KENYA

A. Regulation on sources

Source of lead	Relevant legislation/regulation	Government agencies	Data source
1. Lead in paint	1. As of 2020, total limit of lead content in paint: 90 ppm.	a. Government of Kenya	1. Overview of Lead Paint Laws in Africa, EPA 2. Kenya leads Africa's efforts in phasing out lead in paint, WHO
	No other standards found at this time for lead.		

B. International Agreements

Agreement	Year Ratified
1. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	2000 (a)[1]
2. Rotterdam Convention on the Prior Informed Consent Procedure for certain hazardous Chemicals and Pesticides in international trade	2005
3. Minamata Convention on Mercury	2013 (signature)
4. Stockholm Convention on Persistent Organic Pollutants	2004

[1] Accession (a)

C. Blood lead-level monitoring programs

Details	Data source
1. No details of a national or regional level structured program for blood lead level testing found. However, published studies point to some presence of testing programs at the local level.	1. Refer to section E on scientific papers that perform blood lead-level sampling

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

Site	Province/Region	Details (all data comes from the TSIP website)
Lead pollution at Malakisi Tobacco Farms, Western	Western	There is serious pollution caused by tobacco farmers in Malakisi by lead and pesticides leading to very serious health effects in the area. These chemicals pollute the surrounding soils, water and air and have many severe negative health impacts on the residents. About 98% of the farmers store pesticides in houses where they live, including bedrooms. This poses a risk of bioaccumulation of toxins. The local community also uses the lead-contaminated shallow well water for drinking and other domestic uses.
Mumias Informal Used Lead-acid Battery Repair and Recycling Area, Mumias Town, Kakamega County	Western	Informal ULAB recycling and repair activities are conducted throughout the area without safety and pollution controls near schools, residences and the main food market in the busy Mumias town in Western Kenya. Lead fumes and lead dust generated by the operations are spread to nearby soils and buildings by wind, air, surface runoffs and human tracking. Lead containing wastes from the operations are dumped in the open on children's playgrounds, near homes and the major food market (Lumino market) in Mumias town. Local residents and employees could be constantly inhaling the lead fumes released. Young children may come into dermal contact with and also ingest the lead dust in contaminated soils while in their playgrounds during their usual hand-to-mouth activities.
Kakamega Informal Used Lead-Acid Battery Recycling, Kakamega Town, Kakamega County	Western	Using crude methods, workers conduct informal Used Lead-Acid Battery (ULAB) recycling and repairing activities within the busy and densely populated Kakamega town, near residences, schools, health facilities, markets and business premises without environmental pollution and human exposure controls. As a result, lead fumes and lead dust from the battery repair and recycling activities find their way into the surrounding environs via wind, air, runoffs, soil and dust. Nearby communities are possibly exposed

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		to the lead through skin contact with and ingestion of the lead dust, lead contaminated dust and soils, and direct inhalation of the lead fumes released.
Eldoret Informal ULAB Recycling Operations, Eldoret Town, Uasin Gishu County	Rift Valley	Unregulated informal used lead-acid battery recycling and repair activities within residential and market areas in Eldoret town release lead fumes and dust which are transported across by air and wind and deposited on nearby buildings and soils. The informal ULAB repairers and recyclers work without safety and pollution controls. The recyclers and the local populations are probably exposed to lead through inhalation of the lead fumes, ingestion of the lead dust, contaminated soil/dust and skin contact (Source: Investigator's Observation and Sampling - XRF data)
Kapsabet Informal ULAB Recycling Operations, Kapsabet Town, Nandi County	Rift Valley	During the processes of breaking down old car batteries from multiple sites throughout the town, lead fumes and dust are released to the surrounding air, wind and soil within Kapsabet town. The contaminated air and dust is later transported by wind and deposited to the nearby buildings, soils and crops. Most of the recyclers work without safety, protective gears and pollution controls. These unregulated ULAB activities possibly expose the recyclers, the surrounding workers, businesspeople, visitors and the local populations to lead through inhalation of the lead fumes, ingestion of the lead dust, contaminated soil/dust and skin contact especially to the children.
Lead pollution at Hilton/Gioto dumpsite-Nakuru	Rift Valley	A large dumpsite approximated to be 54 acre in Nakuru, located 2 miles away to the northwest of the Nakuru town is suspected to be polluting the soil and air of the area with DDT, PCBs, mercury, cadmium, and primarily lead. Other chemicals, which have not been tested, may cause serious danger to the occupants via ingestion of food waste (as orphan children do at the site), dermal contact from sorting and collecting of waste products and inhalation of toxic fumes from dump site.
Ganesh Informal ULAB Recyclers, Nyamathi, Naivasha.	Rift Valley	Large scale informal ULAB recycling was being conducted in a residential area in Nyamathi, Naivasha. Large amounts of lead dust and fumes from the recycling plants was transported via air and wind and settled on soils, homes and farms on the downwind side. The surrounding communities and workers are probably exposed to lead from battery recycling operations in Ganesh Eco Solutions in Nyamathi-Naivasha through ingestion of lead-contaminated soil dust and food, inhalation of lead fumes, and skin contact with lead-contaminated dust and soils.
Lead pollution at Olkaria Geothermal Power Plant, Naivasha, Rift valley	Rift Valley	A geothermal power plant in Olkaria 1 disposes water with heavy metals. The waste water is not protected. Livestock consume the waste water and graze near the wells where the waste water is dumped. Humans are exposed to lead through consumption of meat and milk.

