

## The effects of pesticides on respiratory system

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### ABSTRACT

**Introduction:** Most of the pesticides have, by nature, some degree of toxicity because they are intended to kill certain organisms and thus create a risk of damage. The use of pesticides has raised serious concerns, mainly about the potential effects on human health and especially on respiratory system. Thousands of people (from 20,000 to 220,000) lose their life due to pesticide poisoning. Ninety nine percent of them (99%) live in developing countries.

**Purpose:** To review the literature, to identify the harmful effects of pesticides on human health, and particularly on the respiratory system, and to define the ways of dealing with them.

**Materials and methods:** Extensive review of the relevant literature was performed via electronic databases (Medline, Pubmed, Cihnal and Google scholar) and scientific journals (Greek and international) using the appropriate key words: pesticides, respiratory symptoms, pulmonary disease and a combination of them.

**Results:** The effects on human health due to exposure to pesticides depend on a number of factors, including the category of pesticides involved, the amount and type of active substance, as well as their form, route of contamination, exposure time and pesticides' residual dose. Pesticides, especially those that inhibit the action of cholinesterase, lead to the onset of respiratory symptoms. A number of respiratory symptoms and diseases have been associated with occupational pesticide exposures, such as wheezing, asthma cough, phlegm, dyspnoea and influenza like syndrome are reported especially among agricultural workers.

**Conclusions:** Pesticides are dangerous substances for the human body and especially for the respiratory system, if they are used without control. Proper use of pesticides can ensure both the quality of the environment and citizen's safety and health. New scientific data require periodic review of safety levels.

**Keywords:** Pesticides, respiratory system

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## **INTRODUCTION**

A number of drugs and chemicals made for effectively combating pests, are referred to as "pesticides". They are strong poisons, high-technology products that act and kill animal and plant organisms damaging crops [1,2].

The use of chemicals to combat plant pests dates back to the era of classical antiquity. Democritus (470 BC) recommended spraying of plants with liquid oils wastes, presumably to protect them from mildew, while sulfur appears to be used in a mixture of oils as insect repellent [3].

From the end of 1880 until the end of the 19th century, effective control of the pests and diseases of plants begins. In 1882, Millardet in Bordeaux, France, discovered the action of "Bordeaux mixture", by observing that rootstocks (stumps) sprayed with a mixture of copper sulphate and calcium hydroxide, remained unaffected by the fungus. This was for many years the sole means of protecting plants from fungal attacks [4,5].

The year of 1930 is considered as the landmark of the era of modern organic pesticides, as the chlorinated hydrocarbons were discovered. Chemists were looking for an inexpensive chemical with a high resistance to sunlight and low toxicity for humans to kill harmful insects in a short time. In 1939, Muller, working for the Swiss company GEIGY, showed that DDT met these standards [6]. It should be noted that the use of DDT, like most organochlorinated preparations, has been later discontinued, due to bioaccumulation and environmental hazards, although it has made a significant contribution to the protection of human life [7].

During the 1970s and 1980s, many new pesticides appeared. Their preparation is based on a more detailed understanding of the biological and action mechanisms and they are often more active, at lower doses, compared to the previously used pesticides. Representative examples of this new plant protection season are sulfonyleureas, as the herbicides, and fungicides such as metalaxyl [8].

The revolution of pesticides, which promised cheap abundance, ultimately brought about the precise chemical dependence with severe effects on nature and our health. In Greece, the first scientific approaches to the pesticide give clear evidence of insidious and chronic effects. According to the Poison Center, every year there are about 1,500 cases of acute pesticide poisoning, some of them fatal [9].

The purpose of this study was to review the literature, to identify the harmful effects of pesticides on human health, and particularly on the respiratory system, and to define the way of dealing with them.

Regarding the **methods** used, an extensive review of the relevant literature was performed via electronic databases (Medline, Pubmed, Cihnal

and Google scholar) and Greek and international scientific journals using appropriate key words: pesticides, respiratory system and disease. The criterion of exclusion of the articles was language other than Greek and English.

