REVIEW ARTICLE

Management of Organochlorine Exposure to Health Risks in Asia – A Review

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ABSTRACT

Organochlorine organic pesticides used on a large scale still pose a great health hazard to humans and animals. Organochlorine pesticides contribute to reduced disease, higher yields and increased production. This research was to review various articles on management of organochlorine exposure and health risks. This research used multiple search engines (Scholar, PubMed). A few significant keywords were chosen to discover considers that fit this theme. Organochlorine as Persistent Organic Pollutants are difficult to remove from the environment. There are several health-causing effects of organochlorine most of which are chronic diseases (i.e., pulmonary function, cancer, reproductive issue). Organochlorine control in the environment is needed to reduce health effects, especially in farming communities, personal protective equipment including masks and gloves is also necessary. Local government may also promote and doing a prevention program from the danger of the use of pesticides in agriculture.

Keywords: Environment, Farmers, Management, Organochlorine

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INTRODUCTION

Pesticide are chemicals that are popularly used to prevent the event or growth of pests, diseases and weeds. Generally, pesticides are defined as chemical compounds, microorganisms, or viruses which attenuated to manage pests. Consistent with Permentan (2014), pesticides are altogether synthetics and different materials likewise as microorganisms and infections that are utilized to: eradicate or forestall irritations and illnesses that harm crops, plant parts or farming items; eradicate grass; kill and thwart undesirable development; regulate or animate the extension of plants or plant parts, barring composts; eradicating or forestalling outside vermin on animals and animals; eradicate or forestall water bothers; eradicate or forestall animals and microorganisms in family units, structures and transportation gear; and/or; eradicate or forestall animals which can cause sickness in people or animals that should be ensured utilizing plants, soil and water (1).

The natural effect of the use of pesticides is identified with the elemental properties that are significant for his or her viability as a pesticide. Pesticides are harmful enough to influence all scientific classifications of biota, including non-target life forms, somewhat relying upon physiological and natural components. Many pesticides are resistant to environmental degradation so they can withstand in the treated areas, but these properties also have a long-term effect on natural ecosystems. It is build-up has been found in seal and penguin networks in Antarctica, and in fish around coral reefs and remote oceans, and in bosom milk far and wide. Dichlorodiphenyltrichloroethane (DDT), for instance, continues to be found in human fat tissue at detectable concentrations, although these concentrations have attended decline since the utilization of this insecticide was banned in many countries since 1980 (2).

Organochlorines are the blends which contain at least one covalently strengthened chlorine molecule. Organochlorine show a colossal combination of structures with much different engineered properties. Because of high atomic heap of chlorine, these blends are found to be denser than water. It is been seen that assimilation of organochlorine through skin and gut divider is awfully expanded by fat and fat solvents (3).

Organochlorine has been banned in the United States and other nations due to its carcinogenicity and toxicity. Moreover, referred to in the Stockholm Convention, even though it is still used in many developing nations, especially in Asia. Use and improper disposal over the years resulted from organochlorine waste spread globally. Organochlorine persistence makes them a potential hazard for the environment (4).

The incidence of poisoning in several regions in Indonesia is extremely high. Supported the results of monitoring blood cholinesterase from 347 workers in agriculture in Central Java, it had been found that 23.64% of workers were moderately poisoned and 35.73% were very poisonous. Nearly all chronic diseases suffered by farmers were caused by the utilization of pesticide sprays that were released into the air, which, if inhaled through the nose and thru the mouth, can enter the lungs and damage them, and quickly the pesticide enters the blood and spreads toxins. throughout the body (5). The aims of this study, therefore, were to review management of organochlorine exposure and health risks in Asia.

METHODS

The current study used multiple search engines (Scholar and Pubmed). Several keywords were selected to discover considers that fit this theme. This study using "Organochlorine" as keywords, all found 56,277 articles. It consists of, research articles, process papers, book reviews, reviews, meeting abstracts, and other form of articles. Then the current research looked for topics using "Organochlorine, Environmental studies" currently took 35,779 articles. This study is using the related keyword "Organochlorine, Health risks", and it resulted in 3,676 articles. We restricted our selection to original articles (Short communication and commentary papers were excluded) published in Indonesian, Malaysian and English language between January 2010 and January 2021. The inclusion is articles contain of health risk because of organochlorine pesticides and the derivatives, environmental risk of organochlorine pesticides, and pesticides management in Asia and other countries outside Asia for comparison. Therefore, 44 articles were choosen to be included in this review.

RESULTS AND DISCUSSION

Organochlorines are manufactured pesticides generally utilized everywhere in the world. They belong to the group of chlorinated hydrocarbon derivatives, which have tremendous applications in the substance business and in horticulture. These mixes are known for their high harmfulness, slow debasement and bioaccumulation. List of organochlorines is shown at Table 1.

Organochlorine exposure and contamination to the environment

Organochlorine waste is a referenced items or substances made out of, containing or debased by organochlorine which was included in group of persistent organic pollutants. Items and products ought to try and be overseen as organochlorine waste if their organochlorine content surpasses a specific norm. Organochlorine synthetics used underway cycles cause high convergences of organochlorine waste build ups in soils round the warehouse and facilities (6).

