Estimating and Assessing Lead Poisoning cases/high risk Environments in Used Lead batteries facilities in Southwestern Nigeria

By

Sustainable Research and Action for Environmental Development
(SRADev Nigeria)
No 18, Olorunlogbon Street,
Anthony Village
Lagos, Nigeria

www.sradev.org

March 2019

Acknowledgements

SRADev Nigeria immensely appreciate our international partners Petra Sorge and Tobias Eisehut of the European Journalism Center (EJC) and Oko Institute Munich and Bill and Melinda Gates Foundation for the financial support.

We gratefully acknowledge the collaborative efforts of the Federal Ministries of Environment and Health, Lagos State Environmental Protection Agency(LASEPA), Ogun states Ministry of Health for the success of this project.

Other members of the Project team is gracefully appreciated including Isaac Anyaogu of the Business Day, the good people of Ipetoro and Ewu eruku and the members of Waste Batteries Recyclers' Association of Nigeria.

Prepared by Leslie Adogame, Executive Director, SRADev Nigeria
Researched and Drafted by Victor Fabunmi and Patience Ashoko Project Officers, SRADev Nigeria

Sustainable Research and Action for Environmental Development (SRADev Nigeria)
Suite 1, No-18, Olorunlogbon Street,
Anthony Village, Lagos, Nigeria
Tel.: +234-8033301305, +234-702528319
Email: sradevnigeria@yahoo.com
Website: www.sradev.org

SRADev Nigeria

Executive Summary

In Nigeria, over 110,000 tons of used lead-acid batteries (ULAB) is generated in Nigeria annually from automotive batteries and alternative energy battery systems according to Recycling and Economic Development Initiative of Nigeria (REDIN). These ULABs are not normally managed in an environmentally sound way[1]. The country does not have a regulatory policy framework to controls the entire management process including, transportation, storage, recycling, processing and exportation of used lead acid batteries [2]. The unsound management practice is becoming a concern to the environment and population health following the devastating occurrence of lead poisoning incidences in Zamfara and Niger states.

Lead battery recycling is an extremely hazardous enterprise which exposes both the workers and environment to significant health risks, contaminating soil, air and water, and contributing to elevated blood lead levels in surrounding communities. The unwholesome Used Lead Acid Battery (ULAB) recycling practice by the informal sector is highly deleterious to the environment and produces metal of poor quality that further refining before being used for manufacturing new lead batteries. With environmentally-sound recycling processes, it can transform the industry to become an exemplary sustainable enterprise.

In a seven-country report on lead contamination in communities around ULAB recycling facilities in 2017 including Nigeria as reported by Sustainable Research and Environmental Development (SRADev Nigeria) in collaboration with Occupational Knowledge International under the auspices of the Federal Ministry of Environment exposed very high values in these facilities. Sequel to the effort, SRADev Nigeria in collaboration with international partners Petra Sorge and Tobias Eisehut of the European Journalism Center (EJC) and Oko Institute Munich, under the ample funding of Bill and Melinda Gates Foundation checked the human exposure levels of ULAB workers and residents of communities around lead battery recycling facilities. The sampling was carried under the ethical supervision of the Ogun State Ministry of Health, Lagos State Environmental protection Agency(LASEPA), The Federal Government Ministries of Health and Environment. The activity was also one of programs of SRADev to commemorate the WHO "International Lead Poisoning Prevention Week of Action (ILPPWA)", 21 to 27 October 2018.

The Blood testing was carried out in two southwestern states of Nigeria, Lagos and Ogun. About fifty-three (53) respondents from workers Everest Metal and residents of Ita Sanni/Ewuruko along the Ikorodu-Sagamu Expressway Ogun state, members of Waste Battery Recyclers Association of Nigeria (WBRAN) and workers of Metalworld at NCIE Premises Oshodi, Lagos and control members which were neither residents nor ULAB workers. The blood lead biomonitoring was carried out using Lead Care II Analyzer and Test Kit from the US Company Magellan Diagnostics, United State. The equipment provides the measurement for the amount of lead in a whole fresh blood sample in 3 minutes.

---

[1] https://ng.boell.org/2018/05/23/africa%E2%80%99s-challenge-used-lead-acid-batteries-ulab-%E2%80%93-can-nigeria-take-lead

Very high blood lead levels were recorded among workers of lead acid battery recycling facilities in Everest metal in Ogijo, Ogun state and members of WBRAN and workers of Metalworld ranged 22-42 and 35-65 µg/dl respectively. While, residents of Ogijo recorded blood lead level range of 9-27µg/dl, controls ranged <3-29µg/dl. Extremely high blood lead level was recorded among the three sampled under5s ranging 19-24 µg/dl which is about 4 time greater than the USEPA reference level which poses adverse neurodevelopmental cognitive impacts occur[2].

1.0 Introduction

Globally, production of lead-acid batteries makes up almost 85% of the total consumption of lead (ILA, 2017). Lead is also used in the production of paints, cosmetics, cable sheathing, lead crystal glass, ammunition weight for lifting. The lead acid batteries are used to power automobiles, for backups in uninterrupted Power Supply (UPS) and inverters for institutions with the need continuous energy availability. The economic development experienced by nations as well as the ever increasing need for renewable energy sources has resulted in the increased global demand for refined lead metal estimated at 10.83 million tonnes in 2016 (International Metals Study Groups, 2016). According to a partner of the German Green Party's foundation Heinrich Boell Stiftung, in Nigeria the number of used lead-acid batteries (ULABs) has increased from about 110,300 tons in 2016 to 500,000 tons in 2018[3]. This creates a huge potential for recycling as a way to reduce to reduce the pollution from mining this metal.

