

Pesticide Exposure and Human Health: A Review

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Abstract

This study was conducted at Department of Zoology, University of Gujrat, Pakistan during 2014-2015. The data for the last two decades regarding pesticide exposure and human health was compiled through a thorough review of thirty three research articles published in various journals of international repute. The way of pesticide exposure and their health outcomes, including the neurological, fetal growth, birth and cancerous outcome. Several pesticides are effect as neurotoxins and cause neuronal disorder and degenerative diseases, some effect fetal growth and cause congenital anomalies and other are carcinogenic for human. The data analysis of international researcher revealed that due to extensive use of pesticide increase their exposure to human which result greatly increase the risk of cancer, neural and birth defects.

Keywords: Pesticide; Exposure; Neurotoxicity; Fetal growth; Carcinogenicity

Introduction

In modern agriculture, use of chemicals increase productivity of crops fertilizer used to increase the growth and pesticide used to protect against pest, due to increase in concentration of these chemical in environment, millions of cases of pesticide poisoning recorded each year [1]. Pesticide include all substances which are used to control insects, fungi and weeds and these substances are classified on the bases of organism which is target by these pesticides, like insecticides, herbicides, fungicides, or fumigants. Some are further sub-classified on the bases of their active agents like insecticides are classified as organophosphates (OPs), organochlorines, carbamates, and pyrethroids [2].

Pesticides due to its harmful effects is controversial to use, Rachel Carson publication "silent spring" elaborate harmful effects of DDT 1962, and lead to banned on agricultural use of that chemical. In the same way other harmful pesticides were banned in flowing years by EPA (Environmental Protection Agency), EDB (ethylene dibromide) banned in 1983 due to its effects as carcinogenic and mutant. Pesticide residues remain for very long time and cause serious toxic effects, and disturb ecological balance by killing unharmed insects, animals and fishes, and also modified their genetics by creating resistance in them (pest) against these pesticides [3].

According to EWG (Environmental Working Group), by analysis of 47 fruits and vegetable they found that 12 foods contain highest concentration of pesticide, and these foods are include in a group called "dirty dozen" (Peach, Apple, Bell pepper, Celery, Nectarine, Strawberries, Cherries, Kale, Lettuce, Grapes, Carrot, Pear) and have very adverse effects on human health especially during period of fetal growth and young age. The same effects of pesticide residue is elaborated by OTA Organic Trade Association [4].

Pesticide and Neurotoxicity

Many pesticides including organophosphates, organochlorine and carbamates affect central and peripheral nervous system by their toxic effects. Pesticides shown acute or chronic and long-term or short-term effects on nervous system by the high or low-level exposure during adult, childhood or in utero exposure, and it lead to very chronic nervous disorders like Parkinson disease [5].

Alzheimer disease

Dementia is decrease in brain capacity, in recent years dementia is increased. One concept about current increased is due to increase in pesticide exposure, may be pesticide increased the dementia pathogenesis. But other research elaborates that pesticide affect neuron function at molecular level by distrusting microtubules and hyperphosphorylation which lead to Alzheimer diseases [6]. Organophosphate and organochlorine pesticides are found to effect acetylcholineestrase regulation at synaptic junction in nervous system and may lead to the Alzheimer disease especially in exposed person during their late life [7]. Another research shows some herbicides (rotenone and paraquat) will disrupt the bioenergetical activities of mitochondria, oxygen metabolism and redox function which lead to Alzheimer disease [8].

Parkinson disease

Parkinson disease is generated when dopamine is not produce by the substantia nigra neuron (dopaminergic) in brain, which lead toward lack of coordination, trembling and loss of muscles control. Research show that some pesticides like rotenone and paraguata will disrupt these dopaminergic neuron and inhibit the production of dopamine and Parkinson disease result [9]. It has found that pesticide exposure have some association with Parkinson disease, pesticide and it's metabolites effects mitochondria and modulate xenobiotic metabolism which lead to Parkinson disease [10]. In a separate research it is found that if rats are exposed to the rotenone then with the passage of time there is neurodegeneration is found in the peripheral nervous system, there is decrease in motor nerve conduction velocity especially in sciatic nerves. It is due to absence of dopamine and disruption of chemical synapse in peripheral nervous system [11].

