1823, Fax: 205 975 3329, jollyp@uab.edu.

pesticides through lack of protective gear, leaky spray equipment, from mixing and applying pesticides with bare hands and storage of pesticides near food.[1,2,5] Global estimates of acute pesticide poisoning are largely based on hospital data as very few studies have been conducted to study the problem of acute pesticide poisoning among agricultural workers.[9] Many episodes of poisoning are not registered, as they are considered minor and in some regions information is missing because the episodes of poisoning are not registered and most patients do not seek medical attention.[9,10] The milder cases that do seek care at health facilities often go unrecognized because the symptoms such as dizziness, rashes, nausea and diarrhea are similar to other health conditions.[11–13] In a study conducted by Mourad (2005), 62.5% of the participants experienced burning sensations in the eyes or face and 37.5% experienced itching or irritated skin after spraying organophosphate insecticides.[14]

Excessive and careless use of pesticides is identified as one of the major causes of chemical poisoning in the Caribbean Region.[15] Farmers in developing countries have grown dependent on pesticides to obtain high yields but this has led to increased risk of pesticide exposure and pest resistance.[4,16] The dependence on pesticides makes it difficult for farmers to practice alternative pest control methods such as biological pest control and Integrated Pest Management (IPM). Biocontrol of pests has been proven effective worldwide and in the Caribbean.[17] In Jamaica, a number of studies have detected high levels of residues of the organochlorine pesticide, Endosulfan, in surface water and aquatic life. Endosulfan is used across the island to control pests on coffee plants.[18,19] Residues of other pesticides such as DDT, aldrin, endrin and di-eldrin, which were released into the Rio Cobre Basin a few decades ago, have been detected in coastal waters and sediment of Kingston Harbour.[20] Organochlorine pesticides affect the nervous system causing convulsions, tremors, seizures and fatalities.[21] Other pesticides such as chlordane and Dichlorodiphenyltrichloroethane (DDT) are associated with cancer;[22] alachor, altrazine and diazinon are associated with low semen quality.[23,24]

The objectives of this study were to determine the occurrence of pesticide poisoning and identify factors associated with reported incidents of acute pesticide poisoning among farmers in northwestern Jamaica. These findings could be used to develop and implement strategies to encourage the safe handling, use and disposal of pesticides and decrease the occurrence of acute pesticide poisoning among farmers.

Study Design and Methods

A population survey study design was used. Participants completed an interviewer-administered questionnaire on knowledge and practices concerning the handling, use, storage and disposal of agricultural pesticides and the occurrence of episodes of pesticide poisoning. The outcome variable of interest was self-reported occurrence of acute pesticide poisoning within the last two years. Predictive variables of interest included education, years of farming experience, pesticide safety training, pesticide storage and handling practices, pesticide safety practices, and pesticide knowledge and symptoms of acute pesticide poisoning.

The study was conducted in the parishes of Westmoreland, St. James and Hanover in northwestern Jamaica from June to August 2006. Potential participants were defined as adults age 19 years and older who worked on a farm in any of the three parishes. The purpose of the study was explained to the farmers and they were asked to participate. Those who expressed interest in participating were asked to read and sign the informed consent form. If the potential participants were unable to read the consent form, the form was read to them by a member of the farm team, or a neighbor and those who were still interested in participating were asked to make an X indicating their consent. The Institutional Review Board of the University of Alabama at Birmingham, the Advisory Panel on Ethics and

Medico-Legal Affairs in the Ministry of Health, Jamaica, and the Western Regional Health Authority of Jamaica approved the study protocol prior to its implementation.

Data Analysis

Absolute and relative frequencies (N and %) were obtained for the distributions of the selected variables for the two groups: those who reported one or more incidents of acute pesticide poisoning within the last two years and those who did not. The General Association Statistic was used to determine differences in the distributions of selected variables by the two groups. Trend was assessed with the Mantel Haenszel chi-square test. Odds ratios (OR) and 95% confidence intervals (CI) were generated as measures of association for all variables by the two groups. Both crude and adjusted measures of association were generated for all variables. All OR and CI were calculated from logistic regression equations. Missing values were excluded from the analysis. The analysis was conducted with SAS software, version 9.0. All reported p-values are two-tailed.

