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Evaluation Of Serum Cholinesterase Levels Among Farm Workers Exposed To Chemical Pesticides In Rural Population Of Tiruchirapalli

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Abstract

In this study, we compared the SChE levels between exposed and unexposed subjects of pesticides. This cross-sectional study was conducted in the tertiary care teaching hospital. A total of fifty-two farmers were exposed to mixture of pesticides. Fifty non exposed controls from same geographical area, who had no history of exposure to chemicals were randomly selected for this study. A detailed history, including the personal and occupational details, list of pesticides employed, duration of exposure and the number of usages were recorded among agricultural workers with the help of questionnaire. Among the exposed group, 88.46% were males and 11.53 % were females. The mean ± S.D of SChE levels in males those who exposed to OP and non-exposed group were 5864±1208 and 7335±1581 respectively. The mean ± S.D of SChE levels in females those who exposed to OP and non-exposed group were 5203±1141and 6608±1611 respectively. In our study, the farm workers had complaints of headache (18.2%), dizziness (15.5%), eye irritation (22.4%) and excessive sweating (15.6%) and were associated with decreased serum cholinesterase levels with significant 'p' value. It is recommended that the farm worker's cholinesterase level should be assessed periodically. There is mounting evidence that chronic moderate pesticide exposure is

always lethal. Further studies are needed to substantiate these findings.

Keywords: Chemical pesticides - farm workers - serum cholinesterase - rural population.

Introduction

Agriculture workers are at high-risk group for exposure to pesticides. The contamination of pesticides may happen in several ways during storing, application in fields, warehouses, and wrong use by peoples. Pesticide exposure often induces acute and chronic neurological toxicity and dysfunctional lipid, protein, and carbohydrate metabolism [1]. In India, 76% of the pesticide used is insecticide, as against 44% globally [2,3]. In India, more than 1 billion people are engaged in agricultural activities and increased amount of pesticides is used to protect their crop against pests to get more yields [4].

Organophosphates (OP) were commonly employed for killing insects on farms, resulting in several adverse effects which affect the health and cause environmental pollution. OP inhibit the activity of cholinesterase (ChE) enzymes in muscle and nerves, [4,5]which results in the accumulation of the neurotransmitter acetylcholine (ACh) in the nervous system. OP exposure may result in acute and chronic cholinergic poisoning effects. Acute toxic effects of OP pesticides are due to inhibition of acetyl cholinesterase (AChE) in the nervous system, which can cause myocardial, respiratory and neuromuscular transmission impairment [4].

Immediate effects of exposure to large doses of OP produce a wide range of neurological symptoms and it can be observed by clinical signs and symptoms and inhibition of acetyl cholinesterase activity. Low or moderate level of exposure remains ambiguous and begins to suspect their adverse health effects. Chronic effects of OP exposures are not well reported; however, several current studies elucidate that certain birth outcomes (e.g., decreased gestational age, decreased birth length) [6] and abnormal reflex functions in newborn [4,7] may be linked with low level environmental exposures to OP pesticides. People are directly exposed to these pesticides through dermal contact and inhalation, and indirectly through the food chain.

Few studies suggested that a low level of exposure to OP can also induce oxidative stress and damage strand break in Deoxyribose nucleic acid (DNA), which poses an increased threat for chronic diseases, like cancer and neurodegenerative diseases [8]. Significant studies have reported cytogenetic damage in agricultural workers, floriculturists, vineyard cultivators, cotton field workers, and others exposed to different types of pesticides. The chlorinated pesticides remain in the environment for very prolonged periods, undergo bioaccumulation, biomagnifications and hence, impart toxicity to non-target organisms including human beings. Pesticides are generally considered as active, evident, and economical solution for controlling weeds and insect pests in urban landscapes.

Serum cholinesterase (SChE) has been used as an exposure index, to assess low-level, chronic residue exposures among field workers [9]. Moreover, AChE is the primary target of organophosphorus and carbamate pesticides, the most commonly used classes of insecticides worldwide. Appropriate legislations and pesticides control, particularly OP, which are the most commonly-used pesticides, are recommended for the developing countries, especially those with poor regulations and controls. Complete understanding of the mechanism of specific pesticide will help to prevent the risk of such exposure.

