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Adverse Health Effects of Organophosphate Pesticides among Occupationally Exposed Farm Sprayers: A Case Study of Bhopal Madhya Pradesh, India

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Abstract

India being an agricultural land, pesticides consumption causes a serious environmental and public health problem. Due to the steep competition and a large demand, many farmers are resorting to extensive and rather over use of organophosphate pesticides to increase their agricultural yields. The sprayers who are involved in the spraying activity of pesticides in fields get the direct exposure of pesticides due to unsafe and non-preventive work practices. They do not use the safety masks, gloves and other protective gears during the spraying of pesticides which results into the access of pesticides in the blood stream through inhalation and dermal exposure which can adversely affect their eyes, skin and the respiratory system. In the present study relationship between the extent of pesticide used and signs and symptoms of illnesses due to exposure among spray farmers of Bhopal, Madhya Pradesh India, who sprayed pesticides by themselves and therefore were directly exposed to pesticides were assessed. 105 spray farmers were interviewed using previously designed questionnaires during a cross sectional survey. The 18 months exposed spray farmers reported maximum acute signs and symptoms like burning/stinging of eyes (18.42%), blurred vision (23.68%), skin redness/itching (50%), excessive sweating/shortness of breath (34.2%), dry sore throat (21.05%) and burning of nose (28.9%). The signs and symptoms were found to be duration dependent among the sprayers. It is concluded that there is need for creating more awareness among the farm sprayers and authorities in implementing and ensuring the use of protective gear while handling pesticides.

Keywords: Organophosphate Pesticides, Environmental Health, Exposure, Risk, Spray Farmers

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INTRODUCTION

Occupational exposures to pesticides occur during the production, transportation, preparation and application of pesticides in the workplace.[1,2] Exposure to pesticides is one of the most important occupational risks among farmers in developing countries.[3,4,5] Occupational exposure to pesticides is of great interest in order to identify the hazards of pesticide use and the establishment of safe methods of pesticide handling. Pesticides exposures both occupationally and environmentally cause a range of human health problems. A series of studies, mainly from Asia, have documented that the easy availability of pesticides in farming households makes it a preferred means of self-harm. It has been estimated that there are 250,000 deaths annually from pesticide self-poisoning worldwide, accounting for 30% of the suicides globally. [6,7].

Acute toxicity is normally the result of a single exposure and the symptoms are seen within a comparatively short time of exposure, usually within hours or days. Acute health effects may include irritation of skin or eyes or respiratory irritation. Organophosphates are associated with well-known acute health problems such as nausea, dizziness, vomiting, headaches, abdominal pain, and skin and eye problems. [8,9] At present, India is the largest producer of pesticides in Asia and ranks twelfth in the world for the use of pesticides with an annual production of 90,000 tons [10]. A vast majority of the population in India is engaged in agriculture and is therefore exposed to the pesticides used in agriculture [11].

In developing countries including India, agricultural workers who are engaged in the occupation of spraying pesticides in crops get the direct exposure of pesticides due to unsafe and non-preventive work practices. They do not use the Personal Protective Equipments (PPE) like safety masks, gloves etc. during the aerial spraying of pesticides resulting in the entry of pesticides in the blood stream via respiratory tract through inhalation which can adversely affect respiratory system. [12] Respiratory symptoms, such as coughing, wheezing and airway inflammation, are commonly observed among people exposed to pesticides. [1] Pesticides being used in agricultural tracts are released into the environment and come into human contact directly or indirectly. Humans are exposed to pesticides found in environmental media (soil, water, air and food) by different routes of exposure such as inhalation, ingestion and dermal contact. Exposure to pesticides results in acute and chronic health problems. These range from temporary acute effects like irritation of eyes, excessive salivation to chronic diseases like cancer, reproductive and developmental disorders etc [13]. Previously the health effects of acute pesticide poisoning among the cotton growers of India have been reported by Mancini et al., [14]. Earlier studies on the pesticide factory workers of Bhopal have demonstrated significant effects of organophosphate pesticides in human beings [15,16].

Reviewing the literature it becomes evident that there are no recent studies conducted in the state of Madhya Pradesh which has the population of more than 80 millions. On the effects of pesticides on human beings except that of Khan and Ali, [15] who reported adverse effects of organophosphate pesticides in human pesticides factory workers. No other work is available in literatures hence the present study has been undertaken to investigate the indirect effects of hazardous organophosphate pesticides like chlorpyrifos, quinalphos and triazophos on the farm sprayers of Bhopal.