Results

Demographic and farm characteristics of the study population

The demographic and farm characteristics of the study population are shown in Table 1. Approximately 16% of the study population reported one or more incidents of acute pesticide poisoning within the last two years. Most of the participants (87%) were males. Although women constituted only 13% of the participants they accounted for 21% of participants who reported one or more episodes of acute pesticide poisoning. Farmers who completed secondary school accounted for 37% of participants who reported acute pesticide poisoning. Farmers who had 40 or more years of farming experience accounted for 11% of participants who reported episodes of acute pesticide poisoning and about 26% of the participants who did not. There were also significant differences in the distributions of pesticide poisoning on family owned versus non-family owned farms. Almost a half (47%) of farmers who worked on non-family owned farms reported acute pesticide poisoning compared to only 13% of farmers who worked on family-owned farms. Farmers who traveled 0.25 to 1 mile from their home to the farm accounted for 56% of participants who reported one or more episode of acute pesticide poisoning compared to farmers (22%) whose home was situated <0.25 miles from the farm.

Symptoms reported by farmers to be associated with acute pesticide poisoning

The most common symptoms that farmers reported experiencing as a result of acute pesticide poisoning were burning skin (13%), headaches (12%), itching eyes (11%), blurred vision (11%), dry throat (9 %), twitching eyelids (7 %), and muscle cramps (5%). The majority (68%) of affected farmers did not seek medical attention when experiencing signs and symptoms of pesticide poisoning.

Most common crops grown and pesticides used by farmers

The most common crops grown by farmers include yam, banana, dasheen, cane tomato, pepper, plantain and corn. Farmers used a variety of herbicides (paraquat, 2,4D, ametryin, ioxynil, terbutryn), fungicides (glyphosphate, copper hydroxide) and insecticides (cyhalothrin, deltamethrin, diazinon) to control pests. Most of these chemicals are moderately or slightly hazardous based on the WHO's hazard classification.[25,26]

Practices of farmers in relation to reported incidents of acute pesticide poisoning

A large proportion of farmers (75%) reported that they had not received training in pesticide handling or safety (Table 2); 67% of these farmers reported incidents of acute pesticide

poisoning. Approximately 26% and 37% of farmers who reported incidents of acute pesticide poisoning, stored pesticides in their homes (in a separate room for chemicals) or under their houses, respectively. There was a significant difference in report of acute pesticide poisoning by farmers in relation to whether they read the instructions on the pesticide bags before applying pesticides ($p<0.001$). Among farmers who reported acute pesticide poisoning, only 50% stated that they always read the instructions on the bag before applying pesticides. In comparison, 86% of farmers who reported no incidents of acute pesticide poisoning stated that they always read instructions on the bag before applying pesticides. Similar results were obtained for use of the recommended rate of pesticide by farmers and acute pesticide poisoning. Among farmers who reported acute pesticide poisoning, approximately 51% reported using the recommended amount of pesticides. In comparison 71% of farmers who did not report acute pesticide poisoning reported using the recommended amount of pesticides ($p= 0.0037$). Framers who reported using pesticides in their houses to kill pests accounted for 21% of participants who reported acute pesticide poisoning and 2.3% of those who reported no poisoning ($p<0.001$). Twelve of nineteen farmers (63%) who reported using pesticides in their houses to kill pests reported incidents of acute pesticide poisoning.

With regard to protective gear, farmers who reported that they never use a mask or respirator when handling pesticides accounted for 42% of participants who reported acute pesticide poisoning and 27% of participants who did not report acute pesticide poisoning ($p=0.27$) (Table 2). About 45% of the farmers reported that they never use protective eyewear and 23% reported never using gloves when applying pesticides. However, no significant differences were found between use of gloves or protective eyewear and reported incidents of acute pesticide poisoning. Wearing special shoes (for pesticide application only) by farmers when applying pesticide was significantly associated with prevention of pesticide poisoning ($p<0.001$). The overwhelming majority (87%) of farmers who reported always wearing special shoes when applying pesticides reported no pesticide poisoning.

