Protecting the Filipino Children's Potential: The Lead Exposure Situation and Interventions in the Philippines

Executive Summary

A 2020 report published by UNICEF and Pure Earth shows that globally up to 800 million children are poisoned by lead, that is 1 in 3 children. Because of the findings that adverse health effects can occur at any level, the World Health Organization has declared that there is no safe level of lead exposure in children. Nevertheless, currently, the public health action level is set at blood lead level (BLL) of 5 ug/dL (WHO, 2021) and even lower at 3.5 ug/dL by the United States Centers for Disease Prevention and Control and Prevention (US-CDC). The Lancet Planetary Health paper published in September 2023 showed the level of harm due to lead exposure is greater than previously thought. Children under five years old worldwide lost 765 million IQ points. This IQ point loss is 80% greater than previously estimated. Also, 5.5 million adults died from cardiovascular disease (CVD) due to lead exposure; this is six times greater than the 2019 estimate by the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD). The global financial cost of lead exposure was US$6 trillion, equivalent to 7% of global GDP. In LMICs, these costs accounted for more than 10% of GDP, or twice as high as in High Income Countries (HICs).

In the Philippines, studies from the 1980s to present show blood lead levels going down, except for specific areas that were clearly lead contaminated. The decline in the BLLs in these studies may be attributed to the elimination of lead in gasoline with the passing of the Philippine Clean Air Act 1999. The most recent blood lead level data comes from the Expanded National Nutrition Survey (ENNS) of the Philippine Food and Nutrition Research Institute (FNRI) of the Department of Science and Technology (DOST) in collaboration with Pure Earth which included 2,932 children ages 6 through 9 from 13 regions covering 20 provinces/districts/cities located in the 3 big islands of the Philippines, namely Luzon, Visayas and Mindanao. The average blood lead level of all children from the 3 islands was 1.96 + 1.26 ug/dL (range of 1.42-38.35). Using the US-CDC public health action level for lead, 257 or 8.76% of all children in this study had BLLs $\geq$ 3.5 ug/dL. This is 9 in 100 children or a prevalence of 9,000 in 100,000 population. Using this value, the estimated number of children with BLLs $\geq$ 3.5 ug/dL for a population of 11.95 children of ages 5-9 years old (Philippine Statistics Office, 2020), is 1.05 million.

With regard to the lead exposure sources, there are lead contaminated sites and consumer products. Pure Earth's Toxic Site Identification Program (TSIP) in the past identified 40 sites, the average lead reading from which was 56,945.06 ppm. Previous studies on lead in the environment from 2007 to 2022 also identified industries typically resulting in lead contamination such as garbage dumping, mining, salvaging of ships, gold and lead smelting and used lead acid battery (ULAB) recycling. On the other hand, in the past decade, the studies on products containing lead in the Philippines clearly showed potential sources of lead exposure through: aluminum cookware, medicines (herbal tea drinks/medicinal plants), cosmetics (lipsticks), toys, paints, other food items (street foods, raw vegetables, packaged snacks and powdered fruit juices, rice, fish, water from restaurants and distilled water), and non-food items (personal protective

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equipment, cigarettes, water bottles, and crayons and other school supplies). Extensive research on the presence and concentration of lead in various products available in the Philippines particularly in Metro Manila was done by Solidum and associates from 2010 to 2014. International Pollutants Elimination Network (IPEN) and EcoWaste Coalition have significantly raised awareness on contaminated consumer items and accomplished action towards elimination of lead in paint.

From 2021 - 2022, Pure Earth also conducted a survey on potential sources of lead exposure in consumer products in selected countries. In the Philippines' preliminary and the final rapid marketplace survey, 17 markets, 144 vendors and 856 samples were covered in Luzon, Visayas and Mindanao. Indicative results show: 24% of metal cookware, 13% of ceramic foodware, 16% of household paints, and 33% of cosmetic samples gathered were above the threshold levels for lead. Piloting of home-based assessments for lead exposures in 21 houses of those who participated in the blood lead level survey indicated similar results: presence of lead in metal cookware samples (100%), ceramic foodwares (50%), toys (28%) and paints (22%).

The recent surveys on blood lead levels and potential sources have produced crucial data that can inform policy and programmatic decisions and actions. It is also worth noting that aside from existing laws setting standards for lead levels in the environment and in consumer goods, addressing lead exposures has been prioritized as expressed in at least 10 of the strategic actionable items in the latest National Environmental Health Action Plan (NEHAP) 2023 - 2030 of the country's Inter-agency Committee on Environmental Health (IACEH) chaired by the Department of Health (DOH) and co-chaired by the Department of Environment and Natural Resources (DENR). In addition, FNRI continued the BLL screening in the 2023-2024 ENNS, which will cover all 117 areas and therefore, render a national baseline BLL level. At the local level, it is worth noting that Muntinlupa City and Valenzuela City have expressed interests to invest on next steps in line with the results and recommendations of the studies conducted.

