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HEAVY METALS IN SMOKED FISH: A COMPREHENSIVE REVIEW OF NUTRITIONAL IMPLICATIONS, HEALTH IMPACTS, AND PUBLIC HEALTH CHALLENGES IN NIGERIA

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Abstract

Background: Smoked fish is a vital protein source and livelihood in Nigeria, but traditional smoking may introduce toxic heavy metals, creating public health concerns.

Objective: This review synthesizes Nigerian literature on heavy metal contamination in smoked fish, examining smoking processes, nutritional implications, health risks, and public health challenges, including occupational exposure of processors.

Methods: A systematic search of PubMed, Scopus, ScienceDirect, Google Scholar, and ResearchGate was conducted for studies published between 2015 and 2025 following PRISMA guidelines. Included studies reported quantitative data on heavy metal concentrations in Nigerian smoked fish. Data on metal levels, health risk indices (THQ, HI, cancer risk), nutritional parameters, and smoking methods were extracted and synthesized thematically.

Results: Studies across Ondo, Ogun, Lagos, Anambra, Borno, and the Niger Delta consistently report elevated lead, cadmium, chromium, and arsenic in smoked fish, frequently exceeding regulatory limits. Traditional drum-smoking yields higher contamination than improved kilns. Smoked fish retains nutritional value, creating a risk-benefit dilemma. Health risk assessments reveal non-carcinogenic effects (HI>1) and unacceptable cancer risks from chromium. Children are most vulnerable. A critical gap is the complete absence of research on occupational exposure of fish smokers.

Conclusion: Heavy metal contamination causes significant risks to consumers while processors face unstudied occupational hazards. Addressing this requires improved smoking technologies, national surveillance, occupational health integration, and community education.

Keyword: Smoked fish; heavy metals; public health; occupational exposure; health risk assessment; nutrition; food safety

Introduction

Fish smoking is a centuries-old preservation technique deeply embedded in Nigerian food culture and economy [Adeyeye, 2016]. It extends the shelf life of highly perishable fish, enables transportation to inland markets, and provides livelihood opportunities, particularly for women processors [Bwala & Imam, 2021; Adeyeye et al., 2017]. Smoked fish serves as a crucial source of affordable animal protein and essential micronutrients for millions of Nigerians, bridging nutritional gaps in both rural and urban diets [Obande et al., 2025; Oli et al., 2024].

However, the smoking process, particularly when conducted using traditional kilns and potentially contaminated fuelwood, introduces chemical contaminants that compromise food safety [Adeyeye, 2019; Ubwa et al., 2015]. Among the most concerning are heavy metals—lead (Pb), cadmium (Cd), chromium (Cr), and arsenic (As)—which accumulate in fish tissues during smoking and pose significant health risks to consumers [Olayinka-Olagunju, 2025; Osuala & Igwo-Ezikpe, 2022; Onoja et al., 2025].

Over the past decade, a growing body of Nigerian research has documented elevated heavy metal concentrations in smoked fish from various regions, with health risk assessments frequently indicating potential non-carcinogenic and carcinogenic effects [Thomas, 2024; Oghenochuko et al., 2022; Adelakun et al., 2024; Oloye & Odedeyi, 2025]. Systematic reviews have confirmed that heavy metal contamination in Nigerian aquatic foods is widespread, particularly in crude oil-impacted areas like the Niger Delta [Umeoguaju et al., 2023] and across Southwest Nigeria [Laoye et al., 2025]. Despite this accumulating evidence, a comprehensive synthesis that integrates the nutritional value, health impacts, and public health implications of heavy metal contamination specifically in smoked fish remains lacking [Idowu, 2022; Nkwunonwo et al., 2020].

This review addresses this gap by critically examining the existing Nigerian literature on heavy metals in smoked fish through four interconnected lenses: (1) the smoking process as a source of contamination, (2) the nutritional profile of smoked fish, (3) the documented health risks to consumers, and (4) the broader public health challenges, including the overlooked occupational exposure of fish smokers. By synthesizing evidence from across Nigeria, this review aims to inform policy, guide future research, and contribute to safer fish smoking practices that protect both consumers and producers.

