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Assessment of Respiratory Health Indicators among Agricultural Workers Exposed to Pesticides: A Cross Sectional Study from Palestine

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Abstract

Pesticides are toxic chemicals commonly used in agriculture. No previous studies have been carried out to assess the respiratory health indicators among agricultural workers who are being continuously exposed to pesticides. So, this pilot study aims to determine the respiratory health effects of occupational exposure to pesticides for those workers in Palestine. A cross-sectional study was conducted in one district in Palestine as a pilot study. Lung function tests (LFTs) are measured using a spirometer. Forced spirometry was used to measure the forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC), the FEV1/FVC ratios and prevalence of restrictive and obstructive lung diseases of the two groups were investigated and compared. A total of 98 workers were screened. Their mean age was 41.9 ± 13 years while the mean duration of exposure to agricultural chemicals was 27.8 ± 7.2 years. According to the type of lung status, 92% of the workers showed lung diseases, 80% were restrictive lung disease, 12% were obstructive lung disease and 8% of workers were normal. The mean FEV1 of the sample was 2.6 ± 0.8 compared with normal reference value of 3.9 ±0.6 [P-value =0.010]. On the other hand, the mean FVC for the study sample was 3.2±1.4 compared with the normal reference value of 5 ± 0.6 [P-value =0.023]. The ratio of these two parameters was 85.4 ± 15.5 compared with a normal reference ratio of 79 ± 2.7 [P-value=0.6].In this study, we concluded that agricultural workers who are exposed to pesticides suffer from variety of diseases that pose a serious risk to public health, mainly on the lung disease (mainly restrictive lung diseases).

Keywords: Pesticides, FEV1, FVC, spirometer, Occupational Lung Diseases.

1. Introduction

Pesticides are toxic chemicals to control pest and diseases. These compounds are among more than 1000 active ingredients that are marketed as insecticide, herbicide, and fungicide that act to fight Pests such as insects, rodents, and microbes that can cause and spread a variety of diseases that pose a serious risk to public health [1]. Acute poisoning with pesticides is a global public health problem and accounts for as many as 300,000 deaths worldwide every year. The majority of deaths occur due to exposure to organophosphates, organ chlorines and aluminum phosphide [2].

The wide use of pesticides has enhanced the agricultural productivity and the controlling of infectious diseases, but on the other hand their extensive use has affected human health and body; Moreover, new and more potent formulations are produced to restrict the growing resistance of pesticides, side by side of being able to cover the fast growing needs of human beings for more food. So increased awareness of respiratory risks and improved monitoring of agricultural environments are necessary to limit pulmonary health risks to exposed populations [3]. Slow progression and long term duration, these are the characters of chronic diseases, which are considered as the leading cause of mortality in the new world, and many evidences exist link between chronic diseases and pesticides exposures. The molecular mechanisms that link pesticide exposure to chronic diseases are genetic damages caused by direct interaction with genetic material resulting in DNA damage or chromosomal aberrations, and epigenetic modifications that is referred to the heritable changes in gene expression or cellular phenotype without any alterations in the DNA sequence. Other mechanisms such as endocrine disruption, mitochondrial dysfunction, oxidative stress, endoplasmic reticulum (ER) stress, unfolded protein response (UPR) and protein aggregation, all cause disruption in maintaining and regulating cellular function leading to cell death [1]. So the use of pesticides has increased tremendously , however , negative side effects have increased also, and several reports showed increase rate of asthma in people occupationally exposed to pesticide[4]. Moreover, the exposure to some pesticides may increase the risk of chronic obstructive pulmonary disease (COPD) in farmers [5]. WHO reports showed that around 50 to 100 million people of the developing countries are exposed to intensive level of pesticide, and around 500 million people receive a lesser extent. Moreover; reports emphasized that long term occupational exposure with high levels of chemical dust and droplets could lead to chronic health effects especially in the respiratory system, but the pesticides droplets that are larger than 5 micrometer in diameter are not absorbed by the lung. More reports showed that around 36 million people died of chronic diseases due to chronic exposure of pesticides, and around 90 % of deaths were reported in developing countries [6].

