



## Global journal of multidisciplinary and applied sciences

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©2014 GJMAS Journal-2014-2-2/36-40

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# METALS AND THEIR IMPACTS ON HUMAN BEINGS

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**ABSTRACT:** Metals occur naturally in the environment, but anthropogenic activities contribute natural concentrations. Industrial wastes, vehicular emissions and certain fertilizers used in agriculture are all contributors. Some of the heavy metals are needed in trace amounts, but lethal in elevated amounts, while others are toxic at any level. Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted. Metals can enter a water supply by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers, and groundwater. Exposure to air, water, and soil all add to our uptake of heavy metals. Inhalation and dermal uptake are both exposure routes, but ingestion is the biggest contributor. Prolonged exposure to heavy metals can have carcinogenic and also adverse non-cancer effects. The aim of the present article is to summarize current knowledge regarding the risks of these widespread metals to human health. The review will be focused common occurring heavy metals and also address some of the issues that covers health risk from exposure of metals.

**Keywords:** Metals, Their Impacts, Human Beings.

## INTRODUCTION

The quality of surface water has deteriorated due to discharge of industrial, sewage and domestic effluents directly into water bodies resulting in eutrophication by adding excess nutrients such as nitrates and phosphates. Deforestation, urbanization and industrialization have adversely affected hydrological regime and environment of the earth. The rate of the recharge of natural spring is depleting continuously causing lowering of water table. Pollutants are increasingly added to the surface and groundwater system through various human activities and the natural degradation processes. Untreated disposal of wastes are adding pollutants to the surface and groundwater system and continuous addition accelerate their movement towards production well. Industrial wastes that include heavy metals and toxic compounds are deteriorating groundwater quality. Heavy metals are also common in industrial applications such as in the manufacture of pesticides, batteries, alloys, electroplated metal parts, textile dyes, steel, and so forth. (International Occupational Safety and Health Information Centre 1999). Many of these products are in our homes and actually add to our quality of life when properly used.

### **DEFINITION OF A HEAVY METAL**

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous even at low concentrations. These occurs as the natural components of the Earth's crust. They have higher specific gravity (at least 5 times the specific gravity of water i.e. 1 at 4°C (39°F)). Specific gravity of some well-known toxic metallic elements is arsenic, 5.7; cadmium, 8.65; iron, 7.9; lead, 11.34; and mercury, 13.546 (Lide 1992). Small quantity of certain heavy metals is nutritionally essential for a healthy life. e.g., iron, copper, manganese, and zinc etc. Hence, these are also called as trace elements. These elements are commonly found naturally in foodstuffs, in fruits and vegetables, and in commercially available multivitamin

products (International Occupational Safety and Health Information Centre 1999). They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. However, heavy metals cannot be detected by sight, smell or taste. They can be detected only in the chemical laboratory. Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. They may enter the human body through food, water, air, or absorption through the skin when they come in contact with humans in agriculture and in manufacturing, industrial, or any other means. Industrial exposure accounts for a common route of exposure for adults. Ingestion is the most common route of exposure in children (Roberts 1999). Less common routes of exposure are during a radiological procedure, from inappropriate dosing or monitoring during intravenous (parenteral) nutrition, from a broken thermometer (Smith et al. 1997), or from a suicide or homicide attempt (Lupton et al. 1985). The Agency for Toxic Substances and Disease Registry (ATSDR), responsible for assessment of waste sites and providing health information concerning hazardous substances, response to emergency release situations, and education and training concerning hazardous substances (ATSDR Mission Statement, November 7, 2001), has compiled a Priority List for 2011. The heavy metals arsenic (1), lead (2), mercury (3), cadmium (7), hexavalent chromium (17), cobalt (52), nickel (57), zinc (75), chromium (78), copper (125), Manganese (140), and aluminium (181) appear on this list. Some of the common occurring heavy metals are described in detail as under:

### **ALUMINIUM**

Aluminum is called the soft in the head mineral because it is associated with memory loss and dementias. All types of salt contain some aluminum. Although aluminium is not a heavy metal (specific gravity of 2.55-2.80), it makes up about 8% of the surface of the earth and is the third most abundant element. Beverages in aluminum cans or food cooked in aluminum may contain elevated levels of aluminum. Anti-perspirants all contain aluminum compounds. It is readily available for human ingestion through drinking water. Various studies shows it is somewhat related to the Alzheimer's disease. Most researchers also agree that it is an important factor in the dementia component. Target organs for aluminum are the central nervous system, kidney, and digestive system.