The Philippines now has this groundbreaking opportunity to aim at developing, piloting and institutionalizing a lead surveillance system for the first time in the Philippines. As such, below are the recommendations on the health, environment and economic fronts to sustainably protect the Filipino children's potential:

Health

1. Update and adopt the national health guidelines for lead exposure among vulnerable populations, particularly children and pregnant women
2. Establish a lead poisoning prevention and surveillance program that will include:
    2.1 Regular national blood lead screening among children of different age groups, and pregnant women as part of maternal and child health services to identify those at risk to lead poisoning, and to institute appropriate and timely interventions; to include in the blood lead screening, levels of serum Vitamins C and D, iron and calcium be determined so as to provide guidance on further interventions that will prevent lead absorption by the human body.
    2.2 Create and adopt clinical diagnostic tools (such as environmental exposure history,

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clinical manifestations) for early detection of lead exposure and poisoning

2.3 Build capacity to monitor exposure of children and pregnant women to lead by assessing the current government and private sector capacity to monitor, test and treat lead poisoning and providing the trainings, manpower, equipment and resources to operationalize such.

2.4 Determine the data set, the frequency and the manner by which it will be gathered. The tool to be developed maybe three-pronged: identifying population at risks, enabling early detection and subsequent case management, and identifying potential sources of exposure.

2.5 Establish an integrated data system drawing on BLL surveillance, industrial and agricultural activity and sources, open burning of waste, management and incineration of hazardous waste, consumer products, and other relevant ministerial data, consisting of a SQL-Server back-end linking data by geographic and demographic characteristics, and a front-end enabling data exploration, mapping, and reporting to data interpretation and decision making.

2.6 Develop and disseminate awareness campaigns on current issues related to lead exposure and poisoning to relevant stakeholders such as policy makers, industry, educational institutions, health sector and the general public

3. Build up an effective feedback and referral system for the clinical management of lead exposure and poisoning

Environment

1. Review, finalize and institutionalize the national action plan (NAP) on the environmentally sound management of used lead acid batteries (ULABs) in the Philippines (please see attached).
2. Design and implement an environmental health monitoring program on lead following the exposure pathway model. The program will identify and assess major sources contributing to lead exposure in households and communities. The program will aim to establish the environmental exposures to health status of vulnerable populations, especially children and pregnant women, as evidenced by their blood lead levels.
3. Develop and implement strategies in the prevention of lead exposure among vulnerable populations, especially children and pregnant women
4. Establish a directory of experts in the industries of concern for developing benchmarking assessment tools and interventions in order to eliminate and find alternatives to specific lead contamination/pollution-causing segments of the industrial processes.
5. Regularly publish advisories on the results of the environmental monitoring with recommended action to continually raise awareness and thus, equip the public with information to employ exposure mitigation measures

*Conduct a pilot implementation of both the health and environmental monitoring and surveillance system in order to further improve the system before full implementation, a phased approach based on

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risk and/or vulnerability (per area or region) might be cost-effective and strategic than a full deployment at the same time.

Economics

Regulation of consumer items production, commercialization and waste management specifically cookware, paints, toys, cosmetics, and ceramics as well as the battery industries, specifically

1. Develop standards for cookware, ceramics and other cooking and eating utensils.
2. Tap industrial associations in agreeing to uphold established standards and protocols in ensuring lead/toxin-free inputs, processes and outputs/products.
3. In the case of batteries, refer to detailed recommendations in the draft NAP.
4. Given that locally manufactured products should be under the environmental monitoring mentioned above, the same monitoring should be applied to imported products before release in local markets.

These clearly complement and support the attainment not only of national goals but even the sustainable development goals of: 1. No poverty; 3. good health and well-being; 4. quality education; 8. decent work and economic growth; 11. sustainable cities and communities; 13. climate action; and 17. partnership and goals among others.