MATERIALS AND METHOD

Study area

The present study targeted the agriculture spray farmers of Bhopal, Madhya Pradesh which is known for huge production of soybean. The other crops grown in the area include wheat, sugarcane, some vegetables etc. The three villages of Misrod district, which are famous for growing soybean in Bhopal, were randomly selected for the study in which Bagarauda village has a population of 4000 people with 1154.75 Hectare agriculture land, the Jhagariya khurd village has a population of 400 people with 235.65 Hectare agriculture land and the Babadiya Khurd village has the population of 750 people with 283.13 hectare agriculture land. This study was conducted in the period from June to September 2009-2011, when organophosphate pesticides were sprayed on the soybean crops in the fields. Usual spraying duration was from 8:00 am to 11:00 am, then from 3:00 pm to 6:00 pm, six days per week. The farmers were examined during working days after the pesticide spraying. The most widely used organophosphate pesticides on the soybean crops are chlorpyrifos 20% EC (Classic 20), quinalphos 25% EC (Vazra 25), triazophos 40% EC (Trifos 40) of Cheminova India Ltd. The subjects who were exposed from 6 months to 18 months were undertaken for the present study.

Interview questionnaire

The questionnaire was designed to elicit details on land ownership, plantation where the farmer is currently working, exposure to organophosphate pesticides, the use of pesticides, precautions taken, signs and symptoms related to pesticide exposure etc. the sprayers were asked whether they experienced these signs and symptoms during or immediately after pesticide spraying. Some signs like blurred vision, tremors, skin patches, excessive sweating, itching etc. which can be chronic in nature were observed at the time of the interview. Being a cross- sectional survey,

details on signs and symptoms were collected as self reported by the farmers. Data collected were with reference to the time of pesticide spraying [17]. The questionnaire has provided the information of sprayers regarding the method used for the spraying by the farmers like hand compressed sprayers, knapsack sprayers and tractor mounted sprayers. In the present study none of the subjects took the precaution as per the guidelines of the spraying which makes it mandatory like plastic raincoats, masks, gloves and boots.

Data collection

The study was carried out on a total number of 145 human subjects who were males and ranged between 18-45 years of age, belonging to same socioeconomic status. The groups were selected on the basis of the questionnaires filled by the sprayers of Misrod Bhopal. 105 subjects were randomly selected from various farms on the basis of full time active involvement in the preparation, storage and spraying of the pesticides on crop for at least six months. Analysis was done on four groups based on the duration of organophosphate exposure (i.e 37 subjects with 6 months exposure, 30 subjects with 12 months exposure and 38 subjects with 18 months exposure). The study was compared with 40 healthy males having no previous or current occupational exposure to pesticides which were taken as controls from near by areas with same socio-economic status. Questionnaires were asked to be filled by the subjects of each group. The questionnaire provided detailed information regarding the socioeconomic status; family history and personal habits which were recorded for each subject. The purpose of the academic study was explained to all the participants and their consent was obtained.

RESULTS

On the basis of the questionnaire it was found that the human subjects exposed to organophosphate pesticide via spraying the pesticides in their farms from 12 months and 18 months showed more prevalence in general health symptoms immediately after the spraying. The symptoms were of general nature like blurred vision, skin redness, white patches, excessive sweating, shortness of breath etc. (Table 1)

An interesting aspect of the present study was the prevalence of ophthalmological problems arising due to organophosphate pesticide spraying being dose and duration dependent. In the 6 months exposure period only 2.7% subjects complained of blurred vision whereas in 12 months it was 6.6% and in 18 months it was 23.6% being the highest. In the control human subjects of same age and same social status it was observed that there were only 2 subjects who complained of blurred vision in the 18 months of exposure that may be because of age or environment. Similarly burning of eyes was found to be highly prevalent among pesticides sprayers. In the 12 months exposure duration 16.6% subjects complained of burning of eyes and in 18 months 18.42% farm sprayers complained itching in their eyes which was quite significant. It was observed that there were no such ophthalmological symptoms found in the control human subjects who were of the same age and socioeconomic status.

With regard to the skin related problems in the 6 months exposure duration only 8.1% subjects complained of skin rashes whereas in the 12 months 13.3% and in 18 months 50 % subjects complained of skin patches, redness and irritation which was also found to be highest in the longer exposure duration period. In the control human subjects it was observed that there were no skin symptoms found in the non exposed workers.

