

## PHILIPPINES

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### A. Regulation on sources

Source of lead	Relevant legislation/regulation	Government agencies	Data source
1. Use and disposal; entry (and transit); and disposal	1. DENR Administrative Order No. 24 of 2013 on the Chemical Control Order (CCO) for Lead and Lead Compounds	a. Department of Environment and Natural Resources (DENR)	1. <a href="#">The United Nations Information Portal on Multilateral Environmental Agreements</a>
2. Food and drink packaging; toys; school supplies; cosmetics; water pipes	1. DENR Administrative Order No. 24 of 2013 on the Chemical Control Order (CCO) for Lead and Lead Compounds 2. EMB MC 2016-010: Clarification on the Prohibition of Paints with Lead and Lead Compounds Used for Children Toy's and Related Products, 2016 3. The use of lead and lead compounds is strictly prohibited in the production and manufacturing of: packaging for food and drink; fuel additives; water pipes; toys; school supplies; cosmetics.	a. Department of Environment and Natural Resources (DENR) b. Environmental Management Bureau	1. <a href="#">The United Nations Information Portal on Multilateral Environmental Agreements</a> 2. Philippines Prohibits Lead in Consumer Products ( <a href="#">Chemicals Watch</a> ) 3. <a href="#">Department of Environment and Natural Resources, Environmental Management Bureau</a>
4. Paint	1. Republic Act 6969 (Toxic Substances and Hazardous and Nuclear Waste Control Act) 2. Section 20 of Chapter IV, DENR Administrative Order (DAO) No. 29, 1992, Implementing Rules and Regulations of RA 6969 3. DAO 27, Series of 2005 4. Establishes 90 parts per million (ppm) as threshold limit for lead in paint used as pigment, drying agent or for some intentional use	a. Department of Environment and Natural Resources (DENR) b. Philippine Association of Paint Manufacturers c. EcoWaste Coalition and IPEN	1. Philippines Moves to Phase Out Lead in Paint ( <a href="#">EPA</a> ) 2. <a href="#">Philippines: Moves to Phase Out Lead in Paint</a>

Source of lead	Relevant legislation/regulation	Government agencies	Data source
	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	1993
2. Rotterdam Convention on the Prior Informed Consent Procedure for certain hazardous Chemicals and Pesticides in international trade	2006
3. Minamata Convention on Mercury	2020
4. Stockholm Convention on Persistent Organic Pollutants	2004

## 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 <a href="#">website</a> )
1. Santa Maria Bay	Ilocos	A popular bay in Sta. Maria that draws many tourists and also has a fish sanctuary was polluted with heavy metals such as chromium, cadmium, and lead when a barge carrying coal wrecked offshore.
2. Poro Point Freeport Zone	San Fernando, La Union	An old U.S. military base in Barangay Puro is now the location of heavy industry, including oil, coal, and cement companies that are polluting the soil and water of the coastal district with mercury, as well as arsenic, lead, and cadmium.
3. Brgy. Poblacion III, Tagbilaran City	Central Visayas	This is a site with generally low level of contamination in terms of lead, arsenic and chromium. Exceedances were found in repair shop, radiator shop, and junkshop. Other sources of arsenic exceedances, on the other hand, were deemed to be of natural origin including erosion and leaching from geologic formations in addition to non-point sources which could include improper disposal waste, fuel combustion products from vehicle among others. Potential pollution pathway to people could include ingestion especially among children via hand to mouth gesture and dermal contact in flooded areas.
4. Informal Use Lead Acid Battery Recycling Plant in Sitio Tingga-an, Barangay San Nicolas, Cebu City	Central Visayas	The operations of an informal used lead acid battery recycling plant in Tingga-an are contaminating local soils with high levels of lead, arsenic, and cadmium.
5. Butuanon River in Metro Cebu	Central Visayas	The Butuanon river is contaminated with heavy metals and other pollutants. The sources are a mix of industries located along the river's edge, including chrome plating, ULAB recycling and paint industries.
6. Abandoned tailing waste dumps of Atlas Mining Corporation, Cambang-ug, Toledo City	Central Visayas	Abandoned mine tailings and open pits contaminate local water and soil with heavy metals, including lead. Open mine pits are used for gravel extraction. Children play in contaminated pools in the pits.
7. Used Lead Acid Battery Recycler in Barangay Felisa, Poblacion, Bacolod City	Western Visayas	This used lead acid battery (ULAB) recycler is situated in the Brgy. Felisa, Bacolod City which is an agro-industrial zone. Other heavy industries are in the same barangay. A retailer shop located in the Poblacion buys, collects and stores ULABs mostly from buy back car batteries and from scrap dealers; ULABs are stacked properly according to size

