HEAVY METAL EXPOSURE IN CHILDREN

Huriye Demet Cabar[1*], Sena Oruc[2], Elif Gumus[2]

[1]*Sinop University, School of Health, Sinop*
[2]*Sinop University, Interdisciplinary Environmental Health, Sinop,* ***TURKEY***

*Corresponding author: gonener@hotmail.com

ABSTRACT

Heavy metals have been ubiquitous in our lives in many ways and for different purposes for centuries. Heavy metals cause health effects not only in adults but also in children. Therefore, it is aimed to give information about the interaction of heavy metals to children and nursing approach in the study which is planned as a review by conducting literature search.

Keywords: *Heavy Metals, Children, Health, Disease*

INTRODUCTION

Industrialization and urbanization have led to the increase of heavy metal levels in the environment and, consequently, the increased contact of living things with heavy metals (Orun and Yalcin, 2011). Therefore, understanding the toxicological effects of heavy metals on ecological systems has gained importance (Kahvecioglu et al., 2003). Environmental pollution emerges in a triple circle formed by air, soil, and water pollution, which affects the ecosystem, including humans (Caglarirmak and Hepcimen, 2010). The increase in heavy metal levels in the living environment leads to an increase in heavy metal levels in most living beings. Humans are at the top of the food chain and are increasingly in contact with heavy metals. People first encounter heavy metals during the intrauterine period, however contact continues after birth through the air and breast milk (Orun and Yalcin, 2011). Heavy metals can cause damage to living things at low concentrations and accumulate in the food chain (Who, 2011). This accumulation in the food chain is supplemented by direct contact with the soil or plant and/or animal products (Caglarirmak and Hepcimen, 2010). Exposure to heavy metals disrupts vital activities in children, harms organs, and causes permanent damage (Who, 2011). Children exposed to heavy metal in utero and during childhood experience neurological injuries (McAlpine and Araki, 1958), growth retardation during the fetal period (Who, 2011; Orun and Yalcin, 2011), low scores on IQ tests compared to their peers (Orun and Yalcin, 2011), and chronic diseases (Who, 2011; Orun and Yalcin, 2011).

Heavy metals are classified as vital and non-vital according to their impact on life. Vital metals must be obtained regularly through food because they participate in biological activities (Kahvecioglu et al. 2003). For example, chromium, selenium, and zinc are found in human blood cells, copper participates in many oxidation and reduction reactions, and cobalt is used in hemoglobin and myoglobin as a coenzyme (Kahvecioglu et al.,.2003; Who, 2011). However, even a low concentration of non-vital heavy metals can cause health problems by affecting psychological health, whereas vital ones are required at a certain dose for biological continuation. The mechanism of heavy metal effects vary according to the dose of exposure and to the specific organism. For example, nickel has a poisonous effect on plants, whereas it is a vital trace element in animals (Kahvecioglu et al., 2003).

Dissolved heavy metals reach surface waters and the sea and persist. Those contaminated waters can be transported to drinking water and food. Contaminated food cannot be removed from the body and the heavy metals accumulate. It is possible to classify heavy metals according to their effects on human metabolism. This classification can be made as those affecting chemical reactions, those affecting physiological and transport systems, carcinogens and mutagens, those affecting building blocks, allergens, and specific agents (Kahvecioglu et al., 2003).

Heavy metals can bind to blood cells in humans causing respiratory, renal, cardiovascular, and skeletal system diseases, as well as lung, kidney, stomach, and prostate cancer (Who, 2011). Exposure to heavy metals can even cause problems such as DNA breakage. In addition, exposure to heavy metals may cause loss of sperm quality, testicular necrosis, and hormone impairment (Yilmaz and Dinc, 2013).

Exposure to heavy metals during growth and development can cause long-term effects on children's health (Who, 2009). Heavy metals can cause acute and chronic poisoning after ingestion by mouth, respiration, and skin. Contact with heavy metals causes harmful effects on all systems, particularly the nervous system, in the developing fetus and child (Ozkan, 2017). For example, growth retardation, neurological disorders, and mental retardation may be seen in children exposed to lead or methyl lead in the womb (McAlpine et al. 1958; Orun and Yalcin, 2011; Ozkan et al., 2017). Compared to adults, children are much more likely to be affected by heavy metals (Who, 2009). Therefore, it is aimed to give information about the interaction of heavy metals to children and nursing approach in the study which is planned as a review by conducting literature search.

