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Adverse Effects of Pesticides on Health of Human Beings

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ABSTRACT: Pesticides can cause short-term adverse health effects, called acute effects, as well as chronic adverse effects that can occur months or years after exposure. Examples of acute health effects include stinging eyes, rashes, blisters, blindness, nausea, dizziness, diarrhea and death. Examples of known chronic effects are cancers, birth defects, reproductive harm, immunotoxicity, neurological and developmental toxicity, and disruption of the endocrine system.

Some people are more vulnerable than others to pesticide impacts. For example, infants and young children are known to be more susceptible than adults to the toxic effects of pesticides. Farm workers and pesticide applicators are also more vulnerable because they receive greater exposures. Immediate health effects from pesticide exposure includes irritation of the nose, throat, and skin causing burning, stinging and itching as well as rashes and blisters. Nausea, dizziness and diarrhea are also common. People with asthma may have very severe reactions to some pesticides, particularly pyrethrin/pyrethroid, organophosphate and carbamate pesticides. Chronic health effects include cancer and other tumors; brain and nervous system damage; birth defects; infertility and other reproductive problems; and damage to the liver, kidneys, lungs and other body organs. Chronic effects may not appear for weeks, months or even years after exposure, making it difficult to link health impacts to pesticides.

KEYWORDS: pesticides, acute, chronic, toxicity, health, impacts, people, vulnerable, death, tumors

I. INTRODUCTION

A pesticide is any substance which is used to prevent, destroy or repel any pest from causing any damage. The term pest represents any living organism that may cause harm to human in respect to food competition, destruction of property and spread of disease. Pests include insects, rodents, microbes, fungi and weeds (unwanted plants), etc. of agricultural, medical and veterinary importance, and therefore, a pesticide can be an insecticide, an insect and plant growth regulator, a fungicide, an herbicide, a molluscicide, and an algacide, etc. based on the target pest organism.

Pesticides have been implicated in human studies of leukemia, lymphoma and cancers of the brain, breasts, prostate, testes and ovaries. Reproductive harm from pesticides includes birth defects, still birth, spontaneous abortion, sterility and infertility.[1,2]

Endocrine disruptors are chemicals that — often at extremely low doses — interfere with important bodily functions by mimicking or blocking hormones (the chemical messengers that circulate in blood and regulate many body processes including metabolism, brain development, the sleep cycle and stress response). Some pesticides act as endocrine disruptors and have been shown to cause serious harm to animals, including cancer, sterility and developmental problems. Similar impacts have been associated with human exposure to these chemicals.

Children are not simply “little adults.” Children are more vulnerable to pesticide exposure because their organs, nervous systems and immune systems are still developing. Children are also less able to detoxify and excrete pesticides. Exposure during certain early development periods can cause permanent damage.

In addition to being more vulnerable to pesticide toxicity, children’s behavior and physiology make them more likely to receive greater pesticide exposure than adults. Most pesticide exposure occurs through the skin and children have more skin surface for their size than adults. Children have a higher respiratory rate and so inhale airborne pesticides at a faster rate than adults. Children also consume proportionately more food and water — and pesticide residues — than adults. With their increased contact with floors, lawns and playgrounds, children’s behavior also increases their exposure to pesticides.

Organophosphates & Carbamates: These pesticides are like nerve gas: they attack the brain and nervous system, interfering with nerve signal transmission. Symptoms include headaches, nausea, dizziness, vomiting, chest pain, diarrhea, muscle pain and confusion. In severe poisoning incidents, symptoms can include convulsions, difficulty

breathing, involuntary urination, coma and death. Acute poisoning of the nervous system by these pesticides affects hundreds of thousands of people around the world each year.