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Organophosphate and neurotoxicity

By research it is found that insecticide (OP, carbamate, organochlorine) and fungicides act as neurotoxin and they will effect by modulating the synaptic neurotransmission. OPs are studied in detail, it is revealed that OPs have two type of effects, one occurred in minutes and show symptoms like headache, nausea, vomiting, pupillary constriction, dizziness and excessive sweating, tearing, and salivation and in case of severe effects other effects include muscle weakness and twitches, bronchospasm, and changes in heart rate and lead to convulsions and coma. OP exposure lead to a disorder called OP-induced delayed polyneuropathy, in which axonal region of neuron is effected badly and unable to produce the neuropathy target esterase enzyme, and also cause overstimulation of postsynaptic cholinergic receptors [12].

Chlorpyrifos poisoning

An organophosphate, chlorpyrifos extensively used pesticide in USA and it is estimated that 5,000 chlorpyrifos poisoning cases are reported each year and one-fourth of these patients show symptoms. Effected persons have chlorpyrifos metabolism in their urine in the form of 3, 5, 6-trichloro-2-pyridinol. If clinically examined then exposed person unable to discriminate from unexposed person, but symptoms include alteration in nerve conduction velocity, arm or hand tremor, vibrotactile sensitivity, modification in vision and smell sense, or in other words neurobehavioral skills, memory problems, emotional states, fatigue, and loss of muscle strength are also seen in effected persons [13].

Parathion poisoning

Parathion pesticide is metabolized into paraoxon (potent cholinesterase inhibitor) in human body by the help of cytochrome p-450 system, and this metabolite is hydrolyze by paraoxonase (PON), to protect body from toxic effects. It is found that, if PON have Arg/Arg polymorphism at 192 amino acids then it show its higher activities in serum. If persons who do not have amino acid polymorphism for high activity of PON gene will exposed then show any two or more symptoms like abdominal pain, nausea, rhinorrhea, dizziness, headache, somnolence, fatigue, gait disturbance, limb numbness, paresthesias, limb pain, or limb weakness, against parathion toxicity [14].

Pesticide and Fetal Growth

It is estimated that 54% women exposed to the pesticides during their pregnancy, and in them 45% exposed due to their bed room and 47% due to pesticide used elsewhere in the home. Women exposed to these pesticide through inhalation, ingestion or contact through skin. In small children exposure is more high and dangerous because they ingest dust which is contaminated and their breathing zone is closed to ground contain pesticide remains, they spend more time in home with large exposed body surface due to the fewer clothes. And the fetus and children have weak immune system which not able to detoxify pesticide, in case of their exposure may be directly or indirectly so they are more vulnerable [15].

Analysis of pesticide exposure in fetus

The estimation of pesticide exposure in fetus is estimated by the analysis of blood from umbilical cord and placenta, but it only shows the recently exposed and persistent pesticides [16]. In a different research by examining the samples taking from body parts, hairs, umbilical

cord blood and meconium of fetus, it is founded that meconium contain highest exposure to pesticide residue, and it contain almost all potential pesticide to which pregnant female exposed during their gestation period and majority of detected pesticide are used in houses include propoxur, pretilachlor, DDT, cyfluthrin and cypermethrin, blood and hairs not contain all pesticide to which mother exposed during pregnancy so it revealed that meconium is most sensitive part for pesticide exposure in infant [17].