THE EFFECTS OF HEAVY METALS ON CHILDREN'S HEALTH

Arsenic, cadmium, lead, and mercury are heavy metals with frequent toxic effects. In this section, the effects of these heavy metals on children's health are discussed.

Arsenic

Arsenic is found in the soil, drinking water, it is used leukemia medicines, agricultural pesticides, and various industrial fields (Who, 2011). Arsenic is absorbed in the body in both organic and inorganic forms. Although 80-90% of inorganic arsenic is absorbed in the gut, organic arsenic, usually obtained from seafood, is absorbed in a proportion that is not considered a health threat for children. Acute arsenic poisoning is more frequent in adults than in children (Who, 2011).

Arsenic in the body binds to red blood cells and globulin, disrupts the structure of proteins, and affects DNA structure (Who, 2011). Arsenic may accumulate in hair and nails and cause skin, lung, and bladder cancers (Caglarirmak and Hepcimen, 2010). The mechanism of arsenic toxicity involves increasing reactive oxygen molecules and oxidative stress, triggering apoptosis, and causing an imbalance between antioxidant levels and cell death (Who, 2011).

Arsenic is usually excreted by the kidneys within 3-5 days. Furthermore, arsenic can be found in very low levels in breast milk (Who, 2011). Findings of hepatomegaly anemia and abnormal ECG were observed in infants poisoned with arsenic-contaminated milk (Caglarirmak and Hepcimen, 2010). Because of placental passage, arsenic exposure can cause stillbirth and severe damages to a fetus. Exposure to 2 mg/kg arsenic in children can be fatal. Arsenic can cause chronic muscle numbness, cancer, and skin problems (Who, 2011).

Cadmium (Cd)

Fibrous greens grown in Cd-contaminated soil, root vegetables such as potatoes and carrots, and grains such as rice and oil seeds are high in Cd. In addition, the accumulation of Cd powders used in various industrial fields and cigarettes are main sources of Cd exposure (Orun and Yalcin, 2011). The amount of Cd taken into the body during the consumption of one pack of cigarettes per day is 5-10 times as much as the amount taken in through the daily diet (Who, 2011). Inadequate intake of calcium, zinc, iron, copper, and protein in the diet increases intestinal Cd absorption. Today, the urine, blood, hair, nails, and breast milk are the indicators of Cd in the body (Orun and Yalcin, 2011).

Cd destroys the absorption of zinc from the intestines, causes a decrease in copper deposits in the liver, binds to ferritin, reduces the amount of hemoglobin, causes anemia, and is stored in the bones (Who, 2011). Following long-term exposure to Cd, the kidneys are the most affected organ (Caglarirmak and Hepcimen, 2010). Cd accumulation can cause chronic proximal tubular necrosis, itai-itai disease, pulmonary fibrosis, proteinuria, and hypertension in the body (Who, 2011). In addition, the effect of Cd on the formation of lung and prostate cancers has been demonstrated (Caglarirmak and Hepcimen, 2010).

The development of the fetus exposed to Cd in the mother's womb is adversely effected. The fetal Cd exposure level in the mother's womb negatively correlates with 4-year-old IQ test results. Low birth weight (<2500 g) was more common in children exposed to high cadmium in cord blood. In a study conducted to observe the effect of Cd exposure in pregnant women in China, no correlation was found between cord and placental Cd amount and birth weight. However, there was a negative correlation between birth height and Cd ratio in cord blood and placenta (Who, 2011). There is also a negative correlation between Cd levels in the hair and intelligence level in children (Orun and Yalcin, 2011).

Lead (Pb)

An important facet of Pb is that it was the first metal that adversely affected ecological structure due to human activities (Kahvecioglu et al., 2003). Most of the Pb environmental pollution is released to the air through gasoline combustion in vehicles (Caglarmak and Hepcimen, 2010; Orun and Yalcin, 2011). Because of the transfer of industrial wastes by water, marine animals can be contaminated with Pb (Caglarirmak and Hepcimen, 2010).