Soil Fumigants: These pesticides are applied to soil, forming a gas that is toxic to nematodes, fungi, bacteria, insects, and plants in the soil. Because they are gases, they move from the soil into the air and expose people living or working nearby. Commonly used soil fumigants in California include 1,3-dichloropropene, chloropicrin, metam sodium, and metam potassium. Symptoms of fumigant exposure include irritation of skin, eyes, and lungs (dichloropropene and chloropicrin), and extremely irritating to eyes and lungs (metam sodium and metam potassium). Dichloropropene, metam sodium, and metam potassium are all cancer causing chemicals and metam sodium causes reproductive harm. In counties where fumigant use is high, premature birth is more common than in counties with low fumigant use.

Pyrethroids: These insecticides are synthetic chemicals that are structurally similar to botanical compounds but have been designed to be more persistent. They are toxic to the nervous system, and there is concern that during pregnancy a fetus is not able to efficiently break down these chemicals. Symptoms of pyrethroid poisoning include tremors, salivation, headache, fatigue, vomiting, stinging and itching skin, and involuntary twitching. [3,4]

Many pyrethroids also cause long term health problems. For example, resmethrin causes both cancer and reproductive harm. Cypermethrin, fenvalerate, and deltamethrin all cause genetic damage and reproductive harm.

Table 1.
Major types of pesticides used in agriculture, forestry, landscape, medical and veterinary sectors.

| Type of pesticide | Active ingredient | Target pests |
|--------------------------|-----------------------|---|
| Insecticides | Natural and synthetic | Insect (6-legged) pests of agricultural, forestry, landscape, medical and veterinary importance |
| Miticides/acaricides | Natural and synthetic | Mites (8-legged) pests of agricultural, forest, landscape, medical and veterinary importance |
| Fungicides | Natural and synthetic | Fungal diseases (molds, mildews, rust) of agricultural, forestry and landscape importance |
| Herbicides | Natural and synthetic | Unwanted plants (weeds) of agricultural and landscape importance |
| Insect growth regulators | Synthetic | Disrupt the growth and reproduction of insect pests. IGR are species or genus specific. |
| Pheromones | Natural and synthetic | Attract and trap male insects and are often species-specific. |
| Plant growth regulators | Synthetic | Alter plants growth, e.g., induce or delay flowering |
| Algaecides | Natural and synthetic | Algae growing on different surfaces, e.g., patios |
| Molluscicides | Natural and synthetic | Slugs and snails of agricultural, forestry and landscape importance |
| Biopesticides | Natural | Can be insecticides, fungicides or herbicides |
| Antimicrobials | Synthetic | Microbes (mostly bacteria) of medical and veterinary importance |
| Rodenticides | Natural and synthetic | Rodents (mice, rats) in agriculture, landscape, building, storages and hospitals |
| Treated seeds | Synthetic | Seeds coated with an insecticide or fungicide or both to prevent damage from soil insect pests and fungus diseases |
| Wood preservatives | Synthetic | Pesticides to protect wood from insect pests, fungus and other diseases |
| Minimum risk pesticides | Natural and synthetic | Any pesticides which have been proven safe for human and are exempt from registration by any regulatory authorities |

Pesticides are sold as formulated products. Pesticide formulations are a combination of one or more active ingredients (a.i.) and several inert ingredients. Active ingredients control the pests. The inert ingredients help in solubility and stability of the product. A ULV (Ultra Low Volume) formulation need specialized spray equipment and the Ready-to-Use formulations are already diluted and are appropriate for indoor or small areas, for example, aerosols (A), granules (G), and most baits (B)



Most liquid formulations are diluted with water according to the label directions. The three main types of liquid formulations are solutions, suspensions, and emulsions. A true solution is a mixture that cannot be separated by a filter or other mechanical means while a suspension is an even mixture of very small solid particles throughout a liquid and an emulsion is a mixture of droplets of one liquid in another liquid. Common Liquid Formulations are Emulsifiable Concentrate (E or EC), Solutions (S, CS), Emulsions in Water (EW), Flowables (F, L, or SC), Microencapsulated Pesticides (M or ME) and Aerosol (A).[5,6]

In dry formulations the active ingredient is on the surface of a solid carrier, such as talc, clay, or ground corncobs. Common solid formulations include Granules (G), Wettable Powders (WP or W), Soluble Powder (SP or S), Water-Dispersible Granules (WDG) or Dry Flowables (DF Water-Soluble Bags/Packages (WSB) and Baits (B).