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Narok Informal ULAB Recycling Operations, Narok Town, Narok County.	Rift Valley	The surrounding population and communities within Narok town may be exposed to lead pollution from informal recycling of old car batteries. Lead fumes and lead dust are transported across nearby communities/areas by air and the strong winds observed. The unregulated recycling operations are carried out within residential areas, markets and close to eating places without environmental pollution and human exposure controls. The communities are likely to inhale lead fumes or ingest contaminated dust/soil/water/ food. Some of the residents especially children would be exposed through dermal contact. River Narok flows through the town and is the major source of water for drinking and domestic use for the surrounding communities.
Lead pollution by Pioneer jua kali Muranga, Central	Central	The site has metal recycling and is a dumpsite for the Jua kali workers. The area is dusty, windy, open burning of waste, and is muddy during the rainy season. The area has a river nearby less than 100 m from the site. Measurements with XRF indicated high levels of lead. The most probable mode of contamination is through dermal, inhalation, and ingestion.
Lead pollution at Murera Dumpsite-Ruiru, Central	Central	The now defunct Murera dumpsite was formerly an abandoned quarry site that received its unsegregated wastes from industrial, hospital institutional and household sources. Due to public outcry, it was closed down but there was no proper decommissioning conducted. The land is currently inhabited, and an orphanage stands right on the former dump site. The soils are used to grow food crops, and there is a borehole on the site, but the water is used for watering crops and household chores. The possible pathways are dermal, inhalation and ingestion.
Lead pollution by Pioneer jua kali Muranga, Central	Central	The site has metal recycling and is a dumpsite for the Jua kali workers. The area is dusty, windy, open burning of waste, and is muddy during the rainy season. The area has a river nearby less than 100 m from the site. Measurements with XRF indicated high levels of lead. The most probable mode of contamination is through dermal, inhalation, and ingestion.
Lead pollution at Kariobangi Light Industries	Nairobi Area	Light industries at Kariobangi South with a cluster of metal working, mostly welding and spraying steel at ground floor of residential area. Lead, Chromium and Arsenic metal and fluoride spray pollutants contacted through dermal and inhalation at the site from the heavy traffic of residents, workers, public and private vehicles that increase the spread of dust. A lot of shops and kiosks that sell consumables exposed to the dust round the site. Most of the pollutants are channeled to a nearby river which has turned opaque and odorous.

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Jua Kali Informal Fabricating and Spray-Painting Area, Gikomba, Nairobi	Nairobi Area	Informal fabricators in Jua Kali use chromium, lead, mercury and cadmium-contaminated paints (See attached KEPHIS laboratory report in Part 6) to spray vehicles, fridges, metallic boxes etc. in the densely populated Gikomba area. The workers do not wear safety gear while working. The sprayed paint is spread in wind and air across the surrounding environs and finally deposited on surrounding soils and buildings causing metal contamination. Local communities can inhale the metal-contaminated air and prayed paint, ingest metal-contaminated soils, dust and food. Workers are mainly exposed to the toxic metals through inhalation of sprayed paint/contaminated air, ingestion of contaminated dust and skin contact with the paint while working.
Lead pollution at Kamkunji Metal Smelting/Blacksmith - Nairobi, Kenya	Nairobi Area	For 50 years artisan blacksmiths in this area of Nairobi have smelted scrap metal to remove chemical remains. This has contaminated the environment with lead, phenols, arsenic, and chromium, and the former has been found in blood samples. People inhale the emissions and come into dermal contact with dust settled into soil.
AP Lead Acid Battery Recycling Company, Nairobi	Nairobi Area	This is a lead-acid battery recycling site. Employees and the surrounding communities are possibly exposed to lead pollution from recycling and assembling process through inhalation of and, dermal contact with lead dust and lead-contaminated soils.
Kariobangi Lead - Acid Battery Recyclers and Metal Smelters, Nairobi	Nairobi Area	Several small-scale lead acid battery recycling and metal smelting operators in Kariobangi Estate release toxic heavy metals to the surrounding residential, soils, water and air. The operators deal with various metals such as lead aluminum, zinc, brass and copper. The wastes from the smelting and recycling areas are dumped within the surrounding residential and children's playgrounds. Workers, residents, businesspeople and children in Kariobangi estates are exposed to the metal pollution through dermal contact with contaminated soil and water, ingestion of contaminated food, water and dust, and inhalation of metal vapors and metal contaminated dust in the area.
Korogocho lead-acid battery recyclers and metal smelters, Nairobi	Nairobi Area	Small scale metal lead acid battery recycling and metal smelting operators in Korogocho release toxic metals such as lead in to the surrounding schools, residential, churches and business centers through their various operations. Metal wastes from the operations are dumped in small open dumps within the area. Dust and metal vapors from the smelting and recycling sites are blown by wind into the surrounding areas and are inhaled by people and or deposited on the surrounding soils and buildings. Children are constantly in dermal contact with the polluted soils and water while playing. Ingestion of contaminated food and water could also be a pathway since foods are openly sold in the Korogocho slums. Residents also use polluted river Korogocho water for washing and irrigation.