However, contamination of soil, water, air and human population around abandoned mines, smelters, industrial facilities, and chemical waste sites is a global concern. Exposure to this pollution poses health threat (Erikson *et al*, 2016), as it accounts for at least 0.6% of global diseases burden[4]. In 2016, it is estimated that lead exposure results in 495 550 deaths and 9.3 million disability-adjusted life years (DALYs) lost due to long term impacts on health, especially in low- and middle-income countries (IHME, 2016). In Nigeria, the worst outbreak occurred in Zamfara in 2012 causing over 400 deaths of children due to exposure to lead in gold mining, and thousands suffered brain damaged among other forms of disabilities.

Lead persists in the soil and infantile exposure is often due to the hand to mouth habit of children. This advertently raises the blood lead levels. For children, there is no safe level. In an assessment report involving the U.S. Environmental Protection Agency's (US EPA) concluded that blood lead levels less than 5 µg/dL may result in adverse cognitive ability. And beyond this, newer findings suggest that chronic elevated BLLs may result in adverse health issue beyond impairing cognitive ability affecting the cardiovascular, immunologic, reproductive, developmental, and endocrine

[2] https://www.pehsu.net/_Library/facts/LeadandDrinkingWater_62116_final.pdf
[3] https://trwstockbrokers.wordpress.com/2018/03/15/why-west-africas-biggest-battery-manufacturing-plant-lies-idle/
[4] https://ng.boell.org/2018/05/23/africa%E2%80%99s-challenge-used-lead-acid-batteries-ulab-%E2%80%93-can-nigeria-take-lead

systems of the body other effect includes anaemia, abdominal pain, nephropathy, and encephalopathy may occur at BLLs as low as 45 µg/dL and are more likely as BLLs increase[5].

1.1 Justification

Lead acid recycling leaves a blueprint of adverse effects in humans, given sufficient exposure and accumulation in the body. During the Zamfara soil lead poisoning, about 400 children had died prior to the intervention of Doctors beyond borders'. While some vulnerable kids with exposure to traces of the heavy metal causing brain injuries in early life can lead to a life-long loss of intelligence and disruption of behaviour. According to the World Health Organisation, lead poisoning is one of the best understood childhood diseases of toxic environmental origin, but remains severely underreported in Sub-Saharan Africa.

Many researches have been carried out to estimate the levels of lead contamination in ULAB recycling facilities but not much has been done to check the extent of occupational and residential exposures in communities hosting ULAB facilities. Occupational knowledge exposed the height of pollution around ULAB recycling facilities sharing the same ambiance with residential communities. In order to establish a link between the lead levels found in the soil samples of recycling plants around Lagos and Ogun states and possible contamination of workers and neighbours, Therefore this project seeks to carry out blood lead testing the Lead Care II Analyzer Kit (Magellan Biometrics Industries) United States.

Furthermore, the development in implementation of the Strategic Approach to International Chemicals Management and its vision to reduce the effect of hazardous chemicals on human health and the environment have been endorsed by Nigeria government. The government recognises the need for a national concerted effort for achieving the 2020 goal towards the overall attainment of Sound Management of Chemicals and Waste outcomes of the post-2015 sustainable development goals.

1.2 Project Goal

The project aimed to re-visit ULAB facilities identified as highly problematic in the earlier study and to evaluate single blood lead levels especially in children, pregnant mothers and occupational workers in the area using the Lead Care II Analyzer Kit (Magellan Biometrics Industries) from the US. This medical device has been used worldwide in some scientific trials and its efficacy and high accuracy is well established.

The main goal is awareness-raising to inform an environmentally sound management (ESM) approach for ULAB facilities focused on the individual exposure to lead. And also to find out how high the lead poisoning is in these specific exposed communities (high-risk populations). It

[5] https://www.pehsu.net/_Library/facts/LeadandDrinkingWater_62116_final.pdf

would help estimating how many households need support in lowering the contamination, information also useful for a local or national lead awareness strategy.

2.0 BACKGROUND

National Institutional and Legal Framework

The **Federal Ministry of Environment (FMENV)** is the overall executing body which has in place the *National Policy on the Environment 1999*, statutory policy document to aid the monitoring, control and abatement of industrial and hazardous wastes. The Ministry is assigned the responsibility for overseeing the implementation of relevant International Environmental Conventions, coordination of national environmental management (including formulation of pollution management policy), regulation of hazardous waste. The specific responsibilities of the ministry among others is to: Prescribe standards and make regulations on air quality, water quality, pollution and effluent limitations, the atmosphere and ozone layer protection, control of toxic and hazardous substances; through its agency - the National Environmental Standards and Regulations and Enforcement Agency (NESREA).

NESREA has the responsibility for protection and development of the environment. Its functions include: enforces compliance with laws, guidelines, policies, and environmental standards on environmental matters; coordinates and liaises with stakeholders within and outside Nigeria on matters of environmental standards, regulations and enforcement, among others. NESREA Regulations relevant to lead acid recycling include:

- **National Environmental (Surface and Ground Water Quality Control) Regulations, 2011 (S.I. 22 of 2011).** This regulation is made under section 34 of the National Environmental Standards and Regulations Enforcement Agency (Establishment) Act, 2007, provide for quality control of and quality standards and requirements of surface waters and groundwater in Nigeria. They also provide with respect to enforcement, define offences and prescribe penalties for such offences. The regulations concern the protection of water resources for purposes of various uses including clean water supply, agriculture, aquaculture. For example, it has standards for Lead (Pb) ambient water quality for ***surface water***, Effluent discharges, Irrigation and Reuse (0.1mg/litre) and Fisheries and Recreation Quality (0.01mg/litre). For ***groundwater*** micro pollutants, its set standard is 15 µg/litre (target value) and 75 µg/litre (intervention value).
- **Other relevant regulations includes:** National Environmental (Sanitation and Wastes Control) Regulations, 2009; National Environmental (Permitting and Licensing System) Regulations, 2009; National Environmental (Air Quality Control) Regulations, 2013. Other 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 however applicable to used Lead acid battery (ULAB) management. There is however, no specific regulatory structure for Lead acid battery recycling facilities in Nigeria.