Human contact with Pb starts during the intrauterine period because it can easily pass through the placenta. During pregnancy, the Pb in the bone mobilizes and passes to the fetus through the placenta. Following birth, the most important Pb exposure in infancy and childhood is via Pb contaminated paint dust, paint chips, soil, water, and placing foreign substances into the mouth (Orun and Yalcin, 2011). Pb was used in high quantities in oxide dyes to prevent rusting in the 20th century. Children eat the sweet tasting Pb oxide found in dyeing agents, which leads to significant health problems (Kahvecioglu et al., 2003).

Pb needs to reach a certain level in blood or soft tissue to produce toxic effects on the body (Caglarirmak and Hepcimen, 2010). Pb accumulation is mostly seen in the bone, brain, liver, lung, spleen, kidney cortex, erythrocytes, and teeth (Ozkan et al., 2017). Pb accumulates in the bone and has a half-life of about 20 years, eventually dissolves, and damages the kidneys (Kahvecioglu et al., 2003).

The rate of Pb absorption in the body is higher in children. Although adults absorb only 3-10% of Pb, this rate increases to 50% when orally ingested by children (Kahvecioglu et al., 2003; Ozkan et al., 2017).

Pb has the most intense pathological effects during the first three years of life. Pb toxicity affects the body through various mechanisms including the central nervous, hematopoietic, reproductive, and urinary systems. Lipid-rich tissues such as the central nervous system are highly susceptible to Pb exposure. Pb causes a decrease in neurotransmitters such as acetylcholine, dopamine, and glutamate, disrupts hemoglobin synthesis, and disrupts the synthesis, release, and elimination of hormones (Ozkan et al., 2017).

Pb is a neurotoxin that causes abnormal functions in the developing brain and nervous system during childhood (Kahvecioglu et al., 2003, Ozkan et al., 2017; Orun and Yalcin, 2011). In early childhood, the blood-brain barrier is not sufficiently developed and the Pb itself destroys this barrier (Ozkan et al., 2017). When children are exposed to Pb, they suffer from decreased scores on specific cognitive tests, behavioral changes, attention deficit, mental retardation, learning problems, hyperactivity, failure in school, hypertension, chronic anemia, and peripheral nervous system issues (Caglarirmak and Hepcimen, 2010, Ozkan et al. 2017). Increases in the blood Pb level cause a decrease in IQ level. A 10 mcg/dl increase of Pb in the blood caused a 2-point decrease in IQ (Kahvecioglu et al. 2003; Orun and Yalcin, 2011).

Pb exhibits adenocarcinoma effects by stimulating DNA, RNA, and protein synthesis in proximal cell nuclei (Yilmaz and Dinc, 2013). Pb has a carcinogenic effect, especially on the kidney. In addition to movement disorders, mental retardation, and renal dysfunction in the fetal period, there is also a relationship between cord blood Pb level and hemangiomas, lymphangiomas, hydrocele, undescended testis, and skin anomalies (Ozkan et al.).

In addition, 50% of the dry weight of paint containing Pb compounds such as

Pb oxide and Pb carbonate contains Pb. Thus, wallpaper, painted floors, and painted toys contain Pb sources that are difficult to protect children from (Dundar and Aslan, 2005). Painted toys containing Pb can cause poisoning in children. Inexpensive teethers and bathroom toys can contain Pb-containing dyes. Children playing with toys containing Pb stearate or painted with Pb-based dye are at risk for exposure to Pb through skin (Bozalan, 2011).

Mercury (Hg)

Mercury is used in medical devices such as the Hg thermometer and amalgam in teeth fillers, in the paper industry as a bleaching agent, and in plastic synthesis as a catalyst. The amount of Hg in the environment increased 3-fold due to industrialization. There is also some Hg accumulation in seafood (Ozkan et al.).

