# Environmental Toxin, Exposure to Toxins among Children around Cement Factory (Review)

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## ABSTRACT

Environmental toxicant may refer to pollutant causing pollution or biologically created toxins in the environment. Chemicals, both natural and synthetic, have the potential to cause disease by either inhalation or ingestion. Toxins threaten everyone's health, but infants and children are more sensitive to toxins than adults, because children organs are still developing and their bodies are less able to detoxify. Children are also more vulnerable to toxins because they lack a fully developed blood-brain barrier and a structure in the central nervous system that prevents the passage of chemicals between the bloodstream and the neural tissue. This research emphasis on identifying and evaluating children exposure to environmental toxins around cement factory and health related issues; the review describe different types of environmental toxins around cement factory and their health effects towards children.

**Keywords:** Toxin, Environment, Exposure, Children, Cement Factory

## INTRODUCTION

The modernization and industrialization of developing countries has led to the increased use of fossil fuels and their derivatives. As such, developing countries are confronted with the great challenge of controlling pollution, especially around the cement factory. Industrial pollution is a problem which may have an adverse effect on the health of the population that leaves around it. Heavy metals are the main sources of environmental pollution around a cement factory [1]. Soil contamination by heavy metals can cause long term problems on the biogeochemical cycle, which may affect soil functioning systems, leading to changes in soil texture [2].

From previous studies in other countries, it has been established that dust containing elevated amounts of trace metals emanating from the vicinity of cement factories may adversely affect humans, plants, and

ISSN: 2277-0097

soil composition within the vicinity [3]. Study shows that cement factories have been noted as potential sources of metals such as Hg, Zn, Pb, Cr, and Cd [4-8]. The effects and concentrations of the dust containing trace metals as pollutants vary and depend largely on technology employed from the cement industries to ameliorate environmental degradation. In humans, trace metals such as Pb may affect the brain and cause retarded growth, especially in children [9]. In plants, excessive [Pb] alters normal metabolic pathways by disrupting specific cellular enzymes and may also inhibit the photosynthetic ability of plants [10]. On a general note, excessive levels of heavy metals may result in the induction of oxidation stress, damage to DNA, and disturbances in the biosynthetic pathways [11]. The main objective of this review is to provide insight into the sources of heavy metals and their harmful effects on the living organisms.

Although, Chemicals both natural and synthetic have the potential to cause disease, toxic pollution is as a result of inhaling or ingesting toxic chemicals that have adverse health effects. At any instant, toxic pollution affects over 100 million people worldwide, shortening the average life span by 12.7 years [12]. In fact, 20% of all deaths in developing nations are caused by environmental pollution [13]. While toxins threaten everyone's health, infants and children are especially sensitive to toxins. This is because children are more exposed to chemicals (pound-by-pound), their organs are still developing, and their bodies are less able to detoxify. Children are also more vulnerable to toxins because they lack a fully developed blood-brain barrier, the structure in the central nervous system that prevents the passage of chemicals between the bloodstream and the neural tissue. In fact, a human brain continues to develop until age 20 [14].

Heavy metals are elements with high atomic masses. Heavy metals may be toxic; these toxins include arsenic, lead, mercury, and cadmium. Other heavy metals are necessary to life, including zinc, cobalt (found in vitamin B-12), and iron (found in hemoglobin). Furthermore, trace elements, such as copper, manganese, selenium, chromium, and molybdenum, are important to the human diet [15].

## EFFECTS OF HEAVY METALS ON HUMANS

Heavy metal toxicity can lower energy levels and damage the functioning of the brain, lungs, kidney, liver, blood composition and other important organs. Long-term exposure can lead to gradually progressing physical, muscular, and neurological degenerative processes

that imitate diseases such as multiple sclerosis, Parkinson's disease, Alzheimer's disease and muscular dystrophy. Repeated long-term exposure of some metals and their compounds may even cause cancer [16]. The toxicity level of a few heavy metals can be just above the background concentrations that are being present naturally in the environment. Hence thorough knowledge of heavy metals is rather important for allowing providing proper defensive measures against their excessive contact [17]

## ARSENIC

Arsenic contaminations have occurred as a result of both natural geologic processes and the activities of man. Anthropogenic sources of arsenic include human activities such as mining and processing of ores. The smelting process, both the ancient and a recent one, can release arsenic to the air and soil [18]. Such types of sources can affect the quality of surface water through groundwater ejection and runoff. Another way of ground water contamination is through geologic sources such as arsenic minerals. The third type of sources is sedimentary and meta-sedimentary bed rocks [19]. Humans are exposed to arsenic by means of air, food and water. Drinking water contaminated with arsenic is one of the major causes for arsenic toxicity in more than 30 countries in the world [20].