Similarly in the present study respiratory related problems like excessive sweating, dry/sore throat, running/ burning nose and shortness of breath/cough were found quite common in the farm pesticides sprayers exposed to organophosphate pesticides from 6 months, 12 months and 18 months. Table 1 shows that in the 6 months exposed sprayers 5.4% subjects showed excessive sweating and shortness of breath during the pesticide spraying as compared to their well matched controls. While in 12 months exposed sprayers the prevalence of symptoms were found higher. 20% sprayers complained the problem of excessive sweating, 10% sprayers reported dry throat, 16.6% reported burning nose and 16.6% farm sprayers reported shortness of breath whereas in the controls only 1 subject showed shortness of breath. In the 18 months exposed sprayers 34.2% sprayers complained excessive sweating, 21.05% reported dry throat, and 28.9% reported burning nose and 31.5% reported shortness of breath and cough. While from the control group 1subject showed excessive sweating and cough. (Table 1 and Fig 1)

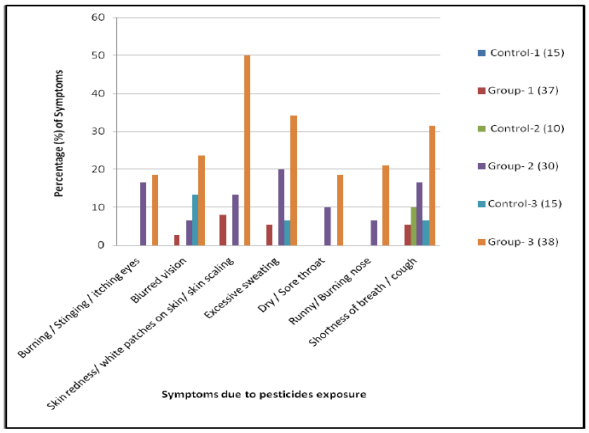

Figure 1: Showing the effect of organophosphate pesticides for 6, 12 and 18 months of exposure on the general parameters of eyes, skin and respiratory related symptoms in the farm sprayers and controls

Exposure Duration	Symptoms→ Groups of Human Subjects (n)↓	Burning / Stinging / itching eyes	Blurred vision	Skin redness/ white patches on skin/ skin scaling	Excessive sweating	Dry / Sore throat	Runny/ Burning nose	Shortness of breath / cough
6 Months	Group- 1 (37)	0	1(2.70)	3(8.10)	2 (5.40)	0	0	2 (5.40)
	Control-1 (15)	0	0	0	0	0	0	0
12 Months	Group- 2 (30)	5 (16.6)	2 (6.6)	4(13.3)	6 (20)	3 (10)	5 (16.6)	5 (16.6)
	Control-2 (10)	0	0	0	0	0	0	1 (10)
18 Months	Group- 3 (38)	7 (18.42)	9 (23.68)	19 (50)	13 (34.2)	8 (21.05)	11 (28.9)	12 (31.5)
	Control-3 (15)	0	2 (13.3)	0	1 (6.6)	0	0	1 (6.6)

Table 1: Showing the effects of organophosphate pesticides for 6, 12 and 18 months of exposure on the general parameters of eyes, skin and respiratory related symptoms in the farm sprayers and control

Note: Values was expressed as n (%), n= number of human subjects with percentage.

Group-1= 37 sprayers exposed to pesticides for 6 months with Control-1 = 15 subjects with no exposure, Group 2 =30 sprayers exposed to pesticides for 12 months with Control-2 =10 subjects with no exposure and Group-3 = 38 sprayers is exposed to pesticides for 18 months with Control-3 = 15 subjects with no exposure and belong to same socioeconomic status.

Table 2 presents the Chi-square comparison between the exposure duration and the general health symptoms of farm sprayers showed due to organophosphate pesticides spraying. The subjects exposed to organophosphate pesticide from 12 months and 18 months are statistically significant than the control who have no exposure to pesticide and from the same socio economic status. No significant difference was noticed in the subjects exposed to pesticide from 6 month (x^2 = 1.73, p=0.18) which is not statistically significant whereas the subjects exposed from 12 months (x^2 = 4.77, p<0.05) is moderately significant similarly the subjects exposed from 18 months (x^2 = 12.73, p<0.001) is highly significant as compared to the control. [18]

Exposure Duration		Total number of subjects	Subjects reported symptoms	P value*
6 months	Control 1	15	0	0.18
	Group 1	37	8	
12 months	Control 2	10	1	<0.05*
	Group 2	30	30	
18 months	Control 3	15	4	<0.001**
	Group 3	38	78	

Table 2: Chi- square comparison between the symptoms and the organophosphate pesticides exposure duration of the sprayers with their well matched control

Note: χ^2 analysis of the association between the symptoms and the pesticides exposure duration of the sprayers with their well matched control.

*=Moderately significant, **= Highly significant

It has been concluded from the findings of the present study that the signs and symptoms are significantly associated with the exposure duration. Thus it is clearly observed in the study that the subjects exposed from longer duration to organophosphate pesticides via spraying showed large number of symptoms like excessive sweating, skin redness, runny/ burning nose, etc. Thus the study indicated that the pesticide exposure mainly occurred through inhalation, dermal route and ingestion respectively in farm sprayers during spraying, as none of the sprayers use masks, gloves, boots and apron which makes it mandatory precaution as per the guideline of spraying.