There are approximately 9000 species of insects/mites (14% loss), 50,000 species of plant pathogens (13% loss) and 8000 weeds species (13% loss) worldwide [2]. Without pesticide application the pest losses to fruits, vegetables and cereals would reach 78%, 54% and 32%, respectively. Pesticides are, therefore, indispensable in agricultural production and there will be a need for pesticide based pest control and food security in the future. Pesticides are also used to control vector-borne infectious diseases such as Zika virus, Lyme disease, and rabies, household pests like cockroaches, bed bugs, and as repellents etc. More than 1000 active ingredients are used in pesticides around the world to ensure food safety and prevention from pests and the highest amount (~45%) is spent on herbicides followed by insecticides, fungicides, and other types of pesticides.[7,8]

II. DISCUSSION

Hazard, or risk, of using pesticides is the potential for injury, or the degree of danger involved in using a pesticide under a given set of conditions. Hazard depends on the toxicity of the pesticide and the amount of exposure to the pesticide and is often illustrated with the following equation:

$$\text{Hazard} = \text{Toxicity} \times \text{Exposure}$$

The toxicity of a pesticide is a measure of its capacity or ability to cause injury or illness. The toxicity of a particular pesticide is determined by subjecting test animals to varying dosages of the active ingredient (a.i.) and each of its formulated products. The active ingredient is the chemical component in the pesticide product that controls the pest. By understanding the difference in toxicity levels of pesticides, a user can minimize the potential hazard by selecting the pesticide with the lowest toxicity that will control the pest.

Applicators may have little or no control over the availability of low-toxicity products or the toxicity of specific formulated products. However, applicators can minimize or nearly eliminate exposure--and thus reduce hazard--by following the label instructions, using personal protective clothing and equipment (PPE), and handling the pesticide properly. For example, more than 95 percent of all pesticide exposures come from dermal exposure, primarily to the hands and forearms. By wearing a pair of unlined, chemical-resistant gloves, this type of exposure can be nearly eliminated.[9,10]

Products are categorized on the basis of their relative acute toxicity (their LD₅₀ or LC₅₀ values). Pesticides that are classified as highly toxic (Toxicity Category I) on the basis of either oral, dermal, or inhalation toxicity must have the signal words DANGER and POISON printed in red with a skull and crossbones symbol prominently displayed on the front panel of the package label. The Spanish equivalent for DANGER, "PELIGRO," must also appear on the labels of highly toxic chemicals. The acute (single dosage) oral LD₅₀ for pesticide products in this group ranges from a trace amount to 50 mg/kg. For example, exposure of a few drops of a material taken orally could be fatal to a 150-pound person.

Some pesticide products have just the signal word DANGER, which tells you nothing about the acute toxicity, just that the product can cause severe eye damage or severe skin irritation.



Pesticide products considered moderately toxic (Toxicity Category II) must have the signal word WARNING and "AVISO" (the Spanish equivalent) displayed on the product label. In this category, the acute oral LD₅₀ ranges from 50 to 500 mg/kg. A teaspoon to an ounce of this material could be fatal to a 150-pound person.[11,12]

Pesticide products classified as either slightly toxic or relatively nontoxic (Toxicity Categories III and IV) are required to have the signal word CAUTION on the pesticide label. Acute oral LD₅₀ values in this group are greater than 500 mg/kg. An ounce or more of this material could be fatal to a 150-pound person.