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Defining the Lead Problem in the World

Lead poisoning has been recognized worldwide as a public health problem. Vulnerable populations such as children, living in communities with high lead exposure and have limited access to health services, are at greatest risk of getting sick. A 2020 report published by UNICEF and Pure Earth shows that globally up to 800 million children are poisoned by lead, that is 1 in 3 children.[1] Possible sources include lead in paints, ceramics and informal used lead acid battery recycling plants. In low and middle income countries, these industries are usually located near residential areas and public places such as schools and community gardens where children among other vulnerable members of the population spend most of their time and are thus exposed. Children are particularly vulnerable to lead poisoning due to their smaller size and higher rates of lead absorption.[2]

The toxicokinetic and toxicodynamic properties of lead can cause adverse effects on humans. Such properties include a long half-life (10-20 years), multi-organ involvement, especially vital organs (brain, heart, kidneys) resulting in neurologic, cardiovascular, renal and developmental effects. Studies have shown that even at very low levels, lead exposure is linked with various end-organ effects. Blood lead concentrations as low as 2.4 µg/dL are associated with decreased intelligence in children, behavioral difficulties, and learning problems.[3] Lead exposure in young children is also associated with juvenile delinquency, violence and crime later in life.[4,5,6] Even low levels of childhood lead exposure are associated with increased risk of death from cardiovascular, liver and kidney disease later in life.[7] Published estimates would suggest that the theoretical minimum risk of health effects of lead may occur at concentrations as low as 0-1 ug/dL.[8]

Because of the findings that adverse health effects can occur at any level, the World Health Organization has declared that there is no safe level of lead exposure in children.[9] Currently, the public health action level is set at blood lead level (BLL) of 5 ug/dL (WHO, 2021) and even lower at 3.5 ug/dL by the United States Centers for Disease Prevention and Control and Prevention (US-CDC).

The Lancet Planetary Health paper published in September 2023 showed the level of harm due to lead exposure is greater than previously thought. Specifically, based on data from 2019, the report showed:[10]

- Children under five years old worldwide lost 765 million IQ points. Those living in LMICs lost 729 million IQ points, an average loss of 5.9 IQ points per child. This IQ point loss is 80% greater than previously estimated.[11]
- 5.5 million adults died from cardiovascular disease (CVD) due to lead exposure; this is six times greater than the 2019 estimate by the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD). Previous estimates included CVD deaths only from lead-mediated high blood pressure. The new mortality calculation is based on the lead's estimated effects on CVD deaths caused by factors

other than high blood pressure, e.g., damage to the heart and arteries due to atherosclerosis and increased incidence of stroke.

- About 90% of CVD deaths and 95% of IQ point loss due to lead exposure were in LMICs.
- The global financial cost of lead exposure was US$6 trillion, equivalent to 7% of global GDP. In LMICs, these costs accounted for more than 10% of GDP, or twice as high as in High Income Countries (HICs).
- More than three-fourths of the economic cost (77%) was due to CVD deaths and associated income loss from premature mortality; nearly one-fourth of the economic cost (23%) was due to estimates of lower future income caused by IQ loss.

Defining the Lead Problem in the Country

Lead Exposure Among Children

Studies on lead exposure among children in both urban and rural communities have been conducted since the 1980s (Table 1). The 1984 study by Fagela-Domingo, et al. was the first published study involving 570 children with a mean BLL of 22.86 ug/dL). The study cited a significant correlation between the elevated lead leads and household proximity to heavy traffic density and lead-emitting industries among children in the urban areas.[12] Subsequent studies in the latter years performed in different areas in the country involving children of different age groups (range of 6 months – 12 years) showed lower mean BLLs (4.56 – 6.9 ug/dL) (Table 1). The decline in the BLLs in these studies may be attributed to the elimination of lead in gasoline with the passing of the Philippine Clean Air Act 1999. However, these studies showed that environmental samples collected in the households and nearby environments of these children detected levels of lead in soil, paint, household dust, fishing weights, fish and canned fish and fossil fuels.

Another set of studies were done focusing on lead exposure of children in high-risk settings (Table 2). These high-risk environments included lead recycling and smelting industries, toxic waste sites, air-polluted areas, and mining operations. The mean BLLs of children living near these sites were higher compared to the ones cited in Table 1. Majority of the studies showed mean BLLs > 10 ug/dL with one study showing mean BLL of 50.77 ug/dL. Two studies have demonstrated that the nearer the residence of the children to the toxic site, the more elevated their blood lead levels.[13,14]

Aside from establishing internal exposure, local studies have investigated the effects of blood lead levels on children's cognitive functions (Table 3). These studies have shown the adverse effect of lead on the cognition of children with a significant drop in IQ for every 1 ug/dL increase in BLL as well as documentation of lead's effect on perceptual reasoning index (PRI) and working memory index (WMI). Furthermore, the study of Solon (2008) showed findings suggestive of folate and iron deficiencies to be risk factors to the adverse cognitive effects of lead.[15]

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Results of the 2021 BLL Survey of Children Ages 6 to 9

Pure Earth, in collaboration with the Philippine Food and Nutrition Research Institute (FNRI) of the Department of Science and Technology (DOST), embarked on a blood lead survey among vulnerable populations in the country, specifically children and pregnant women. The survey was part of the 2021 National Nutrition Survey (NNS). The NNS is the only survey being conducted in the country that collects blood samples from a representative population to assess a wide range of nutrition parameters. The survey population included 2,932 from 13 regions covering 20 provinces/districts/cities located in the 3 big islands of the Philippines, namely Luzon, Visayas and Mindanao.