DISSCUSSION

On the basis of the questionnaire it is concluded that effect of organophosphate pesticide is duration dependent. Most of the farmers in the present study were not aware of the health hazards caused by the inappropriate handling of the poisonous organophosphate. In the present study ten common symptoms were included in the questionnaire. Subjects who self reported have had two or more of the mentioned symptoms within 24 hours after pesticide spraying were considered to have suffered acute pesticide poisoning. In this study it was found that the organophosphate pesticide induced physiological changes which were observed in above mentioned groups, included ophthalmological changes, dermatological disorder, and respiratory disorders.

The findings of the present study clearly demonstrate that the organophosphate pesticide induced effects in the farm sprayers are duration and exposure dependent being maximum in the period of 12-18 months affecting a large number of population. In this regard it is mentioned that continuous and direct

pesticide exposure of eyes lead to complications like inability of the pupil to dilate fully in darkness, blurred vision, and pain around eyes[19,20]. Similar symptoms of eye-irritation and vision problems have been also found among farmers exposed to organophosphates [21]. Exposure of unprotected eyes to pesticides resulted in the absorption in ocular tissue causing potential toxicity.[22] Recently vision problems (eye itchiness, blurred vision) have also observed which can be endorsed to direct contact of pesticides with eye because of non-observance of eye protecting measures such as goggles, thus these findings are in corroboration with the present study.[23]

It may also be reported that effects of organophosphate pesticide on skin were also found to be time dependent which is in accordance with that of who have reported skin problems such as itching as the most common symptoms. [24,21] It has been observed that the skin is the primary route of exposure to pesticides for sprayers, handlers, and people using repellants. Excluding acute poisonings, contact dermatitis is thought to be the most common health effect of pesticides, through either irritant or allergic mechanisms [25]. Burning sensations in eyes/face (62.5%), itching/skin irritation (37.5%), and chest symptoms (29.2%) have also been reported.[26]

The results of present study have been found to be similar to some earlier epidemiological and toxicological studies done elsewhere. A cross sectional study was conducted in Canada on farmers for pesticides and their respiratory effects, the pesticide use was associated with isolated asthma and pulmonary function change. [27] In a study of Kenyan agricultural workers, reported that exposure to organophosphate pesticides resulted in a higher prevalence of respiratory symptoms, such as chest pain, cough, running nose, wheezing, difficulties in breathing, shortness of breath, and irritation of the throat.[28] A cross-sectional study of workers in a bottling plant also showed that in comparison with controls, pesticide processing workers had a significantly higher risk of developing respiratory symptoms, including chronic cough in females, dyspnea, nasal catarrh and nasal dryness in females and males, throat irritation in males. [29] These observations are in conformity with the present study, where it has been found that the maximally duration wise exposed sprayers reported most of the symptoms related to skin and respiratory problems. The prevalence of respiratory symptoms was found higher in the 12 and 18 months exposed farm sprayers as compared to their well matched controls. It appears that the inhalation of the excessive amounts of pesticides is resulted in choking of the bronchial pathways.

In the present study subjects were also found to be afflicted with dry/sore throat, runny/burning nose and shortness of breathing and coughing which was quite prominent. The survey results of present study on the general health aspects of farm sprayers of Bhopal are also in accordance with the findings of Sharma and Bhattacharjee [30,31] who found similar types of symptoms in farmers exposed to pesticides, where majority of the farmers were unaware of the pesticides used, level of poisoning, safety precautions and potential hazards on health and environment. This seems to be another issue which requires more such studies to be conducted and effects explained to the subjects as well as concerned authorities with regard to awareness and effects, to curb these malpractices.

Thus the present study provides imperative information related to the short and long term effects of organophosphate pesticides on the farm sprayers of Bhopal. In surveillance of the serious nature of the problem it has been thought worth while to study thoroughly the effect of organophosphate pesticides on the farm sprayers, who have been working in the most improperly managed environment without any protective measurements.

CONCLUSION

Thus in the present study it is concluded that the maximally duration wise exposed sprayers reported most of the symptoms related to respiratory problems. The prevalence of respiratory symptoms was found higher in the 12 and 18 months exposed farm sprayers. The findings from the present study evidently show that the pesticide exposure in the long term causes acute symptoms via inhalation along with skin or dermal problems. It is accomplished in the present investigation that awareness needs to be created on use of personal protective measures among farmers, while handling pesticides. Farmers needs to be encouraged to reduce, if not eliminate the use of pesticides and should be educated about bio-pesticides and their benefits, with the introduction of incentives to the farmers to help them shift from synthetic pesticides to bio pesticides and organic farming a new revolution can be introduced.

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