Although, 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 the inland water is 0.01mg/l. The solid waste and particulates had no guideline limit. It is apparent that there is no monitoring and regulatory enforcement of standards by government regulatory bodies despite the presence of industrial standards. The urgent need for enforcement to ensure compliance is a matter of urgent attention.

2.3 *Environnemental Impacts of Lead Battery Recycling*

Lead batteries globally rank among the most recycled products. It is estimated that 75% of all Lead mine production, along with secondary lead from recycled used lead batteries, are increasing to meet global demand. Lead battery recycling is highly deleterious with exposing workers to significant health risks, contaminating soil, dust and water, and contributing to elevated blood lead levels in surrounding communities.

Small-scale informal lead battery recycling is destructive to the environment more so produces metal of poor quality that requires re-smelting and refining to make it useful for manufacturing new lead batteries. Lead batteries can be recycled economically at very high efficiency with minimal losses in plants with modern pollution control systems including ventilation for reducing employee exposures and minimizing environmental emissions. Experience from some countries with increased environmental regulations have been implemented has demonstrated that improved lead battery recycling plants can economically operate at great efficiency with extremely low emissions while controlling employee exposures. With any battery disposal method, the potential exists to release heavy metals into the environment through landfill leachate or incineration. The improper recycling and disposal may contribute significantly to the levels of Pb observed in solid wastes from residential areas. Untreated effluent will seep into land and would result to soil contamination, pollution in ground water table and their runoff may also lead to pollution of nearby water sources.

Lead recycling activities creates a persistent effect on the host environment even after seizure of recycling. Such is the case in China, Kenya, and Brazil, which have been identified as sources of elevated blood lead levels in surrounding communities (Zhang et al., 2016; Kenya Ministry of Health, 2015; de Freitas, 2007). Studies after the recycling plants have ceased to operate and from others reported in the U.S. showed a link between blood lead levels and lead contamination that persists in topsoil (California Department of Public Health, 2016; U.S. Agency for Toxic Substances and Disease Registry, 2011). Most studies focused on these exposure sources have shown an inverse relationship between blood lead levels and distance from the recycling plant location (Zhang et al., 2016; Duggan, 1983)

2.4 *Health Impacts of Lead Poisoning*

Blood-lead concentrations of about 0.016mg/dl have been measured in pre-industrial humans indicating minimal level of lead exposure[6]. Theoretical minimal risk is reported in levels <1 µg/dL. However, lead poisoning is most commonly caused by ingestion and inhalation of leaded substances. Chronic lead poisoning occurs when small amounts of lead are taken in over a longer period. The Centers for Disease Control and Prevention (CDC) defines childhood lead poisoning as a whole-blood lead concentration equal to or greater than 10 micrograms/dL. Acute lead poisoning, while less common, shows up more quickly and can be fatal, when a relatively large amount of lead is taken into the body over a short period of time. Children constitute the vast majority of such cases(UNEP 2010). Implications of raised blood lead levels to public health is several unwanted specific health effects. In infants, this poses a wide range of influence on both the development and behavioural patterns. A raised blood lead levels less than 10 µg/dL may result in delayed puberty, and decreases in hearing, cognitive ability, and postnatal growth[7]. Another defect is *Attention deficit hyperactivity disorder* (ADHD) which may affect both the infant and adult. This can affect someone throughout life.

In adult, the BLL level is proportional to the severity of the problem. Effect of these raised levels greater than 15 µg/dL ranges from disorders in the cardiovascular and nervous systems, dysfunctional kidney and reproductive systems resulting to delayed conception, lower sperm count and motility. Level lower than 10 µg/dL is associated with increase blood pressure, hypertension, nervous problems such as a tremor of the arms or hands. In Pregnant women, Blood lead level is associated with reduced fetal growth.

In 2000, about 120 million people globally had blood-lead concentrations of >10µg/dL,. Forty per cent of all children had blood-lead concentrations of >5 µg/dL and half of these children had blood-lead concentrations of >10 µg/dL; 97% of these children were living in developing countries. The burden of disease caused by mild mental retardation attributable to lead exposure resulted in 9.8 million Disability-Adjusted Life Years (DALYs), and the burden from cardiovascular diseases caused by elevated blood pressure resulted in 229 000 pre-mature deaths and 3.1 million DALYs. These account for about 0.9% of the global burden of disease[8]. Other effects ranges include

i. Disruption of the biosynthesis of haemoglobin and anaemia
ii. A rise in blood pressure
iii. Kidney damage
iv. Miscarriages and spontaneous abortions
v. Disruption of nervous systems
vi. Brain damage

[6] https://www.who.int/publications/cra/chapters/volume2/1495-1542.pdf
[7] https://www.niehs.nih.gov/health/materials/lead_and_your_health_508.pdf

vii. Declined fertility of men through sperm damage
viii. Diminished learning abilities of children
ix. Behavioural disruptions of children, such as aggression, impulsive behavior and hyperactivity
x. Entering a foetus through the placenta of the mother which can cause serious damage to the nervous system and the brains of unborn children.

