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website:- www.journalofchemistry.org**Toxicity of Heavy Metals to the Human Health and Environment****Pradeep Kumar Jadon and Sudeshana**

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Corresponding Author Email: sudeshanayadav10793@gmail.compkjadon@yahoo.com<http://dx.doi.org/10.22147/juc/180401>**Acceptance Date 15th December, 2022,****Online Publication Date 30th December, 2022****Abstract**

Almost each heavy metal is serious toxicants as carcinogens. Heavy metals are kept under environmental pollutant category due to their toxic effects in plants, human and food. These are heavy metals persistence, accumulate and not metabolized in other intermediate compounds and do not easily breakdown in environment. Heavy metals are naturally occurring elements, and are present in varying concentrations in all ecosystems. Some of the heavy metals *i.e.* Arsenic (As), Cadmium (Cd), Lead (Pb), Mercury (Hg) are accumulative poison. Arsenic (As), cadmium (Cd), chromium (Cr), and nickel (Ni) are category 1 heavy metals according to the International agency for Research on Cancer. There is the large of number of heavy metals. Total metals have caused major human health problems in various parts of the world. The term “heavy metal” is connected in many people’s minds to metals that are toxic. There is a relationship between the chronic diseases and geologic environment. Geochemical environment is indeed a significant factor in the serious health problems. These metals have been extensively studied and their effects on human health regularly reviewed by international bodies such as the WHO. This reviews paper definite heavy metals and their toxicity and effects on human health.

Key words : Heavy Metals, Human exposure, Toxicity, Carcinogenicity.**Introduction**

Heavy metals are individual metals and metal compounds that can impact human health.

Eight common heavy metals are discussed in this brief arsenic, cadmium, barium, chromium, mercury, lead, silver and selenium. These are all naturally occurring substances which are often

present in the environment at low levels. In larger amounts, they can be dangerous. Generally, human are exposed to these metals by ingestion (drinking or eating) or inhalation (breathing). Working in or living near an industrial site which utilizes these metals and their compounds increases ones risk of exposure, as does living near a site where metals have been improperly disposed. Subsistence lifestyles can also impose higher risks of exposure and health impacts because of hunting and gathering activities¹. The toxic Heavy Metals including As, Pb, Cd, and Hg are not required by human beings but are reported to induce carcinogenicity if the accumulated for a longer time in the bodies.² Toxic heavy metals can accumulate in the body and disrupt the functioning of the kidney, bones, liver, heart, brain, etc. They replace the minerals in the body which disrupts the biological functioning.³ Heavy metals find their way into the environment via natural sources such as weathering of rocks and volcanic eruptions, and anthropogenically due to the industrial activity, mining, and sewage disposal. Physical factors such as the temperature, air circulation, wind speed, and water direction influence the stability of heavy metals in the environment.⁴ Heavy metals are defined as metallic elements that have a relatively high density compared to water⁵. With the assumption that heaviness and toxicity are inter-related, heavy metals also include metalloids, such as arsenic, that are able to induce toxicity at low level of exposure⁶. In recent years, these have been an increasing ecological and global public health concern associated with environmental contamination by these metals. Also, human exposure has risen dramatically as a result of an exponential increase of their use in several industrial, agricultural, domestic and technological applications⁷. Reported sources of heavy metals in the environment include industrial, agricultural, pharmaceutical,

domestic effluents, and atmospheric sources. Environmental pollution is very prominent in point source such as mining, foundries and smelters, and other metal-based industrial operations⁸. Environmental Protection Agency (USEPA), Heavy metals are considered priority pollutants. According to the US Agency for Toxic Substances and Diseases Registry (ATSDR), lead (Pb) is the most toxic substance followed by the mercury (Hg), and arsenic (As) whereas cadmium (Cd) is the sixth most toxic metal on the list.⁹ Although heavy metals are naturally occurring elements that are throughout the earth's crust, most environmental contamination and human exposure result from anthropogenic activities such as mining and smelting operations, industrial production and use, and domestic and agricultural use of metals and metals-containing compounds¹⁰. Environment contamination can also occur through metal corrosion, atmospheric deposition, soil erosion of metal ions and leaching of heavy metals, sediment re-suspension and metal evaporation from water resources to soil and ground water¹¹. Nature phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metals pollution¹². Industrial sources include metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations and high tension lines, plastic, textiles, microelectronics, wood preservation and paper processing plants¹³. It has been reported that metals such as cobalt (Co), Copper (Cu), Nickel (Ni), Manganese (Mn), Chromium (Cr), Magnesium (Mg), Iron (Fe), Zinc (Zn), Selenium (Se) and Molybdenum (Mo) are essential nutrients that are required for various biochemical and physiological functions. Inadequate supply of these micro-nutrients results in a variety of deficiency diseases or syndromes¹⁴. Heavy metals are also considered as trace elements because of their presence in trace concentrations [ppb range to less than 10ppm] in various environmental