The average blood lead level of all children from the 3 islands was 1.96 + 1.26 ug/dL (range of 1.42-38.35).

Using the US-CDC public health action level for lead, 257 or 8.76% of all children in this study had BLLs $\geq$ 3.5 ug/dL. This is 9 in 100 children or a prevalence of 9,000 in 100,000 population. Using this value, the estimated number of children with BLLs $\geq$ 3.5 ug/dL for a population of 11.95 children of ages 5-9 years old (Philippine Statistics Office, 2020), is 1.05 million. Furthermore, it was observed that the majority of children from the Visayas (21.21%) had BLLs above or equal to the action level. A Pearson chi-square test was performed to assess the relationship between the geographical locations and the blood lead levels. A significant relationship was obtained for these two variables at X^2 (2,775) = 21.42, *p*=.002. This would mean that the blood lead level is related to the geographical location.[16]

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Table 1: Studies on Blood Lead Levels in Filipino Children from Urban and Rural Communities

Title of Study/Authors	Year	Location	Number of Children	Age Group (months/years)	Mean Blood Lead Levels (BLL) (ug/dL)	Observations
Blood lead, free erythrocyte protoporphyrin and delta-aminolevulinic acid dehydratase levels (Fajela-Domingo C, Alavanza B, et al.) (referenced from Suplido ML, David A, et al.) Milk, lead levels and mental development (Gole Cruz RV, Fagela-Domingo C, et al.)	1984	Metro Manila communities, Luzon Rural communities	570 801 Note: Only 554 with blood lead determination	4 months – 14 years	22.86 24.14	Overall prevalence rate for elevated blood lead = 7.76% (urban) 1.2% (rural)
Blood Lead Levels in Filipino Grade School Children in Three Selected Urban Areas: Olongapo City, Metro Cebu and Metro Davao (Suplido ML, David A, et al.)	2003	Olongapo City, Metro Manila, (Luzon) and Metro Davao (Mindanao)	1,756	6.7 (SD 0.9) and 12 (SD 1.1) School children	5.39 (SD 4.42) with 7.5% with BLL>10 ug/dL Metro Manila (Olongapo): 5.09 Metro Cebu: 5.7 Metro Davao: 5.39	7.5% prevalence of BLL≥ 10 µg/dL; Most children in Metro Cebu with high BLL were living near car battery recycling.
Elevated blood-lead levels among children living in the rural Philippines (Riddell TJ, Solon O, et al.)	2003-2004	30 districts nationwide	2,861 (100 per district)	6 months to 5 years	6.9 ug/dL 21% with BLL > 10	21% of 2861 children had BLL≥ 10 µg/dL with Leyte having the highest mean BLL
Blood lead levels of children in four lakeshore villages in the Calabarzon Region, Philippines	2012-2013	Calabarzon Region, Luzon	100	7.72±0.79 (range 6-9)	4.56±3.01 (range 1.33-22.4)	22% with BLL >5 (mean of 8.46±4.36)

(Panganiban LR, Bermudez ANC, et al.)						

Table 2: Studies on Blood Lead Levels in Filipino Children From High-Risk Settings

Title of Study/Authors	Year	Location	Number of Children	Age Group (months/years)	Mean Blood Lead Levels (BLL) (ug/dL)	Observations
Health Profile of Child Scavengers of Smokey Mountain in Tondo, Manila (Torres EB, et al.) (Referenced from Health Safety and Environmental Management Consultancy, Inc.)	1991	Manila	186	6-15	28.38	In comparison, mean BLL of school children was 11 ug/dL
Impact of vehicular emissions on vulnerable populations in Metro Manila (Subida RD & Torres EB) (Referenced from Health Safety and Environmental Management Consultancy, Inc.)	1993	Manila	488 street child vendors	6-14	14.8	32.7% of 101 sample population had BLL $\geq$ 20 µg/dL compared to 10.3% of school children.
Blood lead levels and cognitive function of child scavengers in Smokey Mountain (Regal MAS)	1997	Metro Manila, Luzon	149	???	20.37 ug/dL	
Health and environmental assessment among residents of a community near a battery recycling plant (Cortes-Maramba NP, Panganiban LR, et al.)	1999	Central Luzon Region	40	9.68 ± 3.58 (7-12)	12.92 ± 4.087 (range 7-25)	Mean BLL of control group was 9.7 ± 1.53 ug/dL
Lead Exposure Among Small-Scale Battery Recyclers, Automobile Radiator Mechanics, and Their Children in Manila, the Philippines (Suplido ML & Ong, CN)	1999	Manila, National Capital Region, Luzon	20	Battery recyclers: 6.37 ± 3.99 Radiator mechanics: 6.28 ± 3.96	49.88 11.84	
Metro Manila children living along heavy traffic (Department of Health)	2000	Metro Manila	207	6-14	16.3	