Arsenic poisoning in drinking water threatens the health of people globally. Some of the most serious cases of arsenic-contaminated groundwater have been found in aquifers in Asia (in Bangladesh, China, India, and Nepal) and South America (Argentina and Mexico). Ingestion of 70-180 mg of inorganic arsenic can cause death. Other acute effects of arsenic ingestion include difficulty breathing and swallowing, intestinal pain, vomiting, diarrhea, muscle cramps, and severe thirst [21]. Symptoms of chronic arsenic poisoning, often due to drinking contaminated water, include garlic breath, extreme perspiration, muscle tenderness, changes in skin pigmentation, anaemia, reduced sensation in the extremities, and peripheral vascular disease [22]. Inorganic arsenic is a human carcinogen, according to the Department of Health and Human Safety (DHHS), the EPA, and the International Agency for Research on Cancer (IARC) [23]. Studies have shown that ingestion of inorganic arsenic increases risk of skin, liver, bladder, and lung cancer, while inhalation of inorganic arsenic increases risk of lung cancer[24-25]. Therefore, the WHO and EPA set current limits for arsenic in drinking water at 0.01 parts per million (ppm) and OSHA limits arsenic exposure

in workplace air at 10 micrograms per cubic meter of air (10 μg/m³) for 8 hour shifts and 40 hour work weeks [26].

Lower levels of arsenic exposure can cause nausea and vomiting, reduced production of erythrocytes and leukocytes, abnormal heart beat, pricking sensation in hands and legs, and damage to blood vessels. Long-term exposure can lead to the formation of skin lesions, internal cancers, neurological problems, pulmonary disease, peripheral vascular disease, hypertension and cardiovascular disease and diabetes mellitus [27]. Chronic arsenicosis results in many irreversible changes in the vital organs and the mortality rate is higher. In spite of the magnitude of this potentially lethal toxicity, there is no effective treatment for this disease [28].

## LEAD

Lead is a naturally occurring metal found in the Earth's crust. But Human activities such as mining, manufacturing and fossil fuel burning has resulted in the accumulation of lead and its compounds in the environment, including air, water and soil In the past, lead has been used in the manufacture of gasoline, paints, ceramics, caulking, and solder pipe, but is no longer used to make these materials due to lead's harmful health effects. Lead poisoning is considered to be a classic disease and the signs that were seen in children and adults were mainly pertaining to the central nervous system and the gastrointestinal tract [29]. Although lead has many useful applications, but yet it is known to cause health complications that affect almost all human organs.

These complications include impaired intellect, memory loss, nerve disorders, infertility, mood swings, and problems with the cardiovascular, skeletal, kidney, and renal systems in adults. Lead can enter the body through ingestion or inhalation. Adults must be exposed to much more lead (compared to children) in order to suffer sustained health consequences. Most adults receive lead poisoning from work, especially in occupations related to welding, renovating, manufacturing car batteries, and maintaining bridges and water towers [30]. Children are exposed to lead in the form of dust and chips. Children are most vulnerable to lead poisoning. In fact, two-year olds have the highest blood level concentration of lead, partly because they place many objects and toys, some laden with lead, in their mouths [31]. Children with blood-lead concentrations greater than 10 micrograms per deciliter (μg/dL), or one millionth of a gram of lead in about half a cup of blood, have excess lead exposure. Recent studies, however, have shown that

children with blood-lead concentrations of even less than 10 µg/dL are subject to adverse health effects [32] Lead poisoning has been shown to cause cognitive impairment (decreased IQ) in children globally [33] A study comparing blood-lead concentrations and IQ in 172 children found that each increase of 10 µg/dL in the lifetime average blood-lead concentration was correlated with a 4.6 point decrease in IQ. In a subsample of children with maximal lead concentrations below 10µg/dL, a given change in lead concentration caused an even greater change in IQ [34]. In addition to lowering IQ, lead exposure also causes behavioural problems. Lead poisoning still remains a dangerous disease which can affect most of the organs. The plasma membrane moves into the interstitial spaces of the brain when the blood brain barrier is exposed to elevated levels of lead concentration, resulting in a condition called edema [35]. It disrupts the intracellular second messenger systems and alters the functioning of the central nervous system, whose protection is highly important.

## MERCURY

Elemental mercury is found naturally as an odorless, shiny liquid metal. Toxic mercury vapors can be released naturally (from volcanic eruptions and from the earth's crust) or synthetically (from waste incineration, coal combustion in power plants, automobile emissions, and disposal of industrial waste) [36].Mercury has the ability to combine with other elements and form organic and inorganic mercury. Exposure to elevated levels of metallic, organic and inorganic mercury can damage the brain, kidneys and the developing fetus [37]. Mercury has been used to make thermometers, barometers, and fluorescent light bulbs. Mercury released into the air settles into water or on land, where it deposits and is converted (by microorganisms) into methyl mercury, a highly toxic form of mercury that builds up in fish. Therefore, people can be exposed to mercury by ingesting fish that contain mercury, inhaling mercury vapors, or touching mercury.

