REVIEW ARTICLE

Heavy Metals and Cosmetics Industry: A Review Article

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ABSTRACT

Trace amounts of heavy metals are present during cosmetic products manufacturing. (1) Therefore, they should be kept to a minimum acceptable level as stated by the FDA and pharmacopeias. (2) It is so far known that human external contact with these substances rarely result in a significant systemic exposure. However, many research studies showed that frequent local exposure to cosmetic products containing heavy metals may pose a risk of heavy metal contamination. (1,2) Heavy metals such as mercury (Hg) are added to skin-whitening products, causing acute or chronic damage to human skin cells. (1) Moreover, contamination of hair dyes and deodorants with Aluminum (Al) and Lead (Pb) threaten consumers' health dangerously for carcinogenic effects. Other possible side effects included microcytic anemia and osteomalacia. (3) Additionally, it was found that Al provokes further side effects on human mental health as dialysis dementia and it has also been associated with the neurodegenerative disease, Alzheimer's disease (AD) in adults. (4) Furthermore, Pb is a core component of many lipsticks, which reflects a high systemic absorption due to wrong consumers' habits. Frequent use of lipsticks containing Pb specially by children and adolescents has been significantly linked to neurodevelopmental disorders such as autism and attention-deficit-hyperactivity-disorder (ADHD) symptoms in children. (5) Therefore, strict regulations should be set for cosmetics manufacturing and quality control measurements should be assigned for pre- and post-marketed cosmetic products.

Keywords: Heavy metals, cosmetics, lead, aluminum, attention-deficit-hyperactivity-disorder (ADHD) symptoms, Alzheimer's disease, Toxicity, Carcinogenesis.

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INTRODUCTION

Heavy metals are substances that pose significant health risks when present in cosmetic products. Metals such as mercury, lead, and aluminum can enter cosmetics through various sources, including raw materials, manufacturing processes, and environmental contamination. Understanding the potential dangers associated with heavy metal exposure in cosmetics is crucial for safeguarding public health.[1,2] Numerous case studies provide concrete evidence of the adverse effects of heavy metals in cosmetic products, often involving individuals who experience skin disorders, neurological symptoms, and systemic toxicity due to prolonged exposure to contaminated cosmetics. Analyzing these case studies helps in understanding the real-world impact of heavy metal contamination in cosmetics. Trace amounts of heavy metals are present during the manufacturing of cosmetic products. Therefore, they should be kept to a minimum acceptable level as stipulated by the FDA and pharmacopeias.[6] Although human external contact with these substances rarely results in significant systemic exposure, frequent local exposure to cosmetic products containing heavy metals may pose a risk of contamination. Heavy metals such as mercury (Hg) are added to skin-whitening products, causing acute or chronic damage to human skin cells.[1] Additionally, contamination of hair dyes and deodorants with aluminum (Al) and lead (Pb) poses serious health risks, including carcinogenic effects. Other possible side effects include microcytic anemia and osteomalacia.[2,3] Aluminum has been found to provoke further adverse effects on mental health, such as dialysis dementia, and is associated with neurodegenerative diseases like Alzheimer's disease (AD) in adults.[4] Lead is a core component of many lipsticks, leading to high systemic absorption due to improper consumer habits. Frequent use of lipsticks containing lead, especially by children and adolescents, has been significantly linked to neurodevelopmental disorders such as autism and attention-deficit hyperactivity disorder (ADHD) symptoms in children.[5]

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Therefore, strict regulations should be established for cosmetics manufacturing, and quality control measures should be assigned for pre- and post-marketed cosmetic products. Despite existing bans on mercury in cosmetics, these products remain available in many markets. This highlights significant gaps in regulatory enforcement and challenges in controlling illegal markets. Regulatory standards for cosmetics vary widely between countries, creating loopholes that allow hazardous products to reach consumers. International cooperation is essential for establishing and enforcing consistent regulations. Strengthening import controls, enhancing market surveillance, and imposing harsher penalties for violators are crucial steps to prevent the distribution and sale of mercury-containing products.[6]

