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THE COMPARATIVE AND HEALTH RISK ASSESSMENT OF HEAVY METALS IN SOME LOCAL AND FOREIGN LIPSTICK BRANDS SOLD IN DOMESTIC AND INTERNATIONAL MARKETS: A RECENT REVIEW

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ABSTRACT

Heavy metals such as lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg) are toxic, non-biodegradable substances that pose significant health risks through bioaccumulation. Their presence in cosmetics, particularly lipsticks, which are semi-ingested during use, is a major public health concern. Long-term exposure to these metals is linked to neurotoxicity, renal dysfunction, endocrine disruption, and carcinogenic effects. While numerous international and regional studies in Southern Nigeria have documented alarming concentrations of these metals in cosmetics, a significant empirical data gap exists for Northern Nigeria, specifically Katsina State. This review synthesizes existing literature to highlight the prevalence, concentration ranges, and associated health risks of heavy metals in lipsticks globally and within Nigeria. Findings reveal recurrent exceedances of international safety limits (e.g., US FDA, WHO) in various markets, with Pb and Hg being the most critical contaminants. The absence of localized data for Katsina impedes effective regulatory enforcement by bodies like NAFDAC and SON and leaves consumers vulnerable. This review underscores the urgent need for original research in Katsina to quantify heavy metal levels in commonly sold lipstick brands, conduct a science-based health risk assessment, and provide evidence for robust public health interventions and policy formulation to ensure consumer safety.

Keywords: Heavy Metals, Lipstick, Health Risk Assessment, Public Health, Katsina State

INTRODUCTION

The global cosmetics industry has experienced exponential growth, driven by evolving beauty standards and aggressive marketing. Lipstick, one of the most universally used cosmetic products, has a history dating back to ancient civilizations (Figueiredo, 2019). Modern lipsticks are complex formulations containing waxes, oils, pigments, and emollients (Lara-Torres et al., 2021). However, these products can be a silent source of exposure to toxic heavy metals, which enter the formulations as impurities in raw materials or through contamination during manufacturing (Attard & Attard, 2022; Dinake et al., 2023). Metals like Pb, Cd, As, and Hg are of particular concern due to their potent toxicity and ability to accumulate in biological tissues over time (Ghaderpoori et al., 2020; Arshad et al., 2020). The risk is exacerbated for lipstick users because the product is applied to the lips and can be inadvertently ingested, providing a direct route for systemic absorption (Ullah et al., 2023; Abed et al., 2024). Despite regulations from bodies like the U.S. FDA and the European Union, studies from countries like Botswana (Dinake et al., 2023), Pakistan (Arshad et al., 2020), Jordan (Ababneh & Al-Momani, 2018), and Iran (Ghaderpoori et al., 2019) consistently report lipstick samples with metal concentrations exceeding permissible limits. In Nigeria, while studies have been conducted in the South (e.g., Lagos [Aloysius et al., 2024], Asaba [Chukwurah et al., 2025], Rivers State [Mgbemena et al., 2024]), the Northern region, including the commercially significant Katsina State, remains critically understudied. This review aims to consolidate current knowledge on this issue and justify the imperative for targeted research in Katsina to protect public health.

