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RESEARCH ARTICLE

Evaluation of dynamic lung volumes and capacities in farm laborers exposed to occupational pesticide spraying

Shivaji S Chalak, Vikas Junghare

Department of Physiology, SMBT Institute of Medical Sciences and Research Centre, Nashik, Maharashtra, India

Correspondence to: Shivaji S Chalak, E-mail: shivajichalak@rediffmail.com

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ABSTRACT

Background: The exposure to pesticide spraying during the process of farming in the fields is becoming a health concern among the farm laborers. The frequent and unprotected inhalation of chemical pesticides during spraying process adversely affects the lung functions secondary to development of obstructive lung disorders. **Aims and Objectives:** The objectives were to evaluate the effect of chemical pesticide spraying on Dynamic lung function tests (DLFT's) and to compare the various parameters such as forced expiratory volume in 1 s (FEV1), FEV1/forced vital capacity (FVC) ratio, forced expiratory flow 25–75% ($FEF_{25–75\%}$), and maximal voluntary ventilation (MVV) in affected individuals with the normal healthy controls. **Materials and Methods:** The study samples were divided into two groups, study and control groups. An analytical study was conducted by including 60 individuals with age- and occupation-matched criteria (control group – 30 and study group – 30). Participants were selected randomly from the outpatient department (OPD) premises, with the age group between 20 and 40 years, and both sexes were included. Dynamic lung volumes and capacities were recorded on the computerized RMS HELIOS 702 Spirometer. **Results:** Dynamic lung volumes and capacities such as FEV1, FEV1/FVC ratio, $FEF_{25–75\%}$, and MVV were evaluated on OPD basis in the pulmonary function test laboratory. Our findings showed that all the DLFT parameter values in case of exposed and affected population were significantly less as compared to the normal healthy controls. This indicates the presence of obstructive lung diseases in such individuals. There was a significant difference between the means of study and control groups, and the affected individuals exposed to chemical pesticides had lower lung function tests as compared to normal population. **Conclusion:** The findings of the present study provide us with useful evidence about the association of pesticide inhalation exposure with adverse respiratory effects among farm laborers. This occupational hazard requires special attention and preventive measures, as it may increase the risk of pulmonary dysfunctions and mortality associated with these diseases.

KEY WORDS: Forced Expiratory Volume in 1 s; Farm Laborers; Forced Expiratory Volume in 1 s/Forced Vital Capacity Ratio; Direct Long Fiber Thermoplastic; Obstructive Lung Diseases

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INTRODUCTION

Inhalation exposure to pesticide spraying can be a major respiratory health problem in farm laborers. The unprotected handling of such poisonous chemical compounds during spraying seasons leads to frequent exposure of farmers to such toxic agents. Globally, around 300,000 deaths

per year are resulted from acute pesticide poisoning, with Organophosphates (OP), organochlorines (OC), and aluminum phosphide being reported most frequently as the cause.[1,2]

Respiratory inhalation and dermal and mucosal absorption are considered as the primary routes of exposures to pesticide in farm laborers. Inhalation of volatile pesticide products usually leads to respiratory exposures, especially those working with no protective equipment. (e.g., mask with filter). Respiratory symptoms associated with pesticide exposures include wheezing, airway irritation, cough, breathlessness, and chest tightness.[3,4]

In farm laborer's occupations, typically about 10% of total pesticide exposure occurs via the respiratory route, with the rest through either dermal absorption or digestion. For nonvolatile pesticides, respiratory inhalation also occurs when pesticides are sprayed an inhalable form.[5,6]

OP compounds belong to the group of anticholinesterase agents and are potent inhibitors of acetylcholine (ACh) hydrolysis. The accumulation of ACh, therefore, results in stimulation of nicotinic and muscarinic receptors, and hence, causes cholinergic toxicity. In few others, they are known to produce a very specific syndrome of delayed peripheral neuropathy. Few studies have investigated the association between occupational pesticide exposures and chronic respiratory diseases, such as asthma, chronic obstructive pulmonary disease (COPD), and lung cancer.[6,7]