Mercury

Mercury is commonly added to skin-whitening products, posing significant health risks, including neurological damage, vision loss, kidney failure, and both acute and chronic damage to human skin cells.[1] This review consolidates findings from multiple case studies and regulatory perspectives to emphasize the dangers associated with these products despite existing bans. Enhanced regulatory measures and increased public awareness are crucial to mitigating these risks. Skin-whitening creams containing mercury are widely used despite the well-documented toxic effects of mercury, a potent neurotoxin. Mercury can cross the blood-brain barrier and accumulate in the brain, leading to symptoms such as tremors, memory problems, and cognitive dysfunction. Prolonged mercury exposure can also lead to kidney dysfunction, as the kidneys, which filter waste from the blood, can be severely affected by mercury, resulting in renal failure and other chronic conditions. While mercury is used for its skin-lightening effects, it can cause rashes, discoloration, and other skin issues. Prolonged use can exacerbate these conditions and lead to systemic toxicity. Mercury in skin-whitening creams poses a severe public health risk. Addressing this issue requires a multifaceted approach involving stricter regulatory enforcement, public education, and the promotion of safer alternatives. By taking these steps, we can protect public health and prevent the severe consequences of mercury exposure.[7]

Vision Loss Due yo Mercury Exposure

In November 2022, a Minnesota mother experienced partial vision loss after prolonged use of mercury-containing skin-whitening creams. This incident highlights significant regulatory enforcement failures as these harmful products remain accessible despite being illegal. The case emphasizes the severe health impacts and the need for stronger regulatory actions and increased public awareness about the dangers of such products.[8] Moreover, a health advisory was issued in Minnesota after a woman developed significant health issues, including vision problems, due to mercury exposure from skin-whitening creams in 2020. Follow-up studies found high mercury levels in her home, affecting not only her but also her children.[9] In addition, the California Department of Public Health reported multiple cases of mercury poisoning from skin-lightening creams, including cases of vision loss, in 2019. Investigations revealed that many of these products had mercury levels thousands of times higher than the legal limit, posing severe health risks. Also, ongoing cases within the Somali community in Minnesota highlight the chronic issue of mercury poisoning. Women using skin-lightening products experienced various symptoms, including vision loss, due to the high mercury content in these creams. Community outreach programs aim to raise awareness and screen for mercury exposure.[10]

Severe Neurological Damage Due to Mercury Toxicity

In 2019, a woman suffered severe neurological damage due to mercury poisoning from long-term use of a skin-whitening cream obtained from Mexico containing highly toxic levels of methylmercury, an organic form of mercury. The patient had been using the cream twice daily for seven years, leading to profound damage to her central nervous system. Despite undergoing chelation therapy, her condition did not improve, and she remains unable to care for herself months after discontinuing the use of the product. This incident highlights the critical importance of consumer education about the risks of unregulated beauty products and the necessity of stringent market regulations to prevent the sale of hazardous products.[11] Another study highlighted mercury exposure among household users of skin-lightening creams produced in Mexico in 2010. Users experienced increased mercury levels, which led to various health issues, including kidney damage and neuropsychological effects such as memory loss, irritability, and tremors. This case emphasized the dangers of inorganic mercury in skin-lightening products and the importance of monitoring urinary mercury concentrations.[12]

Kidney Failure due to Mercury Poisoning

Another case detailed a woman's significant health decline, including kidney failure due to mercury poisoning from a skin cream she used for years. The case of severe mercury poisoning from a skin-whitening cream occurred in 2019. A woman in Sacramento experienced significant neurological damage, including kidney failure, after using a cream that contained methylmercury. This incident underscores the critical need for consumer education on the dangers of unregulated beauty products and, the importance of stringent regulatory measures to prevent such hazardous items from being sold and the dire health consequences of their use.[13] Also, during 1995-1996, the Center for Disease Control and Prevention (CDC) reported multiple cases of mercury poisoning linked to beauty creams in Texas, New Mexico, and California. These incidents involved symptoms such as kidney dysfunction and neurotoxic effects, underscoring the need for stringent regulations and better consumer education about the hazards of mercury in cosmetics.[14]