Site	Province/Region	Details (all data comes from the TSIP website)
Lead pollution at Tononoka Jua Kali Artisans, Mombasa	Coast	Tononoka Jua Kali Artisans are located adjacent to Kisauni Road opposite Kenya Coast National Polytechnic, along Wajir Road in Tononoka area, Mombasa Island. There are series of workshops and garages which are privately owned. Several activities take place such as spray-painting using lead-contaminated paint, paintwork repairs to scratches, panel beating, oiling and greasing etc. The sprayed paint and metal particles are suspended in air which are eventually transported by wind and air across the surrounding environs and finally deposited on surrounding soils causing lead metal (key pollutant) pollution in the surrounding soils and water. The area is opposite a tertiary college, next to a health facility, food joints, mosque, stadium and schools. The local populace and travelers are exposed to heavy metal pollution through ingestion, inhalation and skin contact. The workers are critically exposed since they do not have the appropriate protective gears in addition, they consume the food prepared in the nearby food joints.
Lead pollution at Changamwe Roundabout, Mombasa	Coast	Changamwe Roundabout is located in Changamwe Division in Changamwe District, Mombasa. It is the connection point of Mombasa Mainland, Port Reitz, Mombasa International Airport, Port of Mombasa and several residential and industrial premises. Residents and travelers in Changamwe are suffering from the dust stirred up by container trucks. There are several air pollutants emission sources in the locations such as the refinery (now closed), oil-fired power plant (KenGen) and fire at landfill site (Kibarani Dumpsite). Several industries, Container Freight Stations (CFS) and garages are located around the roundabout and along the Mombasa – Nairobi highway. Key pollutant (lead) was reported in sector 1 where there is a garage which does more of spray-painting using lead based paints, radiator repairs and general car repair. Lead was present in all the sampled soil though at permissible levels in soil in Sectors 2, 3 and 4. Polluted soil, dust, smoke and wastes are transported by wind and runoff water during rainy season to the surrounding areas. The local populace and travelers are exposed to heavy metal pollution through ingestion, inhalation and skin contact.
Lead pollution at Bangladesh Slums, Mombasa	Coast	Bangladesh slums is located off Nairobi - Mombasa Highway in Mikindani ward, within Changamwe/Jomvu constituency and it approximately covers 20 acres. It is located 5.5 Km west of Mombasa Island Several garages, auto works, industries and go-downs are located along the Mombasa – Nairobi highway. Several informal activities take place in the area ranging from scrap metal dealers to burning of tyres to extracting the metals in tyres. These activities, coupled with the garages and industries, release heavy pollutants in the area. Chromium was reported in sector 1 which may have resulted from tyre burning; lead metal was present in all the sampled soil though at permissible levels in

Site	Province/Region	Details (all data comes from the TSIP website)
		soil. Polluted soil, dust, smoke and wastes from these premises are transported by wind and water to the slums. The local populace and travelers are exposed to heavy metal pollution through ingestion, inhalation and skin contact.
Lead pollution at Owino Uhuru Slum, Mombasa	Coast	Metal Refinery EPZ Limited is one of the many companies that refine lead from used car batteries in Mombasa- Kenya. It is in close proximity to a nearby dwelling of Owino Ohuru Slums, less than 50 meters. It was cleared to operate in this area without proper environmental impact assessment. It releases lead particles through the chimneys through a crude cool-down process. The dust particles settles on the slum area, the residents have been complaining of severe lead poisoning. The solid waste from the factory is taken to the municipal dump site which has not been partitioned and labeled. The residents are exposed through inhalation/ingestion of dust particles and consumption of contaminated food.
Lead pollution at Mariakani, Coast Province	Coast	The water, soil, and air are being polluted by heavy metals (specifically lead) through the discharge of raw effluents by the Mabati Rolling Mills Ltd.
Lead pollution at Malindi Municipal Dumpsite, Coast	Coast	Malindi town is a well known tourist hub in the East African coast. The municipal dumpsite is located about 14 km from Maliondi town a long Casurina Road. The site was chosen to be a landfill to fill the hollows and voids created as a result of quarrying activities which were ongoing in the area. The surrounding locality is full of Tourist hotels, cottages, Clubs, bar and restaurants and residential houses both low class, middle class and high class. The dumpsite has been in operation since early 1980s. Main people affected are those living nearby through inhalation of dust and smoke when the dump is burned as well as ingestion through the runoff and leachate from the dumpsite that contaminates nearby source of water.