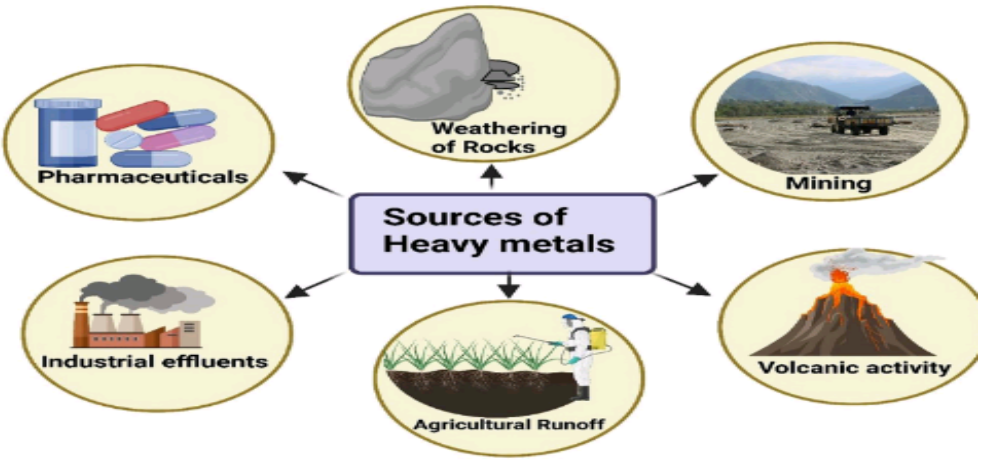

Figure 1: Sources of Heavy Metal

Objective of the Research

The main objectives of this review are to summarize the body of research on the levels and health hazards of heavy metals (Pb, Cd, Cr, As, and Hg) in lipsticks, draw attention to the significant data gap in Northern Nigeria, and support an empirical investigation in Katsina State. The following are the specific objectives:

i. To examine and contrast the heavy metal contents in lipsticks reported by international and Nigerian studies.
ii. To provide an overview of the health risk assessment methodologies and results from the literature.
iii. To identify the key research gap related to Katsina State and outline the necessary steps for future study.

Related Literature Review

A large amount of research supports the pervasive presence of heavy metal contamination in cosmetics. Studies conducted in many geopolitical circumstances show a troubling trend of non-compliance with international safety standards.

According to a comparative study conducted in Gombe Metropolis, Northern Nigeria, other metals such as nickel (Ni) and chromium (Cr) in powders and creams surpassed safety standards, whereas lead and cadmium were frequently found to be below limits (Goje et al., 2024). While a study conducted in Rivers State found that Cd concentrations ranged from 0.62 to 1.42 mg/kg, but Hazard Quotients (HQ) were below the risk threshold (Mgbemena et al., 2024), research conducted in Asaba, Southern Nigeria, found nickel levels in lipsticks as high as 23.98 mg/kg (Chukwurah et al., 2025). A traditional product called "tiro" was discovered to have Pb at 65.34 ppm, significantly above limits, in a Lagos study on natural cosmetics (Aloysius et al., 2024).

The situation is equally worrisome on a global scale. One of the largest Pb contaminations was found in Botswana, where concentrations ranged from 45.75 to 193.60 mg/kg, resulting in exceptionally high Hazard Quotients (HQ = 177– 749) (Dinake et al., 2023). Ababneh & Al-Momani (2018) discovered mercury levels in skin-lightening cosmetics in Jordan as high as 1008 parts per million. Pb concentrations as high as 410,000 ppm were found in studies on traditional kohl-based cosmetics conducted in Germany and Spain, posing a serious risk to public health (Navarro-Tapia et al., 2021). Risks still exist even in markets with stricter regulations; a European study on lipstick discovered that the Margin of Safety (MoS) for lead was as low as 62, suggesting possible danger (Lara-Torres et al., 2021).

According to a study conducted in Bangladesh, both local and imported lipsticks and eye pencils included significant amounts of metals like Pb and Cr, which could pose health hazards to users (Baroi et al., 2023). Similar to this, Alqahtani et al.'s (2023) study on lipsticks on the Saudi market found Pb and Cd, albeit at levels below FDA standards, but stressed the danger of long-term exposure from frequent use. Additionally, Voica et al. (2022) demonstrated that regulatory markets are not impervious to contamination by reporting alarming amounts of Cr and Ni in face cosmetics from the Romanian market, with some samples surpassing EU-recommended norms. It has been demonstrated that conventional and handmade cosmetics, which are frequently thought of as safer substitutes, contain dangerously high levels of hazardous metals. Lead values of up to 1923 mg/kg were discovered by Kilic et al. (2020) when they examined traditional Turkish cosmetics including henna and smear. The results of Navarro-Tapia et al. (2021) on kohl-based eyeliners in Germany and Spain, where lead levels reached 410,000 ppm, are consistent with this. Additionally, there is a special risk from costume cosmetics, especially those marketed to youngsters. According to Junqueira et al. (2022), face paints in Brazil contain potentially harmful elements like Ba and Pb, with some metals having cancer risk values that are higher than permitted limits for both adults and children.

It is common practice to use models such as the Hazard Quotient (HQ), Hazard Index (HI), and Margin of Safety (MoS) in health risk evaluations. The majority of research that show HQ/HI values below 1 indicate that certain metals have a minor non-carcinogenic risk. However, research like that of Khodabakhshi & Bagherzadeh (2024) and Dinake et al. (2023) revealed HQ>1 for Pb and Cr, indicating high risk. Additionally, biomonitoring studies offer concrete proof of exposure; Parizi et al. (2020) in Iran discovered a favorable relationship between young women's serum levels of Pb and Cd and the length of time they used cosmetics.

