Okoduwa S.I.R., Imam A.M. 2025. "Leather and public health nutrition: Exploring the layers beyond the surface." *World Nutrition*, *16*(3), September, 5–8. https://doi.org/10.26596/wn.20251635-8

Trend Editorial

Leather and public health nutrition: Exploring the layers beyond the surface

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Keywords: Leather industry, public health nutrition, heavy metals, food safety, environmental health, policy, Nigeria

https://doi.org/10.26596/wn.20251635-8

World Nutrition 2025;16(3):5-8

Abstract

Leather production is a vital sector in Nigeria, contributing to livelihoods, exports, and cultural heritage. However, its hidden costs—particularly the nutritional and health impacts of environmental contamination—remain poorly understood. This trend editorial highlights how tannery effluents and waste, often laden with heavy metals, contaminate soil, water, and food crops, thereby threatening food safety and public health nutrition. Vulnerable populations such as children and pregnant women face heightened risks of anaemia, stunting, and micronutrient deficiencies due to chronic exposure. Drawing lessons from South Asia, the paper emphasizes the need for low-cost effluent treatment technologies, circular economy solutions for chromium recovery, and stronger policy enforcement. Major research gaps, including human biomonitoring and dietary risk assessments, must be urgently addressed. Framing leather not only as an economic asset but also as a determinant of nutritional health can guide Nigeria and West Africa toward a more sustainable and health-conscious leather industry.

INTRODUCTION

Leather production has long-standing cultural, social, and economic importance in Nigeria and across West Africa. From the historic tanning centres of Kano and Sokoto to the industrial clusters in Kaduna, the sector supports livelihoods, drives exports, and shapes local economies (Onakpa et al. 2018). Nigeria is one of the continent's major producers of raw hides and skins, with leather exports ranking among the country's top non-oil commodities. Beyond its economic value, leather also carries cultural significance, being central to traditional crafts, fashion, and artisanal heritage. Yet, beneath these visible benefits lie hidden challenges. Tanneries release wastewater and solid waste laden with heavy metals and other toxicants, contaminating rivers, soils, and agricultural fields (Okolo et al. 2016; Shaibu & Audu, 2020; Arti & Mehra, 2023). Such contamination is not merely an environmental issue—it directly intersects with food production and nutritional health. For example, effluent seepage into farmlands and irrigation channels can lead to the uptake of metals by crops, with vegetables and grains serving as pathways for dietary exposure. These risks raise urgent questions about food safety, micronutrient availability, and long-term public health outcomes (Igiri et al. 2018). The purpose of this trend editorial is to spark dialogue and action by exploring the intersection of leather production, environmental contamination, and public health nutrition. By reframing leather not only as an economic asset but also as a determinant of food and nutrition security, this article aims to encourage policymakers, researchers, and industry stakeholders to pursue solutions that balance growth with human well-being.

HIDDEN PATHWAYS: EFFLUENTS, SOIL, AND FOOD CONTAMINATION

Tannery effluents are a well-documented source of environmental contamination in Nigeria. For example, studies on the Challawa River in Kano State show that wastewater from tanneries and textile industries significantly elevates chromium, copper, iron, and other metals in water, sediments, and nearby soils (Zango et al. 2023; Shaibu & Audu, 2020). Likewise, the use of tannery sludge as a soil amendment in the Challawa Industrial Estate has led to the accumulation of metals such as chromium and nickel in food crops, including sorghum and millet (Bareen & Tahira, 2011; Ghosh et al. 2012).

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These pollutants do not remain confined to the environment; they enter the food chain through crop uptake and irrigation with contaminated water. Leafy vegetables—key staples in local diets—are especially prone to heavy metal bioaccumulation, often exceeding safe consumption limits (Yusuf et al. 2017; Bareen & Tahira, 2011). Such contamination pathways pose serious risks to food safety and nutritional security in affected communities.

NUTRITIONAL IMPLICATIONS OF HEAVY METAL EXPOSURE

Heavy metals such as hexavalent chromium, cadmium, and lead disrupt metabolic processes and interfere with micronutrient absorption. Chromium is particularly harmful, as it competes with essential trace minerals like iron and zinc, increasing the risk of anaemia and impaired growth (Ajibola et al. 2024; Kalsoom & Batool, 2020). Chronic intake of toxic chromium species has also been associated with gastrointestinal distress, kidney damage, and oxidative stress (Chris et al. 2023; Lofrano et al. 2014).