3.0 Methodology

3.1 Study locations

Following the initial assessment of the soil around four ULAB smelting facilities, two high risk communities were identified including: Ipetoro Ogijo community, Ogun State (ii) members of Waste Batteries Recyclers Association of Nigeria, Lagos State chapter around Metal world Ltd, Lagos. These relevant communities already signaled their support to participate in this bio-monitoring assessment having been educated on their exposure levels and the effect by virtue of their occupation and residence.

3.2 Study Approach

In collaboration with SRADev Nigeria, Petra Sorge (a freelance journalist) of European Centre for Journalism and Dr Tobias Einshut (a paediatrician) in Oko Institut under the auspices of Bill and Melinda Gates Foundation sought ethical approval from the University of Munich, the German Ethical Medical Board (Ethikkommission) and its division in Bavaria which issued (pediatrician) license to operate. Also, the support and approval of the Lagos State Environment Protection Agency (LASEPA), Ogun State Ministry of Health, Federal Ministries of Health and Environment to conduct this project following intensive initial consultation of these respective authorities. A questionnaire to obtain information on the biodata, exposure levels and envisaged health effects and also consent for their voluntary participation and confidentiality was filled by the respondents.
Moreso, the study mainly focused on individuals with the highest risk of lead poisoning and the largest proximity to the ULABs, and among them the most vulnerable groups. These were mainly children, for whom lead poisoning is especially harmful and can have life-long effects up to brain diseases, pregnant women where the risk of harming the unborn child is very high, and ULAB workers strongly exposed to the sources of lead contamination.

3.3 Sampling Method

The blood sampling procedure was done as less invasive as possible. The sampling was conducted by medical practitioners including a Pediatrician Dr Tobias Einshut and a senior nursing staff Mrs

Adelaja (Matron) of Lukosi Health Centre as directed by the Ogun State Medical officer. In the kit provided in the LeadCare II containing:

- A well labelled Treatment reagent tube.
- Container with Heparinized capillary tubes/plungers
- Sensor container
- Dropper for depositing the sample on the sensor
- LeadCare II blood lead analyzer

The sampling procedure starts with calibrating the instrument after turning on the device, it is been zeroed with the calibration button and ensuring the calibration code on the button matches the lot number displayed on the device. Blank is run by reading the provided standards (high and low) in the Lead Care II instrument. The blood sampling was done by pricking the finger, holding the Heparinized capillary tube horizontally positioned to take about 50µl blood. This is plunged into the well labelled treatment reagent tube. The cap is replaced and inverted to mix the sample and the treatment about 8-10 times. To analyse the samples, about 2 drops of the result is dropped on the sensor plugged to the device and the reading is taken 180 seconds after dropping.

Data Management

Results were entered and managed in the computer software and analysed using Microsoft Excel. With descriptive statistics, the data was presented.

Figure 1: Blood sampling process

4.0 Results and findings

4.1 Summary of Biodata

The study carried in two states sampled about 54 respondents with thirty-seven (37) from Ogijo, nine (9) members of the Waste Batteries Recyclers Association of Nigeria and seven(7) controls. Summary of the Bio-data of the respondents (see: table 1) includes 19 and 34 males and females respectively. With profession ranging from ULAB factory work, trading, students and artisans, clergy and others. Ages of the respondents ranged 2-67years. The household members of the respondents ranged 1-10 members.

The marital status of the respondents are ranged from single(17), married(31), separated(2)and widow(3)(see figure 2).

Table1. Summary of the Biodata

Bio-data	Kind of responses	Response (persons)
Sex	Male	19
	Female	34
Location	Ogijo respondents	37
	Lagos respondents	9
	Control	7
Profession	ULAB workers	14
	Traders	13
	Student	9
	Others	18
Age range(years)		2-67
Range of no household members		1-10

