Section: Respiratory Medicine

Original Research Article

RESPIRATORY PROFILING AMONG THE FARMERS WITH PESTICIDE EXPOSURE – A FIELD-BASED CROSS-SECTIONAL STUDY

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Abstract

Background: Pesticides serve as insecticides, herbicides, fungicides, rodenticides, and fumigants in agriculture, minimizing pest-related losses. The impact on human health hinges on factors like quantity, duration, exposure route, and protective measures. Despite knowing the risks, many farmers still use pesticides without caution. The study aims to determine the clinical and respiratory profile of the farmers exposed to pesticides. **Materials and Methods:** An analytical cross-sectional study was conducted among 97 farmers from rural Puducherry in 2021. A pre-tested, semi-structured questionnaire was used to capture data and a hand-held digital spirometer was used to assess pulmonary function. Data was exported to Microsoft Excel and was analyzed using JASP R 4.2.1 software and a p-value < 0.05 was considered to be statistically significant. **Result:** The pesticide exposure period was found to be eleven to fifty hours and more than a hundred hours in 45.5% and 12.7% of study participants respectively. Around 76.4% of them had a history of cough during exposure. Mean values of the Pulmonary Function Test had significantly reduced than expected values, with the majority showing Mixed restrictive and obstructive types of lung disease. **Conclusion:** Pesticides may contribute to the development of respiratory impairments. Longer exposure periods are linked to increased pulmonary abnormalities, indicating a gradual decline in lung function over time.

INTRODUCTION

Agriculture has been the backbone of human survival since ancient times.[1] To enhance the productivity of the land, pesticides and, fertilizers come into the role. Pesticides are the compounds that are used as insecticides, herbicides, fungicides, rodenticides, and fumigants in agriculture; which reduces the loss due to pests.[2,3] Effect on human health, depends on the quantity, duration, route of exposure, and use of personal protective equipment.[3,4] WHO has organized various international conventions, such as the Stockholm Convention, and the Rotter Convention, but there has been limited data on successful implementation. Most of the farmers themselves, though they are aware that pesticides can harm health, yet they indiscriminately use pesticides.[5–7]

Though there has been a surplus of literature on Pesticide exposure and its harmful effects, only a handful of studies have assessed the effect of pesticides on respiratory health status in India. So, the study aims to determine the clinical and respiratory profile of the farmers exposed to pesticides.

MATERIALS AND METHODS

This analytical cross-sectional study was conducted among farmers residing in the rural field practice area of a medical college in Puducherry in 2021. Considering, the prevalence of respiratory morbidity among farmers exposed to pesticides was 36.75%8 from existing literature, the minimum sample size

was estimated as 97, using the formula n = Z(1-α/2)2 pq/d2, assuming absolute precision, d=5%, significance level, α = 0.05 and with 10% non-response rate. All farmers exposed to pesticides in the study setting and who had given consent were included in the study.

A pre-tested, semi-structured questionnaire comprising of the socio-demographic profile, exposure history, and clinical status was incorporated in Epicollect_5 (v4.2.0; Centre for Genomic Pathogen Surveillance) application for data capturing, followed by which clinical examination and pulmonary function using hand-held digital spirometer was done under aseptic and safety precautions. Data was exported to Microsoft Excel and was analyzed using JASP R 4.2.1 software. Mean ± SD and Median (IQR) were used for normally distributed continuous variables whereas qualitative variables were summarized in terms of frequency & percentage. The chi-Square test was used to find the association between various variables and p-value < 0.05 was considered to be statistically significant. Prior to initiating the study, the necessary approvals from the scientific and ethics committee of the institute were obtained.