Although some attempts have been made in this regard, more comprehensive studies are required to find a preventive approach from the hazardous effects of pesticides. Apart from their lethal acute toxicity at high doses, the extensive use and availability of OP in agricultural and domestic applications raise questions about the safety of long-term exposure at the currently approved levels. Serum cholinesterase levels estimation indicates whether the person has been exposed to pesticide exposure or not. It is recommended that the farm worker′s cholinesterase level should be assessed periodically. The main objective of the study is to find out the serum cholinesterase levels in agricultural workers related to symptoms and duration of exposure.

Materials and Methods

This is a prospective cross-sectional study and was conducted in tertiary care teaching hospital in the rural area of southern part of Tamilnadu. The study was conducted over a period of three months at tertiary care teaching hospital and research Centre during the months of August to October 2019. A total of 52 farm workers aged 18 to 60 years were randomly selected and included as cases. Additionally, 50 apparently healthy people who were not exposed to pesticides (Profession other than farming) were selected as control.

Agricultural workers exposed to pesticides residing in the rural area were included in this study.Known liver disease, pregnancy, malignancy and those who are not willing to participate were excluded from the study. A detailed demography, working pattern, type of pesticides used, and duration of exposure, exposure frequency and usage of personnel protective equipment (PPEs)was recorded by contacting them personally. The health paradigm related to chemical exposure was explained to the subjects included and further all are requested to attend medicine OPD of the study centre for further clinical and laboratory investigations. Ethical clearance was obtained from Institutional ethical committee (Ref: No. 636/ TSRMMCH&RC/ME-1/2019-IEC No.012 dated 17.07.2019) and the present research work has been carried out according to the guidelines issued by the Institutional human ethical committee.

Under strict aseptic precautions, 3ml of venous blood was collected from the study population after getting informed written consent. Serum cholinesterase level was measured by kinetic photometric method in fully automated analyzer Mindray BS-420. The reference range of serum cholinesterase was 4620-11500U/L. Calibration of instruments and reagents were done before performing procedures.

After completing the *in vitro* biochemical procedures, all the data were analyzed statistically using SPSS software, version 21. Variables are expressed as mean ± standard deviation. Student′s *t*-test/chi-square test was used to compare the significance of the mean differences in ChE activity between exposed and control subjects. For all analyses, ’p’values<0.05 was considered as significant.

Results

The study subjects of 52 individuals who were exposed to pesticides were recruited as cases and mean spraying time was 90 minutes ranging from 30 to 120 minutes. According to the period of exposure to pesticides, 35% had worked in agriculture for more than 5 years, 24.5% for 2 to 5 years and 40.5% for less than 2 years. Fifty eight percent of the farmers reported that frequency of spraying pesticides range from one to two times a week, 12% sprayed once or twice a month and 0.8% applied pesticides daily. The prevalence of individuals with abnormal cholinesterase levels were 19.5%.

Among the study group, 88.2% were males and 11.8% were females. The age group of the most of the participants was found among 46 to above 55 (Table 1). Among the control groups, the age and gender matching were more or less equal and coherent.

Table 1: Age and Gender wise distribution of study population

Age groups (in years)	Gender wise distribution	
	Males (n=90)	Females (n=12)*
Cases (n=52)		
18 to 25	6 (6.7)	1 (8.3)
26 to 35	9 (10)	1 (8.3)
36 to 45	7 (7.8)	1 (8.3)
46 to 55	11 (12.2)	1 (8.3)
Above 55	13 (14.4)	2 (16.7)
Controls (n=50)		
18 to 25	4 (4.5)	1 (8.3)
26 to 35	8 (8.9)	1 (8.3)
36 to 45	9 (10)	1 (8.3)
46 to 55	11 (12.2)	2 (16.7)
Above 55	12 (13.3)	1 (8.3)

[Figure in parentheses denoted percentage; *the percentage decimal cannot be 100]