Cases of chronic lung diseases in pesticides using farmers are reported around the world. However, no studies, to our knowledge, have been conducted on Palestinian farmers to detect the prevalence and association between lung diseases and pesticides usage. The aim of this study is to investigate the relation between pesticide use and respiratory system health status among farmers, by using a pyrometer.

2. Material and Methods

2.1. Study design

This was a cross-sectional study as a pilot study. This study recruited farm workers working in open or closed fields (greenhouses), or both, and using pesticides during the time of the study. The farms were selected randomly from within the study regions. As a result, a total of 98 farm workers were invited. The study results were compared with standard values reported by valid respiratory technique the study was carried out in May, 2015.

2.2. Population

The population where the study is in western Palestine, Jericho district. Jericho district was chosen because it is the Palestinian city with a large number of farm workers using pesticides.

2.3. Sample size and sampling technique

This was a cross-sectional study as a pilot study, and the technique that was used is convenient sampling

2.3.1. Study tool

Lung function tests are measured using a spirometer (Microlab, Germany). The specificity and sensitivity of spirometer in diagnosis of obstructive lung disease are reported as 84% and 92%, respectively [7]. While in the diagnosis of restrictive lung disease, it has a sensitivity and specificity of 42.2% and 94.3%, respectively [8]. FEV1 is the maximum air volume exhaled with maximal effort in the first second from a position of full inspiration. This value declines less severely with restrictive diseases than obstructive diseases. FVC, on the other hand, is the maximal air volume exhaled with maximal effort from a position of full inspiration [9], and is reduced by airflow obstruction and ventilation restriction, which results from lung-exterior factors such as skeletal pains or intrinsic lung disease, especially restrictive ones [10]. In the latter, there is a decline in the lung compliance associated with the presence of partial or diffuse lung fibrosis. These fibrotic changes render the lung smaller and stiffer, leading to a decrease in the FVC. The FEV1/FVC ratio is reduced in obstructive patterns, but it is normal or increased in restrictive patterns as both nominator and denominator proportionally change

2.3.2.Data collection form

The data collection form contained four sections; the first was the demographic section, which contained questions regarding **age**, gender, education level, health history, smoking status, body mass index, duration of exposure to pesticides, type of agricultural field (open vs. closed fields). The second section of the data collection form consisted of questions related to pesticide practices. The third section of the data collection form consisted of questions related to correct procedures adopted by the farm workers. The fourth section of the data collection form is Micro lab Spirometer. LFTs were performed using a Micro lab Spirometer by Care Fusion compliant to ATS/ERS 2005 standards [9]. Regular guidelines for spirometer testing were followed [11]. The subjects were seated during the test, with the nose clipped to prevent air leakage through the nares. Three attempts for each subject were allowed, and the best Spiro graph was selected automatically by the spirometer. Forced spirometry was measured for each subject. For each subject, FEV1, FVC, FEV1/FVC ratios were measured.

2.3.3. Ethical issues

IRBfrom An-Najah National University has approved the study

2.4. Descriptive analysis

All data were coded, entered, and then analyzed using the Statistical Package for Social Sciences (SPSS; Chicago, IL, USA) program, using Pearson correlation to measure the p value to find out the significance of the associations. The level of significance was considered significant at a p value < 0.001. Based on SPSS Survival Manual 2nd Edition, the focus should be directed at the amount of shared variance rather on statistical significance, which should be reported but ignored.

3. **Results and discussion**

3.1. Sociodemographic Characteristics and Lung Status

As table (1) shows, the mean of the age were 41.877 ± 13.009 years while the mean of the duration of exposure to agricultural chemicals was 18.693 ± 12.484 years. According to the type of lung status, 92% of the workers showed lung diseases, 80% were restrictive lung disease, 12% were obstructive lung disease and 8% of workers were normal.

Table (1): sociodemographic characteristics.