Site	Province/Region	Details (all data comes from the <a href="#">TSIP website</a> )
		in a fenced and roofed property in the Poblacion. This served as the temporary storage and collection site before is it transported to the ULAB recycling plant in Barangay Felisa.
8. Brgy. South Baluarte, Molo District, Iloilo City	Wester Visayas	Barangay South Baluarte is one of the sites randomly selected for site assessment using investigative approach. Out of the 94 samples collected, six samples exceeded the lead standards, potential sources include an old junkshop. Potential exposure to contaminant is through ingestion of soil from hand to mouth habits of individuals involved in this industry.
9. Philceramics, Putsan, Tiwi, Albay	Bicol	Workers in a ceramics factory coat pottery with lead glaze and without the use of protective equipment. Direct contact with glaze is prevalent with nasal allergies reported as the main ailment.
10. Makban Geothermal Plant in Bitin, Bay, Laguna	Southern Tagalog	Pipelines built in the community to harness geothermal heat accumulate lead and other heavy metals which are released as dust and inhaled by residents.
11. Panday Pateros Metro Manila Vegetable Farm (near Laguna de Bay)	Central Luzon	Vegetable farming in the vicinity of the Pateros River is being irrigated with water polluted by industrial discharges. Main pathway is ingestion of heavy metal-containing food crops.
12. Legacy site - Former Used Lead-Acid Battery Plant, Meycauayan, Bulacan	Central Luzon	An abandoned RAMCAR facility and ULAB plant in Meycauayan City has contaminated the nearby soil with lead, arsenic, and cadmium. Residents have been eating crops grown in contaminated soil.
13. Manufacturing and ULAB recycling in Meycauayan City, Bulacan	Central Luzon	ULAB small scale site, informally processing lead and contaminating the environment.
14. Aluminum Recycling Plant in Meycauayan City, Bulacan	Central Luzon	The aluminum recycling plant in Meycauayan has been the subject of complaints from local residents, due to air pollution damaging their health and environment. The raw materials found in the aluminum recycling include lead, arsenic and cadmium.
15. ULAB recycling facility, Marilao, Bulacan	Central Luzon	Heavy industry in Marilao includes paper, plastic, and metal production, as well as the legacy site of the largest secondary lead recycling plant in the country. These industries are polluting the air, soil and water of local and downriver communities with chromium, cadmium and primarily lead.
16. Boom Town Industries in Brgy. Lalakhan, Sta. Maria, Bulacan	Central Luzon	Boom town in Bulacan is home to textile manufacturing factories located near a creek and a residential area. Wastewater is released directly into the water system, contaminating it with lead, cadmium and chromium.

Site	Province/Region	Details (all data comes from the TSIP <a href="#">website</a> )
17. Asia Pacific's Used Lead Acid Battery in San Simon, Pampanga	Central Luzon	Lead bars were found on the site of an industry that was closed for violations. Main pollution pathways are through inhalation of lead dust and soil, although the latter had no direct human contact.
18. Former ULAB Recycler in Barangay Tabuateng, San Leonardo, Nueva Ecija	Central Luzon	Former operations of a lead acid battery facility have contaminated this community with high levels of lead in soil.
19. ULAB Recycling Facility in Soledad, Sta Rosa, Nueva Ecija	Central Luzon	ULAB recycling plant is in the middle of a vast rice field. It releases lead into soil and air, and workers are exposed by dermal contact. Lead can accumulate in rice, which is a main food crop in and of the area.
20. Lead-Acid Battery Collection Facility and Transfer Station at Barangay Sto. Cristo, Guimba, Nueva Ecija	Central Luzon	Barangay Santo Cristo has total land area of 65.74-hectare, majority of the land area is classified as residential (41.4850 ha) only a small portion is allotted for agriculture (8.03 ha), commercial (6.69 ha) and institutional (1.5050ha). The total barangay population is 2,216 with 478 households based on the 2014 barangay data. Source: Barangay Socio-economic Profile, 2014. Pollution source is lead from an active car batteries collection and transfer station. Pathway into the body is from inhalation/ingestion/dermal contact of lead dust.
21. Former Used Lead Acid Battery Recycling Facility in 16th St., Tambo, Parañaque City	National Capital Region	Used lead acid battery plant has contaminated this community with high levels of lead in soil.
22. Firm Pollux Lead Battery Recycling in Caloocan City	National Capital Region	A ULAB recycling facility is said to be contaminating the environment in this region. Residents complained of foul odors and attribute common ailments to the facility. A grade/high is situated across the facility.
23. Informal Used Lead Acid Battery Recycling in Velasquez, Tondo Manila	National Capital Region	The operations of informal used lead acid battery recycling units are contaminating the soil, water, and air with lead.
24. Pier 18, Tondo, Manila	National Capital Region	E-waste is being dumped at a site located at Pier 18, Tondo, Manila. As scavengers recycle this waste, it releases toxic chemicals such as cadmium, lead and mercury.

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

Topic	Authors	Year	Title	Abstract/ description
Airborne lead	Solidum, J.N.	2008	Distribution of airborne lead in Metro Manila, Philippines	<b>Abstract:</b> The adverse effects of heavy metal contamination, such as lead in the environment, have been a worldwide concern. In the Philippines, the use of leaded gasoline was phased-out in Metro Manila in April 2000. This study investigated the distribution of airborne lead in three major thoroughfares in Metro Manila. Lead levels in plants and soil surfaces were correlated with both human blood samples and rainwater collected from selected building rooftops in Metro Manila. The range of lead levels in plant species and soil samples were 0.25 to 17.36 mg/kg and 83.74 to 183.51 ug/g, respectively, lead levels in rainwater and blood samples ranged from 0.95 to 1.29 mg/l and 0.05 to 0.038 ug/g, respectively, showing that lead levels in Manila are beyond allowable limits. There was significant correlation between lead levels of plant species and the different areas of studies, as well as with those of soil and rainwater samples. Of the 76 human respondents, with mean age of 39 years old and mean stay in the streets as street workers for 16.5 years. 43.4% complained of both respiratory and non-respiratory ailments, respectively. The respondents were generally restless and easily distracted. Only 25% admitted of committing crime.
Blood-lead levels	Solon, Orville; Riddell, Travis; Quimbo, Stella; Butrick, Elizabeth; Aylward, Glen; Bacate, Marife; Peabody, John	2008	Associations between Cognitive Function, Blood Lead Concentration, and Nutrition among Children in the Central Philippines	<b>Objective:</b> Because little is known about its effects on cognitive function among children in less-developed countries, we determined the impact of lead exposure from other nutritional determinants of cognitive ability. <b>Results:</b> A 1 µg/dL increase in BLL was associated with a 3.32-point decline in cognitive functioning in children aged 6 months to 3 years and a 2.47-point decline in children aged 3 to 5 years olds. BLL was inversely associated with hemoglobin and folate levels. Higher folate levels mitigated the negative association between BLL and cognitive function. <b>Conclusions:</b> These population-based data suggest greater lead toxicity on cognitive function than previously reported. Our findings also suggest that folate and iron deficient children are more susceptible to the negative cognitive effects of lead. Folate supplementation may offer some protective effects against lead exposure.