### **ARSENIC**

Arsenic is the most common cause of acute heavy metal poisoning in adults. It is also called as slow death mineral and it was used to kill people because it is colorless and tasteless so it was added to food and slowly killed people. Arsenic is released into the environment by the smelting process of copper, zinc, and lead, as well as by the manufacturing of chemicals and glasses. Arsine gas is a common byproduct produced by the manufacturing of pesticides that contain arsenic. Arsenic may be also be found in water supplies worldwide, leading to exposure of shellfish, cod, and haddock. Other sources are paints, rat poisoning, fungicides, and wood preservatives. Arsenic is used in pesticides and, as a result, may be found in commercial wines, beers, fruits, vegetables, rice and other foods. Target organs are the blood, kidneys, and central nervous, digestive, and skin systems.

### **CADMIUM**

Cadmium is a minor metallic element, one of the naturally occurring components in the earth's crust and waters, and present everywhere in our environment. It was first discovered in Germany in 1817 as a by-product of the zinc refining process. Its name is derived from the Latin word *cadmia* and the Greek word *kadmeia* that are ancient names for calamine or zinc oxide. It is used in nickel-cadmium rechargeable batteries, PVC plastics, for the production of special alloys and paint pigments. Cadmium is also present in tobacco smoke and marijuana smoke. In the industry, cadmium is hazardous both by inhalation and ingestion and can cause acute and chronic intoxications. Cadmium dispersed in the environment can persist in soils and sediments for decades. When taken up by plants, cadmium concentrates along the food chain and ultimately accumulates in the body of people eating contaminated foods. Long term exposure to cadmium is known to produce toxic effects on humans i.e. excess concentrations can cause adverse effects on the kidneys, placenta, bones, brain and lungs. In addition to its extraordinary cumulative properties, cadmium is also a highly toxic metal that can disrupt a number of biological systems, usually at doses that are much lower than most toxic metals (Jarup, 1998). Outbreak of the Itai-Itai bone disease in Japan in the 1960s was also due to this heavy metal that had been discharged in the environment at an uncontrolled rate for more than one century (Hagino and Yoshioka, 1961). It is called as pseudo-macho or the violent element. Like lead, it is an older male mineral that is associated with macho behavior, violence and horror. Cadmium toughens the tissues and hardens the arteries. Some women have cadmium in them that allows them to function in a male-oriented jobs and positions of authority.

### **CHROMIUM**

Chromium is a hard, grey metal that is valued for its incredible resistance to corrosion. Chromium derives its name from *chrōma*, a Greek word meaning color, due to its ability to produce vivid, colourful compounds, such as chrome oxide. Chromium is an essential micronutrient for animals and plants, and is considered as a biological and pollution significant element. Generally the natural content of chromium in drinking water is very low ranging from 10 to 50 µg/L except for the regions with substantial chromium deposits (Jayana, 2009). People can be exposed to chromium through breathing, eating or drinking and

through skin contact with chromium or chromium compounds. The level of chromium in air and water is generally low. In drinking water the level of chromium is usually low as well, but contaminated well water may contain the dangerous chromium(IV); hexavalent chromium. Chromium in excess amounts can be toxic especially in the hexavalent form. Chromium(III) occurs naturally in many vegetables, fruits, meats, yeasts and grains. Various ways of food preparation and storage may alter the chromium contents of food. When food in stores in steel tanks or cans chromium concentrations may rise. Chromium(III) is an essential nutrient for humans and shortages may cause heart conditions, disruptions of metabolisms and diabetes. But the uptake of too much chromium(III) can cause health effects as well, for instance skin rashes. Chromium(VI) is a danger to human health, mainly for people who work in the steel and textile industry. People who smoke tobacco also have a higher chance of exposure to chromium ([www.lenntech.com](http://www.lenntech.com)). Sub chronic and chronic exposure to chromic acid can cause dermatitis and ulceration of the skin. Long-term exposure can cause respiratory problems, lung cancer, weakened immune systems, alteration of genetic material, kidney, liver, circulatory and nerve tissue damages. Chromium often accumulates in aquatic life, adding to the danger of eating fish that may have been exposed to high level of chromium (Hanaa, 2000; Pandey, 2010).

### **COPPER**

Copper is a mineral. It is found in many foods, particularly in organ meats, seafood, nuts, seeds, wheat bran cereals, grain products, and cocoa products. The body stores copper mostly in the bones and muscles. Even though our body needs a trace amount of copper, it is toxic if the amount is too high. At very high levels it is toxic and can cause vomiting, diarrhea, loss of strength or, for serious exposure, cirrhosis of the liver. Contamination of drinking water with high level of copper may lead to chronic anemia (Acharya, 2008). Water turns blue-green in colour as the corroded copper comes off the inside of the pipes and appears in the water as a precipitate. This reaction only occurs in a small percentage of cases. Excess amount of copper in tissue stimulates the biogenic amines, neurotransmitters associated with depression, anxiety, mood swings and schizophrenia. Copper imbalance is quite common but goes undiagnosed because the tissue mineral test is not often done.