Han's survey of chosen organochlorine information in China's water bodies found that zones intensely contaminated with organochlorine in several region in China within the last 10 years. Natural toxins are likely to quietly eat up China's as of now constrained water assets and posture continuous potential dangers to biological systems and human wellbeing. Polycyclic Aromatic Hydrocarbons (PAHs) and organochlorine pesticides within the oceanic environment are worldwide contamination issues that are in numerous zones more extreme in China than detailed worldwide information (7).

Waste from agriculture that enters the water is really not dangerous for the sustainability of the aquatic ecosystem, but because at this point many farmers use chemical fertilizers and pesticides in large quantities in order that it can cause damage to the prevailing ecosystem. This may be worse if the pesticide used may be a sort of herbicide and insecticide (8).

The existence of organochlorine in river water was also found in Mulyadi's (2011) research of physical and chemical properties of river water and tributaries of the Upper Citarum River in Indonesia with eleven sampling location (9). The water samples taken were separated by bottles which were analysed for the content of organochlorine compounds with other parameters which was pH, Dissolved Oxygen, Chemical Oxygen Demand and also water conductivity. More endosulfan organochlorine were detected in water than aldrins, as endosulfan is detected in every location with the concentration range around 0,001-0,005 mg/L and the aldrins is detected in only three location with the concentration range around 0,005-0,022 mg/L. However, the levels of aldrin in the Cikapundung river had exceeded their maximum use for drinking water which is 0,020 mg/L. Source of aldrin compound in water is derived from the residue in the soil as a result of past use. While at present, pesticides with endosulfan as their active ingredients are still available on the market for example: Thiodan, Indodan 25 EC and Akodan 35 EC (9).

The existence of organochlorine in air was also found in Prananditya's (2016) research in Indonesia (10). The sampling method used the reference from United States Environmental Protection Agency (EPA) Methods T04 for determination of pesticides and polychlorinated biphenyls in ambient air. It can be seen by the ambient air

Table I: List of Organochlorine

No	Chemical name	Use	Persistance in Environment	Toxicity LD50	WHO Classification
1	1,1-dichloro-2,2bis (p-chlorophenyl). ethane (DDD).	Insecticide	High Persistence Half life: 5–10 years	Rat: 4000mg/kg	Acute hazard is unlikely
2	1,4- dichlorobenzene $C_6H_4Cl_2$	Insecticide	Moderate Persistence Half life: < 50 days	Rat : 1516–2138 mg/kg	Moderately hazardous
3	Aldrin $C_{12}H_8Cl_6$	Insecticide	Moderate Persistence Half life: 4–7 years	Rat : 39 to 60 mg/kg	Highly hazardous
4	Benzene hexachloride (BHC). C6H6Cl6	Acaricide Insecticide Rodenticide	High Persistence Half life: 3 – 6 years	Rat : 10,000 mg/kg	Acute hazard is unlikely
5	Chlordane $C_{10}H_6Cl_8$	Insecticide	High Persistence Half life: 10 years	Rat : 200 to 700 mg/kg	Moderately hazardous
6	Chloropropylate $C_{17}H_{16}Cl_2O_3$	Insecticide Acaricide	Moderate Persistence Half life: 50 days	Rat : 5000 mg/kg	Acute hazard is unlikely
7	Dichloro diphenyl dichloroethane (DDE).	Insecticide	High Persistence Half life: 10 years	Rat : 800–1240 mg/kg	Slightly hazardous
8	Dichlorodiphenyltrichloroethane (DDT). $C_{14}H_9Cl_5$	Acaricide Insecticide	High Persistence Half life: 2–15 years	Rat : 113–130 mg/kg	Moderately hazardous
9	Dicofol $C_{14}H_9Cl_5O$	Acaricide	Moderate persistence Half life: 60 days	Rat : 684–1495 mg/kg	Moderately hazardous
10	Dieldrin $C_{12}H_8Cl_6O$	Insecticide	High Persistence Half life: 9 months	Rat : 46 mg/kg	Highly hazardous
11	Endosulfan $C_9H_6Cl_6O_3S$	Insecticide	Moderate Persistence Half life Alpha Isomer:35days Beta Isomer:150days	Rat : 18 to 220 mg/kg	Highly hazardous
12	Endrin $C_{12}H_8Cl_6O$	Avicide insecticide	Moderate Persistence Half life: 1Day to 12 Years	Rat : 3 mg/kg	Highly hazardous
13	Heptachlor $C_{10}H_5Cl_7$	Insecticide	High Persistence Half life: 2 years	Rat : 40– 220 mg/kg	Highly – Moderately hazardous
14	Isobenzan $C_9H_4Cl_8O$	Insecticide	High Persistence Half life: 2.8 years	Rat : 4.8 mg/kg	Highly hazardous
15	Isodrin $C_{12}H_8Cl_6$	Insecticide	High Persistence Half life: 0.5–6 years	Rat : 8.8 mg/kg	Highly hazardous
16	Lindane $C_6H_6Cl_6$	Acaricide Insecticide Rodenticide	High Persistence Half life: 15 months	Rat : 88 – 270 mg/kg	Moderately hazardous
17	Methoxychlor $C_{16}H_{15}Cl_3O2$	Insecticide	High Persistence Half life:< 120 Days	Rat : 5000–6000 mg/kg	Acute hazard is unlikely
18	Mirex C10Cl12	Insecticide	High Persistence Half life: 10 years	Rat : 600–740 mg/kg	Acute hazard is unlikely
19	Pentachlorophenol C6Cl5OH	Fungicide Herbicide Insecticide	Moderate Persistence Half life: 45 days	Rat : 27–211 mg/kg	Highly – Moderately hazardous
20	Toxaphene (Camphechlor). C10H10Cl8	Acaricide Insecticide	Moderate Persistence Half life 11 Years	Rat : 80–293 mg/kg	Slightly hazardous