Topic	Authors	Year	Title	Abstract/ description
	Riddell, Travis; Solon, Orville; Quimbo, Stella; Tan, Cheryl; Butrick, Elizabeth; Peabody, John	2007	<a href="#">Elevated Blood- Lead Levels Among Children Living in the Rural Philippines</a>	<b>Abstract:</b> Generally, lead poisoning is not considered a significant environmental hazard for children in rural areas of developing countries. With a prospectively designed policy experiment, the research community and the government are conducting a broad-based investigation to introduce and evaluate the impact of health policy reforms on children in a rural area of the Philippines - the Quality Improvement Demonstration Study (QIDS). As part of this study, we researched lead exposure in children under the age of five. We sampled a population of children from the Visayas region in the central Philippines, covering approximately one third of the country's geographical area. From December 2003 to September 2004, the survey collected blood lead levels (BLL) together with demographic, socioeconomic and child health data points. Supplemental field-testing among a sub-sample of the most exposed children assessed the sources of environmental lead exposure. Among children in this study, 21% (601 of 2861 children) had BLL greater than 10 microg/dl. BLL were associated independently with age, hemoglobin concentration, water source, roofing material, expenditures and history of breastfeeding. A follow-up assessment of possible environmental exposures among the sub-sample of children with elevated BLL revealed no single or predominant exposure source. Instead, there appear to be multiple potential sources, such as fossil-fuel combustion, lead paint (in or around 38% of homes) and household items. Elevated BLL are common among children in the Visayas and may signify an under-recognized threat to children living in rural areas of other developing nations. This setting has varied environmental sources of lead. Observed correlates of BLL may be of clinical, environmental and public health utility to identify and mitigate the consequences of lead toxicity.
Lead in batteries	Hoffmann, U.; Wilson, B.	2000	Requirements for, and benefits of, environmentally sound and economically viable management of battery recycling in the Philippines in	<b>Abstract:</b> The ban on the export of used lead-acid batteries (ULAB) from Annex VII to non-Annex VII countries pursuant to decision III/1 of the Basel Convention reduced the availability of imported scrap feedstock for battery recycling in the Philippines. As ULAB supply from other developing countries becomes scarcer, the ban is likely to encourage and enhance collection and recuperation for domestically generated scrap. From a short-term perspective, this study explores the technological and managerial opportunities for improving the environmental and occupational health

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			the wake of Basel Convention trade restrictions	performance of the formal battery recycling sector and unregulated reconditioning. From a medium- and long-term point of view, the study investigates restructuring the informal ULAB's collection and recycling sector. The objective has been to make the smaller battery recyclers and reconditioners in the informal sector part of an effective and efficient collection infrastructure that supports an environmentally sound secondary lead sector. This approach gradually phases out uncontrolled, inefficient and environmentally unacceptable methods of secondary lead recovery. Due attention has also been paid to the logistical peculiarities of an archipelago, in particular the regional spread of collection infrastructure, collection and shipment costs as well as the assurance of environmentally safe transport.
Lead exposure	Ostrea, Enrique; Ostrea, Angelo; Villanueva-Uy, Esterlita; Chiodo, Lisa; Janisse, James	2014	<a href="#">Alluvial and riparian soils as major sources of lead exposure in young children in the Philippines: the role of floods</a>	<b>Abstract:</b> The objective of this paper was to determine the prevalence and sources of high lead (Pb) exposure among children in Bulacan, Philippines. A total of 150 children (6–7 years old) and their caregivers were studied. Lead was analyzed in children hair and deciduous teeth. Sources of lead exposure were determined by caregiver interview and Pb analysis of house soil, drinking faucet water, air, and water from seven Bulacan rivers. Lead was positive in 91.3 % of children's hair (MC or median concentration = 8.9 µg/g; range = 0–38.29), in 46.2 % of the teeth (MC = 0.000 µg/mg in positive samples; range = 0.00–0.020), in 100 % of soil (MC = 27.06 mg/kg; range = 3.05–1155.80), in 21.1 % of air (MC = 0 µg/Ncm; range = 0–0.10), in 4 % of house, faucet water (MC = 0.0 ppm; range = 0–40). There was a significant correlation (Spearman's rho) between Pb in children's hair and soil ( $r = 0.195$ ; $p = 0.017$ ) and between Pb in house water and outdoor air ( $r = 0.616$ ; $p = 0.005$ ). There is no significant correlation between Pb in children's hair and teeth. None of the potential sources of Pb from interview were related to lead exposure in the children. Water from seven Bulacan rivers was 100 % positive for lead (MC = 70.00 ppb; range = 30–90). Widespread flooding with river overflow occurred in Bulacan in 2009 which likely caused lead contamination of the soil. There was no significant difference in the lead concentration of the soil whether near or far from the river ( $p = 0.205$ , Mann-Whitney U test). High lead exposure in children in Bulacan is likely from soil contaminated by lead-polluted rivers during

