

Environmental Contamination and Reproductive Health

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Editorial

Rapid industrialization and urbanization have reduced the percentage of land under cultivation impelling nonchalant application of agrochemicals for boosting food production to support a continuously growing population especially in the developing world. Due to these activities a significant volume of pollutants introduces into the environment and aquatic ecosystems. In addition to natural activities anthropogenic activities like mining, agricultural operations, paint industry, combustion of fossil fuel, coal, oils and vehicular emissions are adding the contaminants to the environment. Contaminated air, food and water is the most common source of exposure and lead to disorders that occur in various organs of human body including the reproductive system, which is more sensitive than other organs. Environmental pollutants are affecting the human and animal health through multiple routes. Although, these contaminants are detected at very low concentrations in food and drinking water, which are raising concerns for human health, particularly in regard to reproductive health.

In current scenario, reproductive health deterioration is very common health problem in today's era. It is estimated that infertility affects up to 186 million people worldwide. World Health Organization (WHO) has recognized Infertility as a worldwide public health concern. According to the reports, the international prevalence of infertility ranges from 4% to 14% in different countries in humans and 33% to 45% in domestic animals with most of the disorders are with unknown etiology. Epidemiological and experimental animal studies indicated that the short and long-term exposure to following groups of environmental contaminants adversely affects the reproductive outcomes of human and animals. These environmental contaminants are:

Heavy metals and metalloids: Exposure to heavy metals and metalloids namely Lead (Pb), Cadmium (Cd), Mercury (Hg), Chromium (Cr), Arsenic (As), Copper (Cu) in air, food and water adversely affects the reproductive

health in mammals. Exposure impairs female reproductive health by affecting the reproductive system at all strata of regulation and functions, resulting in female infertility, menstrual disorders, spontaneous abortion, endometriosis, endometrial cancer, breast cancer, etc. Further, following low dose chronic exposure causes reduction in follicle-stimulating hormone, luteinizing hormone, follicular development and disturbance of the estrous cycle. Similarly, exposure in male human and animals lead to diminished sperm count, motility, sperm abnormalities and spermatogenesis in exposed population. Heavy metals can accumulate in blood, urine, hair follicles, embryos, testes, liver, kidneys, and other tissues, thus exerting adverse effects.

Organic solvents: Organic solvents like perchloroethylene, toluene and xylene are often associated with unfavorable reproductive outcomes. Occupational exposure to volatile organic solvents also interferes with male and female reproductive hormones in mammals. These solvents are commonly used in the dry cleaning, paint, glue, electronics, auto repair, and health care product industries. There is a higher risk of exposure for occupational populations that are linked with these industries. According to certain researches on women exposed to organic solvents, there is a considerable increase in the chance of infertility with daily or heavy exposure to organic solvents. By directly impacting testicular function, exposure to organic solvents may have a deleterious effect on male sex hormones, particularly in those who have been exposed for an extended period of time. Gasoline exposure has also been associated with increased risk of spontaneous abortion. It also causes disruption in ovarian functions, changed level of female sex hormones thus affects the fertility.

Pesticides: Pesticide exposure in humans can happen at workplace, at home, and in the surrounding environment. It has been found that women who had previously worked in the agricultural sector are more likely to become infertile. Following are the most commonly used pesticides having direct impact on reproductive system:

- **2,4-Dichlorophenoxy acetic acid (2,4-D):** One of the most commonly used pesticide 2,4-Dichlorophenoxy Acetic Acid (2,4-D) is linked to various reproductive disorders, abortion, infertility and alteration in reproductive hormone levels.
- **Organochlorine insecticides:** organochlorine like γ -hexachlorocyclohexane (HCH), 1,1-dichloro-2,2-bis ethylene (DDE), and 1-dichloro-2,2-bis (p-chlorophenyl) ethane (DDD), have been found to decrease sperm motility in concentration and duration dependent ways. It has also been found that high blood levels of organochlorine pesticides in combination with the wild type CYP17 A1A1 genotype could be regarded as a significant factor in "idiopathic" premature birth in women.
- **Organophosphorus Insecticides:** Organophosphate insecticides have a sensitive target in the chromatin of human sperm. Elevated exposure to pesticides containing organophosphates may lower the quantity and quality of sperm. It has also been reported that Male reproductive parameters are also affected by occupational exposure to organophosphate pesticides, including sperm chromatin damage, decreased semen quality, and changed reproductive hormone levels (increased Luteinizing Hormone (LH) and Follicular Stimulating Hormone (FSH) levels).