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
Blood-lead levels	Odongo, Alfred; Obonyo, Meshack; Moturi, Wilkister	2019	Risk of high blood lead levels among informal sector automobile artisans: a case study of Nakuru town, Kenya	**Abstract:** Artisans in the informal automobile sector are involved in diverse occupational activities that could predispose them to health risks associated with lead exposure. A case-control study was conducted to assess the risk of having high blood lead levels among the artisans. Data were collected using structured questionnaire and laboratory analysis. Sixty purposively sampled participants, 30 artisans and 30 age-matched control subjects, were assessed. Lead levels in blood samples were analysed using NIOSH method 8003 and data were analysed using SPSS version 22. The artisans had four times odds of having high blood lead levels compared to the control subjects (Odds ratio = 4.0; 95% CI = 1.37 – 11.70). The study concludes that the informal automobile repair workshops pose risks of high blood lead levels to the artisans. Therefore, there is a need for occupational health and safety monitoring and intervention programmes in the informal sector automobile industry to curb such health risks.
	Etiang, Nancy; Arvelo, Wences; Galgalo, Tura; Amway, Samwel; Gura, Zeinab; Kioko, Jackson; Omondi, Gamaliel; Patta, Shem; Lowther, Sara; Brown, Mary	2018	Environmental Assessment and Blood Lead Levels of Children in Owino Uhuru and Bangladesh Settlements in Kenya	**Background:** Lead exposure is linked to intellectual disability and anemia in children. The United States Centers for Disease Control and Prevention (CDC) recommends biomonitoring of blood lead levels (BLLs) in children with BLL ≥5 µg/dL and chelation therapy for those with BLL ≥45 µg/dL. **Objectives:** This study aimed to determine blood and environmental lead levels and risk factors associated with elevated BLL among children from Owino Uhuru and Bangladesh settlements in Mombasa County, Kenya. **Methods:** The present study is a population-based, cross-sectional study of children aged 12–59 months randomly selected from households in two neighboring settlements, Owino Uhuru, which has a lead smelter, and Bangladesh settlement (no smelter). Structured questionnaires were administered to parents and 1–3 ml venous blood drawn from each child was tested for lead using a LeadCare ® II portable analyzer. Environmental samples collected from half of the sampled households were tested for lead using graphite furnace atomic absorption spectroscopy.

Topic	Authors	Year	Title	Abstract/ description
				Results: We enrolled 130 children, 65 from each settlement. Fifty-nine (45%) were males and the median age was 39 months (interquartile range (IQR): 30–52 months). BLLs ranged from 1 µg/dL to 31 µg/dL, with 45 (69%) children from Owino Uhuru and 18 (28%) children from Bangladesh settlement with BLLs >5 µg/dL. For Owino Uhuru, the geometric mean BLL in children was 7.4 µg/dL (geometric standard deviation (GSD); 1.9) compared to 3.7 µg/dL (GSD: 1.9) in Bangladesh settlement ($p<0.05$). The geometric mean lead concentration of soil samples from Owino Uhuru was 146.5 mg/Kg (GSD: 5.2) and 11.5 mg/Kg (GSD: 3.9) ($p<0.001$) in Bangladesh settlement. Children who resided <200 m from the lead smelter were more likely to have a BLL ≥5 µg/dL than children residing ≥200 m from the lead smelter (adjusted odds ratio (aOR): 33.6 (95% confidence interval (CI): 7.4–153.3). Males were also more likely than females to have a BLL ≥5 µg/dL (39, 62%) compared to a BLL<5 µg/dL [aOR: 2.4 (95% CI: 1.0–5.5)]. **Conclusions:** Children in Owino Uhuru had significantly higher BLLs compared with children in Bangladesh settlement. Interventions to diminish continued exposure to lead in the settlement should be undertaken. Continued monitoring of levels in children with detectable levels can evaluate whether interventions to reduce exposure are effective.
	Were, Faridah; Kamau, Geoffrey; Shindu, Paul; Wafula, Godfrey; Moturi, Charles	2012	Air and blood lead levels in lead acid battery recycling and manufacturing plants in Kenya	**Abstract:** The concentration of airborne and blood lead (Pb) was assessed in a Pb acid battery recycling plant and in a Pb acid battery manufacturing plant in Kenya. In the recycling plant, full-shift area samples taken across 5 days in several production sections showed a mean value ± standard deviation (SD) of 427 ± 124 µg/m(3), while area samples in the office area had a mean ± SD of 59.2 ± 22.7 µg/m(3). In the battery manufacturing plant, full-shift area samples taken across 5 days in several production areas showed a mean value ± SD of 349 ± 107 µg/m(3), while area samples in the office area had a mean ± SD of 55.2 ± 33.2 µg/m(3). All these mean values exceed the U.S. Occupational Safety and Health Administration's permissible exposure limit of 50 µg/m(3) as an 8-hr time-weighted average. In the battery recycling plant, production workers had a mean blood Pb level ± SD of 62.2 ± 12.7 µg/dL, and office workers had a mean blood Pb level ± SD of 43.4 ± 6.6 µg/dL. In the battery manufacturing plant, production workers had a mean blood Pb level ± SD of 59.5 ± 10.1 µg/dL, and office