The methodologies for detection are also advancing, with research like that of Radwan et al. (2022) developing new, sensitive optical chemosensors for quick on-site monitoring of metals like cobalt and cadmium in everyday cosmetics. Collectively, this expanded body of literature underscores that heavy metal contamination in lipsticks and other cosmetics is a complex, global issue necessitating continuous monitoring, robust regulatory frameworks, and heightened consumer awareness.

Table 1: An Overview of Key Findings from the Reviewed Literature on Heavy Metals in Cosmetics

Reference	Location	Metals Analyzed	Concentrations & Risks	Health Risk Assessment Outcome
Dinake et al. (2023)	Botswana	Pb, Ni, Cr, As	Pb: 45.75-193.60 mg/kg (exceeded FDA limit); HQ for Pb: 177-749 (Extremely high risk)	High non-carcinogenic risk from Pb.
Navarro-Tapia et al. (2021)	Spain/Germany	Pb, As, Cd, Sb, N	Pb up to 410,000 ppm in kohl; multiple samples exceeded EU/German limits.	Acute and chronic toxicity risk, especially for children and pregnant women.
Ababneh & Al-Momani (2018	Jordan	Ni, Cd, Pb, Hg	Hg up to 1008 ppm in skin-lightening creams; 34.4% of such creams exceeded Hg limits.	Significant risk of systemic toxicity from Hg, Pb, and Cd.
Arshad et al. (2020)	Pakistan	Cd, Cr, Ni, Pb, Fe	High Ni (7.99 mg/kg) and Pb (6.37 mg/kg) in sunscreens; MoS <100 and	Potential long-term cancer and non-cancer risks from lotions and sunscreens.

Reference	Location	Metals Analyzed	Concentrations & Risks	Health Risk Assessment Outcome
			LCR exceeding limits in some products.	
Chukwurah et al. (2025)	Asaba, Nigeria	Pb, Ni, Cd, Cr	Ni up to 23.98 mg/kg in lipsticks; 70% of products contained at least one heavy metal.	Potential for skin absorption and bioaccumulation, necessitating regulatory oversight.
Goje et al. (2024)	Gombe, Nigeria	Cu, Fe, Cd, As, Ni, Cr, Pb	As and Ni exceeded limits in some powders; locally made cosmetics were generally safer than imported ones.	Potential health risks from prolonged cutaneous exposure to As, Ni, and Cr.
Mgbemena et al. (2024)	Rivers St., Nigeria	Pb, Cd, Zn, Cr, Cu, Co, Ni	Cd: 0.62-1.42 mg/kg; HQ <1 for all metals, but MoS for Cu and Zn in some products raised concerns.	Negligible immediate non-carcinogenic risk, but long-term accumulation a concern.
Lara-Torres et al. (2021)	Europe & China	Al, Cd, Pb	European lipsticks had higher Pb-related risk (MoS=62) than Chinese (MoS=88).	Modest but non-negligible Pb exposure risk from European products.
Parizi et al. (2020)	Iran	Pb, Cd (in serum)	Serum Cd and Pb levels positively correlated with duration of cosmetic use.	Direct biological evidence linking cosmetic use to increased body burden of heavy metals.
Zakaria & Ho (2015)	Malaysia	Pb, Cd, Cr	Pb: 0.77-15.44 mg/kg; Cd: 0.06-0.33 mg/kg.	HQ < 1 for all metals over 35-year exposure; negligible non-carcinogenic risk.
Öztaş et al. (2024)	Turkey	Pb	Lower mean Pb in premium (1.41 mg/kg) vs. low-cost (2.09 mg/kg) brands. Max Pb: 3.68 mg/kg.	IEUBK model predicted no significant increase in children's blood lead levels (>1 µg/dL).
Khodabakhshi & Bagherzadeh (2024)	Iran	Cd, Pb, Cr	All analyzed brands contained measurable metals; Brand A had highest Pb, Pb: 2.31 mg/kg (Brand A); Cd: 0.037 mg/kg.	HQ>1 and CR>10^{-4} for Cr, indicating non-carcinogenic and carcinogenic risk.
Ali et al. (2024)	Benghazi, Libya	Cr, Ni, Pb, Cd, Fe	Variance in metal concentrations across different facial cosmetic brands. Pb: 1.85 ± 0.4 mg/kg; Cd: 0.31 ± 0.06 mg/kg.	HQ and HI < 1 for all metals; negligible non-carcinogenic risk.