Mercury exposure can damage the brain, heart, kidney, lungs, and immune system. Each three form of mercury compounds can causes different health effects. Elemental mercury, usually inhaled as vapors and found in thermometers, can cause mood swings, irritability, nervousness, insomnia, headaches, muscle twitching/tremors, and decreased cognitive functions. Organic mercury, or mercury covalently bound to carbon, impairs neurological development in fetuses, infants, and children, since methyl mercury can pass from mother to fetus through the placenta. Inorganic mercury, or mercury bound to inorganic

compounds, often causes skin rashes, inflammation and, if ingested, diarrhea [38].
In marine foods it is often seen at higher levels. Organic mercury can easily permeate across the biomembranes and since they are lipophilic in nature, mercury is present in higher concentrations in most species of fatty fish and in the liver of lean fish [39]. Micro-organisms convert the mercury present in soil and water into methyl mercury, a toxin which can accumulate with fish age and with increasing trophic levels. Symptoms of organic mercury poisoning include depression, memory problems, tremors, fatigue, headache, hair loss, *etc.* Since these symptoms are common also in other conditions, it may be difficult to diagnose such cases [40]. Due to the excess health effects associated with exposure to mercury, the present standard for drinking water has been set at lower levels of 0.002 mg/L and 0.001 mg/L by the Environmental Protection Act and World Health Organization [41].

## CADMIUM

Cadmium and its compounds are classified as Group 1 carcinogens for humans by the International Agency for Research on Cancer [42]. Cadmium is released into the environment through natural activities such as volcanic eruptions, weathering, river transport and some human activities such as mining, smelting, tobacco smoking, incineration of municipal waste, cement manufacture and manufacture of fertilizers. Although cadmium emissions have been noticeably reduced in most industrialized countries, it is a remaining source of fear for workers and people living in the polluted areas such as cement factory cites. Cadmium can cause both acute and chronic intoxications [43]. Cadmium is highly toxic to the kidney and it accumulates in the proximal tubular cells in higher concentrations. Cadmium can cause bone mineralization either through bone damage or by renal dysfunction

Numerous epidemiological studies conducted in the 1970s and 1980s provided evidence for the profound effect of this metal on children's behaviour and neurological development [44]. Research on children whose development was slower compared to their peers revealed that cadmium levels in their hair were considerably higher [45]. Other authors have noted that the presence of this metal correlated positively with learning difficulties and dyslexia in children [46]. The cohort study carried out by R. Thatcher et al. demonstrated that cadmium affects children's intelligence level (IQ score) [47]. Apart from the correlation between IQ and cadmium levels, other researchers noticed that this metal had an effect on children's visual, locomotive and cognitive

abilities [48]. The results reported by R. Pihl and M. Parkes show that the presence of cadmium, cobalt, manganese, chromium or lithium in blood results in a 98% certainty that a child is going to have learning problems [49]. Research conducted among 149 children aged 5-16 years demonstrated that the presence of cadmium considerably affected test results measuring their intelligence, physical fitness and academic achievement [50]. Inhaling higher levels of cadmium can cause severe damage to the lungs. If cadmium is ingested in higher amounts, it can lead to stomach irritation and result in vomiting and diarrhea. On very long exposure time at lower concentrations, it can become deposited in the kidney and finally lead to kidney disease, fragile bones and lung damage [51]

## CHROMIUM

Chromium (Cr) is considered an essential nutrient and a health hazard. Chromium is present in rocks, soil, animals and plants. It can be solid, liquid, and in the form of gas. Chromium compounds are very much persistent in water sediments. They can occur in many different states such as divalent, four-valent, five-valent and hexavalent state. Cr(VI) and Cr(III) are the most stable forms and only their relation to human exposure is of high interest [52]. Chromium (VI) compounds, such as calcium chromate, zinc chromates, strontium chromate and lead chromates, are highly toxic and carcinogenic in nature. Chromium (III), on the other hand, is an essential nutritional supplement for animals and humans and has an important role in glucose metabolism.

Occupational sources of chromium include protective metal coatings, metal alloys, magnetic tapes, paint pigments, rubber, cement, paper, wood preservatives, leather tanning and metal plating [53-54]. Reported that cigarettes contained 390 g/kg of Cr, but there has been no significant report published on the amount of chromium inhaled through smoking. When broken skin comes in contact with any type of chromium compounds, a deeply penetrating hole will be formed. Exposure to chromium compounds can result in the formation of ulcers, which will persist for months and heal very slowly. Ulcers on the nasal septum are very common in case of chromate workers. Exposure to higher amounts of chromium compounds in humans can lead to the inhibition of erythrocyte glutathione reductase, which in turn lowers the capacity to reduce methemoglobin to hemoglobin [55-56]. Results obtained from different *in vitro* and *in vivo* experiments have shown that chromate compounds can induce DNA damage in many different ways and can lead to the formation of DNA adducts, chromosomal

aberrations, sister chromatid exchanges, alterations in replication and transcription of DNA [57-58] Health effects are categorized as carcinogenic (causing cancer) and noncarcinogenic including the following three different exposure durations that result in adverse health effects: Acute (14 days or less), Intermediate (15 to 364 days) and Chronic (365 days or more) [59].