2. SMOKING PRACTICES AND HEAVY METAL CONTAMINATION

2.1 Fish Smoking in Nigeria

Fish smoking in Nigeria is predominantly artisanal, employing traditional technologies that vary by region. The most common methods include drum kilns (repurposed metal oil drums), mud kilns, and wire-mesh ovens, all of which rely on direct combustion of wood or another biomass [Adeyeye, 2016; Adeyeye et al., 2017; Adeyeye, 2019]. While these methods are effective for preservation and impart desirable sensory characteristics, they offer limited control over temperature, smoke density, and exposure duration, which are the factors that influence contaminant formation and deposition [Ubwa et al., 2015; Tongo et al., 2017]. Studies have shown that smoking methods significantly affect the quality and safety of the final product, with drum-smoking often associated with higher contaminant levels compared to improved kilns [Adeyeye et al., 2017].

2.2 Sources of Heavy Metals in Smoked Fish

Heavy metals in smoked fish are mainly from two primary sources: the raw fish itself and the smoking process. Fish harvested from polluted waters accumulate metals in their tissues through dietary and dermal uptake [Adesiyan et al., 2018; Edogbo et al., 2020; Enuneku et al., 2018]. Rivers in industrial areas - such as those in Kano [Edogbo et al., 2020], Southwest Nigeria [Adesiyan et al., 2018], and the Niger Delta [Umeoguaju et al., 2023; Enuneku et al., 2018] - have documented elevated metal levels, which are reflected in resident fish species [Oloye & Odedeyi, 2025; Odey et al., 2020].

During smoking, additional contamination can occur through various means. Firstly, wood harvested from metal-contaminated soils or treated wood may release metals during combustion, which deposit on fish surfaces [Laoye et al., 2025; Idowu, 2022]. In addition, corroded metal drums or galvanized wire meshes can leach metals such as lead, cadmium, and zinc into the fish, especially under high heat and acidic smoke conditions [Adeyeye et al., 2019; Nwosu et al., 2021].

Also, smoking removes moisture up to 70% weight loss, concentrating existing metals in the remaining tissue [Osuala & Igwo-Ezikpe, 2022; Oghenochuko et al., 2022].

2.3 Evidence from Nigerian Studies

Various studies across Nigeria have documented elevated heavy metal concentrations in smoked fish compared to fresh samples or regulatory limits. Table 1 summarizes heavy metal concentrations in smoked fish reported from different Nigerian regions.

Location	Fish Species	Metals Detected	Key Finding/limits	Reference
Ondo State	Clarias gariepinus (smoked catfish)	Fe: 149.0±7.76 - 155.0±5.10; Mn: exceeded 1 mg/kg; Ni: 0.00±0.00 – 1.00±1.41; Cd, Cr reported	Exceeded limits; HI > 1; Cr cancer risk	Olayinka-Olagunju, 2025
New Bussa Market	Smoked Freshwater fish	Chemical qualities and heavy metals evaluated	Contamination linked to processing	Adelakun et al., 2024
Southwest Nigeria local markets	Fresh, frozen, smoked	Multiple	Smoked > fresh; children at risk	Oghenochuko et al., 2022
Lagos State	Catfish	Cd, Pb, Zn	Smoking increases metal concentration	Osuala & Igwo-Ezikpe, 2022
Eke-Awka Market, Anambra State	Smoked-dried fish	As, Cd, Cr, Hg, Pb	Health risk >1	Onoja et al., 2025
Zaria	Catfish	Multiple	Smoked from polluted sources > home-bred	Odey et al., 2020
Ose River, Ondo	Multiple	Multiple	Water-sediment-fish transfer	Oloye & Odedeyi, 2025
Borno State	Multiple	Not specified	Socioeconomics documented	Bwala & Imam, 2021

TABLE 1: Heavy metal concentrations in smoked fish from Nigerian studies

Across these studies, lead and cadmium are the most frequently detected metals exceeding regulatory limits, with chromium emerging as a metal of great concern due to its carcinogenic potential [Thomas, 2024; Olayinka-Olagunju, 2025]. The Niger Delta region shows particularly elevated levels due to crude oil pollution [Umeoguaju et al., 2023], while industrial areas like Kano show contamination from industrial effluents [Edogbo et al., 2020].