### **IRON**

Iron is a lustrous, ductile, malleable, silver-gray metal and believed to be the tenth most abundant element in the universe. Iron is also the most abundant (by mass, 34.6%) element making up the Earth; the concentration of iron in the various layers of the Earth ranges from high at the inner core to about 5% in the outer crust. In water, it occurs mainly in ferrous or ferric state (Ghulman, 2008). Iron in surface water generally present is ferric state. Iron is the most used of all the metals, including 95 % of all the metal tonnage produced worldwide. Its applications go from food containers to family cars, from screwdrivers to washing machines, from cargo ships to paper staples. Iron is essential to almost living things, from micro-organisms to humans. A more common problem for humans is iron deficiency, which leads to anemia. A man needs an average daily intake of 7 mg of iron and a woman 11 mg; a normal diet will generally provided all that is needed. It is a heavy metal of concern, particularly because ingesting dietary iron supplements may acutely poison young children. Ingestion accounts for most of the toxic effects of iron because iron is absorbed rapidly in the gastrointestinal tract. The corrosive nature of iron seems to further increase the absorption. It can cause a rusty red or brown stain on fixtures or laundry and/or cause your water to develop a metallic taste. Iron may cause conjunctivitis, choroiditis, and retinitis if it contacts and remains in the tissues. Chronic inhalation of excessive concentrations of iron oxide fumes or dusts may result in development of a benign pneumoconiosis, called siderosis ([www.lenntech.com](http://www.lenntech.com)). It mainly affects organs like liver, cardiovascular system, and kidneys. But still it is an essential and non-conservative trace element found in significant concentration in drinking water because of its abundance in the earth's crust. It is also necessary element for the body. Usually, iron occurring in ground water is in the form of ferric hydroxide, in concentration less than 500 µg/L (Oyeku and Eludoyin, 2010). The shortage of iron causes disease called "anemia" and prolonged consumption of drinking water with high concentration of iron may lead to liver disease called as haemosiderosis (Rajappa, 2010; Bhaskar, 2010). No guideline is set by WHO (2008) for iron content in drinking water because it is not of health concern at concentrations normally observed in drinking water.

### **MANGANESE**

Manganese is a naturally occurring metal that is found in many types of rocks. Pure manganese is silver-colored, but does not occur naturally. Manganese is an essential trace element because the body requires it to function properly. It is found in several foods including nuts, legumes, seeds, tea, whole grains, and leafy green vegetables. People use manganese as medicine. Manganese is used for prevention and treatment of manganese deficiency, a condition in which the body doesn't have enough manganese. It is also used for weak bones (osteoporosis), a type of "tired blood" (anemia), and symptoms of premenstrual syndrome (PMS). It can enter the air from iron, steel, and power plants, coke ovens, and from dust from mining operations. In the water and soil it enters from natural deposits, disposal of wastes, or deposits from airborne sources. However, it exists naturally in rivers, lakes, and underground water. Plants in the water can take up some of the manganese from water and concentrate it. People who improperly use pesticides such as maneb and mancozeb, may be exposed to excess levels. Long

term exposure of manganese can developed mental and emotional disturbances and slow and clumsy body movements in some individuals. This combination of symptoms is a disease called "manganism." Manganism occurs because too much manganese injures a part of the brain that helps control body movements. Exposure to high levels of airborne manganese, such as in a manganese foundry or battery plant, can affect motor skills such as holding one's hand steady, performing fast hand movements, and maintaining balance. Exposure to high levels of the metal may also cause respiratory problems and sexual dysfunction. Daily intake of small amounts of manganese is needed for growth and good health in children. Manganese is constantly present in the mother and is available to the developing fetus during pregnancy. Manganese is also transferred from a nursing mother to her infant in breast milk at levels that are appropriate for proper development. Children, as well as adults, who lose the ability to remove excess manganese from their bodies develop nervous system problems. Because at certain ages children take in more than adults, there is concern that children may be more susceptible to the toxic effects of excess manganese. In animals, high manganese exposure can cause birth defects in the unborn.

### ***NICKEL***

Nickel is called the depression and suicide mineral, as it is associated with these feelings and symptoms. It is a particularly deadly toxic metal. It is found in large quantity, sadly, in some older metal or even ceramic dental fixtures such as crowns and some wires used in bridges and braces. Nickel can contribute to cancer and other horrible problems. Nickel in much smaller quantity in hydrogenated oils found in commercial peanut butter, margarines including soy margarine and vegetable shortening. Nickel is also used as catalysts in various chemical reactions.