## **Risk of pesticides for the environment**

There is a high environmental burden from the use of pesticides. Leaching of pesticides from soils and their movement in the underground aquifer is a serious risk of groundwater pollution. A significant proportion of the groundwater pollution problem is due to day-to-day farming activities such as filling and flushing spraying machines next to water supply boreholes, as well as throwing the packages from fertilizers and pesticides on the land [10,11].

There is a great danger for the soil fauna due to soil pollution. The substances that are not easily decomposed and remain in the ground, are led via fauna's food and nutrition to the humans' and animals' body with harmful and sometimes irreversible effects [12,13].

The use of illegal pesticides is also a common phenomenon that has health consequences. Several studies have shown that in our daily diet pesticide residues have been found three times more than the permitted level [14].

## **Pesticides associated risks**

Most of the pesticides have, by nature, some degree of toxicity because they are intended to kill certain organisms and thus create a risk of damage. In this context, the use of pesticides has raised serious concerns, mainly about the potential effects on human health. Consequently, exposure to plant protection products poses a potential health risk, especially in the agricultural working environment [15].

There are two types of toxicity, the "acute toxicity", or toxic effects resulting from a brief exposure to a substance, and "chronic toxicity" or toxic effects that arise after a long exposure to it [16].

The effects on human health due to exposure to pesticides depend on a number of factors, including the category of pesticides involved, the amount and type of active substance, as well as their form, route of contamination, exposure time and pesticides' residual dose [17].

According to the World Health Organization, it is estimated that annually, direct pesticide poisoning ranges from 1 to 3 million. These numbers represent only the cases they have been recorded, that is to say, episodes of acute poisoning that have been hospitalized. Three-quarters of survivor victims suffer from chronic health problems such as dermatitis, nervous disorders and, in the worst of the cases, cancer [18].

Thousands of people (from 20,000 to 220,000) lose their life due to pesticide poisoning. Ninety nine percent of them (99%) live in developing countries. The population groups primarily affected by such effects are the direct agricultural workers and their family members, as well as the workers in the pesticide production and packaging industry [19].

### **Effects of pesticides on human body**

People can be exposed to plant protection substances in different ways. The route of exposure is defined as the entry point of the substance into the human body. There are three main routes of exposure [12]:

- skin is an entry gate for skin exposure
- mouth for exposure through ingestion
- the lungs and the respiratory system for exposure through the respiratory tract.

All categories of pesticides can affect the brain and nervous tissue, even if they do not cause any perceived effects [20]. Chronic neurological effects include lesser performance in memory and learning, reduced sensitivity to vibration or visual stimuli, reduction in the scope of visual stimuli, and reduced muscle strength [21].

Many plant protection products suppress the immune system by reducing the antibody-producing ability, but also macrophage and lymphocyte phagocytic ability while they still lowering serum content of immunoglobulins [22].

Furthermore, pesticides affect the endocrine system as well as the pituitary and hypothalamic activity [21]. They may also affect human reproduction including menstrual disorders, male or female infertility, or hormonal disorders [23]. There is still an increased risk of having children with congenital limb abnormalities, nervous and musculoskeletal system, hypospadias, cryptorchidism, cardiovascular abnormalities, cleft palate and other multiple and specific abnormalities [3]. Research on exposure to endosulfan showed in male children a delay in sexual maturity, but also effects in the synthesis of sex hormones [24,25].

### **The effects of pesticides on respiratory system**

Pesticides, especially those that inhibit the action of cholinesterase, lead to the onset of respiratory symptoms. A number of respiratory symptoms and diseases have been associated with occupational pesticide exposures, especially among agricultural workers [26,27].