## ALUMINIUM

Aluminium is the third most common element found on the earth's crust. It exists in only one oxidation state ($^{3+}$) in the environment. The main routes of aluminium consumption by humans are through inhalation, ingestion and dermal contact and sources of exposure are drinking water, food, beverages, aluminium containing drugs and industrial dust. Aluminium is naturally present in food. Aluminium and its compounds are poorly absorbed in humans, although the rate at which they get absorbed has not been clearly studied. Symptoms that indicate the presence of higher amounts of aluminium in the human body are nausea, mouth ulcers, skin ulcers, skin rashes, vomiting, diarrhea and arthritic pain. These symptoms have however been reported to be mild and short lived [60].Aluminium exposure is probably a risk factor for the onset of Alzheimer disease (AD) in humans, as hypothesized by the WHO [61].

Aluminium contributes to the brain dysfunction of patients with severe kidney disease who are undergoing dialysis. High levels of aluminum have been found in neurofibrillary tangles (characteristic brain lesions in patients with Alzheimer's disease), as well as in the drinking water and soil of areas with an unusually high incidence of Alzheimer's disease. Nevertheless, the experimental and epidemiologic evidence for a causal link between aluminium exposure and Alzheimer's disease is, overall, relatively weak [62].

## IRON

Iron is the most abundant transition metal in the earth's crust. Biologically it is the most important nutrient for most living creatures as it is the cofactor for many vital proteins and enzymes. Iron mediated reactions support most of the aerobic organisms in their respiration process. If it is not shielded properly, it can catalyse the reactions involving the formation of radicals which can damage biomolecules, cells, tissues and the whole organism. Iron poisoning has always been a topic of interest mainly to paediatricians. Children are highly susceptible to iron toxicity as they are exposed to a maximum of iron-containing

products [63]. Iron toxicosis occurs in four stages. The first stage which occurs after 6 hours of iron overdose is marked by gastrointestinal effects such as gastro intestinal bleeding, vomiting and diarrhoea [64]. The second stage progresses within 6 to 24hrs of overdose and it is considered as the latent period, a period of apparent medical recovery. The third stage occurs between 12 to 96 hours after the onset of certain clinical symptoms. This stage is characterized by shocks, hypotension, lethargy, tachycardia, hepatic necrosis, metabolic acidosis and sometimes death [65]. The fourth stage occurs within 2–6 weeks of iron overdose. This stage is marked by the formation of gastrointestinal ulcerations and development of strictures. Excess iron uptake is a serious problem in developed and meat eating countries and it increases the risk of cancer.

## CONCLUSION

This review critically examine the effect of environmental toxin, exposure to toxins among children around cement factory such as heavy metal *i.e.* arsenic, lead, mercury, cadmium, chromium, aluminium and iron. Children living near cement industry or toxic waste sites may be exposed through air, dust (both outdoor and indoor), water and food. Because of children's dynamic and continuous process of growth and development, the effects of environmental threats may be cumulative (e.g. in some instances children may be exposed repeatedly to toxicants and their effects continue to accumulate). Childhood exposure may affect health in adulthood, or the health of the next generations (i.e. effects are intergenerational, as is the case with children born to mothers who were exposed to heavy metal in their childhood). Exposure may have long-term consequences and produce permanent disability. The result of the review confirm that cement dust is both toxic pathogenic to children, there is no doubt that the people living or working within the vicinity of cement factory stand the risk of being affected by different type of disease arisen from the cement dust.

## RECOMMENDATION

There is need for effective legislation, guidelines and detection of the areas where there are higher levels of heavy metals. Failure to control the exposure will result in severe complications in the future because of the adverse effects imposed by heavy metals on children. Exposure to heavy metals can be decreased by engineering solutions. Monitoring the exposure and probable intervention for reducing additional exposure to heavy metals in the environment and in humans can become a momentous step towards prevention. National as well as international

co-operation is vital for framing appropriate tactics to prevent heavy metal toxicity.

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**Reference** to this paper should be made as follows: M. Musa, et, .al (2017) Environmental Toxin, Exposure to Toxins among Children around Cement Factory (Review). *J. of Environmental Sciences and Resource Management,* Vol. 9, No. 1, Pp. 19-32