NIGERIA

A. Regulation on sources 2

B. International Agreements 4

C. Blood lead-level monitoring programs 4

D. Inventory of toxic sites (Toxic Sites Identification Program (TSIP), Pure Earth) 4

E. Scientific papers on lead exposure 6

F. Blood testing in National Health Surveys 13

A. Regulation on sources

Source of lead	Relevant legislation/regulation	Government agencies	Data source
1. Used lead-acid battery recycling	1. No specific regulatory structure for used lead acid battery recycling facilities. 2. Guidelines such as the National Environmental Base Metals, Iron and Steel Manufacturing and Recycling Regulation (2011), National Environmental Vehicle and Miscellaneous Assembly Regulations (2012) are applicable to ULAB management. 3. While in the National Environment Protection (Effluent Limitation) regulation 1991 (now S.I. 22 of 2011), it was stated that the guideline for the maximum concentration of lead allowed to be discharged with automotive battery industry effluent into inland water is 0.01mg/, there is no monitoring and regulatory enforcement of standards by government regulatory bodies despite the presence of industrial standards for lead.	a. Ministry of Environment b. National Environmental Standards and Regulations Enforcement Agency	1. Sustainable Research and Action for Environmental Development. 2019. Estimating and Assessing Lead Poisoning Cases/High Risk Environments in Used Lead Batteries Facilities in Southwestern Nigeria.
2. Standards for lead in food	1. The National Agency for Food and Drug Administration and Control (NAFDAC) regulates the maximum permissible levels of lead in food products. 2. The Nigerian Government is a member of Codex Alimentarius Commission, a joint FAO/WHO food standards program.	a. Ministry of Health b. National Agency for Food and Drug Administration and Control (NAFDAC) c. Standards Organisation of Nigeria (SON)	1. USDA FAS. 2020. Food and Agricultural Import Regulations and Standards Country Report. 2. National Agency for and Food and Drug Administration and Control. 2019. Fats and Oils Regulations.

Source of lead	Relevant legislation/regulation	Government agencies	Data source
3. Standards for lead in cookware	1. No specific set of regulations around cookware found so far		
4. Standards for occupational exposure	1. Both the Factories Act (2004) and Employee Compensation Act (2011) contain a schedule of occupational diseases that include lead poisoning (including poisoning by any preparation or compound of lead or their sequelae). 2. However, as of 2017, there were no workplace legislation and regulations directed towards these categories of workers against lead exposure. The ministry of labor does not have data on lead poisoning and no occupational exposure limits (OELs) are provided for lead compounds	a. Ministry of Labour and Productivity	1. ILO. 2016. Nigeria Country Profile on Occupational Safety and Health. 2. Olusegun Rasheed, Tajudeen. 2017. "Safety Practices on Lead Poisoning Among Battery Technicians in Lagos Nigeria, 2017." Central African Journal of Public Health 4(1):27.
5. Lead in paint	1. Does not currently have a lead paint law		1. UNEP. 2019. Update on the Global Status of Legal Limits on Lead in Paint September 2019.
6. Waste generated from smelting or mining	No regulations found		

B. International Agreements

Agreement	Year Ratified
1. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	1991
2. Rotterdam Convention on the Prior Informed Consent Procedure for certain hazardous Chemicals and Pesticides in international trade	2001 (Accession)
3. Stockholm Convention on Persistent Organic Pollutants	2004

C. Blood lead-level monitoring programs

No structured programs found.

D. Inventory of toxic sites (Toxic Sites Identification Program (TSIP), Pure Earth)

Site	Province/Region	Details (all data comes from the TSIP website)
1. Azuabie Creek, Port Harcourt	Rivers state	
2. Port Harcourt Waste Dumpsites	Rivers state	
3. Cemetery Road Aba Scrap Metal Recovery site, Abia		

Site	Province/Region	Details (all data comes from the TSIP website)
4. Ogbunagha	Bayelsa state	
5. Lead-acid Battery Manufacturing company, Ibadan		
6. Gbagi Battery Waste recycling site	Oyo state	
7. West African Battery Limited, Ibadan		
8. Boluwaji Battery Waste Recycling Site	Oyo State	
9. Contraband goods open burning site	Shagamu Ogun state	
10. Odo iyara alaro e-waste recycling site, Lagos		
11. Abule-Egba, Lagos		
12. Oo Iyara alaro e-waste recycling site, Lagos		
13. Yargalma village, Bukkuyum area	Zamfara State	
14. Kududdufin DanAgundi	Kano-Nigeria	