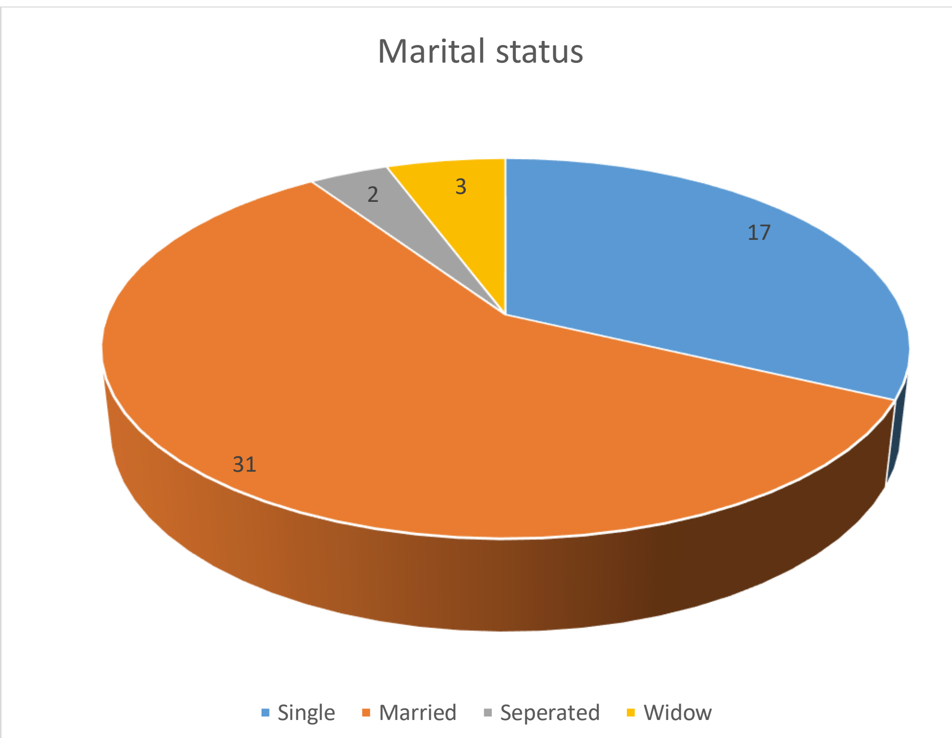

Figure 2: Marital status of the respondents

4.2 Information on Exposure pattern of the respondents

The exposure of respondents to this chemical of interest is a function of proximity and frequency. Workers of the ULAB facilities work for about 8hours daily and are exposed to high acute dose of lead within their stay at work while residents around these facilities low dose but for as long as

Table 2: Information on Exposure pattern of the respondents

Nature of exposure	Respondents	Length of Exposure (yrs)	Closeness to the ULAB facility(m)	Average BLL (µg/dl)	Range of BLL (µg/dl)
Occupationally exposed	13	<1-14	N/A	43	35->65
Occupationally exposed (Paint manufacturer)	1	10	N/A	35.2	N/A
Exposure by residence	31	1-14	100- 2000	19.4	12-27
Unexposed (control)	8	N/A	N/A	5	<3-10

*N/A: Not applicable; BLL Blood Lead Level

they stay in their residence(chronic exposure) both cases have harmful implications. While thirteen were occupationally exposed, thirty–one were exposed owing to their place of residence (residents of Ipetoro community) and eight were not exposed (control). They were all non-smokers.

Generally BLLs in unexposed respondents was found to be about four times lower (5µg/dl) compared with the those exposed by the virtue of their residence around the facility (19.4 µg/dl) while those that are occupationally exposed are were found highest 43 µg/dl. Also, the study also sampled a non ULAB worker who manufacturers paints and the BLL was very high (35µg/dl). This level is as a result of the exposure of paint makers to lead as pigment and driers of oil based paints.

No measureable level of blood lead is regarded to be safe. A new "reference level" for blood lead levels (≥ 5 µg/dL) was established in 2012 by the Centers for Disease Control and Prevention (CDC) thus reducing the level at which evaluation and interventions (public health and clinical) are recommended.

Table 3: Pattern of Exposure by vulnerability (age and sex)

Categories	Occupationally Exposed (µg/dL)	Exposed by residence (µg/dL)	Unexposed (µg/dL)
Male	42->65	20	6.5
Female	22-65	19	<3
Children(<18years)	>65	22	N/A
Children (<5 years)	N/A	21	N/A

*N/A: Not available

Among the residents of Ipetoro in Ogijo community, 3 under 3years were sampled and their levels ranged as high as 19-24 µg/dL (see Table 3). This level is similar to the findings in ten studies from seven developing countries which reported a mean blood lead level of 29 µg/dl in children living near formal lead battery manufacturing and recycling facilities (Gottesfeld and Pokhrel, 2011). This lead poisoning cases is 4 times greater compared with the recommended level of 5 µg/dL for which both public health and clinical intervention is required. The levels of the children were found to be more than the adult probably due to that fact that children barely leave the community having their school and life around the community unlike the adults who may need to leave their houses on daily basis to make earnings. The implication of this could be the impairment of neurological system resulting to poor performance in school and entire life of this children More also, among the occupationally exposed individual, a lad of 17years was reported to have BLL of above 65 µg/dl who has worked with ULABs for 7 years. This is the peak period of his reproductive development. And the level could greatly damage the process.

The mechanism of absorption lead into the body system is similar to that of calcium, iron and zinc. Therefore nutritional deficiency of any of these minerals will result to its substitution with lead. Thus cause deleterious effect in the organ/system.
Blood lead levels less than 5 µg/dL have been reported to result in adverse neurodevelopmental cognitive impacts by the National Toxicology Program and U.S. Environmental Protection Agency's (US EPA) Lead Integrated Science Assessment and long term exposure to elevated blood lead levels (BLLs). Increased BLL may complicate into cardiovascular, immunologic, reproductive, developmental, and endocrine effects.