III. RESULTS

As mentioned earlier, the hazard or risk involved with using a pesticide depends on both the toxicity of the product and the amount of exposure to the product (Hazard = Toxicity x Exposure). Ideally, use a low-toxicity product when possible, but even they can be harmful if your exposure level is high. However, regardless of the product's toxicity, if the exposure level is low, then the hazard will also be low. To reduce the possibility of exposure and to protect your health, always wear the personal protective equipment (PPE) as indicated on the product label. The following are general PPE guidelines to protect against the four routes of entry.

Dermal

More than 95 percent of all exposures are dermal. Dermal absorption may occur as the result of a splash, spill, or drift or when cleaning or repairing equipment. Wear unlined, chemical-resistant gloves to eliminate most dermal exposures. Minimum dermal protection for most pesticides consists of a long-sleeved shirt, long trousers, gloves, and proper footwear. For extra precaution, consider wearing coveralls, a waterproof hat, and unlined rubber boots. Additionally, wearing a liquid-proof apron or rain suit is recommended when mixing and pouring concentrates or when using highly toxic products.

Inhalation

For many toxic chemicals, the respiratory (breathing) system is the quickest and most direct route of entry into the circulatory system. Respiratory protection is especially important when pesticide powders, dusts, gases, vapors, or small spray droplets can be inhaled.[13,14]

Use the respirator as designed for its intended use, and always follow the manufacturer's instructions. Select only equipment approved by the National Institute of Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA).

Oral

Accidental oral exposure most frequently occurs when pesticides have been taken from the original container and put into an unlabeled bottle or food container. Unfortunately, children are the most common victims in these situations. Store pesticides only in their original containers, and keep the original label attached to the container. Store pesticides only in their original containers and keep the original label attached to the container. Store in a locked cabinet and/or on a high shelf to keep out of the reach of children. Never use your mouth to clear a spray line or to siphon a pesticide from a tank or container. After handling or working with pesticides, wash your hands and face thoroughly with soap and water before eating, drinking, or smoking.

Eyes

Eyes are very sensitive to many pesticides and, considering their size, are able to absorb large amounts of chemical. Serious eye exposure can result from a splash, spill, or drift or by rubbing the eyes with contaminated hands or clothing. Tight-fitting chemical splash goggles or a full-face shield should be worn if there is any chance of getting pesticides in the eyes, especially when pouring or mixing concentrates and handling dusts. When pouring from a



container, keep the container below eye level to avoid splashing or spilling chemicals on your face or protective clothing.[15,16]

IV. CONCLUSIONS

All pesticides have the potential to be harmful to humans, animals, other living organisms, and the environment if used incorrectly. The key to reducing health hazards when using pesticides is to always limit your exposure by wearing PPE and use a low-toxicity pesticide when available. Reading the label and practicing safe work habits will minimize hazards from the use of pesticides. Poisoning from pesticides is a global public health problem and accounts for nearly 300,000 deaths worldwide every year. Exposure to pesticides is inevitable; there are different modes through which humans get exposed to pesticides. The mode of exposure is an important factor as it also signifies the concentration of pesticides exposure. Pesticides are used extensively in agricultural and domestic settings. These chemicals are believed to cause many disorders in humans and wildlife. [17,18] Research from past few decades has tried to answer the associated mechanism of action of pesticides in conjunction with their harmful effects. This perspective considers the past and present research in the field of pesticides and associated disorders. We have reviewed the most common diseases including cancer which are associated with pesticides. Pesticides have shown to be involved in the pathogenesis of Parkinson's and Alzheimer's diseases as well as various disorders of the respiratory and reproductive tracts. Oxidative stress caused by pesticides is an important mechanism through which many of the pesticides exert their harmful effects. Oxidative stress is known to cause DNA damage which in turn may cause malignancies and other disorders. Many pesticides have shown to modulate the gene expression at the level of non-coding RNAs, histone deacetylases, DNA methylation patterns suggesting their role in epigenetics.[19,20]

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