About 18% of farmers reported that they washed pesticide application tools in streams. Farmers who washed pesticide application tools in streams accounted for 30% of participants who reported acute pesticide poisoning and 16% of participants who did not report pesticide poisoning ($p=0.012$). Although, only 3% of farmers reported using empty pesticide containers to collect or store farm water, these farmers accounted for 16% of participants who reported pesticide poisoning; in comparison only 1% of farmers who did not report pesticide poisoning ($p< 0.001$). Farmers who reported that they threw empty pesticide containers in bushes accounted for 42% of participants who reported acute pesticide poisoning (Table 2); in comparison 22% of these farmers did not report pesticide poisoning (p-value =0.002).

Association between knowledge of pesticides and farmers report of acute pesticide poisoning

Table 3 shows that approximately half of the farmers reported that they did not know the difference between a fungicide and a herbicide. About 59% of farmers reported that they had heard of pesticide awareness week. Farmers who reported that pesticides enter the body through the eyes constituted about 77% of participants who reported acute pesticide poisoning and were significantly different ($p =0.014$) from those who reported no pesticide poisoning (89%). Farmers who reported that pesticides enter the body through the palms of the hand constituted 63% of those who reported acute pesticide poisoning and were significantly different ($p<0.001$) from those who reported no pesticide poisoning (84%). Large percentages (91%) of farmers knew that people can get sick from pesticide runoff and that water can be polluted from pesticide runoff. Approximately 85% of farmers reported that they used pesticides to obtain high yields and better crop quality. The majority of

farmers (71%) reported that pesticides did not pose a health problem in their community, however, 51% of these farmers reported episodes of acute pesticide poisoning compared to 75% who did not report acute poisoning (p-value =<0.001; Table 3).

Association between pesticide application equipment and farmers report of acute pesticide poisoning

Table 4 shows that a large proportion of farmers (85%) use backpack sprayers to apply pesticides. Farmers who used a handheld sprayers represented 63% of farmers who reported acute pesticide poisoning (p<0.001). Farmers who used band sprayers accounted for 5% of those who reported pesticide poisoning and 1% of those who did not (p=0.022).

Multivariate logistic regression

For the final adjusted model (Table 5), all statistically significant variables from the primary analyses were entered into a logistic regression model. Backward stepwise logistic regression was performed. Variables with a statistical significance of p<0.10 were retained. Variables that appeared to act as confounders were also retained. In the final model, farmers who were 40–49 years of age were almost 6 times more likely to report an occurrence of acute pesticide poisoning in the last two years, compared to farmers in the youngest age group (20–39 years) (95% CI:1.48, 23.94). Overall, reports of acute pesticide poisoning appeared to decrease with age. However, the associations in the other age categories failed to achieve statistical significance.

Farmers who traveled 0.25 to 1 mile from their home to the farm were 4.44 times more likely to report symptoms of acute pesticide poisoning in the last two years compared to farmers whose farms were less than 0.25 miles from their homes (95% CI: 1.19, 16.56). Compared to farmers who worked on non-family farms, those who worked on family farms were 96% less likely to report episodes of acute pesticide poisoning (95% CI: 0.01, 0.25). There was a significant association between farming experience of 20–29 years and acute pesticide poisoning (95% CI: 1.43, 41.58). Always reading pesticide instructions before use was associated with a decreased risk of acute poisoning among farmers (OR=0.12, 95% CI: 0.004, 0.41). Use of a hand-held sprayer to apply pesticides was associated with a 4-fold increased risk of acute pesticide poisoning (95% CI: 1.55, 10.34). Farmers who reported never using a mask or respirator when handling pesticides were nearly 3 times more likely to report acute pesticide poisoning compared with farmers who reported that they always used a mask or respirator (95% CI: 1.05, 9.47). Farmers who reported using special tools (no other use) to mix and apply pesticides were 82% less likely to report acute pesticide poisoning compared to farmers who used tools for multiple purposes including pesticides (95% CI:0.05,0.69).

Discussion

Only one-quarter of the farmers in this study reported ever receiving training in pesticide handling or safety. This finding is consistent with previous studies conducted in developing countries as most developing nations lack resources to train and educate farmers in safe pesticide handling and use.[6,27] Approximately (16%) of farmers in the study reported one or more incidents of acute pesticide poisoning within the last two years. Of these, only 32% consulted a clinic, hospital or private doctor following the accidental poisoning. This degree of underreporting is consistent with results of other studies.[28–30] A study by Maumbe and Swinton (2003) which determined health costs of pesticide use among Zimbabwe's smallholder cotton growers found that 7–12% of famers reported pesticide poisoning. However, only 2–8% of these cases sought medical attention and the majority relied upon home-made treatments and prayer to relieve their health ailments. The cost and efficacy of

clinical treatments were reported as reasons why the farmers did not seek medical attention.[29] This might be the case in our study, since most farmers in developing countries face financial hardship and lack health insurance.[29,31,32] In addition, most medical professionals lack the ability to identify pesticide related illnesses, [12,29] thus raising further concerns. Underreporting of pesticide poisonings is a major problem in the developing world, especially in occupational settings.[33,34] Medical attention is mainly given to suicide attempts with pesticide due to the greater severity of illness.[31,34]