(Referenced from Health Safety and Environmental Management Consultancy, Inc.)						
Metro Manila children in high and medium pollution areas (Public Health Monitoring and Air Pollution Study) (Referenced from Health Safety and Environmental Management Consultancy, Inc.)	2003	Metro Manila	298	6-10	9.3	
Castillo ES, et al Study among residents exposed to the Marcopper Mining Corporation mine tailing leakage	2003	Marinduque	???	???	12.34 µg/dL (11 to 14 µg/dL)	Levels increased to 15.86 ug/dL (13 – 19 ug/dL) after 6 months
Health effects of lead exposure among 6–7-year-old children in 3 barangays in Central Luzon near an abandoned used lead acid battery (ULAB) plant (Dioquino CPC, Panganiban LCR)	2010	Central Luzon Region	74	6-7	8.004 (SD 1.81)	Twelve children out of 74 (16.2%) had blood lead levels of 10 µg/dL or above.
Chatham-Stephens K, et al. The pediatric burden of disease from lead exposure at toxic waste sites in low and middle-income countries	2014	TSIP sites including the Philippines (27 sites)	579/site	0.5 -2	21.04	85% of children living in the identified sites were found to have higher than 5 µg/dL BLL.
Health status of children exposed to lead-contaminated soil near a lead smelting plant in Central Luzon, Philippines (Panganiban LCR)	2017	Central Luzon Region	15	10.07 range (2-16)	50.77 (20.3 - >65)	

Table 3: Studies on BLL and children's cognitive function

Title of Study/Authors	Year	Location	Number of Children	Age Group (months/years)	Mean Blood Lead Levels (BLL) (ug/dL)	Cognitive Function Results
Blood lead levels and cognitive function of child scavengers in Smokey Mountain (Regal MAS)	1997	Metro Manila, Luzon	149	???	20.37 ug/dL	Inverse relationship between BLLs and IQ scores
Associations between Cognitive Function, Blood Lead Concentration, and Nutrition among Children in the Central Philippines (Solon O, et al.)	2003-2004	Visayas	877	6-59 months	7.1 ug/dL	A 1 ug/dL increase in BLL was associated with a 3.32-point decline in cognitive functioning in children (6 months-3 years); 2.47-point decline in children (3-5 years)
Health effects of lead exposure among 6–7-year-old children in 3 barangays in Central Luzon near an abandoned used lead acid battery (ULAB) plant (Dioquino CPC, Panganiban LCR)	2010	Central Luzon Region	74	6-7	8.004 (SD 1.81)	There appears to be an inverse relationship between BLLs and the IQ scores for the working memory index, processing speed index and perceptual reasoning index, especially with the latter.
Blood lead levels of children in four lakeshore villages in the Calabarzon Region, Philippines (Panganiban LR, Bermudez ANC, et al.)	2012-2013	Calabarzon Region, Luzon	100	7.72$\pm$0.79 (range 6-9)	4.56$\pm$3.01 (range 1.33-22.4)	Children with BLLs > 5 ug/dL had low average IQ scores in perceptual and processing speed indices as compared with dose with BLLs $\leq$ 5 ug/dL
Health status of children exposed to lead-contaminated soil near a lead smelting plant in Central Luzon, Philippines (Panganiban LCR)	2017	Central Luzon Region	7	12.71 (range 7-16)	43.3 (range 20.3 - >65)	All had abnormal IQ scores for the different indices. Four of 7 had extremely low scores for fluid reasoning index and working memory index

Sources of Exposure

Lead Contaminated Sites

In 2011, Pure Earth wrapped up its first TSIP (then known as Global Inventory Project) with 114 sites assessed in the Philippines. Out of 114, 40 sites were contaminated with lead. The regions with the highest number of lead-contaminated sites were Region 3 (12 sites), NCR (12 sites), and Region 4-A (6 sites). Lead contamination in these regions usually originate from the informal recycling of used lead-acid battery.[17] A total of 20 sites were re-assessed in 2014, 11 in Bulacan and 9 in Metro Manila. Half or 50% of the sites were related to two industry sectors: treater, storage and disposal (TSD) facilities and lead smelting and ULAB recycling, majority of which belong to the formal sector. Lead was identified as the key pollutant present in 55% of the sites.[18] In 2017, another survey was conducted by DENR-EMB with Innogy and Pure Earth to serve as a basis in determining the scope of lead pollution and human health exposure risks posed by ULAB activities from collection and storage to recycling/treatment and disposal. A total of 282 sites were surveyed all over the country. Of these, 50 sites comprising 20 storage facilities and 30 recyclers/smelters were identified as priorities in assessing potential lead contamination.[19] Currently, the average lead reading from TSIP's lead sites is 56,945.06 ppm. In 2018, Pure Earth under the USAID TSIP piloted an investigative approach in that cities are blanketed for soil sampling and heavy metal concentration readings without first identifying any known potential sources of contamination. In this study, 0.7% or 64 of the Iloilo City samples yielded an average reading of 5,680 ppm and 2.39% of 65 of the Tagbilaran City samples yielded an average of 14,509.26 ppm. For both cities, the lead sites are associated with ULAB-handling establishments like junk shops.[20]

