

Heavy Metal Toxicity

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Introduction

Gradual accumulation of any substances above the normal recommended level in different tissues and body parts of human being result in toxicity. Heavy metals are defined as metals having density higher than the density of water and high atomic weights. In general mercury, lead, bismuth, chromium, copper, cobalt, nickel, cadmium and arsenic are considered as heavy metals. Heavy metal toxicity occurs when these elements get deposited in higher than the normal recommended concentration in different tissues and organs of body. Potential sources of heavy metal poisoning include industrial waste, mining, tailing, smelting, paints, timbers, pesticides, insecticides, nuclear explosion, agricultural runoff, treated timber and different occupational exposure during working in factories and industries. The major media of entry of heavy metals into human body are contaminated water, food sources, inhalation and direct contact with skin and eyes.



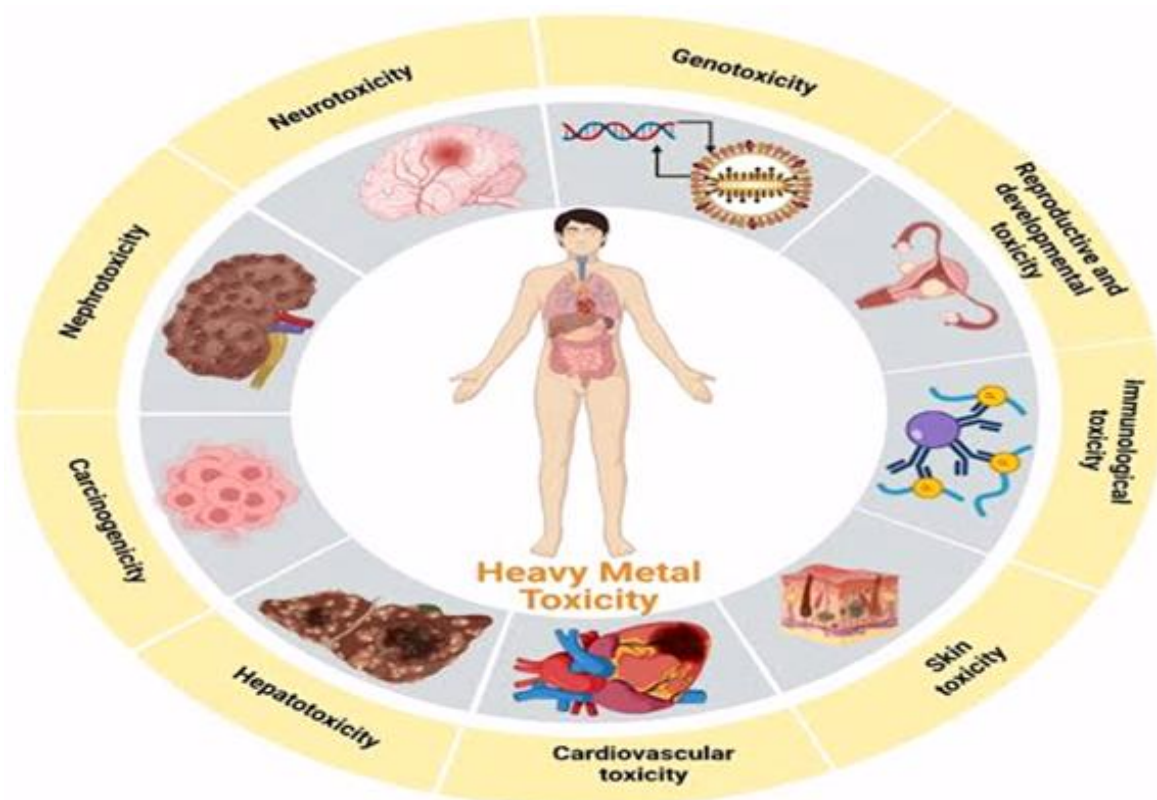
Effects of heavy metals on health

Heavy metals induce toxicity by inhibiting enzymatic system, Reactive Oxygen Species (ROS) and free radical generation and alteration of antioxidant actions as well as immune system. Complications like gastro-intestinal and kidney dysfunction, neurological disorders, vascular damage, skin infections, birth defects, angiogenesis and cancer. After getting entered into cells, heavy metals lead to alter the genetic sequences of DNA and RNA in nucleus resulting in mutation and loss of normal cell function like contact inhibition. It facilitates overgrowth of cell, tumour formation and metastasis of tumours finally resulting in cancer.