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				flooding. In areas where flooding is common, alluvial and riparian soils from polluted rivers are important sources of lead exposure in children.
	Sharma, Kamala; Reutergardh, Lars	2000	Exposure of Preschoolers to Lead in the Makati Area of Metro Manila, the Philippines	<b>Abstract:</b> A study was conducted in the Makati area of Metro Manila, the Philippines. The study evaluated the significance of playground soil lead intake to the total daily lead burden in preschool children. The lead concentration was measured in residential playground soils, food, water, and hair samples by atomic absorption spectrometer and the data were used to draw conclusions. All of the playground soils were contaminated with lead levels ranging from a minimum of 34.54 µg/g to a maximum of 283.13 µg/g in comparison to the naturally occurring lead level of 15 µg/g in soils. Further, the study conducted a lead analysis on the hair of the study population to determine the accumulated lead intake. Ingestion of 25 mg/day of soil contributed to 4% of the total lead intake per day by children exposed to the study sites. Food (83%) was found to be the major source of lead compared to other sources. The study also includes economic valuation and cost benefit analysis from reducing lead in gasoline.
	Suplido, Maria; Ong Choon Nam	2000	Lead Exposure among Small-Scale Battery Recyclers, Automobile Radiator Mechanics, and Their Children in Manila, the Philippines	<b>Abstract:</b> Blood lead (PbB) and hemoglobin levels (Hb) were determined in 40 battery repair/recycling shop workers, 16 radiator repair shop workers, and 20 children living in the immediate vicinity of these shops. Unexposed residents with similar socioeconomic status were also investigated. Mean PbB level was significantly higher for battery workers (54.23 µg/dL) when compared to radiator workers (20.04 µg/dL) and unexposed adults (12.56 µg/dL) (P<0.001). Among battery workers, 94% had PbB levels above the WHO permissible exposure limit of 40 µg/dL for males and 30 µg/dL for females. There was no demarcation between workplace and living quarters; therefore, workers' families were similarly exposed to hazards. Children living in the immediate vicinity of battery shops also had significantly higher mean PbB levels (49.88 µg/dL) compared to radiator shop children (11.84 µg/dL) and unexposed children (9.92 µg/dL). For workers with PbB > 40 µg/dL, 90% were anemic (Hb < 13 g/dL for males and <11.5 g/dL for females). Linear regression showed a correlation (r=-0.214; P=0.03) between Hb level and log <sub>10</sub> PbB. There was no significant relationship between anemia and blood lead in children (r=-0.146). We conclude that radiator repair activities appeared to increase the body burden of lead,

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				although not up to a level significantly different from unexposed counterparts. Battery recycling/repair activities, however, significantly increased blood lead levels in workers and their children.
	Zhang, Z.; Subida, R.D.; Agetano, M.G.; Nakatsuka, H.; Inoguchi, N.; Watanabe, T.; Shimbo, S.; Higashikawa, K.; Ikeda, M.	1998	Non-occupational exposure of adult women in Manila, the Philippines, to lead and cadmium	<b>Abstract:</b> In total, 45 adult women in Manila, the Philippines, volunteered to participate in the study by offering peripheral blood samples and 24-h total food duplicate samples. In addition, they offered raw (uncooked) rice as well as wheat flour and maize starch from the kitchen. Lead (Pb) and cadmium (Cd) in food duplicates and blood samples were measured by inductively coupled plasma mass spectrometry after homogenization (when necessary) and wet ashing. The consumption of rice, wheat and maize was calculated by weighing each food item in the duplicates taking advantage of the food composition tables. The dietary exposure level of the women was 11 µg Pb/day and 14 µg Cd/day, and the levels of Pb and Cd in their blood were 37 ng Pb/ml and 0.47 ng Cd/ml. There is a subtle age-dependent increase in the dietary burden of Pb and Cd and also in blood levels of Pb and Cd. Rice accounted for 18 and 21% of dietary Pb and Cd intake, respectively and cereals (i.e. rice, wheat and maize in combination) accounted for 24% both for Pb and Cd. The calculation from the published data on air quality in Manila suggested that another and yet a greater source of Pb burden was Pb in atmospheric air which may account for 85% of total Pb uptake, whereas the amount of Cd in air was quite small (i.e., <10% of the total uptake).
	S, Matsuno; K, Makino; N, Hisanaga; VS, Ortega; MB, Villanueva; MT, Cucueco; S, Yu- Sison; FT, Castro	1994	Medical examination of workers exposed to lead in the Philippines	<b>Abstract:</b> The medical examination of workers exposed to lead was conducted as part of the activity of the Occupational Safety and Health Center (OSHC) Project in the Philippines (JICA Project). The subjects of the medical examination were 21 male and 193 female workers of a semiconductor plant (abbreviated A company), 59 male and 6 female workers of a refrigerator manufacture (B company); 199 male workers of a storage battery manufacturer (C company); and 107 male and 6 female workers of a lead smelter (D company). Among the examination items were questions regarding occupational history, subjective complaints and objective signs, determination of blood lead levels, urine delta aminolevulinic acid levels, and examination for anemia. The survey was conducted from June to September in 1990. The following results were obtained: 1) The mean age