quality measurements in the Upper Citarum Watershed, a number of organochlorine pesticide concentrations was identified (Lindan, Heptaklor, Dieldrin, Endrin, DDT, Aldrin and Endosulfan) with 1 sample exceeded the quality standard, namely the Endrin parameter which the safe level 0,1 mg/m3. Detected pollutants were semi volatile and consist of 2 phases, namely the particulate phase (0-0,119 mg/m3) and the gas phase 0-0,183 mg/m3). Air pollution caused by organochlorine pesticides in the Upper Citarum watershed was an air pollution originating from the area near the sampling location, which was not continuous because the source is from farmers spraying the organochlorine only around 7 in the morning to 12 at noon. And also, every farmer has different schedule of spraying, it usually happened once in 5 to 7 days. Spreading of organochlorines on air is affected by meteorological factors such as wind direction, windspeed, air pressure, humidity, temperature, and also particle size of spray drift (10).

Organochlorine was also found in poultry, in line with Mahacitra's (2011) study which uses a mixture of breast meat, wing meat, and thigh meat of chicken (11). Chicken obtained from 16 slaughter house, samples 100 of Lohman strain broiler chickens for 42 days with an average weight of 1-1,5 kg. In view of the after effects of the investigation it very well may be presumed that the administration of S. molesta Rawa Pening weed as a mixture of feed up to the level of 18% caused a significant increase in the total organochlorine content in broiler chicken meat by 0.05 ppm to 0.18 ppm for each increase in *S. molesta* levels. Meanwhile, organochlorine profile in broiler chicken meat in all treatments was declared undetected because the analysis results were still below the detection threshold (11).

The effect of organochlorine residue in watershed is also affecting aquatic animals in that area, for example tilapia because of the residue's persistence.

According to Putri's research on the effect of endosulfan organochlorine insecticide residue to hatchability of tilapia (Oreochromis niloticus) eggs in Padang, Indonesia (12). Tilapia eggs had given the treatment of organochlorine endosulfan at concentrations of 0.00395%, 0.00400%, 0.00405%, 0.00410% and 0.00415% within 96 hours. The results were endosulfan organochlorine insecticide residue significantly affected the hatchability of tilapia (*Oreochromis niloticus*) eggs, but did not significantly affect larval abnormalities. The hatchability of tilapia eggs (*Oreochromis niloticus*) and the highest larval abnormalities were found in the control group. While the lowest eggs hatchability and the larvae abnormalities were found in the treatment with endosulfan concentration of 0.00415% (12).

In addition, research from Suryono et al (2016) showed that benthos macro animals found in Mlonggo waters can be said to be affected by pesticides in both sediment and water (13). Sediment and sea water sampling carried out 'stratified random' at 3 stations determined with a distance of 0, 500 and 1000 meters from the middle of estuary towards the sea with bottom sampler grab and Nansen bottle. The use of pesticides in farmers was not yet based on the principle of IPM (Integrated Pest Management). In the IPM conception, the use of pesticides is the last alternative if other control methods do not provide satisfactory results. The application of pesticides in general does not follow the rules of the five right namely on time, on target, dosage, process, and type, so that the potential for residues and biomagnification in agricultural land (13, 14).

The use of pesticides to eradicate pests and plant diseases in order to increase agricultural production must be controlled. The use of pesticides must be based on information about the threshold of economic damage, knowledge of biology and knowledge of the ecology of the target organism and not the target to prevent or reduce the adverse effects that may be caused (15).

Organochlorine was also detected in urban areas. Organochlorine detection indicate that the source of pollution came from past usage rather than from current usage. Shoiful's (2015) study took location in Jabodetabek (Jakarta-Bogor-Depok-Tangerang-Bekasi), which is an area that is most dense its inhabitants in Indonesia (16). In the Bogor area, an upstream area is a plantation area, so pesticides and fertilizers are a major source of pollutants. While in the Jakarta area or downstream area is an urban area and also industry, where the source of the main pollution is from domestic and also industry. The water sample was taken in five area. This study detected Alpha-Hexachlorocyclohexane (α-HCH) (0,13-0,25ng/L), Lindane (α-HCH) (0.083-0.82 ng/L), Hexachlorobenzene (HCB) (0.55-688.28ng/L), Dieldrin (0.18-0.29ng/L), cis-chlordane (0.12-0.74ng/L), trans-chlordane (0.14-0.89ng/L), cis-nonachlor (0.16ng/L), trans-nonachlor (0.48ng/L), and Dichlorodiphenyldichloroethylene (p,p'-DDE) (0.21ng/L). An interesting result was the detection of HCB in high concentrations (688,28ng/L) which was likely an unintentional side product from industrial processes (16).