Endocrine disrupting chemicals (EDC): Exogenous chemicals are known as endocrine disrupting chemicals, those obstruct the processes of endogenous hormone synthesis, secretion, transport, metabolism and binding or removal. An EDC is any chemical that tampers with the regular function of hormones. Some metals, a variety of industrial

chemicals, synthetic and natural hormones, pesticides, fungicides, herbicides, pharmaceuticals, and even personal care products may include EDCs fall under this group. EDCs can occasionally bind to a natural hormone receptor; for instance, bisphenol A can bind to estrogen receptor. When an EDC binds to a receptor, it can both function as an agonist and activate the receptor in the same manner as a typical ligand or it can function as an antagonist and block the receptor's regular hormonal action. As an alternative, EDCs can interfere with gene activation, alter the amounts of hormone-binding proteins, or bypass the receptor to activate or deactivate second messenger systems or hormonal pathways. Common EDC are:

- **Diethylstilbestrol (DES):** One of the most commonly used EDC is diethylstilbestrol (DES) which causes various reproductive disorders including vaginal cancers, cervical incompetence etc.
- **Bisphenol A (BPA):** BPA is an artificial estrogen, produced worldwide. Human epidemiological data suggests that BPA acts as an estrogen agonist as well as antagonist. It also possesses obesogenic properties in various animal models. It has also known to interfere with male reproduction and causing various anomalies.
- **Phthalates:** Phthalates are another class of chemicals that have been implicated as endocrine disrupters. It causes adverse effects on reproduction which includes association with poor semen qualities and miscarriages. Its exposure directly harms the maternal health.
- **Flame retardants:** These are another class of chemicals which causes reproductive toxicity. Polybrominated Diphenyl Ethers (PBDE) has been used extensively. Its exposure causes adverse neurodevelopment problems in the children. It interacts with steroid hormone receptors, thus suppresses normal thyroid function.

Human and animals can be exposed frequently with various environmental contaminants viz. agrochemicals, heavy metals, endocrine disruptive chemicals, etc. Although, most of them do not induce acute mortality but their long-term exposure adversely affects the reproductive performance in human and animals. Additionally, due to their chemical nature they can easily cross the physiological barriers (placental and testicular barriers) can easily concentrated in male and female reproductive organs and leads to reproductive disorders. Most of these contaminants on exposure induces production of free radicals or interfere with the antioxidant system or both in mammalian tissues. Increased ROS levels interact with the membrane lipids, which are one of the most common targets for the reactive metabolites. Due to presence of poly-Unsaturated Fatty Acids (PUFAs) (multiple double bonds), specifically linoleic and arachidonic acids which are easily oxidized by the excessive RONS especially hydroxyl (OH), superoxide anions (O_2^-) and peroxy radicals. Due to their structure, PUFAs exhibit cellular membranes in peril to damage from free radicals, causing peroxidation. When free radicals like OH, O_2^- come knocking, they steal electrons from PUFAs, triggering a chain reaction called lipid peroxidation. To favor creation of an oxidant milieu oxidative stress impacts cellular functioning which may lead to a wide array of pathological conditions in male and female reproductive organs. An imbalance between free radicals and antioxidants over a period of time creates testes and ovary damage. Epidemiological and experimental scientific evidences suggest that oxidative stress induced by environmental contaminants is an important player responsible for the reproductive disorders in mammals.

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