Guidelines for the cleanup of potentially lead contaminated areas in the Philippines are not yet established. But based on the DENR-EMB Memorandum Circular No. 2017-004 entitled 'Site Remediation Guidelines', international guidelines can be adopted as long as it is coordinated with and approved by the EMB. In 2017, Pure Earth conducted a community exposure mitigation in San Simon, Pampanga where housing conditions revealed very high lead levels from 2,078.88 ppm on linoleum to 300,116.60 ppm on furnace bricks used as floorings; soil range was 25 to 11,300 ppm; and In 2017, dust concentration range of 50 to 40,545 ug/ft2.[21] EPA standard was at 400 ppm for lead in residential soil, and 10 ug/ft2 for floor dust and 100 ug/ft2 for window sill dust as of 2019.[22]

Previous Studies on Lead in the Environment

Previous studies on lead in the environment from years 2007 to 2022 are summarized in Table 4. This included one study from Mindanao and three studies covering several areas in the Philippines and 11 studies in Luzon.

In a study conducted in 2018 in Lanao Del Norte, Mindanao, the identified source of lead contamination were the salvaging of ships which uses paint and welding equipment as well as leaded petrol cars and some discharges from industries and residential houses near the port. These activities lead to the contamination of marine water with lead concentration of 0.18 mg/L exceeding 0.05 mg/L allowable limit set by DENR.[23]

For the studies covering several areas in the Philippines, the identified sources of lead contamination were lead dust coming from different sources including chipping paints, landfills and gold and nickel mining, and direct garbage dumping into water bodies and mining activities. Study on lead in household dust in the Philippines conducted by EcoWaste Coalition and IPEN in 2014 recorded exceedance up to 110 µg/ft2 (against the US EPA standard of 40 µg/ft2) taken in an area near a classroom wall decorated with artworks where paint has chipped off. [24] Prior to this national survey, a study conducted by Louella F. Ona in 2010[25], documented exceedances in the lead concentration in the dust collected from the schools in Tarlac City, Philippines. Lead range in dust collected was 158.3 ug/ft^2 to 287.8 ug/ft^2 exceeding the maximum exposure limit (40 ug/ft^2) set by US EPA. In 2020, a study entitled 'Environmental Biomonitoring of Terrestrial Ecosystem in the Philippines: A Critical Assessment and Evaluation' highlighted landfills in Manila (specifically the airborne pollutants coming from e-wastes), nickel mining operations in Mindoro and gold mining operations in Mindanao as among the sources of lead contamination. Based on this study, lead is among the reported pollutants in terrestrial ecosystems. These pollutants caused genotoxicity at the chromosomal level based on the assessment in the terrestrial ecosystem, bioindicators to human hair, lichens, and biomarkers in the chromosomal damage.[26] Another study by Emil D. Sumayaw and Jay P. Picardal in 2022 identified lead as among the heavy metal pollutants in mined out areas as evident in the heavy metal accumulation data of the selected plants that are hyperaccumulators and photostabilizers.[27]

As for the studies conducted in Luzon, identified lead sources were mining activities and mine tailings, rapid industrialization, urbanization and population growth, ULAB and gold smelting activities, landfill, and dumpsite. Mining activities and other anthropogenic sources in Marinduque contaminated the surface water with 20 ppm lead exceeding the maximum limit of 0.05 ppm set in the DENR Administrative Order No. 34 Water Quality criteria for Class C based on the study conducted in 2007[28], rendered lead concentration range in sediment (dry wt) from <1 ug/g to 78 ug/g based on the study conducted in 2013[29], and contaminated agricultural soil with average lead concentration range from 393 to 1291 mg/kg against 55 mg/kg Soil Quality Standard of the Department of Agriculture according to the study done in 2022.[30] Another study conducted in Zambales in 2022, identified mine tailings to be the source of heavy metal (including lead) in soil. Lead presence in soil in this study was recorded to be 50.00 mg/kg against the maximal permissible concentration of 55 mg/kg Soil Quality Standard of the Department of Agriculture.[31]