Among all the heavy metals arsenic, cadmium, mercury and lead toxicity are more common than others. The arsenic species that most commonly act as toxicants are As (III), As (V), monomethylarsenic (MMA), dimethylarsenic (DMA), arsenobetaine and arsenocholine. Arsenic binds with different biological ligands and deactivates the human enzyme system causing the entire metabolism defective. Chronic exposure to arsenic causes damage peripheral vascular system, cancer in skin, lungs and bladder. Lead, which is used in manufacturing of batteries, pigments, pipes, gasoline etc. is carcinogenic and leads to tumour formation and cancer in brain. Cumulative deposition of lead in various tissues of body damages kidney, neurons, hematopoietic and gastrointestinal system, bones and reproductive organs. Exposure to lead during pregnancy can cause hypertension, miscarriage and different birth defects in the new born foetus. Lead creates imbalance in the prooxidant-antioxidant system by producing more reactive oxygen species leading to oxidative stress in DNA, proteins and other soft tissues. Mercury contaminated food and water consumption produces toxicity in body finally resulting into mental retardation and epilepsy.

Deposition of methyl mercury in gestation period hinders brain and cognitive development of the growing foetus in womb as well as leads to carcinogenicity, immunotoxicity, genotoxicity, cardiotoxicity and reproductive toxicity. Bio-magnification of mercurous compounds occurs after entering into water bodies in edible fishes and other aquatic species which get accumulated in other organisms' body as consumption continues up to the higher strata of food pyramid. Methyl mercury gets deposited in peripheral nerves, spinal cord, blood brain barriers and placenta. It binds with proteins having sulphur containing amino acids like methionine, cysteine and produce toxic effects in liver, kidneys and gonads. It can also pass through breast milk during lactation causing pneumonia in neonates. Cadmium, mostly found in phosphate fertilizers, used in production of alloy, amalgam, paint pigments, electric cables, batteries etc. is readily absorbed by plants and retained in their tissues whose consumption leads to deposition in human and other herbivores' body. In industries workers getting exposure to cadmium suffer from respiratory, gastrointestinal and skin problems. Food stuffs, especially meat, cereals and dairy products and pipeline water supply are the main source of non-occupational exposure of human beings to cadmium. Cadmium mainly accumulates in internal organs like kidney, liver and also in milk. Cadmium replaces calcium in bones leading to osteoporosis and osteomalacia. Itai-itai

disease (ouch-ouch disease) caused by cadmium poisoning is characterized by bow legs, bidding ribs, severe pain in bones and joints, bending of backbone and renal dysfunction. Cadmium is highly carcinogenic and leads to cancer in pancreas, kidneys, lungs, urinary bladder, breast and prostate. It can induce hypertension and diabetic complications. Other heavy metals like Uranium and Thorium used in nuclear reactors emit harmful radiations like alpha-, beta- and gamma- rays that cause cancer in skin and other internal organs.



Element	Adverse health effects
Antimony	Hypercholesterolemia, hypoglycaemia
Arsenic	Skin damage, cancer, vascular problem
Barium	Hyperglycemia
Beryllium	Intestinal lesions
Chromium	Allergy, dermatitis

Copper	Gastrointestinal distress, Wilson's disease, kidney and liver damage
Selenium	Hair and nail loss, numbness in fingers, toes
Thallium	Hair loss, blood, kidney, liver, intestine problems
Uranium	Cancer, kidney issues

Prevalence of heavy metal toxicity

The extensive use of arsenic contaminated tube wells for drinking water, cooking purposes, and livestock feeding causes toxicity in Bangladesh, Mexico, Chile, Cambodia. According to EFSA, lead dietary exposure ranges from 0.36 to 1.24, up to 2.43 $\mu\text{g}/\text{kg}$ body weight per day in high consumers in Europe is responsible for lead poisoning. Illegal mining and industrial waste disposal polluted the area of Minamata bay with high concentrations of methyl mercury resulted in degeneration of neural system, mental retardation, constricted vision and hearing disability of many people in 1953. Another incident of seed grain intoxication in Iraq in 1971-72 took place due to mercury contamination. Itai-itai disease broke out in Japan in 1960s due to cadmium contamination of underground water.

Conclusion

Heavy metals are a potential threat to the health of plants, human beings and all other organisms. Being highly carcinogenic, heavy metal toxicity causes severe damage to both external as well as internal organs of human body. During using different agrochemicals, fertilizers, pesticides, while disposing industrial waste materials, chemicals careful treatment measures should be followed so that contamination of water pipeline, food sources with heavy metals will be minimized. Reuse, recycle and replacement of different heavy metals with biodegradable harmless substances should be practised regularly to prevent heavy metal toxicity and all the fatal consequences associated with it.

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