

## Environmental Impact of Pesticide and its Adverse Effect on Human Health: A Narrative Review

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### Abstract

The societies have been used various chemical substances for different purposes specifically due to the rapidly evolving technology, such situation they exposed to several types of substances with broad spectrum. Among these chemical substance groups the most frequently used is pesticides, they play crucial roles in agriculture to protect crops and livestock from pest infestations and yield reduction for many decades. Despite their importance, pesticides could have potential risks to the environment, food safety, health status of individuals and all living things. About the environmental impact concern, repeated using of pesticide abrupt effect on the environmental pollution, which can emigrate from treated fields to air, another land, and water bodies. The issue of pesticides on human health and environmental risks has emerged as a key problem for these countries in accordance with a number of studies. Even though pesticide usages increased the quantity and improved the quality of food in the last five decades, with the increasing amounts of their usage, concern about their adverse effects on non-target organisms, including human beings, has also grown. The purpose of this narrative review is to explain the nature of pesticides and their history, classification, risks, and effects on health and the environment after navigating and reviewed several literatures.

**Keywords:** Environmental Impact; Organophosphate; Organo Chlorine; Pesticide Human Health

### Introduction

Pesticides are commonly employed in agriculture to protect plants and crops against pests and plant diseases. Pesticides are divided into three categories: insecticides, fungicides, and herbicides [1]. In 2010, the European Union estimated that 208,000 tons of biologically active pesticides with specified inherent toxicity were used [2]. Furthermore, because of their toxicity, pesticide use has been linked to human health risks and environmental damage. Pesticide exposure over time has also been linked to carcinogenesis, genotoxicity, and endocrine disruption [3]. Regulatory authorities across the world set maximum residue levels (MRLs) (or tolerances in the United States) that limit the types and amounts of residues that can be legally present on foods. In assessing whether or not a pesticide is safe to use pesticide residue analysis is a critical step. With pesticides damaging the environment and causing difficulties in humans and wildlife, knowing how much pesticide is consumed is essential. Unfortunately, due to the large number of pesticides and crops in production, and a variety of analytical procedures developed to assess various pesticide residues, not all farmers follow legal standards [4].

Pesticides are chemicals or mixes of chemicals that are mostly employed in agriculture or public health programs to protect plants from pests, weeds, and illnesses, as well as humans from vector-borne diseases like malaria, dengue fever, and schistosomiasis [5]. Pesticide pollution of water resources as a result of agricultural activities is a global issue. Pesticides are essential agents for the sustainable production

of high-quantity agricultural food at the same time and as a result of massive population pressure, globalization, and social civilization growth. Key sources of drinking water around the world such as surface water and in some cases groundwater frequently contain traces of these chemicals [6]. The frequent finding of pesticide residues in natural waters is of great concern to the public, authorities, and everyone involved in the provision of drinkable water. There are variety means of pesticides renders environmental contamination; including direct entry from the spray, runoff from agricultural land, industrial effluents, and dust. Pesticide residues have serious environmental consequences for aquatic ecosystems and wildlife [7]. The Drinking Water Directive (98/83/EC) establishes a limit of 0.1 µg/L for any single pesticide and 0.5 µg/L for the total of all pesticides discovered and quantified through monitoring, independent of hazard or risk, for water meant for human consumption [8]. The significance of this review is that it will identify the impact of pesticides on the environment and human health based on prior research and provides a clear comparative analysis of the findings.

Despite their multiple benefits, pesticides produced by agricultural intensification are recognized as some of the most harmful environmental toxins. Pesticides are now widely used in agriculture to increase yield, improve quality, and extend the storage life of food and other incoming sources of our country, as well as to protect plants from pests, weeds, and diseases, and to protect humans from vector-borne diseases like malaria, dengue fever, and schistosomiasis. Pesticides are necessary agents for the long-term production of high-quantity agricultural food in the face of massive population pressure, globalization, and the rise of social civilization [7,8]. But the residue after uses of pesticide are the major cause of cancer, lung, and breathing infection disease due to carcinogenic and toxicity of the pesticide [5]. Despite the fact that different studies on the assessment and risk of pesticides on the environment and human health have been undertaken. Pesticides are the leading source of environmental damage, particularly water and air pollution, according to the current study. Thus, in this review addressed the current status of pesticide impact on environments and human health depend on the reported study.