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				<p>of the workers ranged from 21.8 to 33.8 years. Those of companies A and B were younger than those of companies C and D. The mean employment duration of males at C company was 10.7 yr, and the longest among the four companies. That in both sexes for A company was 1.8 yr and the shortest among the above mentioned companies. 2) The blood lead geometric mean levels of companies C and D showed the highest concentration. The level in males of C company was 64.5 micrograms/dl and that of D company was 80.8 micrograms/dl. The level in females of A company was 9.9 micrograms/dl and the lowest in concentration. The urine delta aminolevulinic acid geometric mean levels were less than 6.0 mg/l in the four companies. There was no company having hemoglobin mean values less than 14.0 g/dl in males or less than 12.0 g/dl in females. 3) The proportion of blood lead levels of 60 micrograms/dl or more was 67.3% in males of C company, and 89.7% in males and 16.7% in females of D company. The proportion of urine delta aminolevulinic acid levels of 6 mg/l or more was 1.0% in females of A company, 20.1% in males of C company, and 43.0% in males of D company. The proportion of hemoglobin values less than 14.0 g/dl in males or less than 12.0 g/dl in females was 4.7% in females of A company, 1.7% in males of B company, 3.5% in males of C company, and 12.1% in males of D company.</p>
Lead in food	Solidum, Judilynn	2014	<a href="#">Heavy Metal Lead in Filipino Staple Food as Studied in Metro Manila, Philippines</a>	<p><b>Abstract:</b> Rice and fish are the staple food for Filipinos. The global environmental condition has continually been deteriorating. Metro Manila, Philippines showed heavy metal contaminations in air, water, plants and soil which could pollute rice and fish. Lead is hard to biodegrade hence may accumulate in the biologic system leading to neurologic deficits particularly among children. From the results obtained using Flame Atomic Absorption Spectrophotometry (FAAS), all rice varieties and fish samples showed the presence of lead. Only regular Malagkit and NFA rice went above while all kinds and parts of fish went beyond the allowable limit for lead in food. The projected blood levels also went beyond the safe limit of lead in relation to fish consumption in both children and adults. However, in relation to rice consumption all of the projected blood lead exceeded the allowed limit only among children. The projected blood lead in adults exceeded the safe limit with rice consumption of only four varieties.</p>

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	Sia Su, Glenn; Ramos, Gliceria; Sia Su, Maria	2013	<a href="#">Bioaccumulation and histopathological alteration of total lead in selected fishes from Manila Bay, Philippines</a>	<b>Abstract:</b> This study aims to assess the bioaccumulation of total lead and the effect of heavy metal on the muscles of fish obtained in the coastal lagoon of the Manila Bay. Fish species muscles were assessed for lead concentrations and were examined for histological alterations. Results showed that lead bioaccumulation in the muscles, and a degree of disintegration in the muscle fibers of all the fish examined were found.
	Solidum, Judilyn; De Vera, Maylea; Abdulla, Ar-Raquib; Evangelista, Jennielyn; Nrosa, Mary Joy	2013	<a href="#">Quantitative Analysis of Lead, Cadmium and Chromium found in Selected Fish marketed in Metro Manila, Philippines</a>	<b>Abstract:</b> Heavy metals are considered as a major pollutant causing environmental cytotoxic, mutagenic and carcinogenic effects in animals and aquatic organisms. Pollution caused by these substances can arise from many sources and the major problem associated with its persistence is its potential for bioaccumulation. Heavy metals such as lead (Pb), cadmium (Cd) and chromium (Cr) are the most common toxicant that can be found in the marine environment including fish. Fish is a common table food consumed by humans for protein nourishment and its use to study heavy metal contamination would benefit majority of individuals living in a country surrounded by bodies of water, such as the Philippines. The study aims to analyze the presence of lead, cadmium and chromium using qualitative and quantitative tests in the head, meat and internals of selected fish samples sold in wet markets located at Metro Manila, Philippines. Quantitative analysis confirmed the presence of lead, cadmium and chromium in all fish samples. Results were reinforced by the Flame Atomic Absorbance Spectroscopy, wherein most of the fish samples exceeded the standard limits set by US-EPA and FDA for lead, cadmium and chromium i.e. 0.5, 0.05 and 0.1 ppm respectively. Single factor ANOVA have shown that there is no significance among the levels of lead, cadmium and chromium with p values of 0.3679, 0.8858 and 0.9593 respectively in the head, meat and internal organs of the fish samples. Therefore, a person will acquire the same amount and effect of the heavy metals regardless of the part of the fish to be consumed. This study would be useful for the creation of guidelines to protect the public from the harmful effects of the toxicants present in fish that is consumed by the public.

