

# Effects of Lead on Human Health: A Review

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## Abstract

Lead is one of the most abundant naturally occurring heavy metal. When it is in low concentration it is beneficial for the physiological and biochemical activities in living organisms, however when its concentration exceed up to a certain limit it cause the serious health problems. It is non-biodegradable poisonous metal, today it has become a global health issue. There is almost no function in the human body which is not affected by the lead toxicity. Developing countries use the lead for their beneficial purposes and it became a common environmental pollutant. However in developed countries the people take preventative measure and apply the management strategies to control the lead toxicity up to a certain limit. Lead is highly persistent in the environment and its continuous use raise the level of lead in every country, cause the serious threats such as carcinogenicity, renal failure, high blood pressure, brain damage, hematological effects, reproductive system damage both in men and women, heart diseases, bone screening, liver damage etc. The effect of lead can be decreased by the number of techniques used today such as chelatin therapy and different types of medications.

**Keywords:** Metal • Lead • Poisonous • Medications • Biodegradable

## Introduction

Lead is one of the most abundant naturally occurring heavy metal. When it is in low concentration it is beneficial for the physiological and biochemical activities in living organisms, however when its concentration exceed up to a certain limit it cause the serious health problems. It is non-biodegradable poisonous metal, today it has become a global health issue. There is almost no function in the human body which is not affected by the lead toxicity [1]. Developing countries use the lead for their beneficial purposes and it became a common environmental pollutant. However in developed countries the people take preventative measure and apply the management strategies to control the lead toxicity up to a certain limit [2].

Lead is highly persistent in the environment and its continuous use raise the level of lead in every country, cause the serious threats such as carcinogenicity, renal failure, high blood pressure, brain damage, hematological effects, reproductive system damage both in men and women, heart diseases, bone screening, liver damage etc. The effect of lead can be decreased by the number of techniques used today such as chelation therapy and different types of medications [3].

## Literature Review

### Lead

Lead is bright silvery metal and lightly bluish in dry atmosphere. When it contacts with air it begins to discolor and forming a complex mixture of compounds [4]. Lead is poisonous metal whose wide ranging causes the serious problems in the world. Lead is considered purely toxic metal while other heavy metals may be essential at low level [5]. It is dense, malleable, corrosion resistant metal that has been used by humans for at least 5000 years. Lead pollution increased approximately from 10 tons per year to 1,000,000 tons per year. Lead is a well-known non-biodegradable poisonous metal in the environment and today, it has become a major health problem [6]. Lead poisoning causes anemia in a number of cases as lead inhibits porphobilinogen synthase and ferrochelatase, preventing both porphobilinogen formation and the incorporation of iron into protoporphyrin IX, which stop heme synthesis [7]. In a recent study lead was investigated in counterfeit cigarettes seized by various law enforcement agencies in the United States. Lead level was found to be markedly higher than in their genuine equivalents. The results suggest that higher level counterfeit cigarettes cause serious health problems [8-10].

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## Discovery

Lead is abundant heavy metal in the earth crust. It is about 1 part per million by moles or 14 part per million by weight. It is found in ores mostly with copper, zinc and silver. Lead is extracted from lead sulphide which is most familiar lead mineral, other are lead carbonate and lead sulphate [11-14].

## History

In Asia lead beads have been found dating back to 7000-6500 BCE, an example of the metal smelting. During this time lead has few applications due to its softness and dull appearance.

The major reason for the spread of lead production was its association with silver, which may be obtained by burning galena (a common lead mineral). In cosmetics lead minerals are used firstly by the ancient Egyptians and also used for sinkers in fishing nets, glazes, glasses, enamels and for ornaments. Lead is used as writing material, currency and for construction by various civilizations of the fertile crescent, as a tonic in the ancient Chinese royal courts as money as a contraceptive as for making amulets used it for making amulets; and also used in wire drawing by the Eastern and Southern African peoples [15-17].

## Applications of lead

Batteries lead is mostly used in rechargeable storage batteries. For the manufacturing of one battery dozens of one kilograms of lead is required. As the energy source for light airplanes, automobiles, electric vehicles, trucks, tanks and broadcasting stations all use rechargeable storage batteries [18-21].

## Antiknock agent in gasoline

Pb, tetraethyl lead one of the most important organic compounds were invented as a very effective and cheap antiknock additive to the gasoline by chemist in 1921 by Thomas Midgley. Due to different gasoline composition their physical and chemical characteristics are also different. For rating the commercial gasoline Octane numbers is used. The better the anti-knock capability of the gasoline the higher the octane number [22-25].