3. METHODOLOGY

This chapter describes the systematic approach employed to identify, screen, and synthesize relevant literature on heavy metal contamination in smoked fish from Nigeria.

3.1 Search Strategy

A comprehensive literature search was conducted to identify studies on heavy metal contamination in smoked fish from Nigeria. The following electronic databases were systematically searched: PubMed, Scopus, ScienceDirect, Google Scholar, and ResearchGate. The search was conducted between February 2026 and March 2026 and covered publications from January 2015 to December 2025 to ensure relevance and currency. The search strategy employed combinations of keywords and Boolean operators. Population terms included "Nigeria" OR "Nigerian" combined with specific state names such as Ondo, Lagos, Ogun, Anambra, Borno, Niger Delta, and Southwest Nigeria. Exposure terms comprised "heavy metals," "trace metals," "toxic metals," "lead," "Pb," "cadmium," "Cd," "chromium," "Cr," "arsenic," and "As." Food terms included "smoked fish," "processed fish," "smoke-dried fish," "Clarias Garie Pinus," "catfish," and "tilapia." Outcome terms covered "health risk assessment," "THQ," "hazard quotient," "hazard index," "HI," "cancer risk," "nutrition," "proximate composition," and "public health."

3.2 Inclusion and Exclusion Criteria

Studies were included if they met specific criteria. Eligible studies comprised original primary research or systematic reviews published in peer-reviewed journals, conducted in Nigeria or specifically focused on Nigerian smoked fish samples, and reported quantitative data on heavy metal concentrations, including lead, cadmium, chromium, arsenic, or mercury in smoked fish. All included studies were published in English between January 2015 and December 2025. Studies were excluded if they examined fresh or frozen fish only without a smoked fish component, reported only polycyclic aromatic hydrocarbons, microbial contamination, or pesticide residues without metal analysis, or were conference abstracts, editorials, commentaries, or opinion pieces without original data. Studies where the full text was unavailable after contacting authors and duplicate publications of the same data were also excluded.

3.3 Study Selection and PRISMA Framework

The study selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The selection involved four stages: identification, screening, eligibility, and inclusion. During identification, records were retrieved from the database by searching using the specified keywords. In the screening stage, titles and abstracts were screened against inclusion criteria, and duplicates were removed. Full-text articles were then assessed for eligibility during the third stage. Finally, studies meeting all criteria were included in the final review.

3.4 Quality Assessment

The quality of included studies was assessed using an adapted checklist. Each study was evaluated on several parameters including clear description of sampling methodology covering location, sample size, and fish species; appropriate analytical methods such as atomic absorption spectrophotometry or inductively coupled plasma mass spectrometry with quality control measures; use of certified reference materials or recovery tests; reporting of detection limits; calculation of health risk indices including target hazard quotient, hazard index, and cancer risk where applicable; and transparent reporting of results including means, standard deviations, and ranges. Studies were not excluded based on quality scores, but methodological strengths and limitations were considered in the narrative synthesis.

3.5 Data Extraction

The following data were extracted from each included study into a standardized spreadsheet. Bibliographic information included authors, year, journal, and digital object identifier. Study characteristics comprised location, including state, specific market, river, or community, fish species sampled with common and scientific

names; and smoking method, such as drum kiln, mud kiln, improved kiln, or unspecified. Heavy metals analyzed were recorded along with mean concentrations in milligrams per kilogram wet weight or dry weight, with standard deviations. Regulatory limits used for comparison, including WHO, FAO, NAFDAC, and SON standards, were noted. Health risk indices, including target hazard quotient, hazard index, and cancer risk, were extracted where calculated. Nutritional parameters, including protein, fat, moisture, ash, and minerals, were recorded if reported, along with key conclusions and recommendations from each study.

