

# Pesticide Poisoning Epidemiological Characteristics

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## ABSTRACT

**Background:** Most patients exposed to organophosphates come into contact with insecticides. The first organophosphate insecticide was created in the mid-19<sup>th</sup> century, but it was not widely used until after World War II. Fungicides are essential to global food security and their use is expected to intensify. Fungicides can reach aquatic ecosystems and occur in surface water bodies in agricultural watersheds.

**Methodology:** A systematic review was carried out through various databases from January 2015 to July 2022; the search and selection of articles was carried out in journals indexed in English.

**Results:** Pesticides are one of the families of chemical products most widely used by man. Pesticides can be classified according to their use (insecticides, fungicides, herbicides, rodenticides) or their chemical family (organochlorines, organophosphates, carbamates, pyrethroids, bipyridyl compounds, inorganic salts).

**Conclusion:** This review offers updated and detailed information on the main groups of pesticides for which poisoning is reported, as well as analyzing the epidemiological aspects of each group, in order to identify which are the most frequent.

**KEYWORDS:** Intoxication; Pesticides; Organophosphates; Herbicides

## INTRODUCTION

Pesticides are one of the families of chemical products most widely used by man. Due to the pests that affect agricultural crops and the large number of diseases transmitted by these products,

these compounds, pesticides, are used. This is classified according to its use in Insecticides, Fungicides, Herbicides, Rodenticides [1]. Most patients exposed to organophosphates come into contact with insecticides. The first organophosphate insecticide was created in

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the mid-19<sup>th</sup> century, but it was not widely used until after World War II. Organophosphates are used as drugs, insecticides, and nerve agents as a weapon [1,2]. It is estimated that 3 million or more people worldwide are exposed to organophosphates each year, accounting for about 300,000 deaths. In the United States, there are about 8,000 exposures per year with very few deaths [2]. Fungicides are essential to global food security and their use is expected to intensify. Fungicides can reach aquatic ecosystems and occur in surface water bodies in agricultural watersheds throughout the growing season due to their frequent prophylactic application [3]. In the European Union (EU), fungicide sales (mass-based) account for more than 40% of total pesticide sales, and synthetic organic fungicides account for approximately 60% of all fungicides [4]. In the United States (USA), which accounts for 80% of the total use of fungicides in North America, fungicides account for less than 10% (including inorganic fungicides), of the total mass of pesticides applied [4]. In urban areas, fungicides released from paints and coatings on walls, flat roofs, and basement seals can contribute significantly to the entry of fungicides into aquatic ecosystems [5]. Due to the need for long-term protection, the application of urban fungicides to buildings can occur throughout the year, which can lead to the mobilization of fungicides mainly during rainfall events [6]. Despite wide availability, reports of herbicide poisoning with suicidal intent are rare in the literature. One of the reasons for this underreporting could be the inability to differentiate them from other more commonly used compounds, such as anticholinergic pesticides. In the absence of specific clinical features and diagnostic tests, the diagnosis is based entirely on a reliable clinical history [6]. Due to the increase in cases of poisoning by these large groups (Insecticides, Fungicides, Herbicides, Rodenticides) and their lethal effects on health, it is convenient to carry out this work in order to provide updated and accurate information on the main groups of pesticides for which intoxication is reported, as well as analyzing the epidemiological aspects of each group.

**MATERIALS AND METHODS**

A systematic review was carried out, PubMed, Scielo, Google scholar and ScienceDirect were the main databases used. The collection and selection of articles was carried out in indexed journals in English from 2015 to 2022. In this review, 99 original and review publications related to the subject studied were identified, of which 22 articles met the requirements. of inclusion specified, such as articles that were in a range not less than the year 2015, that were full text articles and that reported on the subject. All articles that lacked information or that did not present the full text in their review were not included in this work.

**RESULTS**

**Classification of Pesticides**

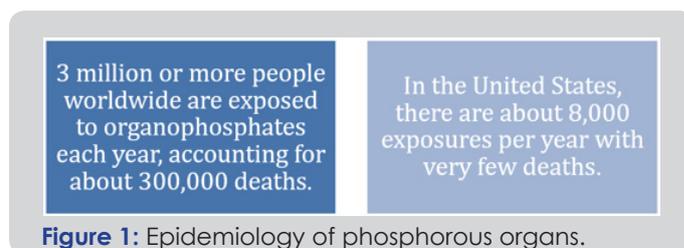
One of the chemical products widely used by man to intensify agricultural productivity, among other factors, are pesticides. They have been used above all to combat pests due to their action on crops or as vectors of communicable diseases [7]. Pesticides can be classified according to their use (insecticides, fungicides, herbicides, rodenticides) or their chemical family (organochlorines, organophosphates, carbamates, pyrethoids, bipyridyl compounds, inorganic salts) [7]. The concern about pesticide poisoning has been increasing, presenting a notable importance since the 20<sup>th</sup> century, since they are biocides with high human toxicity [8]. Due to human toxic epidemics, causing high mortality, demonstrates the wide growing use of these compounds (pesticides). This is described