Based on chemical properties, pesticides can also be categorized into OC, OP, carbamates, dithiocarbamates, pyrethroids, phenoxyl, triazine, amide, and Coumadin compounds. Factors involved in occupational pesticide exposures usually include application intensity, frequency, duration and method, safety behaviors (e.g., use of personal protective equipment), as well as the physiochemical and toxicological profiles of the pesticides in use.[8,9]

Need for Study

The use of pesticides in occupational settings by farm laborers is associated with impaired lung function. The catchment area has a tribal population with farming as their means of livelihood, and majority of the farmers are abundantly using pesticides spray for cultivation. The issue is becoming serious and has a disastrous adverse effect on the respiratory functions affecting health of such population.

The objectives of the present study will be targeted to find the effect of OP pesticide spraying on dynamic lung volumes and capacities. Dynamic lung function tests (DLFT's).

MATERIALS AND METHODS

Place of Work

The present study was carried out at the Department of Physiology in a 700-bedded tertiary hospital of SMBT Institute of Medical Sciences, Dhamangaon, Igatpuri, Nashik, which is situated in a hilly and tribal area.

Study Design

It is a cross-sectional analytic study.

Ethical Committee Requirement

Ethical approval of the study was obtained from the Institutional Ethical Committee of SMBT Medical College and Research Centre, before the initiation of the study, vide letter no SMBT/IEC/18/395/12/07/2018.

Patients' Selection

Sixty age- and occupation-matched individuals were recruited between the age group of 20 and 40 years, in which both the sexes were be included (30 study group and 30 controls). On the basis of detailed history of duration of exposure to pesticide for more than 5 years, farm laborers were selected on random basis. The effective toxic dose of a pesticide for an individual was considered either by measuring working hours or by monitoring the contamination level of the workplace.

The sample size was selected from the outpatient department (OPD) population and by doing farm labourer's home visit who were later called to OPD for necessary investigations. The control group population was selected among the healthy individuals and relatives visiting in OPD.

Instrumentation and Laboratory Method

The dynamic lung volumes and capacities were recorded on computerized RMS HELIOS 702 spirometer. After taking detail history and clinical examination of the subjects regarding exposure to OP pesticide spraying, informed consent was obtained. Then, the procedure for dynamic lung function test was explained to the subjects making them aware that DLFT are harmless and noninvasive studies which were recorded with the help of computerized spirometer machine.[10,11]

Inclusion Criteria

1) Farm laborers who were exposed day-to-day OP pesticide spraying, with a duration of exposure to pesticide for more than 5 years.
2) Normal healthy age-, gender-, and occupation-matched subjects with the age group of 20–40 years were included as controls for comparison.

Exclusion Criteria

1) Age group not falling in between 20 and 40 years.
2) Subjects with any pre-existing lung disorders due to any other occupational hazards and with a history of smoking.
3) Subjects with any other systemic diseases such as COPD, pulmonary tuberculosis, and bronchitis.

Statistical Analysis

Statistical analysis was done by descriptive and inferential statistics using Student's paired *t*-test, using software Statistical Package for the Social Sciences 17.0 version. $P < 0.05$ was considered as statistically significant.

RESULTS

In all, 60 farm laborers were included in the study; among which, 30 farmers were those who were unintentionally exposed day-to-day OP pesticide spraying, with the duration of exposure to pesticide for more than 5 years. For comparison, 30 normal healthy subjects with the age group of 20–40 years were included as controls. Table 1 shows the type of OP pesticide to which the study group patients were exposed. Table 2 shows the comparison of means of dynamic lung volumes and capacities in control and study groups. There was a significant difference between the mean values of control and study groups. The means of forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1), FEV1/FVC ratio, and forced expiratory flow 25–75% ($FEF_{25–75\%}$) were significantly less in the study group as compared to the control group.