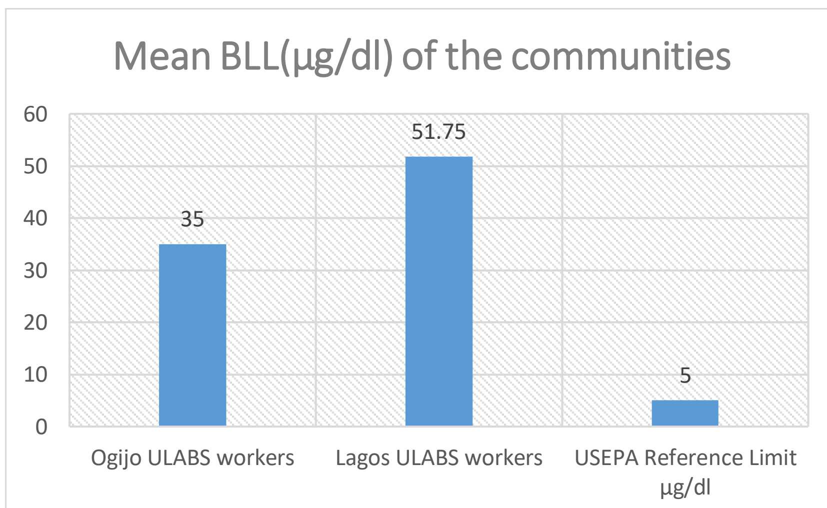

Figure 3: Average Blood Lead levels of the ULAB workers

Generally, the BLLs of the Lagos ULAB workers was found higher compared with the Ogijo workers. Among the Lagos ULAB workers were factory workers and business owners therefore their engagement and level of activities is expected to be higher than the ULAB workers at Ogijo which were majorly females factory workers which at times may have work shift aluminum recycling units. Moreso, the reason for the higher values seen among Lagos ULAB workers can be also attributed to accumulation of the lead in their system over the years (see: Table 4). Many of the Lagos ULAB workers have been in that business for 1-14 years while the Ogijo was has less than 1 year of occupational lead exposure. In fact, two from the Lagos ULAB workers were found to have BLL higher than the detection limit (65µg/dL) of the instrument, of them was a 16 year old lad. This may greatly impact on his reproductive health later in life. When, levels as low as 45 µg/dL has been clinically confirmed to cause effects such as anemia, abdominal pain, nephropathy, and encephalopathy.

Table 4: Years of experience of selected workers at the different ULAB communities

Workers of ULAB Communities	Years at work
Ogijo	<1
Lagos	1-14

4.3 Health Effects of Raised Blood lead Level

Generally, the unexposed individual had rarely come down with many of these health issues unlike the other who are exposed (see Table 5).

a. **Gastroenterological symptoms:** About 10% of the dwellers around Ipetoro ULAB facility always complain of constipation and poor appetite. When, around 50% of the occupationally exposed ULAB workers sometimes come down with these gastrointestinal issues, 40-50% of those exposed from their dwellings sometimes had them.
b. **Teratogenic problems (Developmental issues):** Generally, close non complaints on developmental defects were made by respondents across the different groups of exposure. However, about 40% (5persons) of the occupationally exposed persons sometimes experienced behavioural problems. Four sometimes had Anaemia among those exposed by their place of residence.
c. **Reproductive disorder:** while one among the occupationally exposed respondents always experience miscarriages, two people occasionally experience it. One from among the exposed respondents from either case complained of low sex drive. About 16%(5 persons)of the environmentally exposed sometimes had low sex drive. While two from among the environmentally exposed people had low sperm count always, two of same group occasionally experience it.

Table 5: Showing the responses of health problems faced by respondents associated with raised BLL

S/N	Medical complaints	Always			Sometimes			Rarely			Never		
	Gastroenterological symptoms:	OE	ER	UE	OE	ER	UE	OE	ER	UE	OE	ER	UE
1	stomach pain	1	2	0	3	7	0	8	17	5	1	6	2
	Nausea	1	2	0	5	12	0	7	17	4	0	1	3
	Constipation	1	3	0	5	17	0	7	11	5	0	1	2
	Poor appetite	1	3	0	6	12	0	6	15	5	0	2	2
2	Teratogenic problems (Developmental issues)												
	Behavioural problems	1	1	0	5	5	0	4	13	5	3	14	2
	Hearing loss	0	0	0	0	0	0	11	15	5	2	12	2
	Kidney problem	0	0	0	0	0	0	9	19	4	4	13	3
	Anaemia	1	1	0	1	4	0	10	17	5	1	10	2
	Stunted muscular and bone growth	0	1	0	0	2	0	9	14	4	4	15	3
3	Reproductive disorder												
	Miscarriage	1	0	0	0	2	0	6	9	2	6	21	5
	Decreased sex drive	1	1	0	1	5	0	7	5	3	4	21	4
	Low Sperm count	0	2	0	0	2	0	8	3	2	5	25	5
	Sperm anomalies	0	1	0	0	1	0	8	5	2	5	25	5
4	Respiratory problem												
	difficulty in breathing	0	4	0	3	6	0	10	19	5	0	3	2
	Cough	2	5	0	6	17	0	5	9	7	0	1	0
	Asthma	0	1	0	0	0	0	11	16	4	2	15	3
5	Muscular part												

	Fatigue	4	13	0	9	10	1	0	4	6	0	5	3
	Joint and muscle pain	6	13	0	5	8	1	1	6	6	1	5	0
6	**Cardiovascular part**												
	High Blood pressure	3	3	0	2	3	0	8	12	5	0	14	2
7	**Neurological symptoms**												
	Memory loss	1	8	0	0	9	1	12	10	5	0	5	1
	Lack of concentration	0	7	0	0	9	1	13	11	5	0	5	1
	Headaches	3	6	1	8	15	1	2	9	5	0	2	1
	Depression	2	4	0	4	11	0	7	12	6	0	5	1

*OE: Occupationally exposed; ER: Exposure by Residence; UE: Unexposed

d. **Respiratory problem:** from among the environmentally exposed individuals, four, five and one had breathing difficulty, cough and Asthma always respectively. While only two had cough from among the exposed one by the virtue of the job they do. Occasionally, about 50% experienced cough among the two exposed groups.

e. **Muscular problems:** while 4 out of 13(30%), 13 out of 31(42%) were often fatigued among the occupationally and environmentally exposed individuals, occasionally, 9(69%) and 10(32%) experienced fatigue among them respectively. Also, 6 out of 13(46%), 13 out of 31(42%) always experience joint and muscle pain and 5 out of 13(38%), 8 out of 31(26%) sometime complain this.

f. **Cardiovascular issues:** Three individuals from each of the exposure groups often came down with raised blood pressure. Occasionally, 2 out of 13 and 3 out of 31 of the occupationally and environmentally exposed respondents respectively complained the same problem.

g. **Neurological symptoms:** of the neurological issues, 8 out of 31 persons reported frequent memory loss,7 lack of concentration and 4 depression from among those environmentally exposed. However, form among the occupationally exposed respondents, 2 and 3 out of 8 reported depression and headache respectively. Occasionally, 9 out 31 respondents experienced memory loss and lack concentration from among those environmentally exposed. However, while about 62%(8) and 31(4) of the occupationally exposed ones reported headache and depression respectively, about 50%(15) and 35%(11) of the environmentally exposed ones had headaches and depression respectively.