Topic	Authors	Year	Title	Abstract/ description
	Zamora, Patrick; De Jesus, Josefina; Su, Glenn Sia; Ragragio, Elena; Su, Maria; Villanueva, Salvacion	2012	Assessing Lead Concentrations in Leafy Vegetables in Selected Private Markets in Metro Manila, Philippines	<b>Abstract:</b> Heavy metal contamination of vegetables poses a threat to consumers' welfare. This study aims to determine the lead concentrations in leafy vegetables sold in selected markets in Metro Manila, Philippines. About five randomly sampled leafy vegetables obtained from two private markets in Metro Manila were examined for their lead concentrations. All vegetables bought in the private markets had lead concentrations. Most leafy vegetables obtained had low lead concentrations. Significant differences on the lead concentrations in all leafy vegetables obtained in the different markets were found ( $p < 0.05$ ). The contamination of vegetables with lead in elevated levels may have potential health hazards to consumers. Proper washing of vegetables before consumption may help reduce the health risk.
	Solidum, Judilynn	2011	Lead and cadmium levels in shell foods, raw vegetables and restaurant drinking water in Metro Manila, Philippines	<b>Abstract:</b> Metro Manila, Philippines is a highly urbanized area in the Philippines. With continued technological progress and with the growth in population, there is concomitant increase in pollutants. Lead had been observed to be present in plants, soil, water, rainwater, street foods and human blood in the aforementioned area. Intoxication from it may result to problems in the nervous system. Other heavy metals like cadmium which may cause kidney damage may also be present in the place as these substances, once introduced in the environment are hard to biodegrade. Daily food regimen of Filipinos may be contaminated by the above said chemicals. This study generally aimed to assess the presence of lead and cadmium in shell foods, raw vegetables and drinking water from restaurants in Metro Manila, Philippines as these are part of the regular Filipino menu. Specifically, this research aimed to obtain the concentration of lead and cadmium from the collected samples and compare it with the set standard limits; project the blood levels of lead and cadmium upon ingestion of the samples and compare it with its set safe blood limits. All samples were acid digested and subjected to Atomic Absorption Spectrophotometry for the quantitative analysis. Golden Snails and oysters approached the standard limits set for lead and cadmium in food, respectively. Bitter gourd and sweet potato went above the standard limits set for lead and cadmium respectively. The mean lead and cadmium levels in the thirteen water samples analyzed exceeded both limits set for the heavy metals lead and cadmium. Projected levels of lead

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				<p>in the blood exceeded the safe limit for all shell foods except for the snails and shrimp body. Not one analyzed shell food exceeded the safe blood limit set for cadmium. Sweet potato, bitter gourd, and eggplant were the only samples that exceeded the safe blood lead levels for the tested raw vegetables. None of it exceeded the limit for safe cadmium blood level. The projected blood concentration for drinking water neared the safe blood level set for lead but not for cadmium. It is recommended that researches on the simplest, most cost effective remediation procedure for the environment be started. Moves to revolutionize processes that affect integrity of commodities must be initiated. Results of the remediation studies must be applied and evaluated. The outcome of this study should serve as guidelines for the local or national government for policy making or implementation of existing laws to safeguard public from ill effects of toxicants in shell foods, raw vegetables and drinking water from restaurants in Metro Manila, Philippines.</p>
	Jumawan, Joycelyn; Salunga, Thucydides; Catap; Elena	2010	<a href="#">Lipid Peroxidation and Patterns of Cadmium and Lead Accumulation in the Vital Organs of the Suckermouth Armored Catfish, from Marikina River, Philippines</a>	<p><b>Abstract:</b> Lipid peroxidation and patterns of cadmium and lead accumulation in the gills, liver, gut and muscles of <i>Pterygoplichthys Gill</i>, 1858 from four stations in Marikina River, Philippines were analyzed to study effects of possible metal toxicity alongside stress response. Mean cadmium (Cd) concentrations from tissues studied are within permissible amounts (0.02=0.05 mg L=1); mean lead (Pb) concentrations from the muscles, gills and gut were within permissible amounts except for the liver (0.22 mg L=1). Lipid peroxidation, indicative of oxidative stress was highest in the spleen, followed by the liver and gills. Malondialdehyde (MDA) values were not correlated with lead and cadmium concentrations in fish samples and were not site= significant which suggest that other possible factors might have also contributed to oxidative stress aside from lead and cadmium determined in the study. Histological observations of gills and gut show fair health for this invasive catfish, confirming several adjustments and adaptations towards air-breathing, although minute pathologic observations were seen in the liver. This study is the first to assess the patterns of heavy metal accumulation in this pollution-tolerant fish under field conditions in relation to oxidative stress.</p>

Topic	Authors	Year	Title	Abstract/ description
	Solidum, Judilynn	2010	Lead Contributed by the Environment and Raw Materials to Popular Street Foods in Metro Manila, Philippines	<b>Abstract:</b> Different hazardous chemicals have been introduced in our environment. Heavy metals, like lead is among those. As the earth approximates that of a closed system, such contaminant will freely distribute itself from one sphere to another at an infinite number of years. Street foods and the raw materials used to prepare it may then be laden with lead. The health and safety of the public is thus at stake particularly if the concentration of lead in food would go beyond the 0.5 ppm EPA standard limit. According to survey, banana cue, kamote cue, turon, different peanut varieties and kwek were the five most popular street foods from Manila City Hall to Baclaran in Metro Manila, Philippines. Using FAAS, the concentrations of lead in these street foods were obtained and ranged from 0.5667 to 0.7924 ppm. All went above EPA standard limit for lead in food. Lead from combined main and additive raw materials to prepare the different popular street foods, ranged from 0,3266 to 0.7329 ppm. Possible mean lead concentrations in blood upon ingestion of the popular street foods ranged from 17.001 to 39.620 ug/dL The possible blood lead levels went beyond the safe 10ug/dL level set by the Center for Disease Control. Peanuts (with skin) showed the highest lead levels as contributed by the immediate environment. For the recommendations, sample collection schedule must include the start and the end of the selling day of the vendors. Study of the possible sources of lead contamination of raw materials used must be explored. The Philippine Government may use this study as basis for policy making for lead-free street foods and raw materials, and for the improvement of environment and health conditions in Metro Manila.
Lead in homes	Riederer, Anne; Shine, James; Danan, Lieza; Ford, Timothy	2005	Concentrations of lead and mercury in multimedia samples from homes near the former Clark Air Base, Philippines	<b>Abstract:</b> We measured lead and mercury in samples collected from 31 homes in communities near the former Clark Air Base, Philippines during May and October 2002. Sample media included water used for drinking and cooking, house dust and entryway soil. Composite samples of 15 food items purchased at local markets were also collected. Samples were analyzed for total lead (Pb) and total mercury (Hg) to evaluate the relative importance of each media to residential exposure concentrations in the community adjacent to Clark (Community A) versus a control community 5 km away (Community B). In general, we measured low (e.g. background) to undetectable levels of the target analytes in all media sampled with two

