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Health hazards resulting from exposure to heavy metals generated during the incineration of electronic and electrical waste in developing countries on the example of Agbogbloshie

Zagrożenia zdrowia wynikające z narażenia na metale ciężkie powstające podczas spalania elektrośmieci w krajach rozwijających się na przykładzie Agbogbloshie

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Streszczenie

Spalanie elektrośmieci jest jedną z podstawowych metod utylizacji sprzętu elektronicznego w krajach rozwijających się. Podczas spalania telefonów komórkowych, komputerów, telewizorów, kabli oraz sprzętu AGD do atmosfery oraz gleby uwalniają się toksyczne dymy zawierające kwaśne gazy, wielopierścieniowe węglowodory aromatyczne (WWA), dioksyny i metale ciężkie. Próbki powietrza pobrane od pracowników i środowiskowe próbki powietrza w Agbogbloshie wykazały podwyższone poziomy dla aluminium, miedzi, żelaza, cynku i ołowiu. W artykule omówiono negatywne skutki narażenia na wybrane wskazane metale ciężkie najbardziej negatywnie wpływające na zdrowie człowieka.

Summary

Combustion of electro-waste is one of the basic methods of e-waste processing in developing countries. When burning mobile phones, computers, TVs, cables and household appliances, toxic fumes containing acid gases, polycyclic aromatic hydrocarbons (PAHs), dioxins and heavy metals are released into the atmosphere and the soil. Personal air samples collected from workers and the environment air samples in Agbogbloshie indicated elevated levels for aluminum, copper, iron, zinc and lead. The article discusses the negative effects of exposure to the some indicated most dangerous heavy metals for human health.

Introduction

E-waste is burning under risky conditions by poor and marginalised population. Electronic and electric equipment are smashed with simple tools including hammer, spanner, chisel, stones and even with bare hands. The fraction of iron, copper, aluminium, gold and other heavy metals in e-waste is over 60% while plastic contains about 30% of hazardous pollutants [1].

The dominant exposure for heavy metals at Agbogbloshie is the open burning of wires and electronic and electric equipment for copper recovery [2]. In order to isolate copper from plastics e-waste workers are manually processing and burning e-waste, especially plastic coated wires and cables in which they are encased [3] This primitive methods cause risk of release of hazardous chemicals including heavy metals (including chrome, cadmium, copper and lead), which have caused severe pollution to air, dust, soil and water within the Agbogbloshie area. [4] E-waste combustion may also result in exposure to a variety of toxins: heavy metals, acid gases, polycyclic aromatic hydrocarbons (PAHs) and dioxins. The e-waste workers and inhabitants of the area are permanently exposed to inhalation of poisonous smoke from the burning process. Majority of them have poor knowledge about the hazards they are exposed to and as a consequence does not use any protective methods [5].

Heavy metals exposure at e-waste yards

Concentrations of chrome, copper and zinc in atmospheric particulate matter of Guiyu e-waste in China were 4–33 times higher [6]. Personal air samples collected from workers and the environment air samples in Agbogbloshie indicated elevated levels for aluminum, copper, iron, zinc and lead [7]. The presence of heavy metals like lead, mercury, arsenic and cadmium

beyond limits in e-waste categorizes them as hazardous waste [3]. Lead and mercury are especially neurotoxic [8]. Calvanos indicated that barium, cobalt, chromium, copper, iron, selenium and zinc levels were elevated in the blood serum among those exposed to toxic fumes at e-waste [2]. The article discusses the negative effects of exposure of few selected the most dangerous heavy metals for human health detected at Agbogbloshie e-waste yard.

Health hazards resulting from exposure to lead

Agbogbloshie population can be expose to lead by air and food lead contamination. Long-term exposure of adults can affect the nervous system and can cause upper limbs weakness, increased blood pressure and anemia. The epidemiological evidence indicates that long exposure in early childhood causes a deficit in cognitive development. Development can be continued again after exposure has stopped [9]. Exposure to high lead levels can severely damage the brain and kidneys and as a consequence cause death. In pregnant women exposure to high levels of lead can cause miscarriage. High level exposure in men can damage testicles and disturb sperm production.

Health hazards resulting from exposure to mercury

Food, fish and direct contact is being a major source of mercury exposure [10] Mercury can cause kidney damage which is potentially reversible after exposure has stopped [11]. Chronic exposure causes neurological and psychological symptoms, such as tremor, changes in personality, restlessness, anxiety, sleep disturbance and depression. The symptoms are reversible after end of exposure. Main symptoms of acute exposure are related to nervous system damage [12]. First symptoms are parestesias and limb numbness. Later, coordination difficulties, constriction of the visual field and auditory symptoms can develop. High doses may lead to death [13].

Health hazards resulting from exposure to copper

Copper is an essential nutrient for humans but too much intake can produce adverse health consequences. Everyday exposure of e-waste yard workers to high levels of copper can result in liver disease and severe neurological defects. Acute copper toxicity can result in a number of pathologies and in the most severe cases death [14].

Health hazards resulting from exposure to cadmium

Inhalation of cadmium fumes can be life threatening [5]. Cadmium is nephrotoxic. Cadmium exposure can cause kidney damage . New research suggests skeletal damage caused by cadmium [15]. Last research indicates that cadmium can also cause bone damage [16]. Cadmium exposure could be associated with occurrences of Itai-Itai disease with low grade of bone mineralization, high risk of fractures, increased rate of osteoporosis and intense bone pain [17]. Exposure for pregnant women is associated with low birth weight and an increase risk of miscarriage [18].