In addition, Islam's (2018) uncovered that the broad utilization of Organochlorine in rural and urban applications must be respected as significant natural presentation route to people (17). In Bangladesh, data on organochlorine, for example, DDTs was figuratively speaking open in a limited number of appropriated considers. For this reason, it is very difficult to understand the current contamination scenario and what will happen in the future. Effective management strategies and punitive regulations should be implemented to control the usage of POPs so that environmental and human exposure to them is reduced to safe levels (17).

Another evidence was found in India. Anand (2020) States that organochlorine Pesticides, particularly DDT and Hexachlorocyclohexane (HCH), are ubiquitous contaminants in both urban areas (Kolkata) and semi-urban areas (Nadia) in India (18). The Estimated Daily Intake of HCH and DDT in human milk samples collected in the urban areas was higher than the Tolerable Daily Intake. Also, HCH and DDT exposure have increased considerably in urban areas than the previous reports of a decade before. The presence of HCH and DDT indicates the need to assess the effectiveness of the existing regulations in the Stockholm Convention and may require specific targeting of urban areas (18).

In South America, human activities have extended the availability of a grouping of metals, organochlorine, oxygen-devouring impurities and solid wastes in maritime circumstances. This has headed to debasement inside the water quality, coming about difficulties for human occupations and risks to biodiversity. If these situations continue without control and regardless of climate variability, it is probable that some South American systems will witness areas of total ecosystem loss, long and lasting periods of contamination and poor quality of natural resources for humans for a few centuries (19).

Outside of Asia, based on Porter's et al (2018) research on accumulation of organochlorine pesticides in reef organisms from marginal coral reefs in South Africa detected Markedly high levels of a range of OCP residues. The location of the study was five sampling sites, reefs, coastal lakes and wetlands within the iSimangaliso Wetland Park World Heritage Site on the north-east coast of South Africa Three species of corals were used as a sample which were Theonella swinhoei, Sarcophyton glaucum and Sinularia gravis. Organochlorine pesticides residue were detected within tissues, with total concentrations ranging from 450–1500 ng/g wet weight for Theonella swinhoei, 1100–

3000 ng/g wet weight for Sinularia gravis and 460 to 1200 ng/g wet weight for Sarcophyton glaucum (20).

Other examples outside of Asia, Nuapia's (2016) research in South Africa show that residues of organochlorine pesticides are present in the food sold in Johannesburg and Kinshasa open markets (i.e., Beef, Fish, Cabbage, and Beans) (21). Most of the organochlorine pesticide compounds exceeded their prescribed limit set by different international agencies. These residues have originated from agricultural past and present activities. These residues might reach the top of the food chain by bioaccumulation. The residue in food may pose serious public health problems (21).

The impact of organochlorine pesticides on wildlife in southern Africa is of growing concern. The results of Buah-Kwofie (2018) study in iSimangaliso Wetland Park (22). It shows the potential of Nile crocodiles to accumulate substantial quantities of organochlorine contaminants within their fat tissue, with potential long-term reproductive impacts on local populations. While these compounds are not used within iSimangaliso Wetland Park's boundaries, they may present serious consequences for wildlife in the region and highlight the need to understand the risks associated with organochlorine Pesticides exposure, particularly in apex predators such as the Nile crocodile (22).

In Argentina, Martinez-Lopez (2015) Research found that organochlorine concentrations found in the three study species (Turkey vulture, American black vulture, and Southern Crested caracaras) (23). This evidence probably indicates the impact of agriculture and other possible uses of organochlorine in the area. This evidence suggests that organochlorine concentrations in feathers of scavenger species from the Argentinean Patagonia reflect organochlorine in the environment (23).

Organochlorine exposure and health risks

Persistent organic pollutants (Organochlorine) are heterogeneous mixes of both both natural and anthropogenic origin with highly persistent and bioaccumulative properties. They cause a run of troublesome effects on human prosperity and the climate around the globe. Pesticide exposure, to be precise the organochlorine group or the insecticide DDT, works to inhibit the synthesis of testosterone so that dihydrotestosterone is inhibited during fetal life. If dihydrotestosterone synthesis is inhibited, DHT cannot modulate differentiation into the prostate, penis, and scrotum, thereby affecting hypospadias (24, 25).

There was a significant relationship between the actions in using pesticides and the pesticide poisoning level in Kembang Kuning Village, Cepogo. This study showed that there was a positive correlation between the action of pesticide uses and the level of pesticide poisoning with moderate correlation strength. In addition, there was a significant difference between plasma GSH levels in the inorganic farmer group (lower) and the organic farmer group (higher) (26).

The greater the intake of organochlorine received by farmers, the more likely it is to increase TSH levels in the blood. Increased levels of TSH are an indicator of hypothyroid disease, so it can be concluded that exposure to organochlorine can cause chronic impacts in the form of hypothyroidism in spraying farmers (27).