E. Scientific papers on lead exposure (Please contact info@gahp.net for information on studies not in the public domain)

Topic	Authors	Year	Title	Abstract/ description
Environmental exposure	Bello, Olanrewaju, Ravi Naidu, Mohammad Mahmudur Rahman, Yanju Liu, and Zhaomin Dong	2016	Lead Concentration in the Blood of the General Population Living near a Lead–Zinc Mine Site, Nigeria: Exposure Pathways	**Background:** Lead (Pb) poisoning in children is a major public health catastrophe worldwide. This report summarises both exposure pathways and blood Pb levels in children below 7 years of age and adults (above 18 years) from the Adudu community living near a lead–zinc mine in Nasawara, Nigeria. **Results:** The average and median blood Pb levels in children and adults were 2.1 and 1.3 µg/dL, 3.1 and 1.8 µg/dL, respectively. However, Pb in 14% of adults' blood exceeded 5 µg/dL, which is the recommended threshold blood Pb concentration in adults as established by the Centers for Disease Control and Prevention (CDC). Furthermore 68% of adults' blood exceeded blood Pb action level of 2 µg/dL. For children, 11.4% and 31% of the blood samples exceeded 5 µg/dL and 2 µg/dL, respectively, while no safe blood Pb level in children has been recommended. In Nasawara, a significant difference ($p < 0.05$) was observed between the various age groups in children with 2–4 years old having the highest levels and 6 year old children having the lowest Pb levels. Although this study did not detect elevated levels of Pb in children's blood in regions such as Zamfara, Nigeria and Kabwe, Zambia, a high percentage of samples exceeded 2 µg/dL. Soils, floor dusts, water and crops also reveal that Pb contamination in the study area could potentially be the major cause of blood Pb in the community exposed to mining. This study also observed a significant correlation between water Pb levels of adults and blood Pb levels, suggesting that water is the major exposure pathway. This analysis highlights the need to properly manage mining activities so that the health of communities living in the vicinity of a Pb–Zn mine is not compromised.
Environmental exposure	Olusegun I. Alatise & Gerhard N. Schrauzer	2010	Lead Exposure: A Contributing Cause of the Current Breast Cancer Epidemic in Nigerian Women	**Background:** Breast cancer incidence in Nigerian women has significantly increased during the past three decades in parallel with the rapid industrialization of that country. This suggested that the associated widespread contamination of the soil and of the water supplies by lead (Pb) and other industrial metals was a major contributing cause. Because of its many domestic, industrial, and automotive uses, Pb is of particular concern as it has been shown to promote the development of mammary tumors in

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				murine mammary tumor virus-infected female C3H mice at levels as low of 0.5 ppm Pb in the drinking water. Lead belongs to the group of selenium-antagonistic elements that interact with selenium (Se), abolishing its anti-carcinogenic effect. Lead on chronic, low-level exposure in addition also accelerates tumor growth rates. Higher levels of Pb were found in blood and head hair samples of newly diagnosed patients with breast cancer, all with infiltrating ductal carcinoma, the most common form of breast cancer in Nigeria, seen at Obafemi Awolowo University, than in cancer-free controls from the same area. **Methods and Results:** Evidence for interactions between Pb and Se was obtained from blood, hair, and tumor biopsy tissue analyses. Furthermore, the Pb levels in hair samples of the patients were directly correlated with the volumes of their tumors, in accord with the tumor growth-promoting effects of Pb. Conversely, Se levels in hair and blood were inversely correlated with the tumor volumes, consistent with the anti-proliferative effects of Se. Several other elements, e.g., Cd, Hg, Cr, Sn, and As, were detected in the scalp hair of the patients and the controls, although at significantly lower levels than those of Pb. However, correlation calculations revealed them also to interact with Se, suggesting that only a fraction of the Se in organs and tissues is actually present in bioactive forms. In metal-exposed subjects, a state of latent Se deficiency may exist, resulting in depressed immune functions and increased cancer susceptibility. Evidence is presented to show that Pb and other metals also interact with iodine, another vitally important essential trace element believed to protect against breast cancer development. Public health programs aiming at lowering the breast cancer risk of Nigerian women thus will have to include effective measures to protect the population from exposures to Pb and other industrial metals that are presently contaminating the environment and the water supplies.