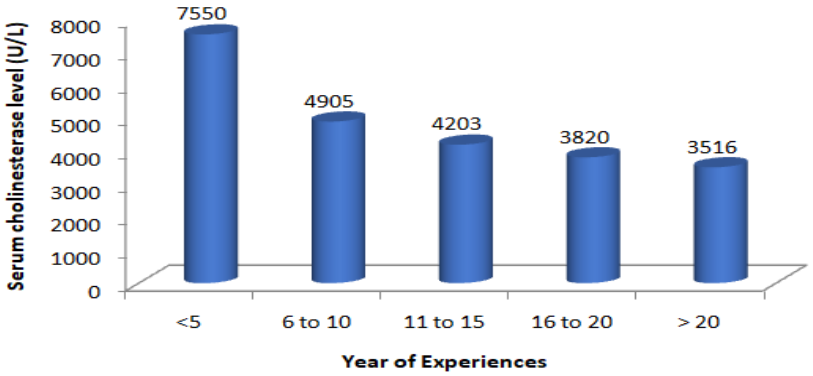
SChE levels among exposed and non-exposed population were observed using student 't' test. The mean ± S.D of SChE in farmers exposed to OP and control group is shown in Table 2. There was no significant difference observed among pesticide exposed and non-exposed individuals. This study observed that the serum cholinesterase activity was decreased in pesticide users/applicators compared to non-exposed group in both males and females.

Table 2: Comparison of serum cholinesterase levels among cases and controls.

Gender	Serum cholinesterase levels		p value
	Cases (n=52)	Control (n=50)	
Males	5864±1208	7335±1581	0.06
Females	5203±1141	6608±1611	0.07

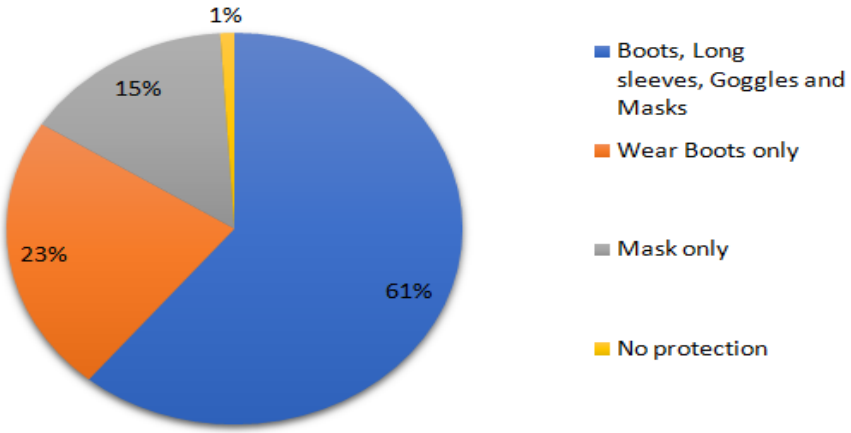
Comparison of serum cholinesterase levels according to duration of exposure of Organophosphates are well analyzed thereby the pesticide spraying individuals verses serum cholinesterase levels were compared. The workers who sprayed pesticides were likely to have decreased serum cholinesterase levels (Figure 1).

Figure 1: Comparison of serum cholinesterase levels according to duration of exposure of Organophosphates



Among the 52 farmers who sprayed pesticides, 34 to 56% practiced good protective behavior before, during, and after application. Among the sprayers, 61% wore boots and longsleeved shirts, mask and during application, only 23% used goggles, whereas 15% wears mask alone. Usage of masks and goggles among farmers exposed to pesticides were given in Figure 2.

Figure 2: Usage of masks and goggles among farmers exposed to pesticides.



Self-reported pesticide-related symptoms among farm workers based on serum cholinesterase (SChE) levels (Table 3). The prevalence of clinical symptoms like headache, dizziness, eye irritation and excessive sweating were associated with serum cholinesterase levels significantly.