Congenital anomalies due to pesticide exposure

In a study it is found that mother periconceptional pregnancy exposure to pesticide cause various congenital anomalies include orofacial clefts, neural tube defects, conotruncal defects, or limb anomalies, the mothers involve in use of pesticides for house hold gardening or live within 0.25 miles of agriculture agricultural area show high risk of these defects in their offspring [15]. Congenital malformation found attributable fraction of 54.4% [16].

Weight loss in fetus due to pesticide exposure

Pesticide exposure effects on growth of fetus especially cause weight loss, exposure to a mixture of pesticides show more adverse effect, in a study on 20 different pesticide (10 insecticides, 6 herbicides, 3 fungicides, and 1 repellent), it is found that 2 pesticide diethyltoluamide and vinclozolin present in greater frequency in blood of umbilical cord fetus and fetus weight is inversely proportional to the pesticide number and decreased by a mean of 37.1 g per detected pesticide. Mixture of pesticide and especially are two fungicide (Vinclozolin and acetochlor) show more harmful effect on fetus growth [18].

Carcinogenic effects of pesticide on fetus

Carcinogenic pesticides also affect the fetus during or after gestation, presence of pesticide in maternal cord blood demonstrated that they transfer from mother to fetus during gestation period, and it may increase the risk of cancer. If exposure is before conception it cause epigenetic alternation in gene expression like imprinting and methylation of DNA in parent's gametes. After conception exposure cause alternation of immunological and hormonal functions and also cause mutation in somatic cell of fetus which cause cancer especially brain cancer. Recent research elaborate that the risk of brain cancer is 2-fold high in those children whose mother exposed to agricultural pesticides especially herbicides during their job [19].

Endocrine disrupting of fetus and pesticide exposure

A research finding elaborate that 5 pesticides (bitertanol, propiconazole, cypermethrin, malathion and terbuthylazine) exposure have high level of endocrine disruption in human [20].

Environmental endocrine disrupting chemicals (EDCs) disrupt endocrine system of fetus if they exposed to them, in utero or early childhood. It causes growth and gestational age defects. Recent research show that overweight and obesity defect are due to the exposure pesticide extensively used in house and agricultural area and it is lead toward high risk of metabolic and cardiovascular diseases [21].

Some persistent pesticides like organochlorine, polychlorinated biphenyls, and polybrominated biphenyl ethers are lipophilic and bind with lipids of serum. Other pesticide azole (fungicide) and atrazine effect by increasing gestational length, vrilize female pups and disrupt the endocrine system of fetus, if it is during early phase of gestation then reproductive organ of fetus fail to develop [20].

Pesticide Exposure: Cancer

Several well-designed epidemiological studies gave solid evidence between pesticide exposures and incidence of cancer. Application of pesticide on commercial level and in houses will highly increase the risk of leukemia, clone thyroid, brain and several other type of cancer. Collaborated efforts at molecular biology, pesticide toxicology and epidemiological studies help us to understand the pesticide carcinogenicity [22]. Epidemiological studies show that many pesticides are carcinogenic like sulfallate, organochlorines and sulfates, while other pesticides lindane and chloradane are tumor causing [23].

Childhood leukemia and pesticide exposure

Leukemia is a cancer which causes abnormal production of white blood cells, several researches show that childhood leukemia risk increased threefold by the parental exposure of pesticides. According to Children's Cancer Study Group the basic reason of acute non-lymphoblastic leukemia is parental exposure to pesticides and those children which are regularly exposed to household pesticide have 3.5 times great chance of leukemia [24].

Pesticide also cause leukemia in children whose mothers are exposed to them during the period of their pregnancy, small children less than one year have seven time more chances of leukemia if they are exposed to permethrin pesticide. Leukemia also caused to those infants whose mothers are exposed during the period of pregnancy. Another insecticide permethrin used to protects pets from production of fleas and ticks and for killing of mosquitoes, this chemical may alter nervous system working in insects, in some researches it also concenter as a carcinogenic. Childhood leukemia is due to alteration in the DNA of infants. By research it is found that time from pregnancy to 11 month of nursing is very critical for children and if the exposed then they have two times more chances of leukemia [25].