Topic	Authors	Year	Title	Abstract/ description
Food exposure	Tirima, Simba, Casey Bartrem, Ian von Lindern, Margrit von Braun, Douglas Lind, Shehu Mohamed Anka, and Aishat Abdullahi	2018	Food contamination as a pathway for lead exposure in children during the 2010–2013 lead poisoning epidemic in Zamfara, Nigeria	**Background:** In 2010, an estimated 400 to 500 children died of acute lead poisoning associated with artisanal gold mining in Zamfara, Nigeria. Processing of gold ores containing up to 10% lead within residential compounds put residents, especially children, at the highest risk. Principal routes of exposure were incidental ingestion and inhalation of contaminated soil and dusts. Several Nigerian and international health organizations collaborated to reduce lead exposures through environmental remediation and medical treatment. The contribution of contaminated food to total lead exposure was assessed during the environmental health response. Objectives of this investigation were to assess the influence of cultural/dietary habits on lead exposure pathways and estimate the contribution of contaminated food to children's blood lead levels (BLLs). **Methods:** A survey of village dietary practices and staple food lead content was conducted to determine dietary composition, caloric intakes, and lead intake. Potential blood lead increments were estimated using bio-kinetic modeling techniques. **Results:** Most dietary lead exposure was associated with contamination of staple cereal grains and legumes during post-harvest processing and preparation in contaminated homes. Average post-harvest and processed cereal grain lead levels were 0.32 mg/kg and 0.85 mg/kg dry weight, respectively. Age-specific food lead intake ranged from 7 to 78 µg/day. Lead ingestion and absorption were likely aggravated by the dusty environment, fasting between meals, and nutritional deficiencies. Contamination of staple cereal grains by highly bioavailable pulverized ores could account for as much as 11%–34% of children's BLLs during the epidemic, and were a continuing source after residential soil remediation until stored grain inventories were exhausted.
Occupational Exposure	Nancy Ibeh, John Aneke, Chide Okocha, Chizoba Okeke, Joseph Nwachukwuma	2016	The influence of occupational lead exposure on haematological indices among petrol station attendants and automobile	**Background:** Lead adversely affects a number of organ systems in the body; routine blood count evaluation is an important component of monitoring for organ related toxicity such as leukemia and aplastic anemia. Objective: To evaluate the influence of blood lead levels (BLL) on heamatological parameters among petrol station attendants (PSAs) and auto mobile mechanics (AMs) in Nnewi, South-east Nigeria. Subjects and **Methods:** One hundred subjects (including 25 PSAs, 25 AMs and 50 normal controls) were prospectively recruited. Five milliliters of blood was collected for full blood

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			mechanics in Nnewi, South-East Nigeria?	count (FBC) and BLL, FBC was done using haematology auto-analyzer (SYSMEX PE 6800), while BLL was determined with atomic absorption spectrophotometer (AAS model: 240FSAA). Results were expressed as means ±SD, while associations between variable were explored using student t-test and analysis of variance. Regression analysis and correlation were used to establish possible link between lead parameters and hematological indices and personal life style habits. Ethical clearance was obtained from our institutional review board and all participants gave informed consent. **Results:** Blood lead and white blood cell count (WBC) were significantly higher in AMs compared with PSAs and controls (P values < 0.001), while haemoglobin concentration (Hb), haematocrit, mean cell haemoglobin concentration (MCHC), mean cell volume (MCV), mean cell haemoglobin (MCH) and platelet count were significantly higher in controls, compared to PSAs and AMs (P values <0.001). The MCV and MCH were negatively correlated with BLL in PSAs (P=0.02, respectively) while the Hb, haematocrit, MCV, MCH, and MCHC were negatively correlated with BLL in AMs (P values all <0.05). Conclusion: Lead exposure adversely affects blood count and red cell indices in occupationally exposed groups in Nnewi, South-east Nigeria.
Occupational Exposure	Lukman Adewale Alli	2016	Blood level of cadmium and lead in occupationally exposed persons in Gwagwalada, Abuja, Nigeria	**Background:** This study was designed to assess the blood levels of cadmium and lead in some occupationally exposed individuals and compare the values with non-exposed individuals, with the aim of increasing the awareness of health risk caused by these heavy metals. **Methods:** A total of 120 subjects (64 occupationally exposed and 56 non-exposed subjects) with the age range of 15–40 years were studied in cross-sectional study conducted between September 2012 and February 2013 in Gwagwalada area of Abuja, Nigeria. Blood cadmium and lead were analyzed using an atomic absorption spectrophotometer (AAS). **Results:** The respective mean blood levels of cadmium and lead were 11.63±1.73 µg/dl and 45.43±6.93 µg/dl in occupationally-exposed subjects, while in non-exposed subjects 2.03±0.55 µg/dl and 12.08±2.87 µg/dl. The results show that occupational exposure increases the blood level of cadmium and lead, which consequently increases the health risk of the exposed individuals.