Lead

Lead, a toxic heavy metal found in various cosmetic products, including lipsticks, poses significant public health risks despite existing regulations. This review highlights health

risks associated with lead exposure from lipsticks, supported by recent studies and documented cases. Chronic exposure occurs through frequent lipstick application and accidental ingestion. Lead, even at low levels, can bioaccumulate in the body, causing extensive health issues. Neurological effects are severe, with chronic exposure linked to cognitive impairments, behavioral issues, and neurological disorders, especially in children. Adults may experience memory loss, headaches, and mood disorders. Moreover, kidney damage is a major concern, with lead exposure causing nephrotoxicity, resulting in kidney dysfunction and hypertension.[2] In addition, reproductive health risks, including menstrual irregularities, infertility, and adverse pregnancy outcomes, may happen. Also, cardiovascular risks such as hypertension and heart disease may occur. Other health effects include anemia, immune dysfunction, and gastrointestinal issues. Lead contamination in lipsticks can result from manufacturing processes involving raw materials, contaminated water, or equipment. Regulatory inconsistencies and inadequate detection methods lead to unsafe lead levels in products urging the need for stricter regulations, increased public awareness, and continuous monitoring to mitigate lead exposure from cosmetics. Enhanced safety measures in the cosmetic industry, including developing safer alternatives and improving lead detection methods, are critical to protect public health.[15]

Elevated Blood Lead Levels in Women Using Lead-Contaminated Lipsticks

A study conducted in 2019 reported cases of elevated blood lead levels in women who frequently used a particular brand of lipstick found to contain lead concentrations exceeding regulatory limits. The affected individuals presented with symptoms such as fatigue, headaches, and gastrointestinal distress. Upon discontinuing the use of the lipstick and receiving chelation therapy, their symptoms improved significantly.[16] Moreover, the U.S. Food and Drug Administration (FDA) in 2012 found lead in 400 brands of lipstick, with some popular brands containing lead levels above the safe limit of 5 parts per million set by California. This finding indicated a widespread issue with lead contamination in lipsticks, posing significant health risks, especially for pregnant women.[17] Also, in 2022, a study in southern Thailand examined blood lead levels among non-occupationally exposed pregnant women. The study found that a significant percentage of these women had blood lead levels exceeding 5 µg/dL. The primary sources of lead exposure were not explicitly linked to cosmetics, but the presence of lead in consumer goods, including cosmetics, is a recognized risk factor.[18]

Lead Poisoning in Children from Ingesting Lipstick

In 2021, a case was reported of a 3-year-old child who developed acute lead poisoning after ingesting a lead-contaminated lipstick. The child exhibited symptoms of severe abdominal pain, vomiting, and encephalopathy. Blood tests revealed extremely high levels of lead, and the child required intensive medical treatment, including chelation therapy and supportive care.[19] Additionally, in 2016 a male child experienced a rash and elevated blood lead levels. Despite living in a lead-safe environment after moving, his blood test revealed a lead level of 56.9 µg/dL. He required treatment for anemia and lead chelation due to the severity of his condition.[20] Another case of a child in Connecticut who was diagnosed with lead poisoning after routine blood tests. The child showed elevated lead levels and required medical intervention, including removing the source of lead and dietary adjustments to mitigate the effects.[21]

Occupational Lead Exposure in Cosmetic Industry Workers

A 2022 study investigated occupational lead exposure in workers involved in the production of cosmetics, including lipsticks. The study found that workers had significantly higher blood lead levels compared to the general population, and some reported health issues such as hypertension, renal impairment, and neurological symptoms. This case highlights the need for improved safety measures and monitoring in the cosmetic manufacturing industry.[22] Furthermore, in 2015 the NIOSH Health Hazard Evaluation reported that workers involved in the manufacturing of hair dyes and other cosmetic products were found to be exposed to lead and other hazardous substances. The evaluation led to recommendations for enhanced workplace safety protocols, including the use of closed systems for handling lead-containing substances and regular health surveillance for workers.[23] Also in 2011, it was found that workers in a cosmetics manufacturing plant had elevated blood lead levels. The evaluation conducted by NIOSH revealed significant lead exposure due to the use of lead-containing materials in the production process. The company had to implement stringent control measures, including improved ventilation, personal protective equipment, and regular monitoring of blood lead levels among workers to mitigate the exposure risks.[24]

