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Airway Resistance in Farmers Exposed to Pesticides as Compared to Controls

Sunitha M[1], S Smilee Johncy[2], Ashwini S[3], Dhanyakumar[4]

Author Affiliation

[1,3,4]Associate Professor, [2]Professor and Head, Department of Physiology, JJM Medical College, Davanagere, Karnataka 577004, India.

Corresponding Author

Sunitha M, Associate Professor, Department of Physiology, JJM Medical College, Davanagere, Karnataka 577004, India.

E-mail: sunithamprof@gmailcom

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Abstract

Background: Productivity in agricultural field has remarkably increased worldwide in this era of green revolution. Agriculture, a very complex occupation, apart from increasing productivity also brings huge loss to community in terms of its ill effects on humans, plant and animal life due to aggressive use of agrochemicals like fertilizers and pesticides. Respiratory diseases among farmers were one of the first-identified occupational hazards associated with agriculture. As farmers cultivating the earth are the most valuable citizens the present study is designed to detect the ill effects of exposure to fertilizers and pesticides on lung function. *Aims:* Present study was designed to study the effect of pesticides on lung function in pesticide exposed farmers and to compare these lung function parameters in exposed farmers to that of normal controls. *Materials and methods:* Pulmonary function test was studied in 60 apparently healthy male farmers exposed to pesticides, and compared with 62 apparently healthy male control subjects. The pulmonary function test was performed by using an electronic spirometer and results were compared by Student's unpaired *t* test. *Results:* Results of the present study showed a significant decrease in the mean values and percent predicted value of FVC, FEV1, %FEV1/FVC, PEFR and FEF 25–75% in pesticide exposed farmers compared to normal subjects. *Conclusion:* Based on results of the present study it may be concluded that pesticide exposed farmers are at increased risk of developing occupationally related pulmonary impairment. There is need for compulsory use of personal protective equipment and measures during pesticide application.

Keywords: Pesticides; Farmers; Pulmonary function.

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Introduction

In the agricultural world, with inadequate rains and insufficient irrigation, there is a persistent crop loss due to pests, diseases and weeds before the harvest.[1]

Pesticides are compounds used to save crops from pests attack and to eradicate pests. Usage of these pesticides intensively, leads to its accumulation not only in soil, water, and crops, but also in the surrounding atmosphere.[2] Pesticides according to their target action includes insecticides, herbicides fungicides and others such as nematicides, acaricides, rodenticides and fumigants etc. Insecticides contains usually organochlorines, organophosphates, carbamates, pyrethroids, neonicotinoids and phenylpyrazoles. Herbicides contains combination of amides, chlorophenoxy, bipyridyls, dinitroanilines, triazines, urea and amines, phosphonates. Fungicides consisting of inorganic compounds, aromatic, dithiocarbamates, anilides, dicarboximides, (benz) imidazoles and conazoles.[3]

During agriculture, these pesticides mainly enter the body through skin, followed by respiratory and oral routes.[4,5]

Inhalation of pesticides occurs during its fumigation, mixture preparation and during application in closed environments.[6,7] Farmers get exposed to these toxic chemicals due to spills and splashes, direct spray contact as a result of wrong technique of application or inadequate protective equipment's, contaminated shoes, clothes, drinking water and food as well.[8]

These toxic pesticides can accumulate in living species resulting in long-term and chronic effects. Long-term exposure and inhalation of these ultrafine ambient fine particulate matter ≤ 2.5 μm (PM2.5) from the agrochemicals pose great adverse effect on respiratory health leading to variety of respiratory diseases like asthama, bronchitis, chronic obstructive lung disease etc.[1]

In occupational respiratory diseases, lung function test like spirometry is oneof the most important diagnostic tools as it plays a very important role in the diagnosis and prognosis of these diseases and differentiates the effect of restriction or obstruction on the lungfunction.[9] Periodic regular lung function testing in farmers can detect pulmonary diseases in its earlier stages where corrective measures are more likely to be beneficial.