Humans encounter Hg in three different forms, elemental Hg, inorganic Hg, and organic Hg. Organic Hg compounds, such as methyl mercury (Me-Hg), are soluble in oil and easily absorbed from the gastrointestinal tract due to their organic structure and short hydrocarbon chains. The most important source of Me-Hg is large fish that live in Hg-contaminated waters (Orun and Yalcin, 2011). The best example of Me-Hg poisoning is the Minamata disaster. In 1950s, a factory discharged its Hg-containing wastes into the sea causing severe poisoning in people who consumed local fish due to the Hg accumulation in those fish. This event was the first Me-Hg poisoning caused by fish consumption, and it took many years to understand the main cause (Koksal, 2008). The disease progressed with numbness in the hands and feet leading to the death of many people and the introduction of a neurological disease called Minamata Disease (McAlpine et al., 1958). In a subsequent study, the symptoms and lesions of Me-Hg poisoning were re-examined and fetal Me-Hg poisoning was reported to cause serious disorders in both mental and motor development, which caused significant disruptions in functions such as chewing, swallowing, speech, and walking and severe damage in the somatosensory cortex (Ekino et. al., 2007). Me-Hg can pass through the blood-brain barrier, placenta, and mammary glands and cause miscarriages or birth congenital anomalies during pregnancy (Caglarirmak and Hepcimen, 2010; Orun and Yalcin, 2011). There is a positive correlation between hair Hg level and cord blood Hg level in mothers consuming whale meat during pregnancy (Orun and Yalcin, 2011).

Compared to inorganic Hg, Me-Hg has additional detrimental effects on children's health (Orun and Yalcin, 2011). For example, exposure to methylmercury during the fetal period or early childhood may cause serious health problems such as mental retardation, whereas the same dose does not cause mental deterioration in adults (Who, 2009). In addition, exposure to Hg leads to cerebral palsy, gait abnormality, muscle weakness, epilepsy, deafness, and blindness in children (Ozkan et al.). High doses of Me-Hg may cause cerebral palsy, whereas low doses may cause neurodevelopmental difficulties manifested as learning and memory problems (Orun and Yalcin, 2011). Contact with Hg also causes kidney damage and psychological changes (Caglarirmak and Hepcimen, 2010). Hg is a neurotoxin that can cause degeneration and death in neurons. The increase in autism in recent years has also been associated with the increase in Hg exposure, but no significant link has been observed (Who, 2011).

THE EFFECT OF HEAVY METALS AT INADEQUATE NUTRIENT INTAKE LEVELS

There are two types of association between heavy metals and nutrient intake levels;

- Nutrients can function as carriers of heavy metals in the body. For example, heavy metal accumulation in seafood causes Me-Hg poisoning.
- The level of heavy metal absorption may be influenced by nutrient intake. The effect of a substance and its harm can be altered by the level of nutrition. Inadequate intake of calcium, zinc, iron, copper, and protein in the diet increases intestinal Cd absorption (Orun and Yalcin, 2011; Who, 2009).

Maternal diets rich in Pb content and adequate hemoglobin levels in the blood prevent the passage of Pb from the umbilical cord to the baby.

The route of Cd absorption is the same as iron, zinc, and calcium. Cd uptake is higher in Pb deficient individuals (Kordas et. al., 2007). Cd may degrade phosphorus and calcium, alter calcium metabolism, and be a factor in kidney stone formation (Who, 2009).

As a result, it is important to minimize the exposure of children to heavy metals as much as possible even though exposure to heavy metals is increasing daily. It is difficult to protect children from heavy metal exposure during childhood, when growth and development as well as the desire to explore occur. Therefore, it is important to know the potential avenues for children's heavy metal exposure and for school/children nurses to direct children towards activities that prevent such exposures. It is also important for nurses to inform parents about this issue. It is vital to raise awareness regarding children and environmental factors (toys during the pre-school period; unhealthy school furnishings and contaminated food during the school period; cigarettes during adolescence) and to provide supervision and preventive measures for such contaminants. In addition, nurses and dieticians can provide education on this subject to mitigate these health problems. Due to the role of food in heavy metal exposure, providing children food with potentially lower heavy metal contamination risks to prevent heavy metal ingestion through diet should be considered. nurses, dietitians, and other health team members, as well as teachers and professionals in the toy and food industry, can collaborate on this subject.

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