3.6 Data Synthesis

Extracted data were synthesized narratively due to heterogeneity in study locations, fish species, analytical methods, and reporting formats. Findings were organized thematically, corresponding to the review objectives. Geographic patterns were examined by grouping results by Nigerian region, including Southwest, Southeast, North, and Niger Delta, to identify regional contamination patterns. Metal prevalence was assessed by examining frequency and concentrations of specific metals, including lead, cadmium, chromium, and arsenic, across studies. Health risk outcomes were summarized by compiling target hazard quotient, hazard index, and cancer risk findings with particular attention to vulnerable groups. Where studies compared different smoking techniques, findings were synthesized separately to evaluate the impact of smoking methods on contamination levels.

4. NUTRITIONAL PROFILE AND THE RISK-BENEFIT DILEMMA

4.1 Nutritional Value of Smoked Fish

Smoked fish remains a nutritionally valuable food. It provides high-quality, easily digestible protein essential for growth and tissue repair [Oli et al., 2024; Adeyeye et al., 2019]. Fish are also the primary dietary source of long-chain omega-3 fatty acids (eicosapentaenoic acid [EPA] and docosahexaenoic acid [DHA]), which support cardiovascular health, brain development, and reduce inflammation [Obande et al., 2025].

Additionally, smoked fish contributes bioavailable micronutrients. Adeyeye et 0al [2019] documented the amino acid, vitamin, and mineral profiles of smoked fish, showing that smoking methods and fish types affect nutrient retention. Aliyu et al. [2024] reported mineral compositions in processed tilapia, while Oli et al. [2024] compared the proximate composition of fresh and smoke-dried fish from Omambala River, finding that smoking preserves protein content while reducing moisture. For many low-income households in Nigeria, smoked fish represents an affordable and accessible source of these essential nutrients [Oghenochuko et al., 2022; Bwala & Imam, 2021].

4.2 Impact of Smoking on Nutrient Content

The smoking process can alter nutrient composition. Heat exposure may degrade vitamins which are sensitive to heat and cause some lipid oxidation. However, protein content is generally well-preserved, and the dehydration process concentrates nutrients alongside contaminants [Oli et al., 2024; Adeyeye et al., 2019]. Studies comparing fresh and smoked fish from the same sources are limited, thereby creating a research gap.

4.3 The Risk-Benefit Calculus

The co-occurrence of heavy metals in smoked fish creates a public health dilemma. While consumers derive nutritional benefits, they are simultaneously exposed to neurotoxic, nephrotoxic, and carcinogenic metals [Lawal et al., 2021; Nkwunonwo et al., 2020]. This risk-benefit analysis is particularly critical for citizens, including children, pregnant women, and frequent consumers who may be at higher risk despite the nutritional advantages [Oghenochuko et al., 2022; Obande et al., 2025].

The key question is whether the levels of heavy metals documented in Nigerian smoked fish negate its nutritional value. Based on the health risk assessments reviewed in Section 5, the answer is context-dependent: for some metals and consumer groups, the risks likely exceed the benefits [Thomas, 2024; Olayinka-Olagunju, 2025; Onoja et al., 2025]. This emphasizes the urgent need for contamination reduction strategies that preserve nutritional integrity while minimizing toxic exposures.

5. HEALTH IMPACTS OF HEAVY METAL CONTAMINATION

5.1 Toxicological Profiles of Detected Metals

Lead (Pb): A neurotoxin that affects cognitive development in children and causes cardiovascular and renal effects in adults. No safe level of exposure exists [Lawal et al., 2021; Nkwunonwo et al., 2020]. Nigerian studies consistently report Pb exceeding permissible limits in smoked fish [Olayinka-Olagunju, 2025; Oghenochuko et al., 2022; Onoja et al., 2025].