These risks are particularly concerning for populations already vulnerable to micronutrient deficiencies, including children, pregnant women, and rural farmers. Anaemia prevalence in northern Nigeria, for instance, exceeds 60% among children under five, while zinc and iron deficiencies are widespread (Onakpa et al. 2018). Continuous exposure to heavy metals, such as chromium and lead, may exacerbate these nutritional gaps, leading to impaired growth, immunity, and overall health outcomes (Onakpa et al. 2018; Gadanya et al. 2019). Although comprehensive epidemiological data from Nigeria are scarce, evidence from local biomonitoring studies (Gadanya et al. 2019; Mshelia et al. 2024) and parallels from South Asia (Ghosh et al. 2012) highlight the risks. In Kanpur, India, for example, stricter regulations and low-cost effluent treatment have begun to lower chromium levels in irrigated farmland (Tripathi, 2025). Such lessons offer important guidance for Nigeria's mitigation strategies. The pathways linking leather production to nutritional and health outcomes can be summarized conceptually (Figure 1), illustrating how industrial effluents translate into hidden risks for food security and public health.

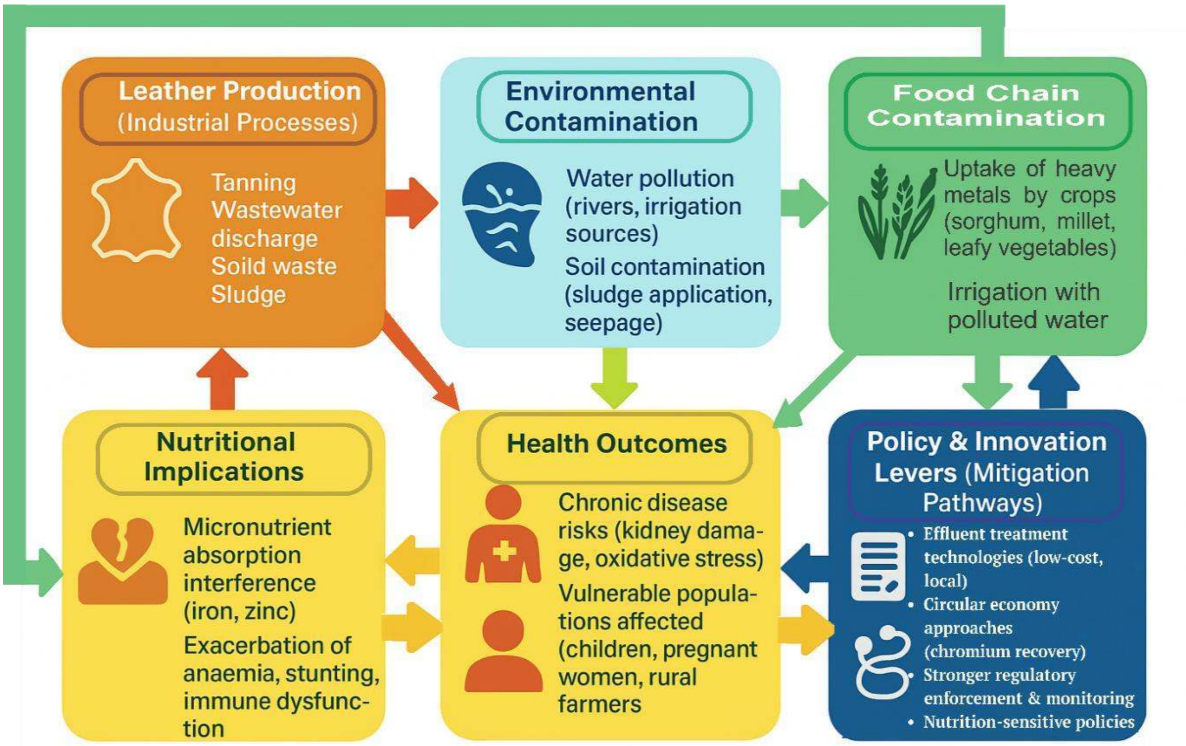

Figure 1. Conceptual framework illustrating pathways from leather production to nutritional and health outcomes

Note: This conceptual framework illustrates the interconnections between leather production, environmental contamination, food chain exposure, nutritional implications, and health outcomes. Arrows indicate causal pathways, with policy and innovation levers presented as mitigation strategies to disrupt the cycle of risk.

