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**ENVIRONMENTAL TOXICOLOGY AND HUMAN HEALTH RISKS**

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Nigeria.**Article Received: 10 April 2026, Article Revised: 30 April 2026, Published on: 20 May 2026****\*Corresponding Author: Ekohwo, Emmanuel Ejiroghene**

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DOI: <https://doi-doi.org/101555/ijarp.5555>**ABSTRACT**

Environmental toxicology and human health risks are closely interconnected fields that examine how exposure to environmental contaminants affects human well-being and ecosystem stability. Environmental toxicology focuses on the study of toxic substances such as heavy metals, pesticides, industrial chemicals, and air pollutants and their effects on biological systems. These substances can enter the human body through air, water, soil, or food, leading to acute and chronic health problems including respiratory disorders, cancers, reproductive issues, and neurological impairments. The magnitude of health risks depends on factors such as exposure level, duration, and individual susceptibility. Advances in toxicological assessment, biomonitoring, and risk evaluation have improved the ability to detect hazardous compounds and predict their impacts on public health. Furthermore, integrating environmental monitoring with regulatory frameworks helps in setting safety standards and mitigating exposure risks. Promoting awareness, enforcing pollution control measures, and encouraging the use of green technologies are critical steps toward reducing toxic burdens on both humans and the environment. Ultimately, environmental toxicology provides the scientific foundation for safeguarding health and ensuring a cleaner, safer, and more sustainable future.

**KEYWORDS:** Environmental toxicology, Human health risks, Pollution, Biomonitoring, Risk assessment.**INTRODUCTION**

Environmental toxicology represents one of the most crucial disciplines in contemporary environmental science and public health. It seeks to understand the interactions between toxic

substances and living systems - humans, animals, and plants - within the biosphere. The central aim is to determine how pollutants cause adverse biological effects, their mechanisms of action, and how such impacts can be mitigated through sound environmental management. Globally, the World Health Organization (WHO, 2023) reports that approximately 12.6 million deaths annually are attributable to unhealthy environments, including exposure to air and water pollution, chemical toxins, and occupational hazards. These environmental risks disproportionately affect low- and middle-income countries (LMICs), where regulatory systems are weak and pollution control infrastructure is inadequate.

In Nigeria, rapid urbanization, oil exploration, and industrial activities have exacerbated environmental degradation. The Niger Delta region, known for its extensive petroleum production, suffers from chronic oil spills, gas flaring, and contamination of soil and groundwater. Such pollution contributes to health challenges such as respiratory illnesses, reproductive dysfunctions, and carcinogenic effects. Despite the establishment of regulatory institutions like the National Environmental Standards and Regulations Enforcement Agency (NESREA) and the National Emergency Management Agency (NEMA), enforcement remains inconsistent, and public health impacts continue to rise.

This study examines environmental toxicology and human health risks in Nigeria, relating them to global standards established by the WHO and UNDRR. It emphasizes the importance of risk assessment, exposure management, and disaster preparedness in mitigating toxic hazards.

## **LITERATURE REVIEW**

### **Historical Development of Environmental Toxicology**

The field of environmental toxicology evolved during the 20th century following increasing awareness of industrial pollution and its health implications. Rachel Carson's *Silent Spring* (1962) marked a pivotal point, revealing the ecological and health effects of pesticides such as DDT. This led to the birth of environmental regulation in many countries and the establishment of toxicological monitoring systems.

In Nigeria, environmental toxicology gained attention in the 1980s and 1990s as industrial and oil exploration activities expanded. Studies by Ite and Ibok (2019) linked gas flaring in the Niger Delta to soil acidification and health hazards among local populations. Subsequent research identified high concentrations of lead, cadmium, and mercury in the aquatic and terrestrial ecosystems of urban and oil-producing areas (Obi and Okonkwo, 2020).

## Concepts and Principles

Environmental toxicology relies on several foundational concepts:

**Dose–Response Relationship:** The degree of toxicity depends on the dose and duration of exposure.

**Bioaccumulation:** Toxic substances accumulate in an organism’s tissues over time.

**Biomagnification:** Toxins increase in concentration as they move through trophic levels in the food chain.

**Exposure Pathways:** Pollutants reach humans through ingestion, inhalation, or dermal absorption.

The interaction of these principles helps explain variations in toxicological outcomes among individuals and populations.