Exposure to pesticides among workers in the agricultural sector caused various respiratory problems and impaired lung function. In lung function, pesticides are proven to reduce lung function such as Peak Expiratory Flow Rate (PEFR), Forced Vital Capacity (FVC), Forced Expiratory Flow (FEF) 25% -75%, Forced Expiratory Volume 1 (FEV1) and FEV1 / FVC ratio (28).

Further, a portion of the organochlorine go about as endocrine disrupting chemical (EDC). Endocrine disrupting chemicals (EDCs) comprise a group of chemical compounds that have been examined extensively due to the potential harmful effects in the health of human populations. Based on Pirard's et al (2018) research on levels of organochlorine pesticides in a Belgian adult populations with 252 samples, detected that several organochlorine pesticides namely 4,4'-dichlorodiphenyldichloroethylene (4,4'-DDE), beta-hexachlorohexane and hexachlorobenzene were positively detected respectively in 48%, 49% and 37% of the serum samples(29).

The reproductive issues and infections include clutters within the working of the male and female regenerative frameworks. These incorporate birth absconds, preterm birth, developmental disorders, low birth weight, impotence, reduced fertility and menstrual disorders. The regenerative frameworks have been influenced by organochlorine defilement. A few thoughts about conducting demonstrated infamous impacts of organochlorine on human creatures. Organochlorine presentation influenced diminish sperm quality and amount. Other than, these poisons modified sex proportion and early adolescence (30).

Diabetes is additionally related with bioaccumulation of organochlorine in human creatures. The chlorinated pesticides and polychlorinated biphenyls are connected to the improvement of metabolic disorder (affront resistance). The relationship of these organochlorine and sort 2 diabetes mellitus was created by calculated relapse. The creators concluded solid relationships between the examined organochlorine and diabetes (30).

Writing with respect to relationship between the other chemical classes estimated in this investigation and

diabetes among pregnant populaces is scant. Studies had analysed possible relationship among diabetes and introduction to organochlorine pesticides, Per- and polyfluoroalkyl substances (PFAS), and PCBs have to a great extent focused on self-reported diabetes or type 2 diabetes (31).

Discoveries from this prospective cohort of multiracial/ethnic pregnant ladies recommended that natural presentation to vigorously chlorinated PCBs, Polybrominated diphenyl ethers (PBDEs) and some PFAS were fundamentally and emphatically connected with Gestational Diabetes Mellitus hazard, despite the fact that discoveries changed by qualities, for example, ladies' family background of Type 2 Diabetes and body adiposity status. Of particular note, these associations were observed among pregnant women with low-risk antenatal profiles and at concentrations the US general population was exposed to during the same period (32).

Men may also have the same problem with their reproductive health. Madrigal (2020) found that exposure to organochlorine pesticides, particularly HCB and DDT, may be positively associated with estradiol levels among adult males in the United States (33). These findings may contribute insights into the mechanism and pathology of chronic diseases known or suspected to be associated with organochlorine pesticide exposure if substantiated (33).

Management of Organochlorine Exposure

The interactive relationship between humans and their behavior with environmental components that have potential disease hazards is also known as the disease process. The process of occurrence of a disease can also be referred to as disease pathogenesis. Each disease has its own pathogenesis. By studying the pathogenesis of disease, we can determine at which point or at which point we can take prevention. Current study used a modified model, as shown in Figure 2 below.

Bug sprays or chemical pesticides that come from manufactured chemicals have been considered a savior since they have contributed altogether to extend agrarian generation which at the same time increment farmers' income. Due to these, it is progressively felt that the utilize of pesticides has had unfavorable side impacts for the conservation of rural biological systems to bolster maintainable rural improvement (34).

Pesticides are generally contact poisons, therefore the use of personal protective equipment for farmers when spraying is very important. This is to reduce direct contact with pesticides. Inhalation and skin exposure are the main routes of pesticide exposure. Inhalation exposure usually occurs when using pesticides without wearing a mask. While the incidence of pesticide contamination through the skin is the most common contamination, although not all of them end in acute poisoning. Farmers who do not use PPE fully have a greater risk of pesticide poisoning when compared to farmers who use PPE in full (35).

One way to avoid exposure through the skin separated from Individual Defensive Hardware is to urge utilized to wash hands. The propensity of washing hands with cleanser could be a degree of great sanitation since cleaning the hands and fingers with water and cleanser breaks the chain of microbial transmission. Washing hands with soap is well known as an exertion to anticipate malady. This can be since hands are regularly the operator by which organisms and pathogens are exchanged from one individual to another either through coordinate or backhanded contact (36).

In addition, storing pesticides properly, reducing working tenure, not working on the same land when other farmers spray, given the long-term dangers of pesticides, especially their effects on health and the need to monitor the occurrence of intoxication (poisoning) in agricultural activities to raise awareness among farmers about the dangers of pesticides and how to protect themselves from exposure to pesticides, so that they do not cause long-term negative impacts. There was a relationship between personal hygiene behaviour and the occurrence of pesticide poisoning among farmers in Srikaton Village, Pekewu Regency (1).

There was a relationship between the method of spraying and the level of pesticide harming among ranchers in Kembang Kuning Village in 2016 with a value of $p = 0.026$ (36). Pesticide exposure can be reduced by being aware of the use of PPE, spraying it in the morning, and applying a direction that is not in the opposite direction of the wind (37).

