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Prevalence of acute pesticide poisoning among pesticide applicators in cardamom plantations: A cross-sectional study from Idukki District, Kerala

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Abstract

Background: Pesticide poisoning is a burning occupational health issue across the world. The pesticide use in the cardamom plantations of Idukki district, Kerala, India is one of the world's highest. However, limited studies addressed its ill effects on the health of pesticide applicators. **Aims:** To assess the magnitude of acute pesticide poisoning (APP) among pesticide applicators and understand the nature of severity based on their occupational characteristics. **Settings and Design:** A descriptive cross-sectional study was conducted in 2018. A total of 300 pesticide applicators with minimum 1-year experience (79.3% males) were selected from 30 randomly selected cardamom plantations in Udumbanchola Taluk. **Methods:** WHO Field Surveys of Exposure to Pesticides Standard Protocol and Murphy's method of Farmer Self-Surveillance system of pesticide poisoning were used for assessing pesticide exposure and APP, respectively. Statistical analysis used: Descriptive (frequencies) and exploratory statistical analyses (Pearson's Chi-square test) were done using IBM SPSS 23.0. **Results:** The prevalence of APP in this study was 100% as all the pesticide applicators reported at least one sign and/or symptom of APP. The mild APP was more prevalent (80.7%), followed by moderate (18.7) and severe (0.60). Decrease in duration and frequency of spraying, use of motor pump sprayer, safe storage and disposal of pesticides, and proper personal hygiene were found to reduce the severity of APP. **Conclusion:** All the pesticide applicators in cardamom plantations of Idukki are at risk of APP. It is important to train them about the measures to prevent the same.

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Full Text

Introduction

More than half of the world's population (60%) depends on agriculture for sustenance.[1] The invention and use of chemicals such as pesticides and fertilizers resulted in the booming of agricultural sector across the world in 1960s. However, the uncontrolled increase in the use of pesticides thereafter poses threat to the environment and human health as well, making it an issue of public health importance.[2]

According to the World Health Organization (WHO-2013), about 600,000 pesticide poisoning cases and 60000 fatal outcomes per year were reported from India annually.[2] Kerala, the southern state in India, is well-known for the production of spices for centuries. Idukki district, located in the central part of Kerala, is famous for the cultivation of spices, especially cardamom. About 94% of cardamom plantations in Kerala are situated in Idukki.[3] It provides constant employment to the local people. Pesticide use in cardamom plantations in Idukki is one of the world's highest; farmers use an average of 27 kg of pesticides per hectare (ha).[4] Average use of pesticides in India is only half kilogram per hectare or all crops. There is no specific season to use pesticides in cardamom plantations and it is applied every 20 days in the field.[5] This frequent pesticide spraying poses a continuous threat of poisoning to those who undertake the pesticide-spraying job, generally known as pesticide applicators.[6] As per a study conducted by National Institute of Advanced Studies (NIAS), the cardamom samples from Idukki had 25 times the maximum recommended limit of quinalphos pesticide.[7] Unscientific practice and improper handling of pesticides could accelerate the risk and might become fatal. Studies that looked into these issues are limited and, therefore, the present study tries to estimate the prevalence of acute pesticide poisoning (APP) among the applicators in cardamom plantations in Idukki district. It also looks into the specific occupational practices that determine the severity of APP.

Methods

The study was a cross-sectional survey. Out of the four taluks in Idukki, Udumbanchola Taluk was selected purposively as it has the highest number of cardamom estates.[5] Thirty estates (out of 80) were taken randomly and from each estate, 10 pesticide applicators were selected by simple random sampling. Thus, data was collected from 300 pesticide applicators who fulfilled the criteria of age more than or equal to 18 years and a minimum experience of 1 year. The sample size was estimated using the equation 3.84pq/d2. The lowest reported perceived prevalence of acute pesticide poisoning (mild) in Kerala was 12.6%.[6] The advantage of taking the prevalence of mild pesticide poisoning was that it could capture mild-to-severe forms of poisoning. With an assumed precision of 4%, the sample size at 95% confidence interval was 264.3. After adding an assumed nonresponse rate of 10%, it was 290.72, which was rounded to 300.