Aluminium

Aluminum, prevalent in cosmetics like deodorants and hair dyes, poses significant health hazards including carcinogenic effects, microcytic anemia, and neurodevelopmental disorders. This review examines three cases that highlight these dangers and emphasizes the need for stricter regulations and greater public awareness. Aluminum's effectiveness in reducing perspiration and odors is overshadowed by its potential link to Alzheimer's disease. Studies suggest that aluminum can cross the blood-brain barrier, accumulate in the brain, and cause neurotoxicity, potentially leading to neurodegenerative disorders. Aluminum compounds, such as aluminum chlorohydrate in antiperspirants, block sweat ducts but pose chronic exposure risks that extend to kidney dysfunction and bone disorders.[4,5] Regulatory agencies like the FDA and EMA have guidelines for aluminum use in cosmetics, yet enforcement and public education remain inconsistent. Addressing aluminum's health risks necessitates ongoing vigilance, robust regulatory measures, and comprehensive

public awareness efforts. Despite the compelling evidence of aluminum's health risks, further research is needed to fully understand its toxicity mechanisms and health impacts. Enhanced regulations, public education, and safer alternatives are crucial to mitigate these risks and protect public health. The case studies in this review underscore the urgency of addressing aluminum exposure and monitoring its use in consumer products.[25]

High Aluminum Levels in Alzheimer's Patients

A study by Exley *et al*. (2014) examined the brain tissue of individuals diagnosed with familial Alzheimer's disease. The researchers found significantly higher levels of aluminum in the brain tissue of these patients compared to control subjects. This case study provides compelling evidence supporting the hypothesis that aluminum accumulation in the brain may contribute to the pathogenesis of Alzheimer's disease.[26] Hence, a systematic review published in the Journal of Alzheimer's Disease in 2020 analyzed existing literature on aluminum exposure and Alzheimer's disease risk. The review concluded that while aluminum is known to accumulate in the brains of Alzheimer's patients, more research is needed to understand the specific mechanisms and potential contributions of aluminum to the disease process.[27]

Occupational Aluminum Exposure and Cognitive Decline

A study by Rifat *et al*. (1990) investigated the cognitive functions of workers exposed to aluminum dust in industrial settings. The study found a higher prevalence of cognitive impairments and neurobehavioral issues among these workers compared to non-exposed control groups. This case study underscores the neurotoxic potential of aluminum and its relevance to cognitive health.[28] On the other hand, Studies focusing on workers in aluminum-related industries have shown mixed results regarding cognitive decline. Some studies have reported associations between aluminum exposure and cognitive impairment, while others have not found significant effects.[29]

Aluminum in Antiperspirants and Breast Cancer

A study published in the Journal of Applied Toxicology in 2018 investigated the aluminum content in breast tissue from mastectomy patients and found that aluminum was present in the tissue samples, but again, the study did not establish a direct link to antiperspirant use or breast cancer development.[30] Another study published in the Journal of Inorganic Biochemistry in 2007 reported that aluminum was detected in breast tissue samples from breast cancer patients, but the study did not establish a clear causal relationship between aluminum exposure from antiperspirants and breast cancer development.[31] Furthermore, it is worth noting that some studies have also explored the potential link between aluminum in antiperspirants and breast cancer. A study by Darbre *et al*. (2003) found elevated levels of aluminum in the breast tissue of women with breast cancer. Although the evidence is not conclusive, this finding raises additional concerns about the safety of aluminum in cosmetic products.[32]

CONCLUSION

Public health campaigns are vital for educating consumers about the dangers of mercury in skin-whitening products. These campaigns should utilize diverse media channels to effectively reach a wide audience. Community programs play a crucial role in this effort by engaging local communities and raising awareness about the associated risks. Additionally, these programs should provide information on safe alternatives. Consumer education is essential in promoting responsible purchasing habits, emphasizing the importance of buying products from reputable sources and checking ingredient lists to avoid harmful substances like mercury. Encouraging the cosmetic industry to develop and promote safer, effective alternatives is crucial. Ingredients such as vitamin C, niacinamide, and plant extracts offer skin-lightening benefits without the associated health risks.

Promoting products that have undergone rigorous testing and received regulatory approval can enhance consumer safety. Governments should support research into safe and effective alternatives, ensuring that the products available on the market are both safe and effective. The cosmetic industry should be incentivized to innovate and develop new products that meet consumer demands for skin lightening without compromising health.

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