There was a relationship between the frequency of spraying, the level of farmer knowledge, the length of time the farmers work, and the length of time they work with the incidence of pesticide poisoning in Jati Village, Sawangan District. Meanwhile, the results showed that almost all respondents did not use personal protective equipment completely, so they were more at risk of experiencing pesticide poisoning (38).

There was a relationship between how to store pesticides ($p = 0.016$); how to mix pesticides ($p = 0.010$); and how to wash spray tools ($p = 0.026$) with the level of pesticide harming in Banjarrejo. Farmers were ought to reduce pesticide exposure by using PPE completely and correctly, storing pesticides properly, reducing working time, not working on the same land when the other farmers are spraying (39,40).

The use of physical filters with various media compositions can reduce the Chlorine content in water. Treatment with activated carbon, silica sand, and zeolite were the most effective treatment in reducing the

content of organochlorine pesticides with a decrease of 82.86% (41).

One of the examples of the nation that controls the organochlorine waste is in Mexico. Mexico is committed to implementing the National Implementation Plan when signed the Stockholm Convention. This plan works on two fronts: the generation of information regarding the levels of organochlorine pesticides (OCP) in soils in high-risk communities in Mexico by their presence in the environment, which cause adverse effects in the human health, like the major agricultural zones in Sonora due to the historical and present use of OCP, and the implementation of programs of risk communication (42).

The Department of Agriculture and the Ministry of Health conduct counselling to increase their understanding about pesticides danger and personal protective equipment usage through lecture methods, brochures, leaflets. Monitor the health of farmers, especially be aware of the symptoms and signs of pesticide poisoning. Farmers must use personal protective equipment when using pesticides so that accidents and health problems can be avoided (43).

Research from Phuspa on farmers in Jurug Village stated that farmers need a health approach and program related to agricultural activities. One of them is by establishing an Occupational Health Effort (OHE). OHE is a Community Based Health Effort (CBHE). that provides primary health care for the working community, especially the informal sector. OHE was formed to accommodate a series of planned, regular and sustainable occupational health care activities organized by the working community themselves (44).

CONCLUSION

Organochlorine are environmental pollutants from the use of fast pesticides in agriculture which do not dissolve quickly, also called Persistent Organic Pollutants. Organochlorine pollute soil, air and water, and accumulate in terrestrial and aquatic animals. Organochlorine cause health effects when they enter the human body through absorption, inhalation and intake of food. Organochlorine can cause disorders of the endocrine system, heart, cancer, reproductive disorders, and diabetes. Organochlorine exposure control to farmers can be minimized by several methods such as using complete Personal Protective Equipment, spraying in the wind direction, storing pesticides in a closed place, or farmers can turn into organic farming. In addition, the agriculture and health office can carry out promotion and education of pesticides dangers and the use of Personal Protective Equipment. Counselling is needed to increase knowledge through lecture methods, brochures, or leaflets.

REFERENCES

1. Octiara DL. Hubungan Perilaku Personal Hygiene Dengan Keracunan Pestisida Melalui Pengukuran Kadar Cholinesterase Dalam Darah Pada Petani di Pekon Srikaton Kecamatan Adiluwih Kabupaten Pringsewu Tahun 2017. 2018.
2. Wirasuta IMAG, Niruri R. Toksikologi Umum.; 2006.
3. Singh Z, Kaur J, Kaur R, Hundal SS. Toxic Effects of Organochlorine Pesticides: A Review. Am J Biosci. 2016;4(March).:11-18. doi:10.11648/j.ajbio.s.2016040301.13
4. Deziel NC, Warren JL, Huang H, Zhou H, Sjodin A, Zhang Y. Exposure to polychlorinated biphenyls and organochlorine pesticides and thyroid cancer in connecticut women. Environmental Research. 2021 Jan;192:110333. https://doi.org/10.1016/j.envres.2020.110333
5. Kurniadi D, Maywita E. Faktor-Faktor yang Berhubungan Dengan Keluhan Kesehatan Akibat Paparan Pestida pada Petani Hortikultura di Desa Siulak Deras Mudik Kabupaten Kerinci. Menara Ilmu. 2018;XII(80).:13-18.
6. Die Q, Nie Z, Yang Y, Tang Z, Huang Q. Persistent Organic Pollutant Waste in China: A Review of Past Experiences and Future Challenges. J Mater Cycles Waste Manag. 2015;17(3).:434-441. doi:10.1007/s10163-014-0282-6
7. Han D, Currell MJ. Persistent Organic Pollutants in China's Surface Water Systems. Sci Total Environ. 2017;580:602-625. doi:10.1016/j.scitotenv.2016.12.007
8. Purnama SG. Dasar-Dasar Kesehatan Lingkungan. Universitas Udayana; 2017.
9. Mulyadi, Indratin, Harsanti ES. Senyawa Organichlorine Aldrin dan Endosulfan pada Air Sungai DAS Citarum Hulu , Jawa Barat. Semin Nas Pendidik Biol dan Saintek II. 2011.
10. Prananditya R, Oginawati K. Identifikasi dan Distribusi Pencemar Pestisida Organoklorin pada Udara Ambien di Daerah Pertanian Hulu Sungai Citarum. Jurnal Teknik Lingkungan. 2016;22(1).:73-82.
11. Mahacitra RA, Sukamto B, Dwiloka B. Kandungan Pestisida Organoklorin Daging Ayam Roiler yang Diberi Gulma Salvinia Molesta Rawa Pening Sebagai Campuran Pakan (Organochlorine Content Of Broiler Administered With S. molesta Containing Feed Of Rawa Pening's Weed).. Anim Agric J. 2014;3(2).:179-188. http://ejournal-s1.undip.ac.id/index.php/aaj.
12. Putri AC, Razak A, Sumarmin R. Pengaruh Insektisida Organoklorin Endosulfan Terhadap Daya Tetas Telur Ikan Nila (Oreochromis Niloticus). 2016.:43-52.
13. Suryono CA, Suwartimah K, Rochaddi B, Sarjito S. Kontaminasi Pestisida Organoklorin pada