Cadmium (Cd): Accumulates in kidneys and bones, with a half-life of 10 - 30 years. Chronic exposure causes renal tubular dysfunction and osteoporosis [Lawal et al., 2021]. Cd is frequently detected in smoked fish from industrial and urban areas [Osuala & Igwo-Ezikpe, 2022; Edogbo et al., 2020].

Chromium (Cr): Hexavalent chromium (Cr VI) is classified as a Group 1 human carcinogen (lung, nasal). Trivalent Cr (III) is essential but toxic at high levels [Thomas, 2024; Olayinka-Olagunju, 2025]. Thomas [2024] specifically identified Cr as the metal of greatest carcinogenic concern in smoked catfish from Ogun State.

Arsenic (As): Inorganic arsenic is a carcinogen (skin, bladder, lung) and causes cardiovascular and neurological effects [Lawal et al., 2021]. Detected in Ondo State samples [Olayinka-Olagunju, 2025].

5.2 Health Risk Assessment in Nigerian Smoked Fish

Health risk assessment estimates potential non-carcinogenic and carcinogenic risks from dietary exposure. The Target Hazard Quotient (THQ) compares estimated exposure to a reference dose; values 1.0 indicate potential non-carcinogenic effects. The Hazard Index (HI) sums THQs for multiple metals. Cancer Risk (CR) estimates lifetime cancer probability; values 1×10^{-4} are considered unacceptable by the US EPA.

Location	**Fish Species**	**Key Findings**	**Health Implications**	**References**
Ondo State	smoked catfish & grasscutter	High Fe/Mn/Ni; exceeded WHO limits	Non-carcinogenic risks from chronic intake	Olayinka-Olagunju (2025)
Niger Delta	Seafood meta- analysis	Elevated THQ/ILCR for heavy metals	Oil-impacted regions cause systemic toxicity	Umeoguaju et al. (2023)
Southwest markets	Smoked fish	HI/THQ >1 for key metals	Higher risks in smoked vs fresh/frozen	Oghenochuko et al. (2022)
Abeokuta	Processe d catfish	THQ for metals in smoked; non-carcinogenic focus	Vulnerable groups at risk (e.g., nephrotoxicity)	Thomas (2024)
Ose River, Ondo	Fish species	Concentrations & risk assessment (water/sediment/fish)	Bioaccumulation led to elevated HI	Oloye & Odede (2025)
Review	Heavy metals public health	General risks (carcinogenic/non-carcinogenic)	Pb/Cd neuro/kidney damage in Nigeria context	Lawal et al. (2021)
Review	Nigeria food chain review	Health implications via food chain	Chronic exposure risks malnutrition synergy	Nkwunonwo et al. (2020)
Anambra	Smoked-dried fish	HI >1; non-carcinogenic adverse effects	Market fish unsafe for regular consumption	Onoja et al. (2025)

TABLE 2: Health Risk Assessment Findings

Table 2 Summarizes health risk indices reported in Nigerian studies.

Across the reviewed studies, a consistent pattern emerges:

Non-carcinogenic risks: In Ondo State, Olayinka-Olagunju [2025] reported HI values exceeding 1.0, indicating potential adverse health effects in regular consumers. Oghenochuko et al. [2022] also found that children face higher health risks per unit body weight compared to adults, due to higher fish consumption rates and greater physiological susceptibility. Onoja et al. [2025] similarly documented HI > 1 in Anambra State.

Carcinogenic risks: Thomas [2024] in Ogun State reported cancer risk values for chromium that exceeded the US EPA acceptable limit (1×10^{-4}), classifying smoked fish consumption as a potential carcinogenic hazard. Olayinka-Olagunju [2025] also documented elevated cancer risks in Ondo State, with chromium as the primary contributor.