Variables	Number	Minimum	Maximum	Mean	Standard deviation
Age	**98**	**15.00**	**76.00**	**41.8776**	**13.00695**
BMI	**98**	**16.90**	**76.00**	**27.7622**	**7.23306**
Duration of exposure	**98**	**1.00**	**66.00**	**18.6939**	**12.48455**

3.2. Respiratory parameters related to the agricultural workers.

Table 2 shows the major respiratory parameters; FEV1, FVC and FEV1/FVC ratio. The mean of the FEV1 of the sample was 2.628 ± 0.814 compared with normal reference (normal reference from the spirometer itself) value of 3.919 ±0.610 (p-value= 0.010). On the other hand, the mean of the FVC for the study sample was 3.2±1.4 compared with the normal reference value of 5 ± 0.6(p-value=0.023). So, there is a significant decrease in the FEV1 and FVC compared to the predictive control value. The descriptive statistics of the FEV1/FVC ratio of these two parameters was 85.4 ± 15.4 compared with a normal reference of FEV1/FVC ratio of 79 ± 2.7(P-value=0.6).

Table (2): Respiratory parameters related to the agricultural workers.

Variables	Numbers	Minimum	Maximum	Mean	Standard deviation
FEV1	98	0.21	4.44	2.6289	0.81464
FEV1 normal	98	1.34	5.41	3.9195	0.61024
FVC	98	0.25	13.60	3.1761	1.40564
FVC normal	98	3.31	6.81	4.9574	0.63213
Ratio	98	31.00	100.00	85.3776	15.54675
Ratio normal	98	72.00	87.00	79.6122	2.70026

FEV1: Forced expiratory volume in the first second, FVC: Forced vital capacity.

Continuous use of chemical inputs such as pesticides have resulted in damage to the environment, caused human ill health, negatively impacted on agricultural production and reduced agricultural sustainability [12]. The pesticide effect on lung function can be explained by the common pathogenesis of occupational lung disease. Entrance of dust particles into lungs could result in inflammatory reactions that lead to lung fibrosis, which is a common cause of restrictive lung disease [13]. Respiratory symptoms that have been reported in association with pesticide exposures include wheezing, airway irritation, dry/sore throat, cough, breathlessness and chest tightness [14]. The most noted Spiro metrical pattern in this study is restrictive. However, 12% of farmers have obstructive pattern and 8% show no abnormalities at all. This restrictive pattern correlates with the decreased FVC and FEV1 values among pesticide users in comparison to a standard values reported by valid respiratory technique, and the increase of FEV1/FVC ratio values among pesticide users in comparison to a standard values reported by valid respiratory technique, as a result of the chronic inflammatory response after exposure to the dust. This result is compatible with the fact that FEV1/FVC may be normal or increased in restrictive lung disease depending on the severity of the condition [15]. This result of this study support other studies conducted on the effect of pesticide exposure on the respiratory system. In a study conducted by Ming Ye showed that there was strong evidence for an association between occupational pesticide exposure and asthma, chronic bronchitis or COPD and lung cancer, especially in agricultural occupations [16]. Based on studies conducted, educational and training interventions on pesticide handling and safety precautions are recommended to change this situation. In addition, governmental interventions and efforts, such as restrictions on hazardous pesticides, monitoring of labels, and enforcement of good agricultural practices are needed to decrease pesticide exposure of farmers and the general population [16]. In most developing countries, a number of important obstacles to agrochemical safety can be identified: there is insufficient legislation for pesticide use and registration in addition to a lack of technical regulatory research facilities to monitor pesticide residues and effects [17]. In summary, epidemiological studies require careful measurement of both exposures and outcomes when assessing the relationships between occupational pesticide exposures and respiratory health. In addition, proper evaluation of important biases, confounders, and effect modifiers, such as genetic predisposition, social, and psychological factors, are important for avoiding spurious results in association studies. It is also important to use longitudinal approaches when there were temporal variations in pesticide exposures [18].

4. Conclusions

Extensive efforts are required by the international agencies, national authorities and nongovernmental organizations to increase the awareness of pesticide use and enforce safety behaviors among farmers, such as applying developed systems and educational training programs to increase the knowledge of pesticide use among farmers, side by side of maintaining the implementation of health standers.
This study has only investigated the relation between pesticide use and respiratory system health status among farmers, so it is recommended that further pathological and clinical studies in this field are carried on.

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