## Wires and cable insulation jacketing

Lead is widely used for sheathing the high voltage cables due to ductility and extrusion as well as corrosion resistance abilities.

## Radiation shields

Lead is mostly used in radiation shields. Due to the high density of lead, it is very effective at reducing radiation exposure from x-rays, gamma rays and other types of nuclear radiation.

## Ammunitions

Due to low melting point and low cost of lead casting become easy. High density and weight of lead can stop bullets from being deflected by wind and air turbulence [26-30].

## Reactions tanks

The colour of lead is typically grey. By the oxygen in the air lead can be easily oxidized into PbO. The dense film of PbO covering the outer layer and protecting the deeper layer from being oxidized and makes lead resistant for degradation. In chemical industries it is used to make reaction tanks and making pipes [31-35].

## Stiffness in candles

In order to ensure candle burn longer and more even lead was used as stiffener in some candles [36,37]. In US this is illegal for many years. The other areas in which lead is used are water pipes, fuse wires, house and buildings roofs, lead crystal glassware, bearings, weight in sports instruments and in various alloys [38,39].

## Sources

The sources of lead exposure include lead plumbing, industrial processes, food and smoking, drinking water, domestic sources, house paints, gasoline, lead bullets, pewter pictures, storage batteries, toys and faucets. In the US, from vehicles exhausts more than 100 to 200,000 tons of lead per year is being released. Some is enter into plants, flow into water bodies and the main reason of human contact is due to food or drinking water. Today in most locales lead solder in drinking water is the principal source of lead. It is used as a components of brass fittings, in the water mains and when water has an acidic pH can leach into drinking water. The current WHO standard for the lead content of drinking-water is 10 µg/l. As the toys are painted with lead and itself is made of lead are the main reason of children's exposure to lead. In 2008 in the United States large amount of imported lead painted toys was introduced [40-45].

Ceramic production and battery recycling operations are the sites of lead exposure [46-50]. Wind and rain influenced the blood lead level. 92% of blood lead level which is greater than 15 µg/dl is among the children in Coahuila, Mexico [51-55].

## Uses of lead

From Romans time corrosion-resistant metal has been used for hair dyes, antiknock additives for petrol, insecticides, lead glazes for pottery, pipes, pewter and in paint. These uses have now been illegal due to severe health problems. Lead is still used for roofing, lead crystal glass, radiation protection, weights for lifting, solders, pigments, architecture, car batteries. Ammunition, cable sheathing, weight belts for diving, stained glass windows and to store corrosive liquids [56-60].

## Occupational exposure

In elders occupational exposure is the main source of lead. In the United States according to national institute of occupational safety and health, three million workers in the workplace exposed to lead. Circuit boards, jet engines, radiation shields, ceramic glazes ammunition, plumbing, fetal monitor, certain surgical equipment and developing dental X-rays are common exposure of lead. Battery recycling and welding are also the exposure of lead [61].

## Physical and chemical properties

Lead occurs in three oxidation states i.e Pb (0), the metal; Pb (II); and Pb (IV). The occurrence of Pb (0) is rare as compare to Pb (II) and Pb (IV). Lead is amphoteric forming plumbites and plumbates in alkali and plumbous and plumbic salt in acid [62-64]. When exposed to water and air lead oxides, lead carbonates and lead sulphate films are formed [65-67]. Due to low melting and best corrosion resistance use of lead is more [68-71]. Lead is slightly above the hydrogen therefore it should replace hydrogen in acid and the high hydrogen overvoltage prevent replacement [72].

## Effect of lead on nervous system

The nervous system is the target of number of metals, the alkyl derivatives of certain metal such as lead and mercury are neurotoxic [73]. The symptoms are fatigue, fine and gross motor deficits, decreased cognitive functioning, neuro-degeneration, emotional disruption, nausea, headaches, depression, anxiety, irritability are more prevalent [74]. Adverse neurological effects of chronic lead exposure have been observed in the immature organisms. As compared to adults mostly children are more sensitive to the toxic effects of low level lead exposure [75].

## Hematological effects of lead

Different hematological effects of lead exposure have been found. Hypochromic and microcytic red blood cells which cause iron deficiency have been seen in lead induced anemia. In this way basophil stippling increases and the main reason of the lead anemia are short life span of erythrocytes, impaired heme synthesis and the inhibition of Na and K dependant ATPases.

## Discussion

### Carcinogenicity, effect of lead

The International Agency for Research on Cancer has categorized inorganic lead compounds as Group 2A carcinogens. The National toxicity programme in the USA states that lead is portable human carcinogen. Lead exposure workers are habitual of smoking and arsenic which cause the lung cancer. In Canada recent studies shows association between lead compounds and lung cancer. Helicobacter pylori may cause stomach cancers and in minor cases cause lung.