Table 1: Type of OP pesticide to which the study group patients were exposed

Type of OP	Number of cases exposed to OP
Aldrin	10
DDT, DDE, DDD	12
Chlordane	2
Unknown pesticide	6

OP: Organophosphate

Table 2: Comparison of means of dynamic lung volumes and capacities in controls and study group

Variable	Group	Mean±SD	*t*-stat.	*P*-value
FVC	Control	3.99±0.63	5.22	0.0611
	Study	3.06±0.74		
FEV1	Control	3.36±0.50	6.29	0.0046*
	Study	2.39±0.68		
FEV1/FVC	Control	84.62±4.54	2.81	0.0078*
	Study	77.81±12.45		
$FEF_{25–75\%}$	Control	3.70±0.86	5.01	0.0036*
	Study	2.46±1.05		
FVV	Control	84.97±22.06	4.32	0.0132
	Study	58.97±24.45		

*P<0.01 considered to be statistically highly significant, SD: Standard deviation, FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 s, $FEF_{25–75\%}$: Forced expiratory flow 25–75%

DISCUSSION

A cross-sectional analytic study was conducted in the age group between 20 and 40 years; both the sexes were included. The selected subjects from the above-said age group were the farmers who were exposed to day-to-day OP pesticide spraying.

Two groups were formed as follows:
- Group 1 (control group): Normal healthy age and gender-matched normal subjects with the age group of 20–40 years ($n = 30$).
- Group 2 (study group): Farm laborers who were exposed to day-to-day OP pesticide spraying, with a duration of exposure to pesticide for more than 5 years ($n = 30$).

DLFT's were recorded and analyzed among the farm laborers. Our findings showed that the DLFT is significantly reduced in case of exposed population due to the undesirable effects of toxic compounds, as compared to the normal population. A large number of studies have identified associations between respiratory symptoms and pesticide exposure.

A number of papers have suggested that the use of pesticides in occupational settings is associated with impaired lung functions associated with OP or carbamate insecticide-induced cholinesterase inhibition. In an another study of agricultural workers in India, exposures to OP and carbamate insecticides were significantly associated with reductions in FVC, FEV1, FEV1/FVC ratio, $FEF_{25–75\%}$, and peak expiratory flow rate, which were also significantly correlated with cholinesterase inhibition. Our findings are compatible with the reports of Chakraborty *et al*., in which they demonstrated impaired lung functions in individuals exposed to pesticide spraying.

Another cross-sectional study of 102 pesticide sprayers and 69 non-sprayers in state farms of Ethiopia by Mekonnen and Agonafir showed that pesticide sprayers in the age group of 15–24 years had significantly reduced FEV1 and FVC, compared to controls.[12,13]

A similar study conducted among agricultural pesticide sprayers in Spain suggested that short-term exposure to pesticides was related to reduction in FEV1, while long-term pesticide exposure was associated with reduction in $FEF_{25–75\%}$.[14]

Other than the adverse effect on dynamic lung volumes, occupational exposures to pesticides may also lead to impairment of gas exchange in the lung. Two studies among

farmers in Costa Rica and the Western Cape showed a relationship between long-term low-level paraquat exposures and exercise-associated oxygen desaturation, suggesting paraquat may cause gas exchange abnormalities.[15,16]

Strength and Limitations of Study

This pilot study can be a benchmark for further evaluation of obstructive lung disorders. Moreover, further similar elaborative studies can be undertaken by selecting larger sample size for more confirmatory results. The results of this study can be utilized for planning of preventive and control measures. The limitations of the study are that the sample size was smaller and a future elaborative study is required.

CONCLUSION

Our study concluded that there was an evidence of obstructive lungs disease in farm laborers exposed to pesticide spraying which was evident by low values of dynamic lung functions in such population, as compared to the normal individuals.

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