Farmers aged 40–49 years and farmers with 20–29 years of farming experience were more likely to report experiencing pesticide poisoning than other farmers. Our study findings are in contrast to other studies whereby younger and less experienced farmers reported higher incidence rates of poisoning.[33,35] This may be explained by a variety of factors including repeated exposure over years and longer working hours compared to younger inexperienced farmers.[30]

This study also showed that the likelihood of occurrence of acute pesticide poisoning increased with distance from home to the farm. Our findings are in contrast with other studies that have reported greater exposure to pesticide with increased residential proximity to farms.[36–42] Due to a lack of facilities on the farm, it is difficult for famers who live further away from home to wash off or change clothes after applying pesticides.[31,32,43] In addition, perspiration in clothing soaked with pesticides for longer periods greatly increases the likelihood of dermal absorption.[28,31,32]. Farmers on Family-owned farms were less likely to report incidents of acute pesticide poisoning than farmers on non-family owned farms. Professional or waged workers are exposed to pesticide for longer times, spray frequently, use pesticides chosen by their employers and have no control over work conditions, thus increasing their vulnerability to pesticide poisoning.[28,30] These factors may explain reports of pesticide poisoning by waged workers in this study. As anticipated, farmers who did not read instructions on the bag before applying pesticides or use the recommended amount had an increased likelihood of acute pesticide poisoning. Therefore, training in pesticide use and safety could greatly reduce the risk of pesticide exposure.[6,8,28] Farmers who used handheld sprayers were four times more likely to report acute pesticide poisoning than farmers who used other methods of pesticide application. Handheld sprayers are inexpensive pesticide application tools used on small farms and in many developing countries.[44–46] However, handheld sprayers are known for leaking,[43,47] thus posing a great risk of exposure to harmful pesticides. Previous research on handheld sprayers has documented the greatest risk of pesticide exposure compared to other methods of application.[46,48] There is a greater risk of dermal exposure because the hands are the most exposed region of the body.[48] In addition, most farmers in this study did not receive training in pesticide safety nor wore protective gear, further increasing the likelihood of poisoning.[25] Given the grave danger of using leaky spray equipment, farmers often do not have the resources to repair or to buy new safe pesticide application tools. [43,44] Farmers who reported always using special tools for mixing and applying pesticides were less likely to report pesticide poisoning than farmers who did not. Mixing or applying pesticides places the famer in direct contact with pesticides resulting in harmful effects. The use of safe pesticide mixing and application tools greatly reduces dermal exposure.[46,48]

This study also showed that the likelihood of acute pesticide poisoning was reduced when a mask or respirator was used. Pesticide dusts and vapors are easily absorbed by the lungs and respiratory system.[49] The use of personal protective devices such as masks and respirators can reduce the risk of pesticide exposure or inhalation; however, protective gear is expensive, uncomfortable to wear and can increase the dermal absorption of pesticides in tropical climates.[2,11,28,30,50] Thus, the replacement of pesticides with non-toxic or less-toxic alternatives seems feasible in this tropical and resource limited country. [30,32] For example,

the implementation of the integrated pest management (IPM) or biological control of crop pests would be a viable alternative. IPM has been proven effective in many parts of the world and in the Caribbean.[17,28,32] Studies on IPM have documented that farmers who went through IPM training sprayed less often and reduced their use of more highly toxic pesticides while still achieving the same crop yields as before.[28] Restricting pesticide use, especially the most toxic pesticides will reduce cases of pesticide poisoning and present a pathway for preventive programs.[30–32] Minimizing pesticide use will take years; in the meantime, the most human health and environmental hazardous pesticides should be restricted.[31]