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				<p>important exceptions. First, the Hg concentrations we measured in canned mackerel composites, which were within the range reported for mackerel from other locations worldwide, may pose a risk to pregnant women who are frequent consumers (e.g. one or more cans per day). Second, we measured Pb above the USEPA residential screening concentration (400 µg/g) in dust and soil from two homes, illustrating the need for periodic residential lead monitoring in these and other communities in the Philippines. We found no significant difference between Communities A and B with respect to Pb and Hg concentrations in water or food, although we were not able to detect very low levels of Pb in most of the foods we sampled because of trace Pb contamination added during sample homogenization. Although the Pb levels we measured in dust and soil from Community A homes were higher on average than Community B homes, the levels in both communities were low (e.g. background) thus we did not investigate the difference further. To our knowledge, these are the first reported measurements of Pb in house dust in the Philippines. The concentrations of Pb we measured in house dust were significantly higher than those in entryway soil from both communities, adding empirical support to the assertion that yard soil should not be considered a proxy for house dust in exposure studies in the Philippines or elsewhere.</p>
Lead in medicinal herbs	Solidum, Judilynn	2014	<a href="#">Lead Levels in Fresh Medicinal Herbs and Commercial Tea Products from Manila, Philippines</a>	<p><b>Abstract:</b> Alternative medicine utilizing the therapeutic effects of plants is commonly used in the community. Contaminants in the raw materials, like lead, may lead to adverse health effects. This study aimed to determine the presence or absence of lead and specifically aimed to obtain its levels in plants and commercial tea utilized as herbal medicine in Manila, Philippines. The blood levels of the heavy metals were mathematically projected as well. The concentrations were compared with the World Health Organization (WHO) and Center for Disease Control (CDC) allowable standards for plants and blood, respectively. Flame Atomic Absorption Spectrophotometry (FAAS) was used to analyze the heavy metals from the samples. All samples tested contained lead but conformed with the WHO limits at 10 ppm. However, only the tea preparation samples conformed with the CDC limit at 10 µg/dL but not the collected plants which went above the prescribed concentration. Herbs and its preparations must be decontaminated prior to use for better health provision to the Filipino people.</p>

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Lead pollution	Pabroa, Preciosa; Santos, Flora; Morco, Ryan; Racho, Joseph; Bautista, Angel; Bucal, Camille	2011	<a href="#">Receptor modeling studies for the characterization of air particulate lead pollution sources in Valenzuela sampling site (Philippines)</a>	<b>Abstract:</b> Valenzuela, an industrial district in the northwestern part of Metro Manila, Philippines, was found to have higher particulate and lead levels than in the other Metro Manila air sampling stations of the Philippine Nuclear Research Institute. Results in 2004–2009 show that while PM10 annual mean levels are in compliance with the long and short-term Philippine standards for PM10, PM2.5, annual mean levels are in exceedance of the long-term standard of the US EPA (15 µg m <sup>-3</sup> ). Energy-dispersive x-ray fluorescence spectrometry, a non-destructive multi-element nuclear related analytical technique, was used to analyze the elemental components of the air particulates. Positive matrix factorization, a receptor modeling tool, was used to identify and apportion air pollution sources. This study has identified Pb sources in both the coarse (PM2.5-10) and the fine (PM2.5) fractions. The conditional probability function analysis plots of 2008 Pb levels in both the coarse and the fine fractions show patterns for probable sources in the 2008 data similar to that in the 2005 data indicating that Pb sources in 2005 were the same Pb sources in 2008. Further studies to locate possible sources of lead are needed to validate the results of this finding.
	Ona, Louella	2010	<a href="#">Lead (Pb) Contamination of Dust from Schools in an Urbanized City in the Philippines</a>	<b>Abstract:</b> Exposure to lead-contaminated dust poses a health risk particularly to young children who are highly predisposed to the adverse effects of lead pollution. The study investigated the extent of lead contamination of dust collected from floors of classrooms in selected public and private elementary schools in Tarlac City, Philippines in order to provide policy makers, public health managers, and the community at large the necessary background information to make further efforts to curb lead pollution and develop meaningful actions and responses to address environmental health problems. A total of 108 dust samples were collected from the six sampling sites. Instrumental analysis for lead content of the dust samples through atomic absorption spectrophotometry showed the presence of lead in all the dust samples. The average lead levels in the dust samples ranging from 158.3 ug/ft <sup>2</sup> to 287.8 ug/ft <sup>2</sup> did not vary significantly among the six schools investigated and were all found to exceed the maximum exposure limit (40 ug/ft <sup>2</sup> ) set by the United States Environmental Protection Agency (EPA). The