in all groups or families of this compound, such as inorganic salts, organomercurial fungicides, carbamates, organophosphate insecticides, organochlorine fungicides and insecticides. Table 1 shows the classification of the main pesticides [6-9]. Next, we will report on the epidemiological characteristics according to the classification of the main pesticides [9].

**Table 1:** Classification of the main pesticides.

Classification Based on your Employment	Classification According to its Chemical Family
Insecticides	Organochlorines
	Organophosphates
	carbamates
	Pyrethroids
Fungicides	Organochlorines
	Mercurial Organ
Herbicides	Bipyridyls
	Organochlorines
Rodenticides	Dicumarinics

**Insecticides**



**Figure 1:** Epidemiology of phosphorous organs.

Insecticides are any toxic substance used to kill insects. As reported, due to pests that affect cultivated plants and the large number of diseases that are transported by these means, these compounds are used. The main pesticide belonging to this group is the organophosphate [10]. The first organophosphate insecticide was created in the mid-19<sup>th</sup> century, but it was not widely used until after World War II. Organophosphates are used as drugs, insecticides, and nerve agents as a weapon [11]. The onset of symptoms usually occurs within minutes and may take weeks to resolve. Exposure to organophosphate pesticides can occur through inhalation, ingestion, or skin contact. Crops that farmworkers come in contact with may also include organophosphates such as apples, celery, bell peppers, peaches, strawberries, nectarines, grapes, spinach, lettuce, cucumbers, domestic blueberries, and potatoes. In Figure 1 we can see the main epidemiological aspects of this group [11-13]. While most of the time exposure is from an agricultural pesticide, there are household items, such as ant and roach spray, that also contain organophosphate compounds. The key feature of organophosphate insecticides is the inhibition of carboxyl ester hydrolases, primarily the inhibition of acetylcholinesterase (AChE). This enzyme plays a vital role in breaking down the neurotransmitter acetylcholine, which is found in both the peripheral and central nervous systems [12,13].

**Fungicides**

Fungicides are agents that kill, repel, prevent or mitigate fungi and are used to protect tubers, fruits and vegetables during storage and plant growth [14,15]. The mode of action of

fungicides depends on their protective role in plants. Thus, there are preventive fungicides that prevent infections, antisporeulants that prevent the production of spores and curative fungicides that inhibit the development of a disease after an infection [16]. In the European Union (EU), fungicide sales (mass-based) account for more than 40% of total pesticide sales, and synthetic organic fungicides account for approximately 60% of all fungicides [16]. In wine regions, fungicides can account for more than 90% of all pesticide applications [17]. In aquatic systems, these compounds affect organisms that are not the objective for which they are being implemented, acting on basic biological processes that are not specific to fungi, within these we highlight the production of energy [17]. Despite the intensive use of fungicides and the associated potential ecotoxicological risks in non-target aquatic systems, the environmental fate and effects of fungicides have received much less attention compared to insecticides and herbicides. For example, only 13% of studies on the effects of pesticides between 1991 and 2013 focused on fungicides, compared to 62% and 24% for insecticides and herbicides, respectively [15]. In agricultural landscapes, fungicides are predominantly used on fruits and vegetables and contribute to more than 35% of the global pesticide market share. Fungicides represent less than 10% (including

inorganic fungicides]. of the total mass of applied pesticides [16]. Despite intensive use of fungicides, fungal pathogens are responsible for 7% to 24% of commodity crop yield losses, which can be attributed in part to the development of resistance to commonly used fungicides [15,17].

## Herbicides

Herbicides, or chemical herbicides, provide an effective and inexpensive means of weed control. Global herbicide use accounts for nearly 48% of total pesticide use. In the last three decades, herbicides have represented the fastest growing segment of the pesticide industry [13]. Other studies report that herbicides account for around 60% of pesticides (by volume) used worldwide [13]. The first synthetic herbicide was discovered in the early 1940s, and its efficacy and selectivity caused a paradigm shift in agricultural weed management practices. New herbicide mechanisms of action (MOAs) were discovered at a relatively constant rate of a single MOA every two years from the early 1950s to the mid-1980s [17]. Herbicides can affect various sites in plants and at the site of action each herbicide manifests different mechanisms, in Table 2 we can identify the mechanisms of action that have been proposed to date [7,12,15,16].