Bladder and colon cancer

Aromatic amines used as pesticides are concenter as carcinogenic, and produce the bladder cancer in exposed persons [26]. Heterocyclic aromatic amines are found in adduct form in several cases of cancer [27]. One of heterocyclic aromatic amine imazethapyr is extensively used in agricultural land as herbicides. Research finding show that person who are exposed to that pesticides have 137% increased risk of bladder cancer [28]. In another research it is found that aromatic amines are used in crops for herbicide. By a research on aromatic amine one pesticide Imazethapyr is cause cancer. From total 20,646 applicator of that pesticide, 2,907 develop cancer. The cancer incidence depends upon the intensity and time of exposure. It is found that incidence of colon cancer is increased 78% in exposed persons. Through that research it is conclude that use of aromatic amine (imazethapyr and imidazolinone compound) is restricted to prevent bladder and colon cancer [29].

Thyroid cancer

Different chemical used including several pesticides like dioxins, phthalates, polybrominated diphenyl ethers (PBDEs), and other halogenated organochlorines can disturbed the normal thyroid function by the mean of effect hormones production, transportation and their metabolism. Some other chemical which have structural similarities with thyroid hormones and bind with their receptor sites, and destroy the thyroid gland [30]. In a research by Agricultural Health Study (AHS), which is conducted on the incidence of cancer especially thyroid cancer and exposure to a pesticide atrazine. The total 36,357

applicators use atrazine in their field and among them 3,146 are cancer patients and 29 are thyroid cancer patients. This research show some links between cancer and atrazine, but have little evidence of atrazine exposure and cancer, due to small number of applicator suffer by cancer [31].

Brain cancer

A research conducted for incidence of brain cancer on 767 patients, elaborate that 462 patients have glioma and 195 have meningioma both are different types of brain tumor. By further research on their disease through questionnaires' show that glioma have no link with pesticide exposure. But meningioma have a clear link with past pesticide exposure in females rather than males. The extensive use of herbicide increases greatly the risk of meningioma [32].

A study conducted on the pesticide exposure and childhood brain cancer show that, exposure before during or after pregnancy can greatly increase the brain cancer incidence. The risk of brain cancer is twofold increased in professional applicators by exposure to pesticide which is used to control the termites, then exposure to other pesticide. The risk of brain cancer is 30% by other pesticides, and 50% by termites controlling pesticides [33].

Conclusion

The pesticide are extensively used now a days in agricultural industries to increase the production by protecting the crops from potential threat, it is also used in homes and other public places to prevent the insect and other unwanted creature, with increase used of pesticide their exposure to human is also increase, due to their long life these chemical not degrade easily and found in area and on products on which they used and their presence and exposure to human cause a serious threat to human worldwide.

According to this research review we come to know that increasing cases of Alzheimer and Parkinson disease and other neural defects like memory loss, disruption of neural coordination in the body and due to that disruption, paralysis of other system of body like digestive and respiratory system, inhibition of production or over production of neurotransmitter, high response or no response of receptor site to these neurotransmitter is due to pesticide exposure or its exposure is increase that defects incidence.

Pesticide exposure is not only harmful for adults, but young children and fetus during their developmental period are more vulnerable to these pesticides due to their weak and inactive immune system. Exposure of fetus in mother womb case congenital anomalies, genetic diseases onset due to disruption of their DNA during development. Endocrine disruption side effect seen both during and after birth.

The most harmful effect of pesticides for both adults and children are due to their carcinogenic effects. This exposure cause childhood and adult leukemia, bladder, clone, thyroid and brain cancer in exposed persons.

According to our studies we found that pesticide are very harmful if they are exposed to human but we cannot completely banned or restricted their use due to economical and medical importance by killing vectors. But we reduce their exposure and effect, by using specific safety measures for farm worker and reduce exposure of children and pregnant females.

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