"WHO Field Surveys of Exposure to Pesticides Standard Protocol" was used as a guide to frame the questions related to occupational pesticide exposures.[8] "Murphy's method of Farmer Self-Surveillance system of pesticide poisoning" was another tool by which farmers could self-report the signs and symptoms of acute pesticide poisoning following spraying.[9] Signs and symptoms occurred within 24 h of exposure with pesticides were taken for consideration. The current study used a structured interview schedule combining the above-mentioned validated tools. The questionnaire was designed in English and translated to local language "Malayalam" for the convenience of the participants. Content validity of the instrument was done by a gazetted officer and one occupational health expert. The tool was piloted among 10 samples to check the comprehensibility. General information included sociodemographic details. The information on total experience; duration of pesticide spraying and area covered in a day; pesticides used; method of mixing, spraying, and storage; use of personal protective equipment and other details were collected under the head of occupational characteristics. The survey was conducted from 15 February–15 April, 2018. Face-to-face interviews were done to collect the data.

The data cleaning and analysis were done using SPSS 23.0.[10] Both descriptive and inferential analyses were done. Acute pesticide poisoning was categorized into mild, moderate, and severe. Moderate and severe APP was merged together as the prevalence of the latter was very low during the bivariate analysis. Pearson's Chi-square test was used to test the associations and a P value of less than 0.05 is fixed as the level of statistical significance.

Ethics approval

Ethical clearance was obtained from the Institutional Human Ethics Committee of the Central University of Kerala, Kasaragod. CUK/IHEC/2018/026 - February 20, 2018 prior to the data collection.

Results

Study participants included 79.3% males and 20.7% females. Response rate was 100%. The mean age was 47.9 years (Standard deviation = 4.8 years). The minimum and maximum age of the applicators was 35 and 59 years. Majority (199, 66.3%) of them had up to 7 years of schooling. Most of the respondents carried out pesticide spraying as their primary occupation. Those who were working in their own land did other farming activities in addition to pesticide spraying. Eight respondents (2.7%) were working in their own land. An average earning per hour was 130 Indian Rupees.

Occupational characteristics

Organophosphorus was the most common pesticide used (51%), followed by pyrethroids (35.7%), pyrazole (7.7%), and thiophosphorous (5.7%). All the applicators followed mixing of pesticides with water. Based on the commercial brands of pesticides, the mixing ratio of pesticides and water varied. More than half of the sample (52.3%) mixed the pesticides at a ratio of 1: 400. Applicators were using a separate container and sticks for mixing pesticides. All of them sprayed pesticides till the sprayer got emptied. Nearly 17% were storing pesticides in the house of an estate owner. Most of the respondents reported that they store pesticides in the shed near to the house. All the respondents were using one or other type of personal protective equipment. No respondent was reported to use all PPEs and most of the participants relied upon local measures rather than standard equipment. More than 60% (65.3%) of the study participants were avoiding protective measures due to discomfort while spraying. They reported that being a hilly area it was difficult to wear all standard protective equipment. About 25.0% were avoiding protective measures due to the cost and 10.0% were not aware of it. The occupational characteristics of the study participants are depicted in [Table 1], [Table 2], [Table 3].{Table 1}{Table 2}{Table 3}

Awareness about pesticide use

The primary source of information about pesticides and their use was local pesticide sellers for 70% of the applicators. Nearly 20% obtained information through their own work experience. The agriculture officers were the source information for 6.3% of applicators. Most of them (92%) did not get any training regarding spraying of pesticides. Majority (92.3%) never read the labels on the containers. [Table 4] shows that more than half of the respondents were unaware of the WHO color codes.{Table 4}

Prevalence of acute pesticide poisoning (APP)

The signs and symptoms of APP self-reported by the study participants are shown in [Table 5]. The APP was categorized into mild, moderate, and severe according to Murphy's method of Farmer Self-Surveillance system of pesticide poisoning.[7] The total of each type of poisoning (mild, moderate, and severe) was estimated based on those who reported at least one sign/symptom within 24 h of spraying. From the table, it is evident that all of them had APP, i.e., the prevalence of APP among the pesticide applicators in the study was 100%. Majority of them had mild poisoning followed by moderate APP. Severe APP was only 0.6%. {Table 5}

Factors affecting severity of acute pesticide poisoning

Among the sociodemographic variables considered, sex was found to be significantly affecting the severity of APP. It was found that females had higher proportion of occurrence of moderate poisoning compared to males (32.3% vs. 16%), with a P value of 0.004.

Many of the occupational characteristics of the participants [Table 6] and [Table 7] were found to have a significant association with severity of APP. Moderate poisoning was significantly higher among those who work for longer duration. Applicators using knapsack sprayer were more likely to have moderate poisoning compared to those using motor pumps. The risk for moderate poisoning increased if the pesticides were sprayed in sunny weather and this finding was significant at 10% confidence limit. It might be due to the fast absorption of pesticide drops fall on body and face of the applicator.{Table 6}{Table 7}

Storage of pesticide outside the house and disposal of empty bottles by burial or selling to scrap dealers reduced the chance of getting moderate poisoning. Practices such as taking bath or changing clothes after spraying were also found to reduce the severity of APP. Drinking of water in between work increased the risk of moderate APP.