Vulnerable groups: Children are consistently identified as the most vulnerable subpopulation [Oghenochuko et al., 2022; Obande et al., 2025].

5.3 Regional and Temporal Patterns

Comparing studies across Nigeria reveals geographic variation in contamination profiles. Northern states like Borno [Bwala & Imam, 2021] and Zaria [Odey et al., 2020] show industrial and domestic effluent impacts. Southwestern states show complex mixtures with Cr-related cancer risks [Thomas, 2024; Olayinka-Olagunju, 2025; Laoye et al., 2025]. The Niger Delta exhibits the most severe contamination due to crude oil pollution [Umeoguaju et al., 2023; Enuneku et al., 2018]. This likely reflects differences in local pollution sources, smoking practices, and fish species.

6. PUBLIC HEALTH IMPLICATIONS AND POLICY GAPS

6.1 Regulatory Landscape

In Nigeria, maximum permissible limits for heavy metals in fish are established by the National Agency for Food and Drug Administration and Control (NAFDAC) and the Standards Organization of Nigeria (SON), which generally align with Codex Alimentarius and WHO/FAO standards [Ogbeide & Henry, 2024; Idowu, 2022]. However, the reviewed studies repeatedly document overruns of these limits [Olayinka-Olagunju, 2025; Oghenochuko et al., 2022; Onoja et al., 2025; Osuala & Igwo-Ezikpe, 2022; Adelakun et al., 2024], indicating a significant gap between standards and actual food safety.

6.2 Monitoring and Enforcement Gaps

Despite the evidence of contamination, Nigeria lacks a coordinated national surveillance program for heavy metals in smoked fish [Ogbeide & Henry, 2024; Idowu, 2022]. Monitoring remains scattered, limited to academic research, with limited translation into regulatory action. Ogbeide and Henry [2024] rigorously assessed Nigerian policies addressing heavy metal pollution, concluding that enforcement remains weak, and remediation strategies are inadequately implemented. This absence of systematic data hinders risk assessment, prevents early warning and leaves consumers unprotected.

6.3 Consumer Awareness

There is a striking gap in research on consumer knowledge regarding heavy metal risks in smoked fish. Studies on microbial safety [Adetuwo et al., 2023] suggest that consumers may be more aware of spoilage than chemical contaminants. The findings suggest that consumers select fish based on sensory qualities (texture, colour, smell) rather than safety considerations [Adeyeye, 2016; Bwala & Imam, 2021]. Without awareness, consumer pressure cannot drive safer practices.

6.4 The Overlooked Population: Occupational Exposure of Fish Smokers

A major oversight in the Nigerian literature is the occupational health of fish smokers, predominantly women who spend hours daily inhaling smoke from burning wood. While studies document heavy metals and PAHs in smoked fish [Ubwa et al., 2015; Tongo et al., 2017], no study in this database assessed inhalation exposure among processors. Emerging findings from West Africa suggest that smoke contains not only particulate matter and PAHs but also volatile metals that can be inhaled or absorbed dermally [Obande et al., 2025; Laoye et al., 2025]. These workers may face health risks exceeding those of consumers, yet they remain entirely absent from food safety discourse and occupational health protections. This represents the most urgent research gap identified in this review.

6.5 Economic and Trade Implications

Heavy metal contamination can affect domestic and international trade. Smoked fish is a tradable commodity within West Africa, and consistent violation of international standards could lead to export restrictions or loss of market access [Ogbeide & Henry, 2024]. Bwala and Imam [2021] documented the socio-economic importance of fish smoking in Borno State, highlighting that contamination could damage livelihoods.