matrices¹⁵. The importance of the combination of environmental exposures to adverse toxicants including heavy metals and the underlying malnutrition has been recognized as potential contributor for the compromised neuronal development with consequent deficit in cognitive function in children¹⁶. Although the phase-out of Pb has contributed to a progressive reduction of blood Pb levels worldwide the prevalence of increased Pb level in 40 per cent of children in developing countries continue to pose great risk. Also consumption of well water in several parts of Southeast Asia (particularly Bangladesh and India) and consequent exposure to high levels of As and Mn have been implicated in chronic health effects in children during development and as well as in adulthood. Another emerging issue related to environmental heavy metals toxicity that needs to be seriously addressed in developing countries including India, is the increasing incidence (1 out of 150 children) of autism spectrum disorder recently reported by Center for Disease Control. High blood levels of heavy metals in autistic children suggest possible relationship with exposure to heavy metals such as Pb, Cd and Hg. There are about 200 industrial chemicals including heavy metals that are recognized as potential toxicants. It may not be possible to establish a direct relationship with a single agent in the environment with the incidence of a neurodegenerative disease process including autism, but suitable regulatory policies and measures must be developed to reduce the overall burden of occupational or environment insults.¹⁷ Heavy metals pollution remains a global environmental challenge that poses a significant threat to human life. Heavy metals cannot be degraded but can be converted to the lesser toxic form. Excessive the concentration of heavy metals harms plant metabolism, hence affecting the production of food qualitatively and quantitatively. Heavy metals

affect the health of human beings and are regarded as a potent carcinogen and mutagen.¹⁸ Several studies conducted by the World Health Organization (WHO) have found that more than 10% of women are at risk of infertility because of their exposure to heavy metals such as lead, cadmium, mercury, and other pollutants, which are the most common environmental contaminants that can cause reproductive disorders. According to a study conducted by the WHO, the condition of infertility is mostly more prevalent in women than in men. Ovulation disturbances are a frequent cause of subfertility in women.¹⁹ Rapid industrialization coupled with the urbanization is a major player in Heavy Metals pollution in the water bodies. Runoffs from villages, cities, and industries can accumulate in the sediments associated with the water bodies. The toxic metals in the trace amounts can be very toxic to the ecosystem.²⁰ The toxicity to the living beings depends on the heavy metals speciation. For ex., hexavalent Cr [Cr (VI)] is more toxic than trivalent Cr [Cr (III)], and duration of the exposure is also important.²¹ The effect of bioaccumulation is most prominent in the humans as they are last in the food chain. Heavy Metals are not removed effectively via the sewage treatment plant, they get degraded in the final sludge produced. Therefore, in the raw sewage, they are found at very high concentrations.²² The WHO health report on “reducing risk, promoting health life” identified environmental and occupational exposures to toxic chemicals as one of the major risk factors for increasing health burden across the world.¹⁷

Toxicity of Heavy Metals :

The term heavy metal” seems to suggest that these metals (or their compounds) are toxic. Certainly, this is rather a feeling than a conclusion on a scientific basis. Two facts have to be kept in

mind. The effect of any substance on living systems is always a consequence of the concentration available to the cells. Thus, there are no toxic substances in contrast to non-toxic substances. Several metal ions are essential for the metabolism of cells. They are necessary at low concentrations but toxic at high concentrations resulting in bell-shaped dose- response relationships²³. Heavy metals can be defined in several ways. One possible definition is the following. Heavy metals from positive ions in solution and they have a density five times greater than that of water. They are of particular toxicological importance. Many metallic elements play an essential role in the function of living organisms. They constitute a nutritional requirement and fulfil a physiological role. However, overabundance of the essential trace elements and particularly their substitution by nonessential ones, such as the case may be for cadmium, nickel or silver can cause toxicity symptoms or death. Humans receive their allocation of trace elements from food and water an indispensable link in the food chain being plant life which also supports animal life. It is a well-established fact that assimilation of metals takes place in the microbial world as well as in plants and these elements tend to get concentrated as they progress through the food chain²⁴.