### The theoretical concept of pesticides

Pesticides are poisonous compounds that are used to kill pests (weeds, insects, molds, rodents etc.) Insecticides and rodenticides are the pesticides that are most harmful to humans. Not all pesticides are lethal to humans or other non-target animals. In farmers/agriculture area synthetic pesticides have been frequently used, because of their simplicity in application, efficacy and economic returns [7-9]. In the country, there are about 180 pesticides registered and 64 technical grade pesticides produced. Herbicides and pesticides are used far less than insecticides, owing to a tropical climate that favors insects over herbs and fungus [8].

### Chemical properties of pesticides

Following their release into the environment, pesticides go through a complicated sequence of interdependent processes known as chemo dynamics of pesticides. Essentially, a pesticide is determined in part by environmental factors such as pH, temperature, moisture, precipitation, salinity, light intensity, and topography, and in part by its inherent physicochemical qualities [9]. Transportation, retention, degradation, and biota uptake are the key chemodynamic mechanisms that govern pesticide persistence, distribution, and ultimate destiny in the environment. Among all of these chemodynamic processes, degradation is particularly important since it involves the chemical transformations of pesticides in the environment, as well as pesticide chemical characteristics [10]. The breakdown or chemical transformation of pesticide molecules into other forms that are not necessarily simpler or less hazardous than the parent molecule is known as pesticide degradation [10]. The breakdown products might be poisonous and have Pesticidal properties in some instances. The degradation of DDT to DDD, which is a pesticide, is a good example of this [11].

The rate of degradation of pesticides is often measured in terms of half-life ( $t_{1/2}$ ), which is the time required for the depletion of half (or 50%) of the amount of pesticide present initially. There are two major groups of degradation process that causes about pesticides transformation; chemical degradation and biological degradation. Chemical degradation generally follows one of four reactions namely: reduction, hydrolysis, oxidation, and photolysis that could be occur in water or atmosphere. Biological degradation generally follows one

of four reaction; reduction, hydrolysis, oxidation, and conjugation it could be occurs in soil and in living organisms [12]. The pesticide inherent phyco-chemical properties and the environmental compartment (water, soil, air, biota) in which it is hosted mostly determined by the type of the reaction in which a pesticide undergoes [12,13].

### Classification of pesticides

Classification of pesticides based on different factors. For instance, they could be classified based on their functions and the type of the intended target pests: insecticides; herbicides; rodenticides; fungicides, etc. and based on their chemical compositions: organochlorine, organophosphorus, carbamates, triazines, pyrethroids [14].

### Organophosphate pesticides

The organophosphates pesticides are able to inhibit insect acetyl cholinesterase and strongly interfere with neural transmission in other organisms, including humans. Therefore, they represent a potential hazard for the environment and human health, which Demands the continuous assessment and monitoring of these pesticides [15-17]. Though when pesticides are properly monitored and utilized it have negligible risk for the consumer's health, toxic symptoms results from Malathion exposure are breathing problems, headache, nausea and dizziness, while the high exposure can produce fatal poisoning in human health [8,15]. In the recent time, some substance which is susceptible to insect and various disease attacks have been widely studied for its pesticide residues like cucumber [16,18,19]. Most organophosphates are lipid-soluble and readily absorbed through the skin, mucous membranes of the mouth, conjunctiva, and gastrointestinal and respiratory pathways. The dose, route of exposure, physicochemical properties of the organophosphate (e.g. lipid solubility), rate of metabolism and whether the organo-phosphorylated cholinesterase ages rapidly all influence the onset, severity, and duration of poisoning [19]. Cholinesterase is inactivated in the blood and a variety of neuronal, neuromuscular and glandular tissues, where these enzymes are involved in cell-to-cell communication and xenobiotic hydrolysis. These enzymes may play roles in cell formation and growths that have yet to be discovered [16,17,19].

### Malathion

Malathion one of the pesticide that society have been used for kill insects on agricultural crops, stored agricultural products, in home gardens, and in outdoor sites where trees and shrubs are grown at home. In addition to this society also utilized it to kill mosquitoes, fruit flies in large outdoor areas, kill fleas on pets and treat head lice on humans [20]. So, Malathion is a wide-spectrum aliphatic organophosphate insecticide widely used for both home and commercial agricultural uses. A pure form of Malathion is a colorless liquid and a brownish-yellow liquid is the concentrated form of Malathion [21]. There are two groups of Malathion metabolites; mono- and di-carboxylic acid derivatives are the major metabolites of Malathion and malaoxon is a minor metabolite.