## Major Classes of Environmental Toxicants

**Heavy Metals:** Lead, mercury, arsenic, and cadmium are persistent pollutants that cause neurological, renal, and reproductive disorders.

**Pesticides and Herbicides:** Widely used in agriculture, these chemicals disrupt endocrine systems and may cause cancers.

**Industrial Effluents:** Hydrocarbons and polychlorinated biphenyls (PCBs) from factories contaminate water sources.

**Air Pollutants:** Particulate matter (PM<sub>2.5</sub> and PM<sub>10</sub>), sulfur oxides, and nitrogen oxides contribute to respiratory diseases and cardiovascular problems.

## GLOBAL AND NIGERIAN CONTEXTS

According to WHO (2023), environmental pollution is a global public health emergency, with over 90% of the world’s population exposed to air quality levels exceeding WHO limits. In Nigeria, poor waste disposal, unregulated mining, and urban emissions have compounded exposure risks. The UNDRR (2022) advocates integrating environmental health into disaster risk reduction policies, while NEMA (2021) calls for greater community-based environmental surveillance.

## METHODOLOGY

### Research Design

This study employs a **descriptive and analytical research design**, combining a systematic review of existing literature, institutional reports, and toxicological data. Both global and Nigerian contexts were considered to ensure comparability and relevance.

**Data Sources**

- ✓ Peer-reviewed journals (2010 - 2024) on environmental toxicology and public health.
- ✓ Reports from WHO, UNDRR, and NEMA.
- ✓ Nigerian policy documents and environmental assessment reports (NESREA, DPR, and Federal Ministry of Environment).

**Analytical Framework**

The study adopts the risk assessment framework proposed by WHO, consisting of:

1. **Hazard Identification** – Determining the types of toxic substances.
2. **Exposure Assessment** – Measuring pollutant levels and exposure frequency.
3. **Dose–Response Assessment** – Linking exposure levels with health outcomes.
4. **Risk Characterization** – Integrating all data to determine overall health risk.

**LIMITATIONS**

The study relies primarily on secondary data; hence, site-specific field measurements were not conducted. However, triangulation from multiple credible sources mitigates bias and enhances validity.

**OVERVIEW OF FINDINGS**

Results show that **environmental toxicants are widespread across Nigeria’s air, water, and soil ecosystems**. Heavy metals such as lead, chromium, and cadmium have been found in fish, vegetables, and drinking water above WHO safety thresholds. The **Niger Delta region** remains the most affected, where crude oil spills contaminate freshwater and farmland.

**Table 1. Placeholder – Major Environmental Pollutants and Health Risks in Nigeria.**

Pollutant Type	Major Sources	Key Health Effects
Lead, Cadmium, Mercury	Industrial waste, batteries, oil spills	Neurological disorders, renal failure, developmental defects
Pesticides	Agriculture	Endocrine disruption, cancers, reproductive damage
Hydrocarbons	Oil exploration, gas flaring	Respiratory diseases, liver toxicity
Particulate Matter	Urban traffic, generators	Asthma, lung cancer, heart disease

## TOXICOLOGICAL MECHANISMS

Toxic substances interact with human biological systems in several ways:

- **Cellular Damage:** Reactive oxygen species (ROS) cause oxidative stress, leading to DNA damage.
- **Endocrine Disruption:** Chemicals such as bisphenol A (BPA) mimic hormones, disturbing reproductive balance.
- **Bioaccumulation:** Persistent organic pollutants (POPs) remain in adipose tissues, leading to chronic exposure effects.