In 2017, industrialization was identified to be the source of lead contamination in Manila Bay Waters (809.81 ug/L in January, 1,102.88 ug/L in March 2013, and 1,507.50 ug/L in November 2015) based on the study conducted by Sy, A. A., Tobias, M. L., et al.[32] In 2018, rapid industrialization and urbanization were tagged to be the source of lead contamination in water (0.05 mg/L and 0.03 mg/L in dry and wet season, respectively) and of lead that has bioaccumulated in the food web (3.87mg/kg (wet season) and 9.66 mg/kg (dry season) lead concentration in phytoplankton and 0.38 mg/kg highest in dry season observed in *Hypophthalmichthys nobilis* and 0.67 mg/kg highest wet season observed in *Oreochromis niloticus)* in the open waters of Laguna de Bay as studied by Tingson, K. N., Zafaralla, M. T., et al.[33] Also in 2020, rapid industrialization and urbanization were tagged to be the source of lead contamination in water and sediment (947 ppm upstream, 391 ppm midstream, and 783 ppm downstream) in the Meycauayan River Segment of the Marilao-Meycauayan-Obando River System in Bulacan, Philippines according to the study conducted by Pleto, J. V., Migo, V. P., et al.[34]

Another identified source of lead contamination were used lead acid battery recycling and gold smelting activities in Meycauayan, Bulacan as mentioned in the study conducted by Diwa, R. R., Deocaris, C. C., et al in 2021 entitled "*Meycauayan, an industrial city in Bulacan, Philippines: Heavy metal pollution in soil and surface sediments and their relationship to environment indicators*". Based on this study, lead causes 53.6 % ecological toxicity.[35]

Landfill and dumpsite were also identified as potential sources of lead contamination. The studies were conducted by Richard Dein D. Alvarez and Noel A. Sedigo[36] and by Santos, AJ, Divina, C., et al.[37] in 2019 at Carmona Cavite and in 2021 in Talavera, Nueva Ecija, respectively. Lead from the closed Sanitary Landfill is contaminating the grazing food chain (in plant 0.2 ppm, in insect 0.05 ppm, and in chicken liver 0.08 ppm as opposed to the Tolerable Daily Intake (TDI) for Pb set by the US FDA (0.006 ppm for 0 - 6 years old; 0.015 ppm for 7 - young adults; 0.025 ppm for pregnant women); and 0.075 ppm for adults) while lead from the dumpsite is contaminating soil with 13.87 ppm against the US EPA regulatory standards for residential soil (4.0 ppm) and for industrial soil (8.0 ppm).

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Table 4. Summary of Previous Studies on Lead in the Environment

Title of Study/Authors	Year	Location	Lead Levels (BLL) in soil, water	Observations/If there are identified lead sources on site
Biosorption Of Copper, Cadmium And Lead By Copper-Resistant Bacteria Isolated From Mogpog River, Marinduque (Parungao, M., Tacata, P., et al)	2007	Marinduque	20 ppm in surface water	Surface water of Mogpog River in Marinduque is contaminated with lead (20 ppm) exceeding the maximum limit of 0.05 ppm set in the DENR Administrative Order No. 34 Water Quality criteria for Class C
Lead (Pb) Contamination of dust from schools in an urbanized city in the Philippines (Louella F. Ona)	2010	Tarlac City, Philippines	Lead concentration range in dust: 158.3 ug/ft2 to 287.8 ug/ft2	The average lead levels in the dust samples taken from the six schools investigated ranged from 158.3 ug/ft2 to 287.8 ug/ft2 exceeding the maximum exposure limit (40ug/ft2) set by USEPA.
Trace metal speciation by sequential extraction in marine sediments of Calancan Bay, Sta.Cruz, Marinduque, Philippines (Dr. Dhalia C. Apodaca, et al)	2013	Calancan Bay, Sta. Cruz, Marinduque, Philippines	Lead concentration range in sediment (dry wt): 78 ug/g to <1 ug/g	The study determined the spatial extent of metal contamination in Calancan Bay, Sta. Cruz, Marinduque was influenced by the presence of a tailings causeway from the past mining activities. Total metal concentrations including lead revealed metal enrichment not only in areas closest to the tailings causeway but also in offshore areas of the bay. Lead was among the metals tested for metal speciation (element distribution in sediments) to assess the geochemical mobility as well as the potential bioavailability of the metal;