Conclusion

Training and educating farmers in safe use and handling of pesticides should reduce incidents of acute pesticide poisoning. The training program should emphasize the need to always use protective gear and the recommended amount of pesticides. Due to limited resources, training and health education can be done in the communities. The infrastructure that currently exists in Jamaica can be extended to implement new farming techniques including the use of IPM. For instance, the Rural Agricultural Development Authority (RADA) which oversees the development of agriculture and economic growth in rural Jamaican communities can implement rural extension services. RADA personnel can conduct short courses and seminars to community leaders who in turn will educate farmers. Overall, this study shows the need for further research on pesticide handling, knowledge and practices among Jamaican farmers. Alternatives to pesticide use such as biological pest control and IPM should be considered or implemented to reduce reports of acute pesticide poisoning.

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Table 1

Demographics and farm characteristics of the study population in relation to reported incident(s) of acute pesticide poisoning within the last two years.

	Pesticide poisoning (N=57)		No pesticide poisoning (N=302)		Total		p-value
Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	
Parish							
Westmoreland	18	31.6	119	39.4	137	38.2	0.265
Hanover	6	10.5	58	19.2	64	17.8	0.117
St. James	**33**	**57.9**	**125**	**41.4**	158	44.0	**0.022**
Gender							
Male	**45**	**79.0**	**267**	**88.4**	312	86.9	
Female	**12**	**21.1**	**35**	**11.60**	47	13.1	**0.052**
Age							
20–39	11	21.2	67	25.6	78	24.8	0.501
40–49	15	28.9	46	17.6	61	19.4	0.061
50–59	10	19.2	63	24.1	73	23.3	0.454
60–69	12	23.1	47	17.9	59	18.8	0.387
70–85	4	7.7	39	14.9	43	13.7	0.169
Education							
None	0	0.0	14	4.7	14	4.00	0.103
Some primary school	16	29.6	121	40.9	137	39.1	0.120
Completed primary school	**20**	**37.0**	**68**	**23.0**	88	25.1	**0.028**
Some secondary school	8	14.8	40	13.5	48	13.7	0.799
Completed secondary	10	18.5	48	16.2	58	16.6	0.676
Post-secondary	0	0.0	5	1.7	5	1.4	0.337
Farming experience (years)							
1 to 9	12	21.8	48	18.1	60	18.7	0.514
10 to 19	15	27.3	50	18.8	65	20.3	0.155
20 to 29	16	29.1	51	19.2	67	20.9	0.100
30 to 39	6	10.9	48	18.1	54	16.8	0.199
40 or more	**6**	**10.9**	**69**	**25.9**	75	23.4	**0.017**
Farm owned and run by family?							
Yes	**47**	**82.5**	**291**	**96.4**	337	94.2	

	Pesticide poisoning (N=57)		No pesticide poisoning (N=302)		Total		p-value
Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	
No	**10**	**17.5**	**11**	**3.6**	21	5.9	**<.001**
Distance from home to farm (miles)							
<0.25	**11**	**22.0**	**110**	**45.5**	121	41.4	**0.002**
0.25 – 1	**28**	**56.0**	**67**	**27.7**	95	32.5	**<.001**
> 1	**11**	**22.0**	**65**	**26.9**	76	26.0	**0.477**
Size is your farm (acre)							
0.25 – 1	**18**	**34.6**	**80**	**28.5**	98	29.4	**0.372**
1.1 – 2.9	**10**	**19.2**	**60**	**21.4**	70	21.0	**0.731**
3.0 – 9.9	**20**	**38.5**	**102**	**36.3**	122	36.6	**0.767**
10 ≥	**4**	**7.7**	**39**	**13.9**	43	12.9	**0.222**

BOLD alpha <0.05

Table 2

Practices of the study population in relation to reported incident(s) of acute pesticide poisoning within the last two years.

