

Organophosphate pesticide exposure induces neurological disorders in the farm sprayers of Bhopal, India

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ABSTRACT

Organophosphates (OPs) are the most widely used group of pesticides and insecticides in the world and are used for agricultural purposes. In this study, we examined the cross-sectional data on neurological signs and symptoms from 45 males who were occupationally exposed organophosphate pesticides during handling, mixing, and spraying. The farm sprayers who are involved in the spraying activity of pesticides in soybean fields do not use the safety masks, gloves and other protective gears get the direct exposure of pesticides due to hazardous and non-preventive work practices. In the present study relationship between the pesticides used and signs and symptoms of neurobehavioral complaint 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. 45 spray farmers were interviewed using previously designed questionnaires during a cross sectional survey. In the 12 months exposed sprayers 3(10%) subjects reported fatigue, 2(6.6%) subjects showed dizziness, 7(23.3%) farm sprayers reported muscle weakness/cramps and 5(16.6%) farm sprayers reported tremors. The 18 months exposed sprayers reported maximum symptoms like 7(18.42%) farm sprayers reported fatigue, 14(36.8) farm sprayers reported dizziness, 13(34.2%) reported muscle weakness/cramps and 9(23.68%) sprayers complained tremors when compared with their well matched controls. The signs and symptoms were found to be duration dependent among the sprayers.

KEY WORDS: ORGANOPHOSPHATE PESTICIDES, NEUROBEHAVIORAL, EXPOSURE, SYMPTOMS, SPRAY FARMERS

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INTRODUCTION

Organophosphorus (OP) pesticide poisoning is a major global health problem with thousands of deaths every year. Recent World Health Organization report shows that every year about three million cases of OP intoxications and 3,00,000 OP poisoning related death occurs worldwide (Hundekari *et al.*, 2013). Organophosphate (OP) compounds are extensively used as pesticides and industrial chemicals. They are primarily neurotoxic and produce well-defined muscarinic, nicotinic, and cholinergic neurosymptoms involving both central and peripheral nervous systems (Rastogi *et al.*, 2010, Khan *et al.*, 2014).

Acute effects of OP exposure have been well documented. Inhibition of neuronal acetylcholinesterase (AChE) enzyme activity is the main mechanism of OP toxicity. AChE hydrolyzes the neurotransmitter acetylcholine, and thereby plays a critical role in regulating nerve transmissions in the central and peripheral nervous systems (Hoffmann *et al.*, 2010). A review of some studies demonstrated a wide range of neuromuscular disorders, acetylcholinesterase (AChE) inhibition and deterioration of the hematological, hepatic and renal functions associated with exposure to pesticides (Steenland *et al.*, 2000; Smit *et al.*, 2003; Kamel *et al.*, 2007, Khan *et al.*, 2014). However, lack of research and toxicological data on spray workers has hindered efforts to improve the agriculture environment for reducing probable risk exposures. Hence, the present study was undertaken to explore and investigate the toxicity reason by means of neurological symptoms developed in the exposed spray farmers of Bhopal, Madhya Pradesh.

MATERIAL AND METHODS

STUDY AREA

The present study conducted on the agriculture spray farmers of Bhopal, Madhya Pradesh, India who involve in the spraying activity on soybean. The villages of Misrod district were randomly selected for the study i.e. Bagarouda village, Jhagariya khurd village and the Babadiya Khurd village. 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. 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). The subjects who were exposed from 6 months to 18 months were undertaken for the present study.

INTERVIEW QUESTIONNAIRE

The questionnaire was designed to obtain 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 neurobehavioral signs and symptoms during or immediately after pesticide spraying. Being a cross-sectional survey, details on signs and symptoms were collected as self reported by the farmers. 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 it has found 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

Questionnaires were asked to be filled by the subjects of each group. The study was carried out on a total number of 85 human subjects who were males and ranged between 18-45 years of age, belonging to same socio-economic status. The groups were selected on the basis of the questionnaires filled by the sprayers. 45 subjects were randomly selected from various farms who actively involved in the preparation, storage and spraying of the pesticides on crop for at least six months. Analysis was done on three groups based on the duration of organophosphate exposure (i.e 15 subjects with 6 months exposure, 15 subjects with 12 months exposure and 15 subjects with 18 months exposure). 40 healthy males having no previous occupational exposure to pesticides were taken as controls from near by areas with same socio-economic status. The purpose of the academic study was explained to all the participants and their consent was obtained.