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				workers had a mean blood Pb level ± SD of 41.6 ± 7.4 µg/dL. All the measured blood Pb levels exceeded 30 µg/dL, which is the maximum blood Pb level recommended by the ACGIH(®). Observations made in these facilities revealed numerous sources of Pb exposure due to inadequacies in engineering controls, work practices, respirator use, and personal hygiene.
Lead contamination	Ericson, Bret; Otieno, Victor; Nganga, Cecelia; Fort, Judith; Taylor, Mark	2019	Assessment of the Presence of Soil Lead Contamination Near a Former Lead Smelter in Mombasa, Kenya	**Background:** The informal settlement of Owino Uhuru near an abandoned lead smelter attracted international attention due to an apparent lead poisoning event. Despite this attention, the environmental data collected to date do not indicate high levels of residual contamination. **Objectives:** To further confirm previous findings and determine any necessary risk mitigation measures, an assessment of surface soil lead concentrations was conducted in the community. **Methods:** Investigators carried out an assessment of the soil in a ~12,000 m2 section of the Owino Uhuru neighborhood over the course of a single day in June 2017 with the assistance of community leaders. Fifty-nine in situ soil measurements were taken using an Innov-X tube-based (40 kV) alpha X-ray fluorescence instrument (pXRF). **Results:** The assessment found that mean surface soil lead concentrations in areas conducive to exposure were 110 mg/kg (95% CI: 54–168); below United States Environmental Protection Agency and the Environment Canada screening levels of 400 mg/kg and 140 mg/kg, respectively. **Conclusions:** There is likely no current need for risk mitigation activities in the community. These results could inform discussions on the allocation of public health spending.

Topic	Authors	Year	Title	Abstract/ description
Lead exposure	Odongo, Alfred; Moturi, W.N.; Obonyo, Meshack	2019	Influence of task-based airborne lead exposures on blood lead levels: a case study of informal automobile repair artisans in Nakuru town, Kenya	**Abstract:** Lead poisoning is an emerging worldwide public health concern, especially in the developing countries. Occupational tasks such as spray painting and welding in informal automobile repair enterprises present risks of exposures to lead generally through inhalation and ingestion. The artisans therefore risk high blood lead (BPb) levels, which is critical to chronic adverse health effects of lead. The study aimed at assessing the influence of occupational tasks on personal airborne lead exposures and to evaluate the association between these exposures with blood lead (BPb) levels among the artisans. A cross-sectional study was conducted in ten informal automobile repair workshops. Task-specific personal inhalable air samples and blood samples were collected concurrently for 20 participants performing five distinct occupational tasks. Lead levels were analysed using inductively coupled plasma atomic emission spectroscopy and data analysed by analysis of variance, simple and multiple linear regressions. The results indicated significant differences in airborne lead (PbA) exposure levels in different occupational tasks ($p = 0.000$). Lead–acid battery repairs recorded mean PbA exposure level of [76.11 ± (10.81 SE) µg/m3] exceeding the WHO 50 µg/m3 airborne lead permissible exposure limit. The average (PbA) exposure level was 22.55 ± (5.05 SE) µg/m3, while the mean (BPb) level was 25.08 ± (3.48 SE) µg/dl. A significant positive correlation between task-based airborne lead with blood lead levels was observed ($r = 0.68$, $p = 0.001$). In conclusion, the occupational tasks influenced personal airborne lead exposure levels, which in turn was an important predictor of blood lead levels. The study recommends lead exposure assessments, medical screening and intervention measures to minimize the risk and consequences of occupational exposures to lead among the study population.
	Ondayo, Maureene; Simiyu, Gelas; Raburu, Philip; Were, Faridah	2016	Child Exposure to Lead in the Vicinities of Informal Used Lead-Acid Battery Recycling Operations in	**Background:** Child exposure to lead from informal used lead-acid battery (ULAB) recycling operations is a serious environmental health problem, particularly in developing countries. **Objectives:** We investigated child exposure to lead in the vicinities of ULAB recycling operations in the Dandora, Kariobangi and Mukuru slums in Nairobi between January and August 2015.