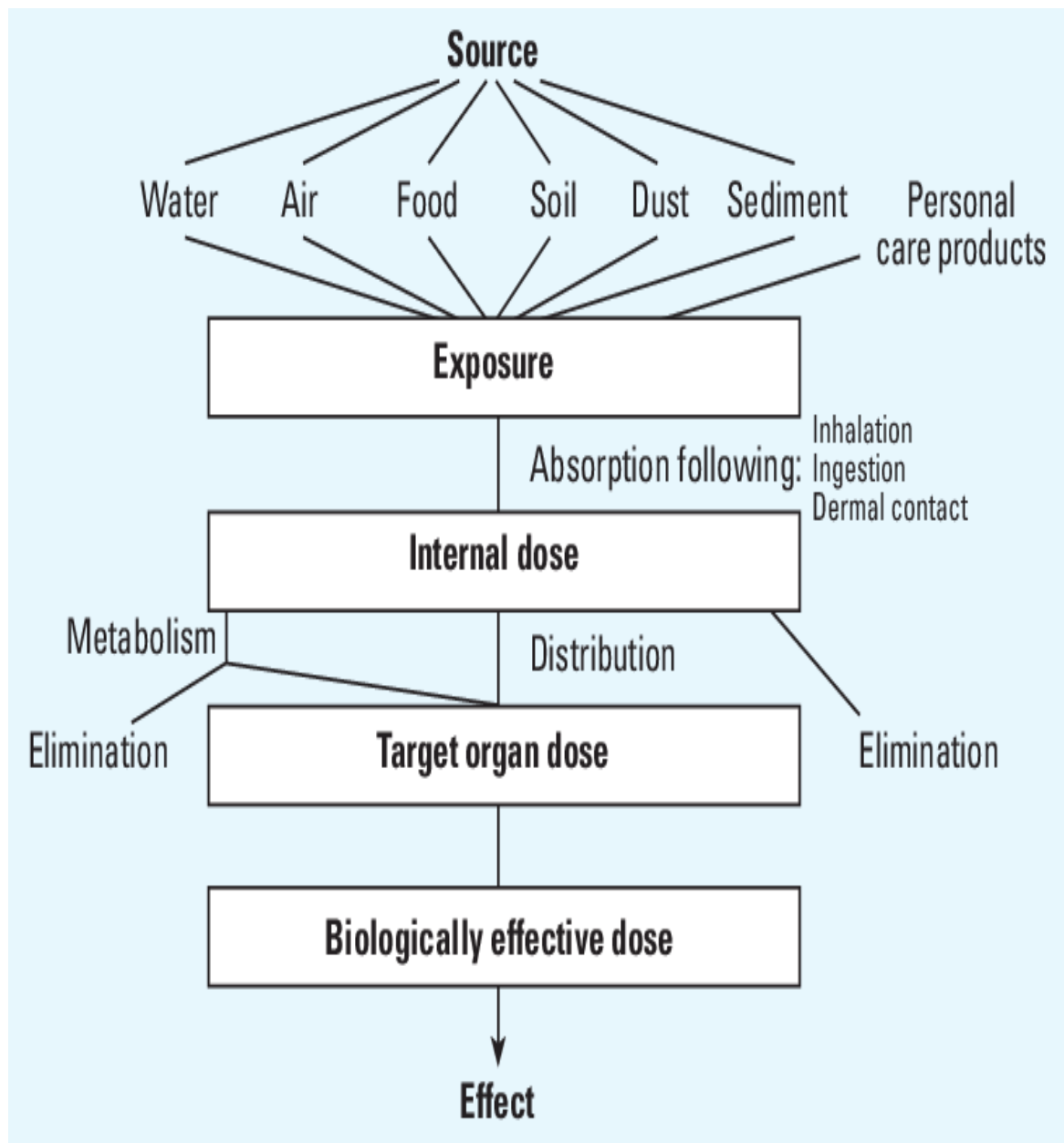
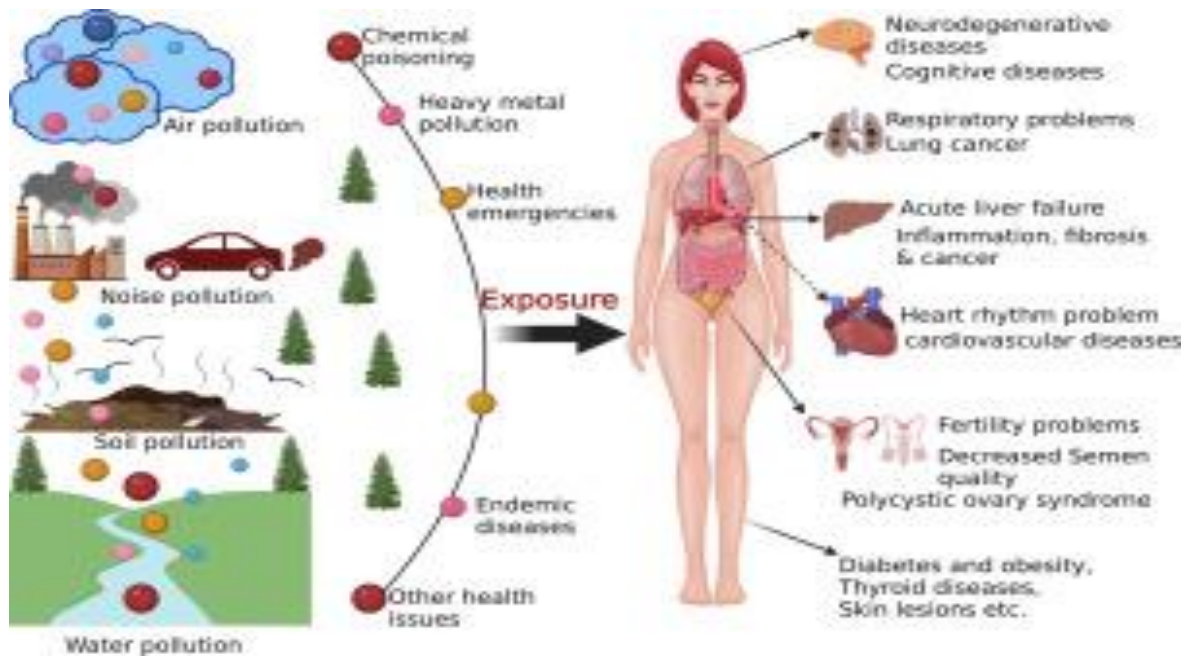