Lead :

Lead is the most common of the heavy elements. Lead is the soft metal that resists toxicity and sources of Pb, Cd, Hg, Cr, As and Radionuclides in the Environment. It is estimated that approximately 2 million tons are mined yearly. Probably 10% of this total is lost in treatment of the ore to produce the concentrate, and a further 10% is lost in making pig lead. The amount of lead discharged into the environment is equal to the amount weathered from igneous rocks. In the global lead level terms, the power storage battery industry may have a relatively low

impact on the environment because about 80% of all batteries are recycled²⁵. Other sources of the lead intake include ceramic ware, activities involving arts and crafts, peeling paint, and renovations resulting in dust or fumes from paint²⁶. Lead can be absorbed by the body through inhalation, ingestion, dermal contact (mainly as a result of occupational exposure), or transfer via the placenta²⁷.

Cadmium :

Cadmium is the silvery-white, lustrous, but tarnishable metal. It is soft and ductile and has a relatively high vapor pressure. Cadmium is the nearly always divalent, chemically it closely resembles zinc and occurs in almost all zinc ores by isomorphous replacement²⁸. Cd is classified by International Agency for Research on Cancer (IARC) as carcinogenic to the humans (Group 1).²⁹ In one of the review, it was noted that the use of cadmium products has expanded in recent years at the rate of 5–10% annually, and the toxicity and sources of Pb, Cd, Hg, Cr, As, and Radionuclides in the Environment potential for further growth is very high³⁰. Symptoms of the acute poisoning include pulmonary edema, headaches, nausea, vomiting, chills, weakness, and diarrhea. Cadmium has been established as a very toxic heavy metal. A disease known as “Itai-Itai” in the Japan is specifically associated with cadmium poisoning, resulting in multiple fractures arising from osteomalacia³¹.

Mercury :

Mercury and its compounds are used in the dental preparations, thermometers, fluorescent and ultraviolet lamps, and pharmaceuticals, and as fungicides in paints, industrial process waters, and seed dressings. The pulp and paper industry is also consumes mercury in the significant

amounts in the form of phenyl mercuric acetate, a fungicide, and in caustic soda, which may contain up to 5 mg kg⁻¹ as an impurity³². High levels of the mercury originating from the nearby plastics factory were found in the shellfish eaten by the villagers. The “minamata disease,” mercury poisoning, has been linked to many more deaths around the globe ever since and symptoms of the mercury poisoning crippled countless more. The Advanced analytical methods made it possible only relatively recently to monitor low levels of mercury in the environment, which, however, are sufficient to cause these serious problems on the large scale³³. Mercury is the extremely hazardous heavy metal that may be found in the biosphere. Due to human activities, it has also become the widespread contaminant and is increasing in the atmosphere. Mercury converts to a highly toxic methylmercury when in the contact with the aquatic sediments.³⁴

Chromium :

Chromium is the used in many industrial applications. It can be either used melted with other metals to produce alloys or plated. Chromium steel alloys provide high corrosion resistance and good hardenability. Other applications of chromium range from tanning agents, paint pigments, and catalysts to the impregnation solution for wood or photography. The world production of chromite is several millions of tons per year³⁵.

Arsenic :

Arsenic is the poisonous chemical that is widely distributed in nature and occurs in the form of inorganic or organic compounds. It is the ranked as twentieth in abundance among the elements in the Earth’s crust. The Arsenic can exist in four valence states: -3, 0, +3, and +5. Under the reducing conditions, arsenite, As (III) is the

dominant form; arsenate, As (V) is generally the stable form in oxygenated environments. Elemental arsenic is not soluble in the water. Arsenic salts exhibit the wide range of solubilities, depending on pH and ionic environment. Inorganic compounds consist of water-soluble arsenite As (III) the most toxic form, and arsenate As (V) the less toxic form, and such pollutants have been the associated with many health problems such as skin lesions, keratosis (skin hardening), lung cancer, and bladder cancer³⁶.

Conclusions

This is the review we reviewed the effects of some heavy metals, arsenic, lead, mercury, cadmium, chromium, aluminium and iron on the environment and living organisms, mainly human beings. The effective legislation, guidelines and detection of the areas where there are higher levels of heavy metals are necessary. Failure to control the exposure will result in severe complications in the future because of the adverse effects imposed by the heavy metals. Occupational exposure to the heavy metals can be decreased by the engineering solutions. Monitoring the exposure and probable intervention for reducing additional exposure to heavy metals in the environment and in the humans can become a momentous step towards the prevention. National as well as international co-operation is vital for framing appropriate tactics to prevent the heavy metal toxicity.

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