**Table 2:** Mechanisms of action of herbicides.

Mechanism of Action	Synthesis
Growth Regulators	This type of herbicide is used to control broadleaf weeds.
Seedling Growth Inhibitors	Among these herbicides, thiocarbamates and acid amides act as potent inhibitors of shoot and root growth.
Photosynthesis Inhibitors	These herbicides (eg, triazines, copper-containing pesticides) block photosynthesis through disruption of biomembranes by highly active molecules.
Amino Acid Biosynthesis Inhibitors	These herbicides block the biosynthesis of certain amino acids. For example, glyphosate
Lipid Biosynthesis Inhibitors	Herbicides in this group, such as fluazifop, sethoxydim, are used primarily for the suppression of post-emergent grasses.
Cell Membrane Disruptors	These chemicals are light activated postemergence contact herbicides.
Pigment Biosynthesis Inhibitors	These herbicides inhibit the biosynthesis of photosynthetic pigments called carotenoids, which protect chlorophyll from destruction by light.

## Rodenticides

Rat poisons or rodenticides or “rat poisons” are mixed compounds used to eradicate rodents. They are one of the most toxic agents commonly found in homes. Historically, heavy metals such as arsenic were the first agents used to control rodent populations, but the most common rodenticide used in the 21st century is anticoagulants [17]. Given the wide range of toxins used as rodenticides, symptoms will vary depending on the toxin ingested. Rodenticides are often rated on their label with respect to toxicity [18].

a. “Hazardous” or highly toxic rodenticides include thallium, sodium monofluoroacetate (fluoroacetate), strychnine, zinc phosphide, among others

b. “Warning” or toxic rodenticides include alpha-naphthyl thiourea (ANTU) and cholecalciferol.

c. Less toxic or “cautionary” rodenticides include anticoagulants (superwarfarin, warfarin), norbormide, bromethalin, and scilla.

## Epidemiological Aspects

According to the 2017 Annual Report of the American Association of Poison Control Centers, almost 10,000 intakes occur

each year in the United States [19]. Of these, more than half of the exposures are in children under the age of six, except for strychnine and zinc phosphide. Anticoagulants were the most common cause, accounting for 5,186 cases, of which 182 were due to warfarin-type rodenticides. The second most common rodenticide was bromethalin with 1,196 reported cases. Only two deaths were reported [20].

## DISCUSSION

A study conducted by Allister Vale, in which he performs a systematic review, answering a question: What are the effects of oxime treatment for acute intoxication by organophosphate insecticides? concluding that the prognosis depends on the dose and the relative toxicity of the specific compound, as well as pharmacokinetic factors. Just as oximes have not been shown to improve results compared to placebo, although there are many biases present in these studies, being of poor quality, which the author clarifies [21]. The descriptive study carried out by Tri et al, in a red onion cultivation center in the Wanasari sub-district, Brebes, Indonesia, from May to June 2018. In which they conclude that the Personal Protective Equipment had a significant correlation with symptoms of pesticide poisoning and became a risk factor. The condition of pesticide poisoning found in this study could not be

compromised. If this condition occurs continuously, it could have more serious health impacts [22].

As reported in these studies and in the review of this work, one of the main pesticides for which intoxication is reported is organophosphate, this being the one with the greatest environmental or social impact. The data extraction that was implemented, the quality evaluation and the selection of relevant articles, we consider to be a strength for this study, when conducting a literature search. However, this study has several limitations, which should be taken into account before reaching a conclusion, among these are analysis studies of clinical trials of other pesticides, for which it is convenient to carry them out to investigate more about this subject.

## CONCLUSION

One of the most widely used chemicals by man are pesticides. Due to the large number of insects, pests or other factors that affect agriculture and other areas, these compounds are used to combat them. Within the insecticides we can find the organophosphates, according to epidemiological aspects 3 million or more people around the world are exposed to organophosphates each year, which represents about 300,000 deaths. Fungicides are agents that kill, repel, prevent or mitigate fungi and are used to protect tubers, fruits and vegetables. In the European Union (EU), fungicide sales (mass-based) account for more than 40% of total pesticide sales, and synthetic organic fungicides account for approximately 60% of all fungicides.

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