Topic	Authors	Year	Title	Abstract/ description
			Nairobi Slums, Kenya	**Methods:** Topsoil (n = 232) and floor dust (n = 322) samples were collected from dwelling units (n = 120) and preparatory schools (n = 44) and analyzed using an inductively coupled plasma-optical emission spectrometer at the Mines and Geological Department Laboratory in the Ministry of Mining, Nairobi. From the obtained lead levels in soil and house dust, child blood lead levels were subsequently predicted using the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK), Windows version. **Results:** Lead loadings in all the floor dust samples from the Dandora, Kariobangi and Mukuru slums exceeded the United States Environmental Protection Agency (USEPA) guidance value for lead on floors with a range of 65.2 – 58,194 µg/ft2. Control floor dust samples recorded lower lead loadings compared to the Dandora, Kariobangi and Mukuru slums. Lead concentration in 70.7% of the soil samples collected from waste dumps, industrial sites, residential areas, playgrounds and preparatory schools in Dandora, Kariobangi and Mukuru exceeded the respective USEPA guidance values for lead in soils. Lead concentration in 100% of control soil samples were below the respective USEPA limits. The IEUBK model predicted that nearly 99.9% of children ≤ 7 years old living near informal ULAB recycling operations in Dandora, Kariobangi and Mukuru were at risk of being lead poisoned, with predicted blood lead levels (BLL) above the Centers for Disease Control (CDC) reference value for blood lead. A total of 99.9% of exposed children living in the Mukuru slums are likely to have BLL above 34 µg/dL. **Conclusions:** There is a need for coordinated efforts to decrease lead emissions from informal battery recycling in Nairobi slums and to remediate existing soils, particularly around battery workplaces and dumpsites. The BLL of local children should be clinically tested and appropriate intervention measures taken.

Topic	Authors	Year	Title	Abstract/ description
	Were, Faridah; Moturi, Charles; Gottesfeld, P; Wafula, Godfrey; Kamau, Geoffrey; Shindu, Paul	2014	Lead Exposure and Blood Pressure among Workers in Diverse Industrial Plants in Kenya	**Abstract:** The study evaluated airborne exposures and blood lead (BPb) levels in 233 production workers at six diverse industrial plants in Kenya. Blood and personal breathing zone air samples were collected and analyzed for lead (Pb) using atomic absorption spectroscopy. Blood pressure (BP) levels were measured using a standard mercury sphygmomanometer. The results indicated mean airborne Pb levels ± standard deviation (SD) as follows: 183.2 ± 53.6 µg/m3 in battery recycling, 133.5 ± 39.6 µg/m3 in battery manufacturing, 126.2 ± 39.9 µg/m3 in scrap metal welding, 76.3 ± 33.2 µg/m3 in paint manufacturing, 27.3 ± 12.1 µg/m3 in a leather manufacturing, and 5.5 ± 3.6 µg/m3 in a pharmaceutical plant. The mean airborne Pb levels exceeded the U.S. Occupational Safety and Health Administration (OSHA) 8-hr time-weighted average (TWA) permissible exposure limit (PEL) for Pb of 50 µg/m3 in the battery manufacturing, battery recycling, welding, and paint manufacturing plants. Similarly, mean BPb concentrations exceeded the American Conference of Governmental Industrial Hygienists (ACGIH®) biological exposure index (BEI) for Pb of 30 µg/dl. A significant positive association was observed between BPb and breathing zone air Pb (R2 = 0.73, P < 0.001). Approximately 30% of the production workers (N = 233) were in the hypertensive range with an average systolic and diastolic blood pressure (BP) of 134.7 ± 12.7 mmHg and 86.4 ± 8.9 mmHg, respectively. In the multivariate regression analysis, age, duration of work, airborne Pb and BPb levels were significantly associated (P < 0.05) with a change in BP. We recommend improved engineering controls, work practices, and personal hygiene to reduce Pb exposures. In addition, workers should undergo comprehensive medical surveillance to include BPb and BP testing, and airborne Pb assessments in all industries with significant lead exposures.
	Ashraph, Jalab; Kinyua, Robert; Mugambi, Fred; Kaleni, Ahmed	2013	Health effects of lead exposure among Jua Kali (informal sector) workers in Mombasa, Kenya: A case study of the Jua Kali workers	**Abstract:** The objective of this study is to analyze the effects of lead exposure among the Jua Kali workers. Correlation study: relationship between lead exposure and its effects on blood lead levels (BLL), kidney function and haemoglobin levels between the lead-exposed versus the lead un-exposed workers. 162 adult Jua Kali workers participated. Out of 119 exposed workers, 8 (6.72%) were aware of lead while only 3 of them (2.5%) used protective equipment. The highest BLL in the test group was 32 µg/dl with 16 of them (13.45%) having BLL above 10 µg/dl. The mean BLL in this