Discussion

Numerous international studies have shown that heavy metals are widely present in lipsticks, which highlights a serious and continuous public health concern. The examined literature consistently shows that contamination is a widespread problem that affects both regulated and less-controlled markets, rather than being limited to a particular location or product category (Attard & Attard, 2022; Ullah et al., 2023). It is especially concerning when metals like lead and cadmium are found at levels that are often beyond global safety thresholds, like those established by the WHO and the US FDA (Dinake et al., 2023; Ababneh & Al-Momani, 2018). This is further worsened by the fact that comparison studies frequently show no trustworthy relationship between a product's safety profile and its price, brand prestige, or place of origin (local vs. imported), giving consumers no clear clues to help them make safer decisions (Zakaria & Ho, 2015; Öztaş et al., 2024). The main health risk stems from the exposure route; because lipstick is semi-ingestible, even low levels of prolonged exposure can cause toxic metals to bioaccumulate in the body, which may have an impact on neurological, renal, and endocrine health (Ghaderpoori et al., 2020; Abed et al., 2024).

Additionally, the results of health risk evaluations paint a nuanced picture. Individual metals in particular products have been found to have a negligible non-carcinogenic risk (HQ < 1) in numerous investigations (Ali et al., 2024; Mgbemena et al., 2024), but this should not be mistaken for a lack of risk. Numerous well-known studies have determined Hazard Quotients and Cancer Risk values that are significantly above permissible limits, indicating a genuine and immediate risk associated with specific items, particularly when used for an extended period of time (Khodabakhshi & Bagherzadeh, 2024; Arshad et al., 2020). In many developing nations, the important data vacuum for Northern Nigeria, more especially, Katsina State, is a microcosm of a bigger

issue. Empirical evidence from Southern Nigeria (Chukwurah et al., 2025; Aloysius et al., 2024) supports the issue's national relevance, but the absence of comparable studies in the North makes it difficult for organizations like NAFDAC to take targeted regulatory action and public health interventions. A significant portion of the population is left susceptible by this discrepancy, which also highlights the critical need for region-specific statistics to support local policy, enforce standards, and educate consumers, thus bringing national cosmetic safety regulations into line with international health security goals.

CONCLUSION

The literature study indisputably shows that lipstick contamination by heavy metals is a widespread worldwide problem with major public health ramifications. The insufficiency of present regulatory frameworks and enforcement, especially in low- and middle-income nations, is highlighted by recurring observations of Pb, Cd, Hg, and As concentrations exceeding specified safety levels in a variety of markets. The nearly total lack of empirical, region-specific data for Katsina State in Northern Nigeria is a serious knowledge gap, even though evidence from Southern Nigeria validates the existence of this issue nationally. In the end, this lack of knowledge fails to protect consumers in the area by impeding evidence-based regulatory action by organizations such as NAFDAC and preventing proper health risk assessment.Therefore, a thorough investigation to ascertain the content of heavy metals in lipsticks sold in Katsina marketplaces and to evaluate the related health concerns to the local people is urgently and justifiably needed.

RECOMMENDATIONS

Based on the findings of this review, we recommend that a comprehensive study be undertaken immediately to determine the levels of Pb, Cd, Cr, As, and Hg in a variety of locally and internationally available lipsticks in Katsina State using standardized methods, such as acid digestion and atomic absorption spectrophotometry (AAS). The data generated should be used to carry out a health risk assessment using existing models (e.g., HQ, HI, MoS, Cancer Risk) specific to the exposure patterns of the local population. The results of such a study should be shared with regulatory bodies (NAFDAC, SON) to help develop and enforce stricter, locally relevant quality control measures and import regulations for cosmetics.

Government agencies and public health organizations should initiate consumer education programs in Katsina and throughout Northern Nigeria to raise awareness about the potential risks of heavy metals in cosmetics and encourage informed purchasing decisions. This study should serve as a baseline for additional research into other cosmetic products and their long-term health impacts in the region, as well as for continued monitoring.

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