RESULTS AND DISCUSSION

Neurobehavioral problems like fatigue, dizziness, numbness/ muscle weakness/ muscle cramps and tremors were recorded in the sprayers during the study. Table 1 shows that the Group 1 in which sprayers exposed for 6 months, out of 15 subjects only 1(2.7%) subject showed the problem of dizziness as compared to their controls.

In the 12 months exposed sprayers it was observed that out of the 15 sprayers 3(10%) subjects reported fatigue, 2(6.6%) subjects showed dizziness, 7(23.3%) farm sprayers reported muscle weakness/cramps and

5(16.6%) farm sprayers reported tremors. However in the 18 months exposed sprayers it is clearly shown in table 1b that out of the 15 sprayers 7(18.42%) farm sprayers reported fatigue, 14(36.8) farm sprayers reported dizziness, 13(34.2%) reported muscle weakness/cramps and 9(23.68%) sprayers complained tremors when compared with their well matched controls. None of the neurobehavioral problem related to fatigue, dizziness and weakness was observed in the control subjects during the study.

Thus in the present study it is revealed that the farm sprayers exposed to organophosphate pesticides for prolonged durations are more prone to develop neurobehavioral symptoms than the control as they ingest the pesticide during spraying and mixing.

Earlier studies have also shown that organophosphate pesticides exposure inhibits mammalian acetylcholinesterase (AChE), resulting in the development of symptoms that have their origin at different parts of the nervous system (Coye *et al.*, 1986; Magnotti *et al.*, 1988) suggested that when cholinesterase is blocked, acetylcholine level increases and builds up in the muscles. The present data regarding neurobehavioural effects are also supported by an epidemiological study between exposure to organophosphate pesticides and neuropathy and neuropsychological abnormalities in sheep farmers and dippers which showed a strong association between exposure to OP concentrate and neurological symptoms (Pilkington *et al.*, 2001). In another study conducted on the Kenyan agricultural workers, it has been suggested that there is the presence of a relation between the change in acetylcholinesterase inhibition from low to high exposure periods, and acetylcholinesterase activity during high exposure and respiratory, eye and CNS symptoms (Mitoko *et al.*, 2000). Although pesticide exposure may have significant effects on neurodevelopment as studied previously by Eskenazi *et al.*, (1999).

A study in Srilanka has shown inhibition of AChE enzyme and impairment of sensory and motor nerve conduction due to long term, low level exposure to OPs (Smit *et al.*, 2003). Kamel *et al.*, (2003) reported in the study of neurobehavioral performance and the work exposure in Florida concluded that that long-term work exposure is associated with measurable deficits in cognitive and psychomotor function. Farhat *et al.*, (2003) also studied the association between pesticide exposure and neurologic health endpoints and concluded that environmental and occupational exposure to OP pesticides leads to neurodegenerative functions in agricultural workers. In this study, we found that increased neurologic symptom was associated with chronic exposure to OP pesticides thereby confirming previous studies (Strong *et al.*, 2004)

The pesticide-related neurologic symptoms, both muscarinic and nicotinic observed in this study could be due to the inhibition of RBCs, AChE, as well as plasma BuChE recorded in the study group and reported in earlier studies by the authors (Rastogi *et al.*, 2008; 2009). Neurologic symptoms found on exposure to organophosphate pesticides in the children of agricultural workers revealed by Rastogi *et al.*, (2010). Tremors, muscle cramp and weakness are reported in the male and female children exposed to pesticides. Recent study conducted on the adolescents applying chlorpyrifos revealed a gradual increase in the neurological symptoms was also found among the applicators (Khan *et al.*, 2014)

Thus the data of the present work demonstrating the prevalence of neurological dysfunctions like early tiredness, dizziness, weakness, salivation, fatigue and pain in muscles weakness/cramps all are nervous system related disorders where the enzymes like acetylcholinesterase are disturbed, are fully corroborated by the above quoted findings. It is concluded that there is need for implementing protective work practices during handling and pesticide spraying.

TABLE 1: Showing the effects of organophosphate pesticides for 6, 12 and 18 months of exposure on the general abdominal disorder and neurological disorder in the farm sprayers along with control subjects.

Exposure Duration	Symptoms→ Groups of Human Subjects (n)↓	Fatigue	Dizziness	Numbness/muscle weakness/ muscle cramps	Tremors
6 Months	Control-1 (15)	0	0	0	0
	Group- 1 (15)	0	0	1 (2.70)	0
12 Months	Control -2 (10)	0	0	0	0
	Group- 2 (15)	3 (10)	2 (6.6)	7 (23.3)	5 (16.6)
18 Months	Control -3 (15)	0	0	0	0
	Group- 3 (15)	7 (18.42)	14 (36.8)	13 (34.2)	9 (23.68)

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