### ***MERCURY***

Mercury is generated naturally in the environment from the degassing of the earth's crust, from volcanic emissions. It exists in three forms: elemental mercury and organic and inorganic mercury. Atmospheric mercury is dispersed across the globe by winds and returns to the earth in rainfall, accumulating in aquatic food chains and fish in lakes. Mercury may be called the mad hatters mineral. People who made raccoon skin hats in the mid 1800s in America and Europe developed mercury toxicity after a few years from rubbing mercury on felt to soften it. They became mentally and emotionally deranged in many cases. Mercury compounds were added to paint as a fungicide until 1990. These compounds are now banned; however, old paint supplies and surfaces painted with these old supplies still exist. Mercury continues to be used in thermometers, thermostats, and dental amalgam. Certain bacteria are able to transform it into methyl mercury, which is concentrated in the food chain and can cause malformations. Fish, especially those caught near the coast or in contaminated streams or lakes, are universally contaminated. Mercury is found today in all fish, bar none. Target organs are the brain and kidneys. Ingestion of high concentration of mercury may result into minamata disease. This disease is methyl mercury (MeHg) poisoning that occurred in humans who ingested fish and shellfish contaminated by MeHg discharged in waste water from a chemical plant (Chisso Co. Ltd.). It was in May 1956, that minamata disease was first officially "discovered" in Minamata City, south-west region of Japan's Kyushu Island (Harada, 1995).

### ***LEAD***

Lead is called the horror mineral because it is associated with violence, lowered intelligent quotient (IQ), attention deficit disorder (ADD), attention deficit hyperactivity disorder (ADHD) and many neurological problems. It is a very soft and most significant heavy metal because it is toxic, very common and harmful even in small amounts (Gregoriaadou, 2001). Lead was added to gasoline until the 1970s when lead-free gas replaced it. The new gasoline has manganese in it instead of lead. It was used in pipes, drains, and soldering materials for many years. Every year, industry produces about 2.5 million tons of lead throughout the world. Most of this lead is used for batteries. Old house paint, current paint used on ships of all sizes, lubricants, medications, cosmetics such as lipstick and others, inks, and perhaps other products may contain lead. Entire books have been written about lead toxicity, which causes hundreds of symptoms from anemia to death. Workers exposed to lead on the job can bring it home on clothing and shoes, exposing their family members. Lead is found in a large array of consumer products, from art supplies and automobile components to speciality paints, some hair dyes, and even candy. PVC products often contain lead. Millions of homes built before 1940 still contain lead (e.g., in painted surfaces), leading to chronic exposure from weathering, flaking, chalking, and dust. Some old homes may have lead water pipes, which can then contaminate drinking water. Lead accounts for most of the cases of pediatric heavy metal poisoning (Roberts, 1999). Target organs are the bones, brain, blood, kidneys, and thyroid gland. Lead enters the human body in many ways. It is found in trace amounts in various foods, notably in fish, which are heavily subjected to industrial pollution. Most of the lead we take is removed from our bodies in urine; however, as exposure to lead is cumulative over time, there is still risk of buildup, particularly in children. Studies on lead are numerous because of its hazardous effects. High concentration of lead in the body can cause death or permanent damage to the central nervous system, the brain, and kidneys (Hanaa, 2000).

## ZINC

Zinc is called an “essential trace element” because very small amounts of zinc play a vital role in the physiological and metabolic process of many organisms. It is also necessary for human health. It is also used for boosting the immune system, treating the common cold and recurrent ear infections, and preventing lower respiratory infections. It is also used for malaria and other diseases caused by parasites. Nevertheless, higher concentrations of zinc can be toxic to the organism (Rajkovic, 2008). It plays an important role in protein synthesis and is a metal which shows fairly low concentration in surface water due to its restricted mobility from the place of rock weathering or from the natural sources (Rajappa, 2010).

## CONCLUSION

Metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver, and other vital organs. Long-term exposure may result in slowly progressing physical, muscular, and neurological degenerative processes and repeated long-term contact with some metals or their compounds may even cause cancer (International Occupational Safety and Health Information Centre 1999). To avoid metal contamination and ingestion of metals regular consumption of fish and seafood should be avoided. Organically grown food crops should be consumed. Use of environmental friendly products should be promoted.

## ACKNOWLEDGEMENTS

Authors are thankful to University Grant Commission for providing financial assistance under post doctoral fellowship for women to carry out present investigations.

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