Studies carried out on people who used insecticides, mentioned of respiratory symptoms and diseases, such as wheezing, asthma and influenza like syndrome [28]. Some more symptoms, such as

cough, phlegm and dyspnoea are also reported by agricultural workers in Ethiopian areas [29]. Adult farmers and spray workers presented the above mentioned symptoms and problems following exposure to insecticides and herbicides [1,9]. Furthermore, cough, pharyngitis, nasal runny nose, sinusitis sinus, and nasal irritation manifested by dryness, throat and increased secretion have been observed more frequently in rural populations in the United Arab Emirates and have been attributed mainly to the exposure to pesticides [30].

Acute exposure to organophosphates or excessive exposure to N-methylcarbamates are also known to cause cholinesterase inhibition, resulting in bronchoconstriction, increased airway secretions, and difficulty breathing. Few plant safeners are known for such sensitivity and can lead to allergic reactions, including asthma [31]. Bronchial asthma has also been associated with carbamate insecticides [1,9] leading to increased cost as it usually needs long-term treatment with medications or other alternative therapeutic interventions [32].

Furthermore, in acute exposure, irritation of the bronchi and lungs occurs. A characteristic pesticide that causes pulmonary damage in the acute effect is the herbicide Paraquat. At high doses, pulmonary edema or alveolar hemorrhage is caused due to disturbance of the physiology of the alveolar type I and II cells and patient results in severe lung injury (paraquatlung). The sulfur compounds are dangerous for users suffering from asthma due to respiratory side effects, while the use of pesticides has been associated with farmers' respiratory impairment [33].

The prevalence of mild, moderate and severe airway obstruction is also observed among workers who are spraying pesticides [34]. In case the various pesticides are used in the form of aerosols it is quite easy to enter the body by inhalation. An important aggravating factor is aerial spraying, creating clouds of insecticide droplets (spray clouds) in bad weather [35]. Another way of entry of pesticides into the body is through its adhesion to the dust particles and cigarette smoke [36]. More specifically, inhalation of pesticides on the worksite occurs in one or more of the following conditions: a. the chemical in use is highly volatile, b. the application is in a poorly ventilated area and c. the manner of application leads to an aerosol cloud of finely dispersed droplets that do not readily settle [37].

The condition is aggravated if the cardiovascular effects coexist. In acute exposure bradycardia or tachycardia, hypotension or hypertension, arrhythmias, haemolytic anemia and bleeding from anticoagulant pesticides have been reported. Significantly higher systolic and diastolic blood pressure has been observed in rural populations with chronic pesticide exposure [1,3]. Electrocardiographic changes such as QT interval

prolongation have been found due to chronic effects on myocardium by organophosphates and dithiocarbamate pesticides. An increased risk of myocardial infarction has also been reported following long-term exposure of female farmers to pesticides. Hyperlipidemia has been reported as a chronic effect of exposure to pesticides due to the possible inhibition of an enzyme functioning as a cholesterol hydrolase [33].

### Rational utilization of pesticides

Proper use of pesticides can ensure both the quality of the environment and citizen's safety and health. New scientific data require periodic review of safety levels. Verification of compliance to the limits established by WHO and FAO is necessary for public health [38].

In addition, the State and the relevant Ministries (Ministry of Rural Development and Food - Ministry of Health - Ministry of Education) have to intensify the necessary controls and also increase their spending, aiming at the training of pesticides' users and consumers of the products that had previously received pesticides. Within the framework of E.U, it is essential that the directive 2009/128 /EK of the European Parliament and of the Council (21 October 2009) about the preservation of the environment and human health, to be also applied and used by other countries outside the EU. This is "*the common position of the Council on establishing a framework for Community action to achieve a rational utilization of pesticides*" [39].

### CONCLUSIONS

Pesticides are dangerous substances for the human body and especially for the respiratory system, if they are used without control. The ignorance of users together with the lack of information about the risks, and the low educational level of users and their environment, have led to continuous accidents but also to chronic severe effects on the human body. The universal provision of information to the public about the risk of pesticides and the treatment of poisonings, through health education programs, both in the community and at all levels of education, will contribute to the improvement of quality of life.

### Conflicts of interest

The authors declare no conflicts of interest.

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