### Effects of lead on reproductive system

Lead effects on both male and female reproductive system. When lead level is 40 µg/dL different changes occur in the volume of sperms. General morphology and motility of sperms also affected at this level. The problems associated with female reproductive system are more complicated as compare to males. It leads to miscarriages, prematurity, low birth weight and developing problems. Blood lead level is similar in mother and infants because lead in mother also passes to infant through placenta and breast milk [76,77].

### Effects of lead on renal system

Different studies shows that even the low level of lead cause the chronic renal failure. Waden and his co-helpers studied the hazards effects of lead on patients. They see tubular dysfunction in patients. Blood lead level and lead burden are increased. The important hazards occupational exposure is lead nephropathy.

Tubular reabsorption, glomerulus filtration rate, inhibiting uric acid secretion, gout, hyperuricemia, proximal tubule and renal clearance is caused by the accumulation of lead.

An inverse relationship between blood lead and glomerular filtration rate seen in cohorts with blood concentration as low as 2 µg/dl.

### Effects of lead on cardiovascular system

Different evidence suggests that lead exposure lead to heart rate variability, heart diseases and death from stroke. When ozone and fine particles are higher it leads to cardiac autonomic dysfunction.

A positive relationship between exposure of lead and clinical cardiovascular events have been identified. In adult population the heart disorders with exposure of lead add economic cost of lead poisoning.

### Effects of lead on bone tissues

Lead effects the bones as it deposited in bone tissues. Calcium released from the bones as we need it but when there is accumulation of lead instead of calcium lead is released from the bones. Lead blocks the natural processes of the body. 95% of lead is stored in the bones and teeth. If lead bounces back from bones into blood it cause severe problems. In 1990 many workers participated in national health and safety conference in bone leading screening. It was observe that workers have high level of lead as compare to the people who have no occupational exposure.

### Effect of lead on immune system

The Chinese article was introduced to show that abnormal T-cell subsets and cellular immune function are suppressed when workers with blood lead levels is >60 µg/100 ml. Lead poisoning affects the immune system that increased the chances of the infectious diseases, cancer and autoimmune diseases. Immune system is considered sensitive to the toxic heavy metals as compare to the toxicological parameters. Environmental factors and heritable traits determine the autoimmunity.

### Effect of lead on blood pressure

The difficulties of interpretation suggested for lead have much longer effects on the blood pressure. The study shows that 220 workers working in lead batteries company have higher chances of blood lead and hypertension.

Pocock does not find any association between hypertension and blood pressure i.e. systolic and diastolic. Recent studies show a relationship between blood lead and systolic blood pressure in black men and women. During pregnancy there is elevation in the blood pressure. The data from the National Health and Nutrition Examination Survey (NHANES III) show impact on all races.

### Effects of lead on Hepatic system

The liver is composed of phase I and phase II enzymes systems that provide protection to the physiological systems from the poisoning effects of the xenobiotic compounds. Changes in the cholesterol metabolism, hepatic xenobiotic metabolism, liver cell proliferation and DNA synthesis are caused by the acute and chronic level of lead. Benzo pyrene hydroxylase ALA dehydratase N-demethylase and ethylmorphine activities decrease with lead toxicity.

### Effect of lead on environment

In environment small amount of lead quantity is present which is increased by the human activities like mining, burning of fossil fuels and manufacturing. In the United States the sources of lead are paints and the work place. Lead has most damaging effects on human health. The study shows that 10 tons per year to 1,000,000 tons per year increased in the lead population has been occur.

### Effects of lead on pregnant women

The effect of lead on pregnant women increased the risk of preterm births. The risk of emergency abortion may increase. There are more chances of lead toxicity in firstly pregnant women. As the lead travels from bones into blood the level of blood lead toxicity increase in pregnancy. It was found that 20% of blood lead level increases and there is association between the blood lead level and hypertension in pregnancy. Blood lead level may increase in women due to deficiency of calcium.

### Lead in developing fetus

There is a study relationship between umbilical cord and maternal blood lead level. It was found that blood lead level is 19% higher in infants as compare to mother at the time of delivery. During gestation and in the first 36 months of life than it is later in life the effect of lead is higher on the central nervous system of fetus. Effects of lead exposure may be manifested on the fetus during gestation and after birth by cognitive tests.