Sedimen dan Air Laut dan Pengaruhnya Terhadap Kelimpahan Makrozoobenthos di Pesisir Jepara. J Kelaut Trop. 2016;18(3):139. doi:10.14710/jkt.v18i3.526
14. Kurnia A, Nurhasan. Identifikasi Potensi Pencemaran Residu Pestisida di Lahan Pertanian Jawa Tengah. 2013. doi:10.1017/CBO9781107415324.004
15. Mulyono D. Pencemaran Pestisida dalam Budidaya Pertanian dan Upaya Pengendaliannya. J Rekayasa Lingkung. 2009;5(3):219-224.
16. Shoiful A, Nugroho R, Fujita H, Honda K. Pestisida Organoklorin dalam Air dari Daerah Jabodetabek: Studi Pada Daerah Padat Penduduk. 2015;8(2).
17. Islam R, Kumar S, Karmoker J, et al. Bioaccumulation and adverse effects of persistent organic pollutants (Organichlorine). on ecosystems and human exposure: A review study on Bangladesh perspectives. Environ Technol Innov. 2018;12(April):115-131. doi:10.1016/j.eti.2018.08.002
18. Anand N, Chakraborty P, Ray S. Human exposure to organochlorine, pyrethroid and neonicotinoid pesticides: Comparison between urban and semi-urban regions of India. Environmental Pollution. 2020 Dec 1;270:116156. https://doi.org/10.1016/j.envpol.2020.116156
19. Barletta M, Lima ARA, Costa MF. Distribution, Sources And Consequences of Nutrients, Persistent Organic Pollutants, Metals and Microplastics in South American Estuaries. Sci Total Environ. 2019;651:1199-1218. doi:10.1016/j.scitotenv.2018.09.276
20. Porter SN, Humphries MS, Buah-Kwofie A, Schleyer MH. Accumulation of organochlorine pesticides in reef organisms from marginal coral reefs in South Africa and links with coastal groundwater. Marine pollution bulletin. 2018 Dec 1;137:295-305. https://doi.org/10.1016/j.marpolbul.2018.10.028
21. Nuapia Y, Chimuka L, Cukrowska E. Assessment of organochlorine pesticide residues in raw food samples from open markets in two African cities. Chemosphere. 2016 Dec 1;164:480-7. http://dx.doi.org/10.1016/j.chemosphere.2016.08.055
22. Buah-Kwofie A, Humphries MS, Combrink X, Myburgh JG. Accumulation of organochlorine pesticides in fat tissue of wild Nile crocodiles (Crocodylus niloticus) from iSimangaliso Wetland Park, South Africa. Chemosphere. 2018 Mar 1;195:463-71. https://doi.org/10.1016/j.chemosphere.2017.12.084
23. Martнnez-Lypez E, Espнn S, Barbar F, Lambertucci SA, Gymez-Ramнrez P, Garcна-Fernбndez AJ. Contaminants in the southern tip of South America: analysis of organochlorine compounds in feathers of avian scavengers from Argentinean Patagonia. Ecotoxicology and environmental safety. 2015 May 1;115:83-92. http://dx.doi.org/10.1016/j.ecoenv.2015.02.011
24. Mouly TA, Toms LML. Breast Cancer and Persistent Organic Pollutants (excluding DDT): A Systematic Literature Review. Environ Sci Pollut Res. 2016;23(22):22385-22407. doi:10.1007/s11356-016-7577-1
25. Annida S, Nadya M, Setiawan G, et al. Paparan Pestisida dan Kemungkinan Dampaknya pada Kejadian Hipospadia. Medula. 2017;7(5):199-204.
26. Mahyuni EL. Terhadap Keluhan Kesehatan pada Petani di Kecamatan Berastagi Kabupaten Karo 2014. 2015;9(1):79-89.
27. Maulidiniawati N, Oginawati K. Terhadap Perubahan Kadar Thyroid Stimulating Hormone (TSH). Petani Penyemprot di Kecamatan Kertasari, Kabupaten Bandung. Jurnal Teknik lingkungan. 2016;22(2):73-81.
28. Syakir MA, Mayasari D. Gangguan Fungsi Paru Akibat Pajanan Pestisida pada Pekerja di Sektor Agrikultur. J Agromedicine Unila. 2018;5(2):596-600.
29. Pirard C, Compere S, Firquet K, Charlier C. The current environmental levels of endocrine disruptors (mercury, cadmium, organochlorine pesticides and PCBs) in a Belgian adult population and their predictors of exposure. International journal of hygiene and environmental health. 2018 Mar 1;221(2):211-22. https://doi.org/10.1016/j.ijheh.2017.10.010
30. Alharbi OML, Basheer AA, Khattab RA, Ali I. Health and environmental effects of persistent organic pollutants. J Mol Liq. 2018;263:442-453. doi:10.1016/j.molliq.2018.05.029
31. Shapiro GD, Dodds L, Arbuckle TE, et al. Exposure to Organophosphorus and Organochlorine Pesticides, Perfluoroalkyl Substances, and Polychlorinated Biphenyls in Pregnancy and the Association with Impaired Glucose Tolerance and Gestational Diabetes Mellitus: The MIREC Study. Environ Res. 2016;147:71-81. doi:10.1016/j.envres.2016.01.040
32. Rahman ML, Zhang C, Smarr MM, et al. Persistent Organic Pollutants and Gestational Diabetes: A Multi-Center Prospective Cohort Study of Healthy US Women. Environ Int. 2019;124(July 2018):249-258. doi:10.1016/j.envint.2019.01.027
33. Madrigal JM, Sargis RM, Persky V, Turyk ME. Multiple organochlorine pesticide exposures and measures of sex steroid hormones in adult males: Cross-sectional findings from the 1999–2004 National Health and Nutrition Examination Survey. International Journal of Hygiene and Environmental Health. 2020 Sep 28;231:113609. https://doi.org/10.1016/j.ijheh.2020.113609
34. Harahap FS, et al. Penyuluhan Penggunaan Pestisida Alami bagi Kelompok Tani di Desa Hutanamale Kec. Puncak Sorik Marapi Mandailing Natal. Martabe: Jurnal Pengabdian Kepada Masyarakat. 2018 Nov 7;1(3):142-8.
35. Mukadar LA, Sulistiyani, Joko T. Faktor Risiko Pajanan Pestisida terhadap Kejadian Keracunan