RESULTS

The socio-demographic details of the study participants are depicted in [Table1]. Exposure period was calculated by multiplying years of experience in current job and duration of weekly exposure to pesticides and with respect to respiratory profiling, nearly half of the study participants [50 (45.5%)] have an exposure period of eleven to fifty hours, and about 14 (12.7%) had exposure period of more than hundred hours. Of those farmers who were exposed to pesticides, 84 (76.4%) had a history of cough on pesticide exposure. More than one-third of the farmers had pre-existing respiratory illness [40 (36.4%)], the most common one being asthma [21 (48.8%)]. The mean values of expected, observed pulmonary function test values are depicted in [Table 2]. Mean observed values of FEV1, FVC, PEFR, FEV1/FVC are significantly reduced than expected values. Pulmonary function status is classified as normal, restrictive, mixed restrictive, and obstructive type and is depicted in [Figure 1]. It has been also observed that the occurrence of pre-existing respiratory illness significantly increased the presence of abnormal pulmonary function status [Table 3]. It is found that most of the participants who had exposure ≥ 50 hours had abnormal Pulmonary function test profile [Table 4].

Table 1: Socio demographic status of the farmers (n = 110)

Variable	Frequency (n, %)
Gender	
Male	60 (54.5)
Female	50 (45.5)
Education	
Illiterate	67 (60.9)
Primary	5 (4.5)
Secondary	23 (20.9)
Higher secondary	9 (8.2)
Bachelor degree	6 (5.5)
Socio economic status*	
Upper	5 (4.5)
Upper middle	35 (31.8)
Middle	30 (27.3)
Lower middle	38 (34.5)
Lower	2 (1.8)
Personal habits	
Smoking	6 (5.5%)
Alcohol consumption	16 (14.5)
Co-morbidities	
Diabetes	10 (26.3)
Hypertension	28 (73.7)
*Modified B.G. Prasad classification	

Table 2: Pulmonary function test status

Variable	Expected [in Mean (SD)]	Observed [in Mean (SD)]	p-Value
FVC	4.06 (0.71)	2.04 (0.64)	0.001*
FEV1	3.39 (0.06)	1.57 (0.58)	0.001
FEV1/FVC	78.48 (2.46)	75.13 (7.32)	0.001*
PEFR	389.52 (87.74)	208.96 (95.74)	0.001*
*p value calculated from independent-t test			

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Table 3: Pre-existing respiratory illness and PFT profile, N=110

Pre-existing respiratory illness	PFT profile			p-value
	Normal (n, %)	Restrictive (n, %)	Mixed restrictive and obstructive (n, %)	
Present	14(20.0%)	46 (65.7%)	10(14.3%)	0.002*
Absent	4 (10.0%)	18 (45.0%)	18(45.0%)	
*p value was derived from chi square test.				

Table 4: Exposure to pesticides and PFT profile, N=110

Exposure period	PFT profile		
	Normal (n, %)	Restrictive (n, %)	Mixed restrictive and obstructive (n, %)
>100	0	11 (78.6%)	3 (21.4%)
51 to 100	4 (13.8%)	18 (62.1%)	7 (24.1%)
11 to 50	8 (16.0%)	26 (52%)	16 (32%)
<11	6 (35.3%)	9 (52.9%)	2 (11.8%)
p value	0.132		
*p value was derived from chi square test.			

DISCUSSION

In the present cross-sectional study, the focus was on evaluating the level of pesticide exposure among farmers and their respiratory function status. Approximately 45.5% (50 participants) of the study's subjects had been exposed to pesticides for a duration ranging from eleven to fifty hours, which aligns with the findings of Chitra GA et al conducted in Thanjavur, Tamil Nadu, 2006.[9] The duration of exposure plays a crucial role in the emergence and progression of health-related complications and illnesses.[10] Although the majority of active substances are not inherently dangerous, excessive exposure to them can still pose potential harm.[11]