Materials and Methods

This study was undertaken in 60 apparently healthy male farmers, aged between 20 to 40 years with history of working for at least 6–8 hours a day for twice a week in the farm. Sixty-two apparently healthy male, control subjects will be selected. Subjects were matched for age, height and weight. Subjects with History of smoking, Alcohol intake, Diabetes mellitus, Hypertension, Anemia, Abnormalities of Vertebral column and thoracic cage, Pulmonary tuberculosis, Bronchial asthma, Chronic bronchitis, other respiratory diseases, Cardiac diseases, Abdominal or chest surgery were excluded from the study.

After taking written consent and asking detailed history about pesticide exposure with series of questionnaires like type of pesticides, mixing procedure, use of protective measures like gloves and masks, frequency of application etc., Lung function test was performed by using computerized RMS Medspirorin the sitting position at fixed time of the day to minimize the effect of diurnal variation and will be repeated at-least three times after adequate rest. Subjects were motivated prior to the start of the maneuver. Results obtained in computerized spirometer were analysed for Forced vital capacity (FVC), forced expiratory volume in one second (FEV1), forced expiratory ratio (% FEV1/FVC), peak expiratory flow rate (PEFR) and forced expiratory flow (FEF 25–75%).

The spirometer is provided with mouthpiece attached to a transducer assembly which is connected to an adaptor box which in turn connected to the computer by a serial cable. Software from recorders and medicare system is loaded onto the computer. The software allows the calculation of the predicted values for age, sex, weight and height and gives the recorded values of all the parameters adjusted for Indian population. The test is simple noninvasive, safe and easy to carry out in the subjects.

Statistical analysis

Wasdone by using SPSS 20.0 software. Results are presented as mean ± SD and percentagedifference. Unpaired *t* test was used for groupwise comparisons. Pvalue of 0.05 or less was considered forstatistical significance.

Results

For the purpose of analysis of data, the results are tabulated as shown in the table. The statistical comparisons of the matching variables (age, height and weight) were inherently similar for both the groups. All lung function parameters are expressed and compared in mean values and percent predicted valuesadjusted by race, gender, height and age. Farmers exposed to pesticides showed significant reduction in percent predicted values and mean values of FVC, FEV1, FEV1/FVC %, FEF25-75% and PEFR when compared withnon exposed controls (Table 1), but these exposed farmers did not show a statistically significant reduction in actual value of FEF25-75% compared to controls.

Table 1: Lung function data in pesticide exposed farmers compared with their matched controls

Parameters	Controls (n = 40)	Subjects (n = 40)	Significance	
	Mean ± SD	Mean ± SD	*t-value	p-value
Age (yrs)	30.92 ± 6.72	35.13 ± 6.71	0.01	NS
Height (cm)	1.63 ± 0.07	1.64 ± 0.10	0.79	NS

Parameters	Controls (n = 40)	Subjects (n = 40)	Significance	
	Mean ± SD	Mean ± SD	*t-value	p-value
Weight (Kg)	61.43 ± 5.97	57.60 ± 8.38	0.03	NS
FVC ($L^{\downarrow}$)	3.18 ± 0.41	1.84 ± 0.29	4.73	<0.001 HS
FEV_1 (L)	2.73 ± 0.37	1.69± 0.31	2.93	< 0.05 S
FEV_1/FVC (%)	85.71 ± 2.33	82.34 ± 4.65	3.89	<0.001 HS
PEFR (L/S)	8.00 ± 0.91	5.64 ± 1.17	2.24	< 0.05 S
$FEF_{25-75\%}$ (L/S)	4.19 ± 0.42	3.00 ± 0.70	1.85	NS

Table 2: Lung function data in (percentage predicted) in pesticide exposed farmers compared with their matched controls

Parameters	Controls (n = 40)	Subjects (n = 40)	Significance	
	Mean ± SD	Mean ± SD	*t-value	p-value
FVC ($L^{\downarrow}$)	93.05 ± 4.97	60.40 ± 6.67	5.84	<0.001HS
FEV_1 (L)	94.25 ± 4.05	64.69 ± 7.35	7.63	<0.001HS
FEV_1/FVC (%)	101.35 ± 3.16	111.18 ± 9.32	3.89	< 0.05 S
PEFR (L/S)	90.55 ± 5.83	66.63 ± 10.50	7.44	<0.001HS
$FEF_{25-75\%}$ (L/S)	97.28 ± 6.46	72.63 ± 13.34	3.81	< 0.05 S