### Organ chlorine pesticides

Organ chlorine pesticides are chlorine-containing compounds which are found in the environment as the result of human activities. Organ chlorine pesticides have remained major pollutants with numerous investigations reporting the continued and ubiquitous presence of these pesticides in the globally [21,22]. Also, its very stable compounds for example the degradation of dichlorodiphenyltrichloroethane in soil ranges from 4 - 30 years [21]. Organ chlorine pesticides have also been reported to cause human breast and liver cancers, testicular tumors and lower sperm counts. They are lipo-soluble substances that can bio accumulate in the fatty tissues of organs including breast milk, blood, and fatty tissues. Because pesticides are lipophilic, their long-term retention at low quantities in mammalian fat tissues could represent a risk [22].

### Carbamate pesticides

Like organophosphate insecticides, are generated from carbamic acid and kill insects in a similar way. They're common in households, gardens, and agriculture. Their mode of action, like that of organophosphates, is suppression of cholinesterase enzymes, which affects nerve impulse transmission. Because the majority of carbamates are exceedingly toxic to Hymenoptera, care must be taken to prevent exposing foraging bees or parasitic wasps to them. Because carbamates may be translocated within plants, they can be used as a systemic therapy. Carbamates are highly poisonous pesticides that have been widely used by societies in agriculture for several years. Carbamate pesticides do not stay in the environment unlike other pesticides such as organophosphate; yet, due to their toxicity to living systems, their breakdown is critical. Carbamate pesticide is classified as harmful, dangerous, and restricted by the World Health Organization. Carbaryl, Aldicarb, Methomyl, and Carbofuran are examples of carbamates insecticides. They are widely employed to control a variety of agricultural insects and pests. Because of pesticides' tendency to damage soil and water bodies, there is a lot of awareness about their negative impacts these days. Microorganisms' ability to degrade carbamate pesticides is dependent not only on the availability of bacteria with appropriate bio degradative enzymes, but also on a variety of environmental conditions [23]. The mixture of dithio-carbamates maneb and zineb could controls many fungal diseases in a wide range of field crops, fruits, nuts, vegetables, and ornamentals [24]. The danger of Mancozeb on soil fauna differed depending on the representative groups of soil fauna and the type of soils, emphasizing the need to assess various pesticide application situations [25].

### Pesticide exposures

Pesticides and other agrochemicals are a serious occupational hazard, accounting for up to 14% of all agricultural-related injuries and 10% of all fatalities in some countries. Pesticide mixers, loaders, and flaggers for aerial applications, applicators (spray men), fumigators, pilots, emergency response personnel, manufacturers, and supervisors are all hazardous vocations [26]. Pesticides are becoming increasingly important in agricultural production, vector control in public health, and animal husbandry. The major usage is agriculture, followed by vector control. Active ingredients account 759 used as the precursors for two million tons of pesticides, these pesticide being current utilized by societies. While pesticide use in Europe and North America approaches saturation or declines, Africa and Central America are projected to see growing trends (WHO 1990). Pesticides that are banned or heavily limited in developed countries are exported to underdeveloped countries, notwithstanding international pesticide trade treaties. Potential carcinogens, endocrine disruptors, and persistent organic pollutants are among them [27].

### Pesticide poisonings

A number of pesticides have acute health effects such as organophosphates are well characterized but the long-term health effects of routine, small exposures are uncertain. According to World Health Organization estimation three million cases of acute pesticide poisoning (two million suicides, one million accidental poisonings) resulting in 220,000 deaths, occur Worldwide each year, based on hospital registries. Because of many cases of pesticide poisoning remains undiagnosed, the burden of pesticide related illness and injury is difficult to determine. As the result of insufficient medical training, diagnostic problems are particularly prominent in developing countries [28]. Regard to suicidal, homicidal and accidental effect of pesticide poisonings are underreported, so that this condition leads to under speculated pesticide poisoning effects, consequently it could bring unpredicted burden to government as well as to societies. Several studies had shade light that organophosphate pesticides block cholinesterase enzyme and have other negative health effects on agricultural workers [29]. Since pesticides design as interrupters of a variety of biological systems, such as the nervous and enzyme systems. Pesticide being having such properties could brought prominent negative effect on health of the societies. Pesticide toxicity varies widely, and the different chemical compositions in each pesticide create a variety of health effects, including systemic poisonings and surface lesions. Pesticides have the potential to harm the respiratory, immune, neurological, and developmental systems, as well as cause cancer [26]. The magnitude of pesticide poisoning effect might be ranged from mild to severe, the onset ranged from immediate to delay and resulting condi-