Other metals, like iron and zinc are elements necessary for our health however excessive exposure to high levels to those metals can also increase risk of carcinogen, mutagen and toxic effects [19, 20].

Conclusion

E-waste combustion may result in exposure to a variety of toxins including heavy metals. Exposure to heavy metals can cause negative health effects including non reversible organ damage and death. E-waste workers should be educated about negative health effects and use of protective equipment while processing e-waste in order to minimize health risks.

Literature

- [1] Widmer, Rolf, et al. "Global perspectives on e-waste." *Environmental impact assessment review* 25.5 (2005): 436-458.
- [2] Caravanos, Jack, et al. "Exploratory health assessment of chemical exposures at e-waste recycling and scrapyard facility in Ghana." *Journal of health and pollution* 3.4 (2013): 11-22.
- [4] Atiemo, Sampson M., et al. "Assessing the heavy metals contamination of surface dust from waste electrical and electronic equipment (e-waste) recycling site in Accra, Ghana." *Res J Environ Earth Sci* 4.5 (2012): 605-611.
- [3] Oteng-Ababio, Martin. "Electronic waste management in Ghana-issues and practices." *Sustainable Development-Authoritative and Leading Edge Content for Environmental Management*. InTech, 2012.
- [5] Seidal K, Jorgensen N, Elinder CG, Sjogren B, Vahter M. Fatal cadmium-induced pneumonitis. *Scand J Work Environ Health* 1993; 19: 429–31.
- [6] Deng, W. J., et al. "Atmospheric levels and cytotoxicity of PAHs and heavy metals in TSP and PM_{2.5} at an electronic waste recycling site in southeast China." *Atmospheric Environment* 40.36 (2006): 6945-6955.
- [7] Caravanos, Jack, et al. "Assessing worker and environmental chemical exposure risks at an e-waste recycling and disposal site in Accra, Ghana." *Journal of health and pollution* 1.1 (2011): 16-25.
- [8] Clarkson, Thomas W. "Metal toxicity in the central nervous system." *Environmental Health Perspectives* 75 (1987): 59-64.
- [9] Tong S. Lead exposure and cognitive development: persistence and a dynamic pattern. *Journal of Paediatrics and Child Health*, 1998, 34: 114-118.
- [10] Sallsten G, Thoren J, Barregard L, Schutz A, Skarping G. Long-term use of nicotine chewing gum and mercury exposure from dental amalgam fillings. *J Dent Res* 1996; 75: 594–8.

- [11] Lindh U, Hudecek R, Danersund A, Eriksson S, Lindvall A. Removal of dental amalgam and other metal alloys supported by antioxidant therapy alleviates symptoms and improves quality of life in patients with amalgam-associated ill health. *Neuroendocrinol Lett* 2002; 23: 459–82.
- [12] Weiss B, Clarkson TW, Simon W. Silent latency periods in methylmercury poisoning and in neurodegenerative disease. *Environ Health Perspect* 2002; 110 (Suppl 5): 851–4.
- [13] Järup, Lars. "Hazards of heavy metal contamination." *British medical bulletin* 68.1 (2003): 167-182.
- [14] Uriu-Adams, Janet Y., and Carl L. Keen. "Copper, oxidative stress, and human health." *Molecular aspects of medicine* 26.4-5 (2005): 268-298.
- [15] Jarup L, Berglund M, Elinder CG, Nordberg G, Vahter M. Health effects of cadmium exposure—a review of the literature and a risk estimate. *Scand J Work Environ Health* 1998; 24 (Suppl 1): 1–51.
- [16] Järup, Lars, and Agneta Åkesson. "Current status of cadmium as an environmental health problem." *Toxicology and applied pharmacology* 238.3 (2009): 201-208.
- [17] Nogawa, Koji, et al. "Environmental cadmium exposure, adverse effects and preventive measures in Japan." *Biometals* 17.5 (2004): 581-587.
- [18] Frery, N., et al. "Environmental exposure to cadmium and human birthweight." *Toxicology* 79.2 (1993): 109-118.
- [19] Kostyuk PG, Popovych IL, Ivassivka SV, Chebanenko LO, Kyenko VM (editors). *Chornobyl', Adaptive and Defensive systems, Rehabilitation. Rehabilitation. Kyiv. Computerpress. 2006. 348 p.* = Kostyuk PG, Popovych IL, Ivassivka SV, Chebanenko LO, Kyenko VM (editors). *Chornobyl', Adaptive and Defensive systems, Rehabilitation. Rehabilitation. Kyiv. Computerpress. 2006. 348 p.*
- [20] Івасівка СВ, Бубняк АБ, Ковбаснюк ММ, Попович ІЛ. Походження та роль фенолів у водах родовища Нафтусі. Проблеми патології в експерименті та клініці: Наук. роботи Дрогобицького медичного інституту. 1994. = Ivasivka SV, Bubnyak AB, Kovbasnyuk MM, Popovych IL. *Pohodzhennya ta rol" fenoliv u vodax rodovyshha Naftusi. Problemy*

patolohiyi v eksperymenti ta klinici: Nauk. roboty Drohobyc"koho medychneho instytutu. 1994. = Ivassivka SV, Bubnyak AB, Kovbasnyuk MM, Popovych IL. [Genesis and role of phenols in waters from Naftussya layer]. Problemy patolohiyi v eksperymenti ta klinici: Nauk. roboty Drohobyc"koho medychneho instytutu.