Pestisida pada Petani Padi di Jawa Tengah (Studi Literatur Hasil-Hasil Penelitian di FKM UNDIP). Jurnal Kesehatan Masyarakat. 2018;6:205-213.
36. Ahmadi LS, Azizah R, Oktarizal H. Association Between Toilet Availability and Handwashing Habits and the Incidence of Stunting in Young Children in Tanjung Pinang City, Indonesia. MJMHS. 2020;16(2):215-218.
37. Purwandari R, Musoddaq MA, Fuada N, et al. Profil Petani Sayur di Kabupaten Karanganyar Berdasarkan Kadar Kholinesterase dan Fungsi Tiroidnya. Media Litbang Kesehatan. 2017;27(4):237-246.
38. Ipmawati PA, Setiani O, Darundiati YH. Identifikasi dan Distribusi Pencemar Pestisida Organoklorin Pada Udara Ambien di Daerah Pertanian Hulu Sungai Citarum. Jurnal Teknik Lingkungan. 2016;4(1):73-82.
39. Putri MS. Hubungan Cara Penanganan Pestisida Dengan Tingkat Keracunan Pestisida pada Petani di Dusun Banjarrejo Desa Kembang Kuning Kecamatan Cepogo Kabupaten Boyolali. 2016.
40. Istianah, Yuniastuti A. Hubungan Masa Kerja, Lama Menyemprot, Jenis Pestisida, Penggunaan APD dan Pengelolaan Pestisida Dengan Kejadian Keracunan Pada Petani di Brebes. Public Heal Perspect J. 2018;2(2):117-123.
41. Rasiska S, Pratama AB, Widiantini F. Pengujian Filter Fisik (Slow Sand Filter). Untuk Menurunkan Kadar Pestisida Golongan Organoklorin. Solirens. 2017;15(1):7-13.
42. Valenzuela A, Gutiйrrez L, Camarena B, Silveira I, Garcна J, Meza M, Aldana L, Bermьdez C, Grajeda P, Robles R, Leal S. Levels of organochlorine pesticides in soils of the major agricultural zones in Sonora, Mexico and the implementation of a communication strategy for the risk exposure prevention. Toxicology Letters. 2016(259):S223. http://dx.doi.org/10.1016/j.toxlet.2016.07.537
43. Yuliyanah W, Meikawati W. Pendidikan dan Sikap Dengan Praktik Penggunaan Alat Pelindung Diri (APD). Pada Petani Bawang Merah Related Knowledge of Hazards of Pesticides , Education and Attitude to Practice the Use Protective Equipment (PPE). the Onion Farmer. J Kesehat Masyarakat Indonesia. 2015;10(2):81-89.
44. Phuspa SM, Rosanti E. Penyuluhan Mengenai Penggunaan Pestisida yang Baik dan Benar di Desa Jurug Kecamatan Sooko Kabupaten Ponorogo. International Journal of Community Service Learning. 2017 Oct 24;1(2):95-100.