Nearly three-fourth of the study population were subjected to the volatile organo-phosphorous pesticides, which have detrimental effects on residents through DNA oxidative harm, suppression of Acetylcholinesterase activity, and elevation of inflammatory marker levels in the bloodstream.[12,13] Furthermore, these volatile substances can cause irritation and narrowing of the airways for employees who inhale them, as they tend to remain suspended in the air even after being sprayed.[12] Among our study participants, highest proportion (76.4%) of the subjects were having cough on exposure to pesticides, similar findings were reported in various studies with respiratory symptoms such as chronic cough, airway irritation, sore throat, breathlessness, wheeze.[14–17] The presence of unstable components in pesticides and their harmful effects on the tissues of the nose, throat, and lungs contribute to the development of these symptoms.[18] The mean observed values of FEV1, FVC, PEFR, FEV1/FVC were found to be lower than the expected values which were statistically significant and also consistent with the results by Del Prado-Lu JL, 2007,[19] Chakraborty S et al,[20] 2009 and Fareed M et al 2013.[8] Pesticides in the form of tiny droplets, can infiltrate the alveolar space and damage the capillary membrane, leading to a disruption in diffusion of gases.[21,22] Additionally, prolonged exposure to low doses of pesticides may trigger a persistent inflammatory response in the small airways, heightening the likelihood of enduring consequences, especially bronchial hyperresponsiveness.[23] While there are various pathways through which pesticides can enter the human body, they tend to enter more rapidly through the respiratory system, leading to potential impacts on lung function.[24,25] Besides that usage of low-volume equipment instead of traditional application equipment increases the risk of respiratory exposure.[26] Because, the droplets from such low-volume equipment are smaller (20 to 100 microns) than those produced by traditional sprayers (more than 150 microns), so these small droplets tend to remain suspended in air for long duration ad also have higher chance of getting inhaled than large droplets.[27]

In our study population, a predominance of restrictive patterns of pulmonary function tests was observed and this was in concordance with studies conducted by Chakraborty S et al,[20] 2009 and Subodh K et al.[28] These findings underscore the reduced flexibility of the lungs and the hindrance in lung expansion, which can result from increased resistance to airflow caused by partial or complete obstructions occurring at any level from the trachea to the terminal bronchioles.[29,30] The shared pathophysiology of occupational lung diseases can help elucidate the impact of pesticides on lung function. When dust particles enter the lungs, they have the potential to induce inflammatory reactions that ultimately lead to lung fibrosis.[31] The relationship between pesticide exposure and lung impairment is further strengthened in our study, as the prevalence of smoking was very minimal in our study population which is considered one of the predominant risk factor for restrictive lung disease.[32] In addition to this, we found in our study that frequency of lung impairment increased as the exposure period increases, that goes in hand with study findings of Wadani ZH.[33] Several factors play a crucial role in determining the effects of pesticides on human health and the environment, despite the intention of these chemicals to work with a certain level of certainty and minimal risk. These variables include exposure duration and intensity, the specific toxicity of the pesticide, combinations of different pesticides used in the field, as well as the geographical and meteorological characteristics of

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the agricultural regions where pesticides are applied.[34]

CONCLUSION

A significant proportion of participants exhibited abnormal pulmonary function, indicating potential respiratory issues. The findings revealed an association between the duration of pesticide exposure and the occurrence of abnormal pulmonary function. This suggests that prolonged exposure to pesticides may contribute to the development of respiratory impairments. The relationship between the duration of exposure and the occurrence of pulmonary abnormalities indicates a progressive deterioration in lung function over time.

Recommendations

Prolonged pesticide exposure directly affects respiratory health, highlighting the importance of heightened awareness and preventive measures. Vendors should actively promote the use of personal protective equipment (PPE) by farmers during pesticide purchases. Moreover, regular screening for respiratory conditions and allergies should be established as standard procedure.

To promote a safer working environment, health education campaigns can play a vital role in raising awareness about the proper handling of pesticides and the importance of using PPE. These campaigns can educate farmers about the potential risks associated with pesticide exposure and emphasize the significance of taking preventive measures to safeguard their respiratory health. By fostering a culture of safety and knowledge, the aim is to empower farmers with the necessary information and resources to protect themselves while working with pesticides can be achieved.

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