Table 3: Self-reported pesticide-related symptoms among farm workers, by SChE levels

Symptoms	Abnormal SChE (%)	Normal SChE (%)
Headache	18.2	6.6
Dizziness	15.5	4.5
Nausea and vomiting	4.5	3.6
Fever	1.2	0.6
Fatigue	2.8	3.5
Eye irritation	22.4	10.5
Skin irritation/itching	13.5	12.9
Burning sensation on skin	12.5	10.5
Excessive sweating	15.6	10.8
Abdominal pain/ Diarrhea	1.2	1.1

$p < 0.01$ - significant

Discussion

This study was proposed to categorize the serum cholinesterase levels of farm workers exposed to chemical pesticides in rural areas. Cholinesterase hydrolyzes acetylcholine (a neurotransmitter) into choline andacetic acid which used in the proper functionig of the nervous systems of humans [8]. The RBC cholinesterase found primarily in the blood and neural synapses while the pseudo-cholinesterase (BuChE) normally found in the liver. The BuChE is generally used in reference to a clinical test that reflects levels of enzymes in blood which chemically interfere with the action of cholinesterase and become potent neurotoxins such as carbamate and organophosphate (OP) pesticides.

Among the exposed group, 88.2and 11.8% were males and females respectively. Male workers are involved in pesticide mixing, loading, application and they spent majority of time in fielding when compared to females. The mean ± S.D of SChE levels in males those who exposed to OP and non-exposed group were 5864±1208 and 7335±1581respectively. The mean ± S.D of SChE levels in females those who exposed to OP and non-exposed group were 5203±1141and 6608±1611 respectively. There was no significant 'p' value observed among pesticide exposed and non-exposed individuals. This study observed that the serum cholinesterase activity was decreased in pesticide users/applicators compared to non-exposed group in both males and females. Males are spraying large hectare paddy field while females are spraying in small fields, particularly involved in vegetable planting. Hence, the decreased levels of SChE are reported in males than females and the decreased data also due to the awareness found among them and usage of PPEs.

The prevalence of abnormal SChE in our study was 19.5%. Chomthaisong et al. found that 66.2% of tomato growers for seed production and 48.1% of tomato growers for consumption were observed to have abnormal SChE activity [11,12]. The serum cholinesterase levels gradually declined as duration of exposure in increased. Prolonged exposures without using proper PPEs resulted in increased risk of developing abnormal SChE levels and health hazards.

In our study, the farm workers had complaints of headache (18.2%), dizziness (15.5%), eye irritation (22.4%) and excessive sweating (15.6%) and were associated with decreased serum cholinesterase levels with significant 'p' value. These results were consistent with the study of Yassin et al [13]. The symptoms of headache, dizziness, fatigue and skin irritation were recorded as 35.2, 27.6, 20 and 11.4% respectively as given in the studies of Tunsaringkarnet al[10]. The factors like application method, use of personal protective equipment, work practices related to hygiene, spills, and attitudes toward risk may all influence the degree of pesticide exposure and the SChE values. Exposure to pesticides is related with increase in prevalence of many symptoms, having little evidence for specificity. The limitations of study are small sample size; symptoms relied on self-reports and examined clinically, may be influenced by recall bias or related to nonspecific symptoms and crosssectional study predicts only causal association between exposure and SChE levels.

Conclusion

The mean ± S.D of SChE levels in males those who exposed to OP and non-exposed group were 5864±1208 and 7335±1581 respectively. Serum Cholinesterase levels were low in farmers those who used pesticides in farming compared to non-exposed persons. The prevalence of clinical symptoms like

headache, dizziness, eye irritation and excessive sweating were associated with serum cholinesterase levels significantly. SChE were likely to be proportionately decreased in individuals with increased duration of exposure. These findings may warrant further studies and investigations in more detail.

From this study, it was suggested that appropriate training to the farmers is needed to reduce exposure to OP pesticide. Government can take certain necessary steps for screening of toxicity in the pesticides provided to the farmers; The farmers who have been supplied with these pesticides can be allowed to have a free access for routine checking of serum cholinesterase in primary health centres nearer to them, so that regular monitoring for blood cholinesterase to reduce pesticide exposure can prevent health effects. Both the farm workers and the non-working populations exposed through other modes of environmental contamination need control over the use of pesticides by developing monitoring and surveillance systems. Farmers can actually opt to organic manures, though possibly not easy to prepare, but it would prevent the ill-effects of these pesticides for both the farmers as well as consumers.

The special suggestion to the producers of the pesticides and the chemical authorities of various levels is to provide the PPEs as complementary material along with the pesticides so as the usage of PPEs may be increased among the end users.

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