### Effects of lead during breast feeding

The effects of lead on infants during breast feeding have been studied. Lead has been seen in the milk of the women, assess to the lead at this point is limited. Infant blood lead levels are linked with the period of breastfeeding. Less than 3% ratios of breast milk lead level to blood lead level have been seen. According to the American Academy of Pediatrics, the breastfeed infants have higher level of blood lead as compare to the infants that are not breastfeed.

### Effects of lead on children 1-6

High level of lead is the major threat to the children. Toys, glazed ceramics, food, drinking water, air, soil, dust and paints are the main sources of threat. Six years old and younger children growing very fast, developing stronger muscles, fast rate of growing bones and creating bones have dangerous level of lead. For the children even the low level of lead causes the seizures, unconsciousness and death. Safe level of the blood lead has not been identified. On the basis of the neurological toxicity the US centres for disease control and prevention has describe blood lead level in children as  $\geq 10 \mu\text{g/dl}$  and anemia in children less than 3 years of age. Due to lead poisoning 15 million children are suffering from permanent neurological damage. Acute and chronic lead poisoning causes fatigue, constipation, ataxia, coma and convulsion and children facing several disorders.

### Effects of lead on younger adults

Lead also effects on younger adults. The more the level of lead in the body more it will be dangerous to the human health. When the blood lead level is greater than  $15 \mu\text{g/dL}$  cause nerve disorders, heart disorders, kidney failure, fertility problems, lower sperm count and motility. However lead level below  $10 \mu\text{g/dL}$  cause hypertension, essential tremor, decrease kidney functioning, damage of central nervous system slowly.

### Effects of lead on senior citizen

Because the older people alive for a longer period of time so they have more chances of lead toxicity. They absorbed lead from the environment especially from the work places. Occupational older people have higher level of lead as compare to the people which are non occupational. They have higher blood lead level as compare to the younger people. As the lead enters into the body it circulates into tissues and bones and cause osteoporosis, kidney failure and cognitive impairment.

### Intervention for prevention

By knowing all the sources of lead, the goal will be diminishing it. If lead is caused by the soil then families should planting grass or wood chips. If lead paint is necessary, cannot removed it than in place of paint encapsulation can be used, it prevent the lead paints, lead dust from entering in the body of organisms. Nurses play an important role in guiding the families to find necessary resources.

### Dust

Different programs are introduced to educate the parents about the home cleaning to decrease the blood lead level in already exposed children. By cleaning the home moderate success is shown but it require labor cost vacuums are used but it is costly. Families are exposed to the lead when workers come to home from lead work places; the lead dust is come with the shoes and clothes. An annual

public report should be made to check the contaminants in the water. If the family has well it also should be checked from the laboratories. The patients with pica should be treated with anxiety and obsessive-compulsive disorders.

Lead is mostly observed by regular snacks, frequent meals and also by empty stomach. Lead toxicity is enhancing by diet deficient in iron, calcium and zinc. More lead absorption causes iron deficiency and the diet in which calcium concentration is less cause bone diseases in pregnant women.

### Management of lead exposure

There is a need to control the level of lead. Workers working in lead industries should change their dresses or shoes before entering the home because with their dresses and shoes lead dust come. There is also need for the nutritional support programs to give awareness about the health. The government should release moderate level of lead in order to reduce the health problems.

### By chelation therapy

In order to reduce the level of lead chelation therapy is used. In this process most of the chelation agents bind with the lead and cannot pass from the cellular membrane. As it cause hepatotoxicity or nephrotoxicity but it is beneficial for acute poisoning but it is not recommended for chronic poisoning. Chelation therapy is not used when blood lead level is below 45 µg/dL in adults.

## Conclusion

In this review we reviewed the effect of lead on the human health. It is found that lead has no beneficial effects on the human health. It leads to several complications like anemia, carcinogenicity, damage of reproductive system of men and women, kidney damage, heart disease, brain damage, raise of blood pressure, liver damage, effects on children learning ability and behavior etc. Due to increased human activities the amount of lead has increased in the environment.

Failure to control the level of lead will lead to severe complications in future. Decreasing the amount of lead in the environment (e.g. in soil, dust, air and products) as much as possible will decrease the risk of harm from lead exposure, especially for young children and unborn babies. The good news is however that the levels of lead can be decreased from the body by a number of techniques used today. The most important among them are chelation therapy, nano-encapsulation, N-Acetyl Cysteine (NAC).

Medications also exist that can reduce the effect of lead from the body to some extent. The treatment strategies are not equally effective for everybody due to the differences ranging from genetic factors to environment and diet. Engineering solution can be helpful for the occupational exposure of the lead. Government should held seminars to promote the awareness about the harmful effect of lead on human health by providing the important preventions and abatement resources through radio and television and should take step to decrease the amount of lead in the environment.

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