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Occupational Exposure	U.A.Lar, C.S.Ngozi-Chika, E.C.Ashano	2013	Human exposure to lead and other potentially harmful elements associated with galena mining at New Zurak, central Nigeria	**Background:** Galena mining in New Zurak, central Nigeria is currently increasing in intensity, with widespread artisanal mining taking place alongside mechanised mining. These activities are causing immeasurable damage to the environment. The prolonged human exposure and ingestion of Pb and other potentially harmful elements (PHEs) such as U, Cd, Se, Zn and As that are released from ores during these (mining) activities is a cause of great concern to populations that live in the vicinity of these mine fields. Many of the communities make their living from subsistence farming, growing food from the surroundings, and obtaining drinking water from nearby surface and sub-surface water resources. **Methods:** An overall assessment of the degree of contamination or toxicity of Pb and other PHEs was carried out using the indices of geoaccumulation (Igeo) and contamination factors (CFs), in the different media sampled – farmland soils, uncultivated lands, mine tailings/dumps, natural waters and vegetables. **Results:** Results reveal that the mine tailings and dumps are highly contaminated with Pb and other PHEs followed in decreasing degree of contamination by the uncultivated lands, farmlands and natural waters. These findings suggest that release of Pb and other PHEs from the galena mining activity has contributed significantly to the enrichment of these elements in the surrounding environment, including the natural water bodies, and are disposed to subsequent entry into the human body through the food chain. As such these PHE accumulations pose significant risks to the environment and human health, especially of children and pregnant women who are the most vulnerable groups in the area. In order to forestall a reoccurrence of the Zamfara Pb poisoning episode in northwestern Nigeria in 2010, where more than 400 children died, the authorities concerned should ensure that mining in New Zurak is done in a more environmentally friendly manner, ensuring the maintenance of an environmental quality adequate for good health and well-being of the surrounding mining communities.

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Occupational Exposure	D.D Alasia P.C Emem-Chioma S.F Wokoma	2010	Occupational and Environmental Lead Exposure in Port Harcourt, Nigeria: Analysis of its association with renal function indices	**Background:** In spite of the high risk of lead exposure in Nigeria, there is a paucity of data on the occupational and environmental burden of lead exposure and its impact on human health especially its nephrotoxic effects. This study aims to assess the degree of occupational and environmental lead exposure in Port Harcourt Nigeria and the relationship between lead exposure and indices of renal function. **Methods:** A cross sectional comparative study of 190 adult subjects with occupational lead exposure and 80 matched controls. Blood lead was used as the biomarker of lead exposure. Serum urea, creatinine, uric acid, urine albumin and glomerular filtration rate were the renal function indices measured. **Results**: Occupationally lead exposed subjects had higher mean blood lead 50.37±24.58 ug/dl, than controls 41.40±26.85 ug/dl (p= 0.008). The mean values of serum urea, creatinine and uric acid were significantly higher in study subjects compared to controls 3.06±0.81 mmol/L vs. 2.7±0.84 mmol/L (p = 0.002), 87.2±14.30 umol/L vs. 80.68±14.70 umol/L (p = 0.001) and 271.93±71.18 umol/L vs. 231.1±62.70 umol/L (p = 0.000) respectively. Creatinine clearance was significantly lower in subjects compared to controls 98.86±21.26 ml/min/1.72m2 vs.108.18±25.16 ml/min/1.72m2 (p = 0.002). Blood lead correlated positively only with blood urea [r = .031, r2 = .017, p = .031] and negatively [r = -.144, r2 = .021, p = .018] with serum phosphate. Conclusion: The level of environmental and occupational lead exposure in Port Harcourt, Nigeria is high, with occupational lead exposure increasing the risk of lead toxicity and renal function impairment.
Occupational Exposure	Oladipo Ademuyiwa, Regina Ngozi Ugbaja, Florence Idumebor & Olugbenga Adebawo	2005	Plasma lipid profiles and risk of cardiovascular disease in occupational lead exposure in Abeokuta, Nigeria	**Background and Methods:** In order to investigate the effects of lead exposure on risk of cardiovascular disease during occupational exposure to this metal, plasma cholesterol and its fractions as high-density liporotein (HDL), low-density liporotein (LDL) and triglyceride were determined in various artisans in Abeokuta, Nigeria who have been shown to be occupationally exposed to lead and these were related to blood lead levels. Increased risk of cardiovascular disease was observed in the artisans. **Results:** Total cholesterol in the artisans was between 1.5 and 2.0 times higher in the artisans than that present in controls while LDL cholesterol was between 1.6 and 2.4 times higher in the artisans when compared with control subjects [p < 0.001]. HDL cholesterol and triglyceride levels were not affected [p > 0.05]. A significant positive correlation was observed between