tion ranged from short to long-term, reversible to irreversible. As the study revealed in China, Organ phosphorus insecticides cause acute pesticide poisonings which account for 79% of the total poisonings via inhibit the normal function of cholinesterase enzymes [29,30].

### Health effects of pesticides

The following section is aimed to review the health effects of pesticides by surveying the existing literature. The people exposed to pesticides via either of the following three; people with direct exposure (those individuals participated in agricultural activities), members of a community with indirect exposure, and consumers. Earlier report pointed out about potential health effects of pesticides on the risks of acute intoxication among people with direct exposure [31]. Additional the risks of chronic intoxication and environmental contamination also justified by longitudinal data. Pesticides chronic exposure effects could be the risks for more recently the concern diseases like cancers [32]. Nowadays, the concern of pesticides exposure effects is not only for people with direct exposure but also for peoples those domain of indirect exposure such as consumers or residents of rural communities (community members) [33]. Furthermore, pesticide exposure could have short-term health effects such as diarrhea, abdominal pain, headaches, nausea, vomiting, etc. and long-term health impacts such as cancer, skin diseases, depression, neurological deficits, diabetes, genetic disorders, or even death [34].

### Health effects of pesticides on people with direct exposure

This category encompasses a wide range of topics. We reviewed the literatures on people who spray pesticides, mixed and loaded chemicals, planted pesticide seeds, weeded and harvested sprayed crops, and cleaned and disposed of pesticide containers. Because the majority of statistically significant data are pesticide specific, it is impossible to generalize about pesticide health consequences [34-36].

### Cancer

The several studies dealt out about cancer associated with pesticide exposure/pesticides toxicity during the last decade. About 43 studies shade light the association between direct exposure to pesticides and the risk of cancer. Most of the studies were used data form the Agricultural Health Study (AHS). In contrast, about 12 of the studies reports no significances among farmers exposed to pesticides as compared the general population on risk of cancer, even though no fully agreement has been reached. While others studies agree with the significance of accompany exposure to certain pesticides and risk of cancer development [35,36]. On certain pesticides like triallates no cancer risks report yet [37].

### Depression and neurological deficits

Three studies demonstrate that high-intensity and cumulative pesticide exposure correlates to pesticide applicators' depression. Numerous studies have been undertaken to evaluate the pesticide exposure effects on neurological function. As several evidence has been explained about relationship between long durations of farm working and decreasing levels of performance. This is as the result of might be chronic exposure to pesticides that considered as one relevant factor. As other studies exposed some of pesticide such as fumigants and insecticides cumulative exposure had neurological symptoms are associated [29,31,34].

### Diabetes mellitus

Recently more studies deal out about association between diabetes mellitus and pesticide exposure. According these reports, the increment of prevalence of diabetes mellitus is associated with exposure to oregano chlorine compounds as well as handling organophosphate insecticides. Virtually all the studies that carried out on association between pesticide exposure and diabetes mellitus had reported a significance, however few studies [3] is not confidant enough to formulate a general conclusion on this association [38].

### Respiratory diseases

There were beyond thirty studies about the relationship between pesticide exposure and respiratory diseases. Most of them justified that an increased risk of respiratory diseases such as rhinitis, bronchitis associated with pesticide exposure. Nonetheless, in the fact no fully confident or it is not possible to establish a causal relationship, and also two studies didn't unanimous agreement a significant association of respiratory diseases and pesticide exposure [39].

### Women specific disorders

Above five studies were that determined the association of pesticide exposure and women specific disorders. Some these studies explained that pesticide exposure is a cause of hormonal disorders however, it has no effect on delayed conception in pregnant women [40].