5.0 Conclusion and recommendations

The blood lead sampling took place among occupationally(13) and environmentally exposed (31) and unexposed(6) respondents in both Ipetoro community and members of Waste Battery Recyclers Association of Nigeria summing up to 53 respondents from Lagos and Ogun states, southwestern Nigeria. Very high blood lead levels were reported among the exposed respondents unlike the unexposed. This raised values were far higher than the Center for Disease Control(CDC) of 5 µg/dl where both clinical and public health interventions is required. The study also espoused the possibility of elevated blood lead level too among paint manufacturers since they also deal with leaded product. Children living around ULAB facilities were also reported to have very high BLL. This has grave consequences on both the economics of the parents and children both from the health and educational points of view.

Recommendations

- There must be a stringent regulation of the management of ULABs in the country.
- The government must ensure that industries embrace environmentally sound management.
- The industry should do a routine blood lead examination of their workers, identify workers with high values and treat as appropriate.
- Facilities of ULABs should be established in greenfield as planned by the government and buildings for residential purposes prevented from been sited.
- A Standard Operating Procedure (SOP) on lead acid battery recycling that will cut across the nation should be developed and the different activities should be adopted.
- The number and size of lead-acid battery companies should be regulated carefully through registration.
- There is a need for sensitization of all practitioners in the distribution chain of the industry on the associated risk and health impact of their profession on themselves and the community at large.
- Shared responsibility systems should be set up, with high mandatory collection targets.
- This kind of study should be extended to other industries where leaded material is used like paint manufacturing, mining, weldering and the likes

References

California Environmental Protection Agency, 2009. Revised California Human Health

CDC, Preventing Lead Poisoning in Young Children:

de Freitas, Umbelino, Clarice, et al., 2007. Lead exposure in an urban community: investigation of risk factors and assessment of the impact of lead abatement measures. Environ. Res. 103 (3), 338–344.

Duggan, M.J., 1983. Contribution of lead in dust to children's blood lead. Environ. Health Perspect. 50, 371.

Gottesfeld, P., Were, F. H., Adogame, L., Gharbi, S., San, D., Nota, M. M. and Kuepouo, G. 2018. Soil contamination from lead battery manufacturing and recycling in seven African countries. *Elsevier Environmental Research* 161(2018) 609-614.

Gottesfeld, Perry, Pokhrel, Amod K., 2011. Lead exposure in battery manufacturing and recycling in developing countries and among children in nearby communities. J. Occup. Environ. Hyg. 8 (9), 520–532. http://www.cdc.gov/nceh/lead/publications/books/plpyc/contents.htm

ILA, 2016 International Lead Association: Lead recycling. URL: http://www.ila-lead.org/lead-facts/lead-recycling, retrieved: 16.03.2016.Lehmann, C., 2013. Presentation during the expert seminar „Der Weg zu einem Batterien- Recycling in Afrika", 20.09.2013, Christian Lehmann, Umweltbundesamt

International Metals Study Groups (2016). Metals Despatch. 2016; Issue No 21 (http://www.ilzsg.org/generic/pages/list.aspx?table=document&ff_aa_document_type=N&from=1, accessed 3 January 2017).

Kenya Ministry of Health, 2015. Report on Lead Exposure in Owino-Uhuru Settlement, Mombasa County, Kenya April unpublished AND de Freitas, Clarice Umbelino, et al. "Lead exposure in an urban community: investigation of risk factors and assessment of the impact of lead abatement measures.".

Prüss-Üstün, A., Fewtrell, L., Landrigan P. J. and Ayuso-Mateos, J. L. 2004. Comparative Quantification of Health Risks. World Health Organization Geneva. 1:1495-1542
Screening Levels for Lead, (September, Accessed online 15 September 2017 at: ⟨https://oehha.ca.gov/media/downloads/crnr/leadchhsl091709.pdf⟩).

UNEP (2010) Lead Pollution and Poisoning Crisis, *Environmental Emergency Response Mission Zamfara State, Nigeria*. Joint UNEP/OCHA Environment Unit, Palais des Nations, CH-1211 Geneva 10, SwitzerlandSeptember/October 2010

Zhang, Feng, et al., 2016. Investigation and evaluation of children's blood lead levels around a lead battery factory and influencing factors. Int. J. Environ. Res. Public Health 13 (6), 541

Appendix

"Poisonous Lead"

Questionnaire for patient investigations in the field

1. Name:
2. Date of birth: Sex:
3. Address:
4. Years lived here:
5. Profession:
6. Have you worked in a lead acid battery recycling facility:
7. If yes, how long (years):
8. Marital status:
9. Family members in household:
10. (If parent, number of children:)
11. Distance to lead-acid battery recycling unit:
12. Do you smoke? Yes/No
13. If yes, how long?
14. Year this lead-acid battery recycling unit has opened:
15. Kind of soil outside of the house: Natural → Sand / Stone / Hard Clay