	Pesticide poisoning (N=57)		No pesticide poisoning (N=302)		Total		p-value
Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	
Training in pesticide use and/or safety?							
Yes	19	33.3	70	23.2	89	24.8	
No	38	66.7	232	76.8	270	75.2	0.104
Ever stored pesticides in home but in a separate room for chemicals?							
Yes	**15**	**26.3**	**37**	**12.3**	52	14.5	
No	**42**	**73.7**	**264**	**87.7**	306	85.5	**0.006**
Ever stored pesticides under your house?							
Yes	**21**	**36.8**	**68**	**22.6**	89	24.9	
No	**36**	**63.2**	**233**	**77.4**	269	75.1	**0.023**
Always read the instructions before use?							
Always	**26**	**50.0**	**246**	**86.3**	272	80.7	**<0.001**
Sometimes	**14**	**26.9**	**25**	**8.8**	39	11.6	**<0.001**
Never	**12**	**23.1**	**14**	**4.9**	26	7.7	**<0.001**
Always use the recommended rate of pesticide?							
Yes	**29**	**50.9**	**213**	**70.5**	242	67.4	
No	**28**	**49.1**	**89**	**29.5**	117	32.6	**0.004**
Ever used crop or animal pesticides in the house to kill pests?							
Yes	**12**	**21.1**	**7**	**2.3**	19	5.3	
No	**45**	**79.0**	**295**	**97.7**	340	94.7	**<.001**
Wear gloves when applying pesticides?							
Always	24	42.1	135	44.7	159	44.3	0.718
Sometimes	18	31.6	99	32.8	117	32.6	0.859
Never	15	26.3	68	22.5	83	23.1	0.533
Use a mask/respirator when handling pesticides?							
Always	22	38.6	133	44.0	155	43.2	0.447
Sometimes	11	19.3	86	28.5	97	27.0	0.153
Never	**24**	**42.1**	**83**	**27.5**	107	29.8	**0.027**
Use protective eyewear when applying pesticides?							

	Pesticide poisoning (N=57)		No pesticide poisoning (N=302)		Total		p-value
Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	
Always	15	26.3	100	33.1	115	32.0	0.314
Sometimes	11	19.3	70	23.2	81	22.6	0.521
Never	31	54.4	132	43.7	163	45.4	0.138
Wear special shoes (no other use) when applying pesticides?							
Always	**43**	**75.4**	**279**	**92.4**	322	89.7	**0.001**
Sometimes	**7**	**12.3**	**6**	**2.0**	13	3.6	**0.001**
Never	7	12.3	17	5.6	24	6.7	0.066
Use special tools (no other use) to mix and apply pesticides?							
Always	**47**	**82.5**	**281**	**93.1**	328	91.4	**0.009**
Sometimes	5	8.8	11	3.6	16	4.5	0.086
Never	**5**	**8.8**	**10**	**3.3**	15	4.2	**0.059**
What do you do with your empty pesticide containers?							
Burn them	43	75.4	207	68.5	250	69.6	0.300
Bury them	22	38.6	112	37.1	134	37.8	0.830
Drop them at the public dump	8	14.0	22	7.3	30	8.4	0.092
Throw them in the bushes	**24**	**42.1**	**67**	**22.2**	91	25.4	**0.002**
Throw them in the stream	1	1.8	3	1.0	4	1.1	0.616

BOLD alpha < 0.05

Table 3

Knowledge about pesticides by the study population in relation to reported incident(s) of acute pesticide poisoning within the last two years.

	Pesticide poisoning (N=57)		No pesticide poisoning (N=302)		Total		p-value[1]
Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	
Know the difference between fungicide and herbicide							
Yes	33	57.9	149	49.3	182	50.7	
No	24	42.1	153	50.7	177	49.3	0.237
Heard of pesticide awareness week?							
Yes	33	57.9	177	58.6	210	58.5	
No	24	42.1	125	41.4	149	41.5	0.920
Routes pesticides can enter the body?							
Skin	49	86.0	267	88.4	316	88.0	0.603
Lungs (breathing)	52	91.2	282	93.4	334	93.0	0.559
Eyes	**44**	**77.2**	**269**	**89.1**	313	87.2	**0.014**
Palms of the hands	**36**	**63.2**	**255**	**84.4**	291	81.1	**<0.001**
Mouth	55	96.5	281	93.1	336	93.6	0.331
Do people get sick from pesticide runoff?							
Yes	52	91.2	276	91.4	328	91.4	
No	5	8.8	26	8.6	31	8.6	0.968
Is the water polluted from pesticide runoff?							
Yes	53	93.0	273	90.4	326	90.8	
No	4	7.0	29	9.6	33	9.2	0.536
Can a farmer obtain the same yields without pesticides?							
Yes	10	17.5	43	14.2	53	14.8	
No	47	82.5	259	85.8	306	85.2	0.519
Will the food be the same quality without pesticides?							
Yes	10	17.5	45	14.9	55	15.3	
No	47	82.5	257	85.1	304	84.7	0.612
Do pesticides pose a health problem in your community?							
Yes	**28**	**49.1**	**76**	**25.2**	104	29.0	
No	**29**	**50.9**	**226**	**74.8**	255	71.0	**<0.001**

BOLD alpha < 0.05

Table 4

Equipment used by the study population in relation to reported incident(s) of acute pesticide poisoning within the last two years.