Discussion

Chronic respiratory diseases affect the entire airway from the ear, nose and throat to the pulmonaryalveoli, and are characterised by an inflammatory condition induced or aggravated by viruses, bacteria, fungi and environmental components.[10,11] Among these, allergens, toxins, tobacco smoke, gaseous orparticulate air pollutants and a number of chemicals, including pesticides, can present a risk to the respiratory system.[12,13,14]

The results of the present study showed that FVC, FEV_1, %FEV_1/FVC and PEFR, FEF25–75% were significantly reduced in the pesticide exposed farmers compared to normal non-exposed subjects which is in agreement with the observations made byother authors.

Mekonnen Y et al. in their study showed that pesticide sprayers had significantly reduced forced expiratory vital capacity (FVC) and forced expiratory volume in 1s (FEV_1) compared to a similarly aged group of nonsprayers.[15]

Kesavachandran C et al. and his colleagues in their study found that FVC, FEV_1, PEFR were lower among the pesticide sprayers compared to controls.[16]

Hernández and his colleagues reported decreased FEF25–75% with lifelong cumulative exposure to pesticides decreased lung volumes.[17]

Chakraborty S and his co-workers observed decrease in PEFR among the farmers when compared to the control group.[18]

While considering the pathophysiological aspects of adecrease in the values of these lung function parameters, FVC is decreased in pulmonary obstruction, emphysema, pleural effusion, pneumothorax, pulmonary edema and poliomyelitis. Similarly, the FEV_1 value is low in obstructive lung diseases and in reduced lung volume.[19] The decline in FEV_1 is a acceptable standard against which we can measure marked declines in subjects with the history of chronic obstructive pulmonary disease (COPD) or in subjects exposed to environmental pollutants, whereas PEFR provides an objective assessment of functional changes associated with environmental and occupational exposures and determines acute or chronic diseaseprocesses in patients with severe COPD.[20] PEFR is persistently low and represents collapsing of small airways.[19] In view of pathophysiological aspects and a decreasein the lung parameters, our results suggest that exposure to pesticides affect the lung functions. The results of the present study can be attributed to and explained by the following facts.

Pesticides are volatile become aerosolized, therefore when breathed inside, can cause irritation and subsequent damage to airways resulting in symptoms of chronic bronchitis. Some of the aerosols can reachthe alveolar space causing damage to the alveolar sacsleading to breathlessness.[21] Extended exposure to these irritating toxic substances maycause acute or chronic respiratory ailments.[22] Because of the nature of inherent biological reactivity, pesticides are potentially hazardous to human health.[23]

The neurological effects caused by cholinesterase inhibiting pesticides especially Organophosphorous compounds and carbamates, are considered to affect airways and lungs, trigger the bronchospasm[24] and increase the airflow resistance leading to impaired lung function and respiratory diseases.[25] Occupational exposures to pesticides not only affects dynamic lung volumes, mayalso lead to impairment of gas exchange in the lung.[26]

Studies have reported that effect of pesticides like Organophosphorous compounds could also be due to the production of oxygen free radicals.[27]

Several animal studies reported that exposure to Organophosphorous compounds increase the muscarinic effect on airwaysmooth muscles and the nicotinic effects on muscles of respiration along with increasing affinity to acetylcholine mediating broncho-constriction.[28]

Conclusion

The present study concluded that pesticide exposure adversely affect the pulmonary function parameters like FVC, FEV1, %FEV1/FVC, PEFR and FEF25–75% in farmers and cause an obstructive pattern of lung function impairment. Were commended to detect respiratory diseases if any, among farmers as early as possible and there is a need to create awareness among the farmers regarding the ill effects of pesticides and to encourage using personal protective equipments and measures, to improve agricultural environments. Farmers can also be educated about the importance of organic farming.

Further studies are needed to particularly focus on effects due to cumulative lifetime exposure to pesticides and identification of specific pesticide exposure, in order to determine possible dose–effect relationships, and thereby assess the causal relationship.

Conflict of Interest: None to declare.

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