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				group was 6.76 ± 5.96. In the control group, the highest BLL was 9 µg/dl with none having BLL above10 µg/dl. The mean BLL was 2.58 ± 1.69. The spearman's correlation coefficient was 0.272 significant at 0.05 level. 14 out of 119 (13.45%) exposed workers had impaired glomerular filtration rates (GFR). The mean GFR in the exposed workers was 104.85 ± 16.485. In the un-exposed workers, 1 out of 43 (2.4%) had impaired GFR. The mean GFR was 109.98 ± 15.408. The spearman's correlation coefficient was -0.113, not statistically significant. 21 out of 119 (17.6%) lead-exposed workers had haemoglobin (HB) less than 13 g/dl with mean HB of 14.12 ± 1.600. 1 out 43 (2.3%) in the control group had an HB of less than 13 g/dl with the mean HB of 14.37 ± 1.34. Spearman's correlation coefficient of negative 0.321 ($P<0.05$) implying significant inverse relationship. Recommendations: education on lead and its effects, provision of protective equipments, medical facilities to diagnose and manage lead and other heavy metal toxicity.
Lead in food	Ngure, Veronica; Geoffrey, Kinuthia	2020	Health risk implications of lead, cadmium, zinc, and nickel for consumers of food items in Migori Gold mines, Kenya	**Abstract:** This paper reports on the concentration levels of lead (Pb), cadmium (Cd), zinc (Zn) and nickel (Ni) in soil and water in the Migori gold mining area of Kenya. To determine the possible entry into the food chain, samples of fish, maize, cabbages, mangoes, potatoes and human scalp hair were collected and analysed from three (3) sites within and one (1) site outside, the study area. The aim was to establish potential health risks posed to miners and communities who consume food crops and fish harvested in the vicinity of the gold mining areas. Samples were prepared by standard methods and analysed by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES). The concentration of Pb, Cd, Zn and Ni in soils exceeded the maximum allowable concentrations (MAC) for agricultural soil. Concentration levels in fish were above MAC levels. Concentration levels in food items were highest in maize, cabbages and potatoes, in that order. Human hair showed elevated levels of Ni above MAC values in some of the samples analysed while all hair samples had elevated Zn contents above MAC. These results indicate that the local food items commonly available in Migori gold mining villages may contribute to increased body burden of potentially harmful elements (PHEs), with R. argentea, maize and cabbages contributing the highest levels.

Topic	Authors	Year	Title	Abstract/ description
	Omwenga, Isaac; Kanja, L.; Nguta, J.; Mbaria, J.; Irungu, P.	2014	Assessment of lead and cadmium residues in farmed fish in Machakos and Kiambu counties, Kenya	**Abstract:** Lead (Pb) and cadmium (Cd) concentrations were determined in muscle, gonad, liver and brain of tilapia fish caught from fishponds in Machakos and Kiambu counties in Kenya. A total of 217 fish samples were randomly sampled from the two counties. Acid digestion method and atomic absorption spectrophotometer were used for analysis. Heavy metal concentrations varied significantly depending on the type of tissue analyzed. Generally, the highest concentration of Pb was detected in brain and the liver. Fish organs contained Pb in the following order: brain > liver > muscle > gonad, while Cd followed the order: brain > liver > gonad > muscle. Kiambu county recorded higher concentration of the studied heavy metals compared to Machakos county although statistically there was no difference. Lead and Cd content in both counties studied exceeded the maximum allowable limit. The study recommended controlling industrial and agricultural effluents into surface water and proper sitting of ponds to minimize the risk of contamination of farmed fish by heavy metals.
	Mutune, A.N.; Makobe, M.A.; Abukutsa-Onyango, M.O.	2013	Impact analysis of lead, copper and zinc content in selected African indigenous and exotic vegetables from Nairobi markets, Kenya	**Abstract:** Vegetables consumed in urban sites can be contaminated with harmful metal levels absorbed from planting sources because metals are commonly present in soil. The present study was carried out to evaluate Pb, Cu and Zn concentration in ten of the commonest vegetables in Nairobi markets. Vegetables were collected from 15 markets in urban and peri-urban Nairobi and analyzed for metal content using an Atomic Absorption Spectrophotometer (AAS). The concentrations were in the order Zn > Cu > Pb with values of 15.6 to 120, 0 to 19 and Pb 0 to 1.37 mg/kg, respectively. There were significant differences in markets and within vegetables ($p<0.05$). Sources were not consistent in the levels of metals indicating that they were supplied from different planting sites. Cu and Zn were within permissible consumer limits while Pb in many vegetables exceeded the limit. Continuous control of pollution and evaluation of metal content in vegetables is recommended in monitoring environmental contamination and food safety.