	Pesticide poisoning (N=57)		No pesticide poisoning (N=302)		Total		p-value
Equipment	**N**	**%**	**N**	**%**	**N**	**%**	
Use handheld sprayer	**36**	**63.2**	**87**	**28.8**	123	34.3	**<0.001**
Use backpack sprayer	49	86.0	255	84.4	304	84.7	0.769
Use band sprayer	**3**	**5.3**	**3**	**1.0**	6	1.7	**0.022**
Use gas canister	0	0.0	0	0.0	0	0.0	
Use mist blower or fogger	3	5.3	10	3.32	13	3.6	0.473
Use pretreated seed	0	0.0	0	0.0	0	0.0	
Use duster applicator	0	0.0	1	0.33	1	0.3	0.663

BOLD alpha < 0.05

Table 5

Crude and adjusted prevalence odds ratios (POR) with 95% confidence intervals (CI) for the study population according to self-reported incidence of acute pesticide poisoning within the last two years

Variables	Crude OR (95%)	Adjusted OR (95% CI)
Age		
20–39	Reference	Reference
0–49	1.99	**5.95 (1.48, 23.94)**
50–59	0.97	3.49 (0.71, 17.29)
60–85	1.13	1.81 (0.30, 10.97)
Completed primary school		
Yes	**1.74**	0.62 (0.22, 1.70)
No	Reference	Reference
Size of farm (acre)		
0.25–1	2.32	0.55 (0.11, 2.64)
1.1–2.9	1.63	0.34 (0.06, 1.99)
3–3.9	1.91	0.24 (0.04, 1.35)
≥10	Reference	Reference
Distance from home to farm (miles)		
<0.25	Reference	Reference
0.25–1	**4.18**	**4.44 (1.19, 16.56)**
≥1	1.69	0.57 (0.15, 2.14)
Farm owned and run by family		
Yes	**0.18**	**0.04 (0.01, 0.25)**
No	Reference	Reference
Farming experience (years)		
1–9	**2.88**	2.45 (0.30, 20.04)
10–19	**3.45**	2.87 (0.45, 18.50)
20–29	**3.61**	**7.71 (1.43, 41.58)**
30–39	1.44	2.60 (0.43, 15.83)
≥40	Reference	Reference
Always read instructions before use		
Yes	**0.16**	**0.12 (0.04, 0.41)**
No	Reference	Reference
Always use recommended rate of pesticide		
Yes	**0.43**	1.42 (0.49, 4.05)
No	Reference	Reference
Ever stored pesticide in home, but in separate room for chemicals		
Yes	**2.55**	0.66 (0.15, 2.81)
No	Reference	Reference
Ever stored pesticide under house		
Yes	**2.00**	3.02 (0.99, 9.19)
No	Reference	Reference

Variables	Crude OR (95%)	Adjusted OR (95% CI)
Ever used crop or animal pesticide in home to kill pests		
Yes	**11.24**	2.12 (0.41, 10.86)
No	Reference	Reference
Use handheld sprayer to apply pesticides		
Yes	**4.24**	**4.00 (1.55, 10.34)**
No	Reference	Reference
Use a mask/respirator when handling pesticides		
Always	Reference	
Sometimes	0.77	1.27 (0.34, 4.78)
Never	**1.75**	**3.15 (1.05, 9.47)**
Wear special shoes (no other use) when applying pesticide		
Yes	**0.25**	1.28 (0.29, 5.69)
No	Reference	Reference
Always use special tools (no other use) to mix and apply pesticides		
Yes	**0.35**	**0.18 (0.05, 0.69)**
No	Reference	Reference
Ever use empty pesticide container to collect and/or store farm water		
Yes	**18.69**	8.10 (0.74, 88.40)
No	Reference	Reference