6.6 Pathways to Intervention

Addressing heavy metal contamination requires a multi-faceted approach. Promoting improved smoking kilns (e.g., Chorkor, FAO-Thiaroye) validated to reduce both PAHs and metal contamination [Adeyeye et al., 2017; Adeyeye, 2019; Ubwa et al., 2015]. Ensuring fuelwood is sourced from uncontaminated areas; exploring alternative biomass [Laoye et al., 2025; Idowu, 2022]. Establishing routine monitoring with clear enforcement mechanisms [Ogbeide & Henry, 2024]. Extending food safety frameworks to include processor protection; study inhalation risks [Obande et al., 2025; identified as a gap]. And finally, developing culturally appropriate messaging on selecting safer smoked fish and diversifying protein sources [Nkwunonwo et al., 2020].

7. KNOWLEDGE GAPS AND FUTURE RESEARCH DIRECTIONS

This review reveals several critical gaps in the Nigerian literature on heavy metals in smoked fish.

No reviewed study simultaneously measured heavy metals and comprehensive nutritional parameters (protein, fatty acids, vitamins) in the same smoked fish samples, preventing direct risk-benefit quantification. While Adeyeye et al. [2019] and Oli et al. [2024] provide nutritional data, and Olayinka-Olagunju [2025] provides metal data, they are from different samples. In addition, no studies assessed heavy metal exposure in fish smokers via inhalation or dermal routes. This is the most urgent research need, given the hours processors spend in smoke [Obande et al., 2025; identified in this review]. All studies are cross-sectional; no data exist on seasonal variation or long-term trends in metal contamination [Idowu, 2022].

No studies have evaluated whether improved kilns or fuel substitutions actually reduce metal levels in smoked fish, though PAH reduction has been studied [Ubwa et al., 2015; Adeyeye et al., 2017]. Total metal concentration does not equal absorbed dose. Studies measuring bio-accessibility (simulated digestion) would refine risk assessments [Lawal et al., 2021; Nkwunonwo et al., 2020]. Research on consumer awareness, preferences, and willingness to pay for safer smoked fish is absent [noted in Section 6]. More research is needed to distinguish metals originating from aquatic pollution versus those introduced during smoking [Laoye et al., 2025; Idowu, 2022]. Policy implementation research: Studies on why existing regulations fail and how to improve enforcement are lacking [Ogbeide & Henry, 2024]. Future research should prioritize these areas to generate evidence for effective interventions.

8. CONCLUSION

This review synthesizes Nigerian evidence on heavy metal contamination in smoked fish, revealing a persistent and alarming trend. Across multiple states and studies, smoked fish contains high levels of lead, cadmium, chromium, and arsenic, frequently exceeding regulatory limits [Olayinka-Olagunju, 2025; Oghenochuko et al., 2022; Onoja et al., 2025; Osuala & Igwo-Ezikpe, 2022; Adelakun et al., 2024; Oloye & Odedeyi, 2025].

Health risk assessments show that regular consumption carries potential non-carcinogenic risks (Hazard Index > 1) and, for chromium, unacceptable cancer risks [Thomas, 2024; Olayinka-Olagunju, 2025; Onoja et al., 2025]. Children are particularly vulnerable due to higher consumption per body weight and greater physiological susceptibility [Oghenochuko et al., 2022; Obande et al., 2025].

Basically, this review identifies a major challenge: the occupational health of fish smokers. While consumers face dietary risks, processors - predominantly women – may face even higher risks through inhalation, yet they remain entirely absent from Nigerian research and policy [identified gap; Obande et al., 2025]. This lapse must be urgently addressed.

Smoked fish remains an essential source of nutrition and livelihood in Nigeria [Adeyeye, 2016; Bwala & Imam, 2021; Oli et al., 2024].

The goal is not to eliminate smoking but to make it safe for all. Achieving this requires investment in validated smoking technologies [Adeyeye et al., 2017; Ubwa et al., 2015], National surveillance linking metal data to health outcomes [Ogbeide & Henry, 2024; Idowu, 2022], Inclusion of occupational health in food safety frameworks [identified gap] and Community education for safer practices [Nkwunonwo et al., 2020].

The evidence is unequivocal; urgent action is required to advance the field and address the challenges identified. Protecting the health of both consumers and producers must become a national priority.

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