Discussion

The study found that acute pesticide poisoning is a major occupational hazard among the applicators in Idukki as all the respondents reported at least one sign or symptom in the last 1-year period. Even though recall bias is a limitation, no similar studies in Kerala or India reported 100% prevalence and it correlates with the high levels of pesticide use in cardamom plantations. Majority of the respondents had (80.7%) mild pesticide poisoning. The proportion of respondents who reported moderate and severe acute pesticide poisonings was 18.7% and 0.6%, respectively. However, the results cannot be generalized to all farmers/pesticide applicators as the amount and frequency of spraying pesticides varies from crop to crop.[11] A study conducted in rural farming village in Tanzania cultivating coffee and vegetables reported 93% of APP.[10] In contrast to this, another study reported only 8.8% work-related APP among Chinese farmers cultivating paddy.[12] A study conducted among cotton farmers reported 16.4% asymptomatic, 39.0% mild, 38.0% moderate, and 6.0% severe APP.[13]

Severe pesticide poisoning was less reported in the current study. It might be due to the restrictions in the use of WHO Class 1a and 1b pesticides by the Government of India in 2017. Headache was a highly reported symptom by 112 participants (37.3%). A study focused on the pesticide applicators of rice fields of low lying areas in Kerala indicated itchy skin as the highly reported symptom with 38.9%.[14] The study could not find the use of banned pesticides; however, highly reported acute pesticide poisoning (100%) in the study might be indicating the illegal trade existing in the community.

Diethquinalphion (36.7%) belonging to organophosphorous chemical family (51%) was the most used pesticide in the study. An environmental study conducted in Idukki district detected that the residual limit of organophosphates in the soils of cardamom plantations was beyond the maximum value.[15] Organophosphorous was the commonly reported chemical family in different literatures causing APP.[16], [17] It could be the reason behind the high prevalence of APP in the study.

Mild acute pesticide poisoning was higher among those who spend more days per year and those spend more hours per day. Moderate poisoning was relatively higher among those who spent less time on spraying. A plausible explanation for this could not be found even though similar observation was found in another study where APP was higher among people who sprayed pesticides 3 to 4 h continuously compared to those sprayed more than 5 h.[13]

The types of equipment used for spraying were strongly associated with APP. Knapsack sprayers showed higher chance of moderate poisoning compared to motor pump sprayers. Similar findings were reported in a study done in Bolivian farmers (Odds Ratio- 4.00, 95% CI 1.70–9.45).[18] This study reported that mode of exposure was dermal as the farmers reported of wetting of clothes due to pesticides while spraying.[18] The

reason for increased severity of APP while using knapsack sprayer could be frequent refilling of the container. Leakage due to blocked nozzles of the sprayer could also increase the risk. Chances of blowing or sucking blocked nozzles while cleaning could also increase the possibility of poisoning.

Storage of pesticide containers in homes was found to increase the chance of moderate or severe APP significantly ($P < 0.001$). One Tanzanian study also reported that farmers who store pesticide containers other than home were less likely to get poisoned.[11] Disposal of empty pesticide containers was significant with moderate APP. Safe disposal practices such as burying reduced the severity of poisoning.

The study found that hygienic practices such as changing clothes and taking bath right after spraying decrease the chance of getting severe APP. Similar observations on decreasing the severity of APP on personal hygiene practices were found to be 1.5 times and 2.9 times, respectively, in another study.[18] Drinking water at the workplace was more likely to cause mild acute poisoning ($P = 0.015$). Similar findings were reported in a study done by Jasmin among paddy farmers ($P = 0.09$).[14]

The results of the study show that all pesticide applicators are at risk of getting APP. This high prevalence of APP could be attributed to the occupation, i.e., pesticide spraying, as it is the most common attribute among them. Lack of awareness about the dangers and inadequate safety measures could aggravate the risk. As most of the signs and symptoms are mild, the applicators are more likely to neglect them and prioritize daily wages over their health. Therefore, it is important to educate them about the need of seeking health care as symptoms occur. The study also suggests that certain factors such as decrease in duration and frequency of spraying, use of motor pump sprayer, safe storage and disposal of pesticides, and proper personal hygiene reduce the severity of APP. Therefore, it is important to train the applicators about these measures as a prevention strategy.

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Conflicts of interest

There are no conflicts of interest.

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