Figure 1. Placeholder – Conceptual Framework of Environmental Toxicology and Human Health Interaction.



### NIGERIAN CASE STUDIES

- **Niger Delta Oil Pollution:** Over 13 million barrels of crude oil have been spilled since the 1970s. Studies reveal high hydrocarbon levels in soil and water, exceeding WHO and NESREA standards.
- **Urban Air Pollution (Lagos, Kano, and Port Harcourt):** PM<sub>2.5</sub> levels frequently exceed WHO limits, increasing respiratory morbidity among children and the elderly.
- **E-Waste Dumping (Aba, Lagos):** Informal recycling releases lead, mercury, and brominated flame retardants, endangering workers and nearby residents.

### GLOBAL COMPARISON

Developed countries like Japan and the United States have reduced toxic exposure through strict enforcement, advanced waste treatment, and continuous biomonitoring. However, in low-income nations such as Nigeria, inadequate data, poor enforcement, and poverty exacerbate vulnerabilities. UNDRR (2022) stresses the need to integrate toxicological hazards into disaster response plans—especially given climate change’s role in spreading pollutants through floods and storms.

### POLICY AND INSTITUTIONAL FRAMEWORKS

NEMA coordinates disaster management, including toxic spill responses, yet lacks sufficient laboratory capacity. NESREA enforces environmental laws, but penalties for violations are minimal. WHO and UNDRR provide technical assistance and frameworks for environmental

health monitoring. Collaboration between these bodies and Nigerian institutions remains limited.

### **SOCIOECONOMIC IMPLICATIONS**

Environmental toxicity leads not only to health crises but also to economic losses from healthcare costs, reduced productivity, and environmental remediation expenses. Women and children are particularly vulnerable due to physiological and social factors affecting exposure.

### **CONCLUSION**

Environmental toxicology and human health risks are interlinked challenges that demand urgent attention in Nigeria. The study concludes that persistent exposure to heavy metals, hydrocarbons, and air pollutants contributes significantly to national disease burdens. Despite efforts by NEMA and NESREA, environmental monitoring and enforcement remain weak.

### **RECOMMENDATIONS:**

1. **Strengthen Monitoring Systems:** Establish toxicological monitoring laboratories across Nigeria's six geopolitical zones.
2. **Policy Enforcement:** Implement stricter penalties for industrial polluters.
3. **Public Health Integration:** Align national health policies with WHO's Environmental Health Risk Framework.
4. **Community Awareness:** Educate the public on pollution hazards through NEMA's outreach programs.
5. **International Collaboration:** Partner with UNDRR and WHO to improve data sharing and early warning systems.

By implementing these strategies, Nigeria can reduce exposure risks, safeguard ecosystems, and align with global sustainable development goals (SDGs 3, 6, 13, and 15).

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