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				findings of the study suggest that schoolchildren in Tarlac City, Philippines are at risk of exposure to the hazards of lead dust.
Lead in soil	Nazareno, Patricia; Buot, Inocencio; Flavier, Maxima	2011	The Plants in a Landfill in the Philippines and their Behavior Towards Lead and Mercury: Their Potential Use For Future Remediation of Metal-Contaminated Soils in The Country	<b>Abstract:</b> During past visits to the Cebu City landfill, plants were noticed growing in the facility. Studying the behavior of these plants is important for selecting those that can be used in mitigating heavy metal contamination. The study aimed to assess whether the plants in the Cebu City landfill excluded or accumulated lead (Pb) and mercury (Hg) in the plant tissues. The floristic composition of the landfill was analyzed prior to sample collection. The plant samples were acid-digested before the analysis of the metals using atomic absorption spectrophotometry (AAS). The Pb and Hg concentrations in the rhizosphere were also measured using AAS. The landfill substrate was generally acidic and the plant species differed in their response towards the heavy metals. As reflected in the Bioconcentration and Translocation Factors, <i>Muntingia calabura</i> (arattles in Tagalog) and <i>Tridax procumbens</i> (tridax daisy) exhibited effective uptake of Hg. <i>Muntingia calabura</i> was able to internally transport Hg while <i>Cynodon dactylon</i> (kawad kawaran in Tagalog) effectively transferred Pb from roots to stems, though it cannot generalize that those plants that did to have Pb and/or Hg in their tissues were not potential candidates for the uptake and translocation of Pb and Hg. Although further studies are needed, <i>Muntingia calabura</i> can be planted to help contain Hg in the soil.
	Ona, F; Alberto, Annie; Prunte, Jacqueline; Sigua, Gilbert	2006	<a href="#">Levels of Lead in Urban Soils from Selected Cities in a Central Region of the Philippines</a>	<b>Aims and Scope:</b> Lead (Pb) is a naturally occurring element that poses environmental hazards when present at elevated concentration. It is being released into the environment because of industrial uses and from the combustion of fossil fuels. Hence, Pb is ubiquitous throughout global ecosystems. The existence of potentially harmful concentrations of Pb in the environment must be given full attention. Emissions from vehicles are major source of environmental contamination by Pb. Thus, it becomes imperative that concentrations of Pb and other hazardous materials in the environment not only in the Philippines, but elsewhere in the world be adequately examined in order that development of regulations and standards to minimize risk associated with these materials in urban areas is continued. The objectives of this study were: (1) to determine the levels of Pb in soil

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				from selected urbanized cities in central region of the Philippines; (2) to identify areas with soil Pb concentration values that exceed estimated natural concentrations and allowable limits; and (3) to determine the possible sources that contribute to elevated soil Pb concentration (if any) in the study area.
Lead in water sources	Solidum, Judilyn; Dahilig, Vina Rose; Omran, Abdelnaser	2010	Lead Levels of Water Sources in Manila, Philippines	<p><b>Abstract:</b> Water is very important. People use it for drinking, cooking, bathing, washing clothes, cleaning materials and recreation. It is vital that water must be free from contaminants that may pose health hazards to living things. Heavy metals are among the toxicants in the environment that are not readily degraded such that once introduced, it will stay there indefinitely. Heavy metals, like lead which this study is focused on may cause adverse health effects to children and adults. Literature review have provided evidences that lead may be implicated in the occurrences of several diseases, primary of which may be related to neurological dysfunctions. This study focused on the detection and quantification of Lead (Pb) concentration in tap and deep well water sources from twenty-four residential areas in the City of Manila and water from Baywalk, Roxas Boulevard Manila during summer when recreational activities occur, comparative to the set standard limit. It compared the levels of lead concentration in tap and deep well water. The analysis made use of Flameless Atomic Absorption Spectrophotometry (FAAS). The mean lead concentration for all tap water samples was found as 0.6059 ppm. Mean lead concentration for deep well water samples was 0.4489 ppm, while that for Baywalk was 2.4801 ppm. Samples obtained from tap, deep well and Baywalk water sources, fell above the 0.015ppm imposed by United States Environmental Protection Agency (US EPA) limits. This standard limit is used as basis in the Philippines. Shore soil in Baywalk showed a mean of 3.2229 ppm. The lead in the soil contributes to the lead source in the water and vice versa. As the concentration of lead in Baywalk soil is very high compared to EPA standard limit, coming in contact with it may prove hazardous. Thus, given the results of this study wherein no sample conformed to the US EPA standard, it is recommended that the Manila, Philippines should begin regular surveillance on lead contamination in water sources from representative areas and their correlation on</p>

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				possible toxicological findings in the consumers. Likewise the government must also take environment clean up initiatives and draft policies to help lessen lead burden in Manila.

## F. Blood testing in National Health Surveys

National Health Survey	Non-Communicable Diseases Risk-Factors Surveillance	Source
Purpose	The survey provides information on fertility, fertility preferences, family planning practices, childhood mortality, maternal and child health, knowledge and attitudes regarding HIV/AIDS, and violence against women.	<a href="#">National Demographic and Health Survey, 2017</a>
Sample size	National sample of over 31,000 households and more than 25,000 women age 15-49.	
Blood sample testing	Blood tests such as blood typing, complete blood count, and screening for HIV/AIDS and Hepatitis B	
Latest round	2017	
Next round	-	