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				blood lead and total cholesterol on one hand [r = 0.372; p = 3.0 × 10-5] and blood lead and LDL cholesterol on the other hand [r = 0.283; p = 0.001]. LDL/HDL cholesterol ratio was also higher in the artisans when compared with control. Blood pressure (systolic and diastolic) and other anthropometric parameters were not significantly different between the artisans and the control subjects [p > 0.05]. Results suggest that lead exposure increases cholesterol synthesis and transport to peripheral tissues whereas reverse cholesterol transport to the liver is not affected
Occupational Exposure	Dioka, C. E., O. E. Orisakwe, F. a. A. Adeniyi, and S. C. Meludu	2004	Liver and Renal Function Tests in Artisans Occupationally Exposed to Lead in Mechanic Village in Nnewi, Nigeria	**Background and Methods**: Additives in petroleum solvents have been reported to have adverse health implications. An evaluation study on some toxicological effects of occupational exposure to petroleum products (especially petrol which contains tetraethyl lead) amongst twenty five occupationally exposed artisans and twenty five graduate students of College of Health Sciences, Nnamdi Azikiwe University, Nnewi, Nigeria as controls, was carried out using the following biochemical markers: electrolytes, urea, uric acid, inorganic phosphorus, creatinine, zinc and blood lead, as well as the activities of alanine and aspartate aminotransferases, and alkaline phosphatase. **Results:** The results showed that occupational exposure of human subjects to lead in petrol increases the concentrations of uric acid (357 ± 123µ mol/L) and phosphate (1.5 ± 0.5m mol/L) in exposed subjects compared with unexposed subjects (uric acid 228 ± 105µ mol/L, phosphate 1.2 ± 0.41m mol/L; p < 0.01 in both cases). Significantly lower activities were observed for alkaline phosphatase (66 ± 18.9 iu/L). The activities of alanine aminotransferase (11.4 ± 4.0 iu/L) and aspartate aminotransferase (15.8 ± 4.4 iu/L) in occupationally exposed artisans were higher compared with unexposed subjects (alkaline phosphatase = 78 ± 22.4 iu/L alanine aminotranferase = 6.8 ± 2.7 iu/L, aspartate aminotranferase = 9.6 ± 3.5i u/L; p < 0.01 in all cases). Occupational exposure of human subjects to lead significantly increased blood lead (59.6 ± 15.9 µg/dL) and decreased plasma zinc (71.3 ± 14.4 µg/L) in exposed compared with unexposed subjects (blood lead = 35 ± 7 µg/dL, zinc = 108.4 ± 16.9 µg/dL; p < 0.01). The results indicate that occupational exposure to lead in petrol may compromise liver and renal function.

F. Blood testing in National Health Surveys

National Health Survey	Nigeria Demographic and Health Survey (NDHS)	Source
Purpose	The objective of the survey was to provide reliable estimates of demographic and health indicators including fertility, family planning methods, breastfeeding practices, nutritional status of women and children, maternal and child health, childhood and adult mortality, women's empowerment, domestic violence, female genital mutilation, malaria, HIV/AIDS and other sexually transmitted infections (STIs), disability, and other adult health issues	National Population Commission - NPC/Nigeria and ICF. 2019. Nigeria Demographic and Health Survey 2018. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF.
Sample size	The nationally representative sample consists of 41,821 women (age 15-49) in 40,427 households and 13,311 men (age 15-59) in one-third of the sampled households	
Blood sample testing	Blood samples were collected from children (age 6-59 months) and women (age 15-49) to test for anaemia. Additionally, blood samples taken from children were also used to for sickle cell genotypes.	
Latest round	2018	
Next round	Unknown	