Topic	Authors	Year	Title	Abstract/ description
	Makokha, A.O.; Mghweno, L.R.; Magoha, H.S.; Nakajugo, A.; Wekesa, J.M.	2008	Environmental lead pollution and contamination in food around Lake Victoria, Kisumu, Kenya	**Abstract:** Exposure to lead (Pb) through food, water, or contaminated air has adverse health impacts that are particularly severe in children. Many countries have outlawed the use of leaded petrol, and enacted policies and regulations limiting lead pollution, and lead levels in foods. However, African countries, including Kenya, have generally been slow in adopting policies and regulatory structures concerning lead pollution. The main objective of this study was to determine lead contamination levels in the environment around Kisumu (Kenya). Lead content in samples of tap water and other surface water ranged from 140 to 260, and 140 to 690 (µg/g), respectively. All the tap water samples had lead content above10 µg/g, the maximum WHO limit for lead in drinking water. The lead content in vegetables and fish ranged between 0.0 to 2.9 and 1.0 to 3.3 (µg/g), respectively. All the fish samples had lead levels above the WHO maximum limit of 0.2 (µg/g). Lead content in soil samples ranged from 0.2 to 3.9 (µg/g). These results indicate that there is considerable risk of lead poisoning from drinking water and eating some foods from these sites.
	Oyaro, Nathan; Ogendi, Juddy; Murago, Elizabeth; Gitonga, Eric	2007	The contents of Pb, Cu, Zn and Cd in meat in Nairobi, Kenya	**Abstract:** The most important uptake of heavy metals by man occurs through ingestion, hence food analysis is of great importance. In Kenya, meat is sold in butcheries, which are strategically situated near the roadsides and near bus stops. Most of these butcheries have their doors open, and there is likelihood that meat is contaminated by heavy metals. In the current research Pb, Cu, Zn and Cd content in meat were determined. Samples of the kidney, liver and muscles from various cattle were taken from Nairobi and its surroundings. The overall concentration of Pb, Cu, Cd and Zn were below 2 ppm. Generally, the muscle had high concentration of Pb and Cd as compared with kidney and liver. This observation is an anomaly from what has been reported in the literature so far with the liver indicating high metal content. Since most of the butcheries in the study area are located along the highway with high vehicular density, there is a high possibility of direct deposition of Pb and Cd in the meat. The Pearson Chi-square gave a value of 0.231 for the lead and cadmium indicating that the two metals have a common source, which is thought to be vehicular density.

Topic	Authors	Year	Title	Abstract/ description
Lead in water	Mwashote, Benjamin	2003	Levels of Cadmium and Lead in Water, Sediments and Selected Fish Species in Mombasa, Kenya	**Abstract:** Flame absorption spectrophotometry was used to investigate the concentration and distribution of cadmium and lead in water, sediments and selected fish species in Makupa and Tudor creeks in Mombasa, Kenya between May 1997 and March 1998. The results were compared with those obtained in relatively less anthropogenically influenced areas along the Kenyan coast. The mean concentrations for Pb ranged from not detectable (nd) to 0.012 mg/l, 0.2 to 58.0 mg/kg and nd to 59.3 mg/kg in water, sediment and fish samples respectively. Cadmium concentrations in water were generally below detection limits, while in sediment and fish samples, they ranged from nd to 1.0 mg/kg and nd to 3.7 mg/kg respectively. Overall, Pb and Cd concentrations were low in the water column of Makupa and Tudor creeks, with a few incidents of elevated levels in sediments and some fish species, especially during the rainy season. Makupa creek had the higher levels overall. The levels of Pb and Cd in most of the fish species analysed were generally within acceptable limits by FAO standards.
Lead poisoning	Mbaria, J.M.; Ochodo, C; Nguta, J.M.	2013	Forensic case of lead poisoning from a battery manufacturing company in Nakuru, Kenya	**Abstract:** Acute sickness involving dairy cattle (n = 5) with a morbidity of 100% occurred in a farm in Nakuru, Kenya. A case study was undertaken with the objective of establishing the cause of the sickness. Samples of blood, soil and industrial waste contained high levels of lead. The symptoms, results of postmortem and history of the case were used to establish the diagnosis of acute lead poisoning. This is a forensic case in court between the owner of the animals and a lead recycling company that dumped the industrial waste that was associated with the poisoning. There could be many unreported cases of lead poisoning in Kenya areas with heavy industrial activities since data on of lead poisoning in Kenya is scanty.

F. Blood testing in National Health Surveys

National Health Survey	**Non-Communicable Diseases Risk-Factors Surveillance**	**Source**
Purpose	Estimate fertility and childhood, maternal, and adult mortality; measure changes in fertility and contraceptive prevalence; examine basic indicators of maternal and child health; collect anthropometric measures for children and women; describe patterns of knowledge and behaviour related to transmission of HIV and other sexually transmitted infections; and ascertain the extent and pattern of domestic violence and female genital cutting.	Kenya: Demographic and Health Survey, Ministry of Health, 2014
Sample size	Women age 15-49 and men age 15-54.	
Blood sample testing	To determine the existence of HIV/AIDS in blood.	
Latest round	2014	
Next round	-	