Solid → Tar / Screed / Cobble

Kind of soil inside of the house: Natural → Sand / Stone / Hard Clay

Solid → Tar / Screed / Cobble

Health Effect

S/N	Medical complaints	Always	Sometimes	Rarely
1.	**Gastroenterological symptoms: stomach pain**			
	Nausea			
	Constipation			
	Poor appetite			
2.	**Teratogenic problems (Developmental issues)**			
	• Behavioural problems			
	• Hearing loss			
	• Kidney problem			
	• Anaemia			
	• Stunted muscular and bone growth			
3.	**Reproductive disorder**			
	Miscarriage			
	Decreased sex drive			
	Low Sperm count			
	Sperm anomalies			
4.	**Respiratory problem**			
	difficulty in breathing			
	Cough			
	Asthma			
5.	**Muscular part**			
	Fatigue			
	Joint and muscle pain			
6.	**Cardiovascular part**			
	High Blood pressure			
7.	**Neurological symptoms**			
	Memory loss			
	Lack of concentration			
	Headaches			
	Depression			

Any prior medical investigations/doctors seen? YES NO If yes, when: -

Closeness of health care facility:

Less than 500m ☐ between 500m -1km ☐ more than 1km ☐

CONSENT FORM

Survey Overview

The primary goal of the Global Health Grant '***BLOOD LEAD LEVEL SAMPLING'*** project will be to generate new data, and raise awareness about lead pollution, primarily from Lagos and Ogun states, Nigeria. The Lead monitoring information generated will include blood sampling results from biomonitoring (via blood sampling) of specific two communities around lead acid facilities (Ikorodu and Ogijo), in order to improve knowledge about their lead occupational and residential exposure (specifically among workers, pregnant women and children in vulnerable communities around these lead acid facilities) while also elevating public knowledge about the threats of global lead pollution.

Blood samples will be collected by qualified medical practitioners, SRADev Nigeria (the national NGO), Dr Tobias from German Oko Institut and Petra under the auspices of Global Health Grant. The Blood samples will be analyzes using Lead Care II device developed by the US Company Magellan Technologies: This is the world's first lead blood testing device suitable in the field and offering instant results. Results will be anonymous and included in outreach and education about lead in the environment. **Names of participants in this analysis will never be used publicly unless agreed to by the participants.**

VOLUNTARY PARTICIPATION

Individuals are free to decline participation in this study or withdraw from participation at any point. In addition, participants in this study do not forfeit any legal rights by signing this informed consent form.

Consent

I have read this consent document and understand the nature of this assessment and procedures for blood sampling. I understand that my participation in this study is voluntary and agree to allow the analysis of my blood sample to be included in this project. I agree to complete this *Blood lead level Sampling* and, if asked, agree to a follow-up interview to discuss my results.

______________________________ ________________

Participant's Name (Print) Date

____

Signature

Confidentiality

The results from this test will be compiled and included as data in a report on mercury exposure and contamination in humans. ***The right of confidentiality is granted to each individual participant unless she voluntarily waives it.***

I, ______________________________ (print), voluntarily waive my right to keep the results of this test confidential.

Signed: ______________________________Date:________________

I understand that by waiving my confidentiality, I am allowing the results of my sample to be discussed in publications, press, or other educational means by Global Health Grant, **but that my name will never be used unless I agree to it**

MINISTRY OF HEALTH

DEPARTMENT OF PLANNING, RESEARCH & STATISTICS
ABEOKUTA, OGUN STATE, NIGERIA

Refs No..........HPRS/381/284 — Date..22/10/2018...............

RE: "ESTIMATING AND ASSESSING LEAD POISONING CASES/HIGH RISK ENVIRONMENTS IN USED LEAD ACID BATTERY (ULAB) RECYCLING COMMUNITIES IN NIGERIA"

Notice of Research Exemption

This is to inform you that the activities described in the submitted protocol/documents have been reviewed by the State Health Research Ethics Committee, the activities described there-in meet the criteria for exemption and is therefore approved as exempt from SHREC oversight.

The State code for Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the Code. The HREC reserves the right to conduct compliance visit to your research site without previous notification.

Please note that, you are expected to share with us the findings of your research work via rantioladeinde@yahoo.com and ogundprs@yahoo.com

OOladeinde

Dr. Ranti Oladeinde BSc MBBS, MPH, PGDHMGT, FMCPH, MNIM
Director, Planning, Research and Statistics
Secretary, State Research Ethics Committee

LAGOS STATE GOVERNMENT

LAGOS STATE ENVIRONMENTAL PROTECTION AGENCY

18th October, 2018

The Executive Director,
Sustainable Research and Action for Environmental Development
(**SRADev Nigeria**)
18 Olorunlogbon St, Anthony village,
Lagos.

Dear Sir,

RE; REQUEST FOR COLLABORATION TO PROVIDE DIAGNOSTICS AND ASSESSMENTS OF BLOOD LEAD LEVEL IN COMMUNITIES AROUND LEAD RECYCLING FACILITIES

Sequel to your letter dated 29th August, 2018, the Agency has agreed to partner with Sustainable Research and action for Environmental Development **SRADev Nigeria** on the above subject matter.

As requested, the Agency would ensure the provision of the following items;

- Identification of the ULAB facilities/ communities
- Access to the facilities

We shall be looking forward to a successful collaboration.

Thanks.

Yours Sincerely

Engr. Antonio, A. Ayodele
General Manager/CEO