### General health, multiple diseases, and others

There are studies conducted on the impact of pesticide exposure on several diseases such as hepatitis, dyspnea hearing loss myocardial infarction, thyroid disease, and sperm quality that precautionary measures have a significant impact on the relationship between pesticides and these disease. Furthermore, others finding revealed significant interaction effects on health of pesticide exposure and genetic polymorphisms. New studies include clever techniques to analyze the effects of pesticides, such as *in vitro* tests that identification of pesticides' effects [41].

### Pesticides and environmental health

Pesticides reach the environment primarily during preparation and application. Application could carry out through different techniques, based on different factors like the formulation type, the controlled pest and, the application timing [42-44]. In regard to agriculture, pesticide application either to the crop or to the soil. Liquids sprays in aspect of agriculture are daily and commonly used pesticide for the crop; for instance boom sprayers, tunnel sprayers, and aerial application. Pesticide for soils application can be applied as sprayed onto the soil surface, injected as a fumigant, or as granules. Seeds are sometimes treated with pesticides prior to planting [43]. Metabolic fate of pesticides after application to both (soil and crop) then can be taken up by target organisms, degraded, or transported to the groundwater. And also can enter the surface water bodies, volatilize to atmosphere, or reach non-target organisms by ingestion. These fates of pesticide could be affected by different factors such as the physical and chemical properties of the pesticide, soil, site conditions. Factors that determines pesticides' transport in surface runoff and their leaching to groundwater by their physical and chemical properties [42]. The more soluble pesticide, the greater the carrying and leaching. Other factors that affect the pesticides properties is partition coefficient due this many chemicals do not leach because soil particles adsorb them [44]. So that adsorption depends on the chemical properties and also on the soil type. The tendency of pesticide to become a gas high in the case of volatility of pesticides; the higher the volatility (high vapor pressure), the larger their loss to the atmosphere and have high probability to contaminate the environment. Volatility of pesticide which can occur from soil, plants, or surface water, and may continue for several days or weeks after pesticide application affected by environmental conditions such as temperature and humidity. These volatilized chemicals could be transported far long distances in the atmosphere. Subsequent can contribute to surface water pollution from atmospheric deposition [45]. Finally, the properties and fate of pesticide chemicals in the environment also determines by the degradation of pesticides. Photodecomposition, microorganisms, and a variety of chemical and physical reactions are the mechanism through which degradation (their brake down into other chemical forms) of pesticide carried out [46]. Some pesticide can remain in the environment for a long time such pesticides which have low biodegradation are called persistent. Soil type or properties can also affect the movement of pesticides. Concerning to the soil properties/textured, coarse textured sands and gravels have high infiltration capacities, so water tends to percolate through the soil and reach groundwater such situation facilitates groundwater contamination (wells, sinkholes) [47]. Some soils like clays which are fine-textured soils generally have low

infiltration capacities, this condition allow water tends to run off, reaching streams and lakes. Others factors that play a role in contamination of water by pesticide are climate (like rainfall or irrigation) may through culminate in large amounts of water percolating through the soil, to reach groundwater. The surface water (like river, seas, lake and etc.) can get the pesticide from rainfall because it can carry the pesticides chemicals from the distant places, then eventually contaminating rivers, lakes, and seas [48]. Finally, management practices of pesticide can affect its' movement. To summarize the application methods versus environmental contamination, these pesticides injected into the soil are more vulnerable to leaching and reaching groundwater, whereas these pesticides sprayed onto crops are more prone to volatilization and surface runoff, reaching surface waters and the atmosphere [43]. With regarding to handling practices, the pesticides containers improperly stored and disposed may impact environmental contamination [45].

### Conclusion

The purpose of this review was to gather information in order to create techniques for reducing and controlling pesticide exposure and preventing pesticide poisoning. The offered conclusion is based on the current research material. The proposed strategies, as well as the feasibility assessment of the plans, provide a foundation for future attempts in Ethiopia to address the problem of harmful pesticide exposures. The strategies offered are those that are possible in the current scenario, assuming enough finance and cooperative linkages. Higher training programs could also be arranged with other universities outside the country as a short- term measure while the possibility of incorporating the subject in the local curricula is sought. The present review showed a lot of pesticide are used in the world specially in developing country, due to that reason it needs further study to reduce the poisoning of pesticide on human health and it need awareness to the farmers, community and the responsible individuals how handle pesticides to uses.

### Data Availability

Data used to support the findings of this study are available from the corresponding author upon request.

### Ethical Approval

Since this narrative review no need of ethical approval.

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