EMERGING INNOVATIONS AND POLICY RESPONSES

Several innovations point to healthier futures for the leather sector. In the coming decade, circular economy models, biomonitoring tools, and community-led water initiatives could redefine how leather production coexists with public health nutrition. With the right policy support and investment, West Africa can avoid the long-term environmental crises seen in other leather-producing regions.

- *EFFLUENT TREATMENT TECHNOLOGIES*: Low-cost methods, such as adsorption with activated carbon derived from Moringa oleifera pods, have significantly reduced chromium concentrations in tannery wastewater (Zango et al. 2023). Scaling such locally appropriate solutions could help limit environmental and health risks.
- *CIRCULAR ECONOMY AND CHROMIUM RECOVERY*: Advances in alkaline thermal hydrolysis now make it

possible to recover chromium from leather waste, reducing effluent toxicity while creating reusable resources (Oloruntoba et al. 2024; Tripathi, 2025). Adapting such circular approaches to low- and middle-income country contexts could lower pollution and industrial costs.

- *POLICY RECOGNITION*: Nigeria's National Leather and Leather Products Policy (2018) identifies environmental compliance and social best practices as strategic priorities (Onu et al. 2018). Yet, enforcement remains inconsistent due to weak institutions, limited monitoring capacity, and the dominance of informal tanneries. Economic pressures to remain export-competitive also often override environmental safeguards, widening the gap between policy and practice.

RESEARCH AND POLICY GAPS

Despite these promising developments, critical research and policy gaps persist:

1. *HUMAN EXPOSURE STUDIES*: Few investigations have measured biomarkers of heavy metal exposure (blood, urine, hair) in populations living near Nigerian tanneries, and even fewer have linked these to nutritional outcomes (Arti & Mehra, 2023; Mshelia et al. 2024).
2. *DIETARY RISK ASSESSMENT*: There is little systematic quantification of heavy metal intake via local staples (e.g., sorghum, millet, leafy vegetables) grown on contaminated soils (Chukwuka et al. 2023; Bareen & Tahira, 2011).
3. *LONGITUDINAL AND COHORT STUDIES*: Evidence connecting chronic heavy metal exposure with nutritional outcomes such as stunting, anaemia, or weakened immunity in Nigerian populations remains virtually absent (Ajibola et al. 2024).
4. *IMPLEMENTATION SCIENCE*: Research on the economic feasibility, scalability, and governance of effluent treatment technologies in local contexts is limited (Lofrano et al. 2014).

CONCLUSION

The leather sector is a vital contributor to Nigeria's economy and culture, but its hidden nutritional costs require urgent attention. The coming decade presents a narrow but critical opportunity: with investment in low-cost effluent treatment, stronger enforcement of environmental regulations, and integration of nutrition monitoring into public health systems, Nigeria could lead the way toward a more sustainable leather future. Reframing leather not only as an economic asset but also as a determinant of food safety and nutrition would allow West Africa to set a global precedent for balancing industrial growth with human well-being. The decisions made today will determine whether leather remains a source of national pride or becomes a legacy of preventable harm.

AUTHOR CONTRIBUTIONS

SIRO conceived and designed the study. Both SIRO and AMI contributed equally to the literature search, data synthesis, drafting, reviewing, and editing of the manuscript. Both authors approved the final version and consented to its submission and publication.

CONFLICT OF INTEREST

The first author (SIRO) serves as a volunteer with the journal but had no role in the editorial decision-making process for this manuscript. The article underwent independent editorial review and oversight. The authors declare no other conflicts of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN SCIENTIFIC WRITING

No generative AI or AI-assisted technologies were used in the writing, editing, data analysis, or production of this manuscript, unless explicitly acknowledged. Where applied, AI tools were limited to language refinement and formatting assistance under direct author oversight, and the authors remain fully responsible for the manuscript's content and integrity.

ACKNOWLEDGEMENTS

None

FUNDING

This research received no specific funding from any public, commercial, or not-for-profit agency.

Received: September 20, 2025; **Revised:** September 23, 2025; **Accepted:** September 23, 2025; **Published:** September 30, 2025

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