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				speciation results indicated that lead was associate with Fe/Mn oxides and hydroxides; lead come from mainly anthropogenic inputs and that lead is in the mobile phase. Source: mining and other anthropogenic activities
National Report: Lead in Households in the Philippines	2014	Philippines	Above 10 µg/ft2 - from 3 private homes, 4 day-care centers and 3 preparatory schools Less that 10 µg/ft2 - from 9 private homes - all samples from oneday-care center and one preparatory school Equal to or greater than 40 µg/ft2 - from two preparatory schools - the highest was 110 µg/ft2 taken in an area near a classroom wall decorated with artworks where paint had chipped off	Collection of lead dust in 21 locations (12 private homes with children, 5 day-care centers and 4 preparatory schools) Other notes: - the low levels indicate thorough cleaning practices in the homes - areas such as entryways to the homes, day- care centers or schools registered a relatively higher level of dust lead as compared to other sites within a room. This can be attributed to the frequency of people carrying dust on their footwear upon entering or exiting rooms
Profile of Salinity, Temperature, Heavy Metals (Pb, Cd, Hg) and Sediments	2017	Manila Bay, Philippines	lead concentration in Manila Bay waters:	Pb, Cd, and Hg concentrations in the bay occasionally exceeded the permissible limits especially the lead concentration in January

Hydrogen Sulfide Concentration of Manila Bay, Philippines from 2012 to 2015 (Sy, A. A., Tobias, M. L., et al)			in January 2013 (ave:809.81 ug/L, March 2013 (ave:1,102.88 ug/L) and November 2015 1,507.50 ug/L)	2013 (ave:809.81 ug/L, March 2013 (ave:1,102.88 ug/L) and November 2015 1,507.50 ug/L) Source: industrialization
Lead Biomagnification in a Food Web of the Open Waters along Sta. Rosa Subwatershed, Philippines (Tingson, K. N., Zafaralla, M. T., et al)	2018	Laguna de Bay	Lead in water: 0.05mgL and 0.03 mg/L in dry and wet season, respectively Lead in phytoplankton: 3.87mg/kg (wet season) and 9.66 mg/kg (dry season) In fishes: 0.38 mg/kg highest in dry season observed in *Hypophthalmichthys nobilis* and 0.67 mg/kg highest wet season observed in *Oreochromis niloticus*	Lead was found in water, phytoplankton and in fishes found in Laguna de Bay. Lead magnification was observed in the following order: water < phytoplanton < zooplankton. However, this increasing trend did not continue up to fishes.
Lead Contamination in the Waters of the Port of Mukas, Kolambugan, Philippines (Jimenez, J. M., Tagaro, S. J., et al)	2018	Mukas Kolambugan, Lanao Del Norte, Philippines	Lead in marine water: 0.18 mg/L exceeding 0.05 mg/L allowable limit set by DENR	The average lead in water in the port under study was 0.18 mg/L exceeding the allowable limit 0.05 mg/L set by the DENR for toxic and deleterious substances in marine waters with beneficial usage; high lead concentration might be due to the salvaging of ships which uses paint as and welding equipment as well as leaded petrol cars and some discharges from industries and residential houses near the port;

Existing Land Use and Extent Of Lead (Pb) Contamination In The Grazing Food Chain Of The Closed Carmona Sanitary Landfill In The Philippines (Richard Dein D. Alvarez and Noel A. Sedigo)	2019	Carmona, Cavite, Philippines	Lead in biota: plant (0.2 ppm) insect (0.05 ppm) chicken liver (0.08 ppm) 1.36 ppm in soil of a former landfill (against 1200 ppm USEPA standard)	Pb level observed in plants, insects and chicken's liver are unsafe as compared to the Tolerable Daily Intake (TDI) for Pb set by the US FDA (0.006 ppm (0 - 6 yo); 0.015 ppm (7 - young adults); 0.025 ppm (0.025 ppm pregnant women); 0.075 ppm (adults) Lead (1.36 ppm) in soil is within the standard set by the US EPA. Source of lead: abandoned landfill
Environmental Biomonitoring of Terrestrial Ecosystem in the Philippines: A Critical Assessment and Evaluation (Berame, J. S., Mariano, M. B., et al)	2020	Philippines	No available Pb levels, only qualitative description: In Luzon, Pb is among the most prominent prominent heavy metals found in the soil and vegetation In landfills in Manila: Pb is among the airborne pollutants coming from e-wastes Mndoro: Pb as among the pollutant In Nickel mining site in Mindoro In Mindanao: Pb comes mostly from gold mining operations	Lead is among the reported pollutants in terrestrial ecosystems; through the pollutants (inc. Pb) assessment in the terrestrial ecosystem, bioindicators to human hair, lichens, and biomarker in the chromosomal damage indicate genotoxicity at the chromosomal level; Studies revealed that pollutants (including Pb) are present both in Luzon and Mindanao terrestrial ecosystem;

Preliminary Water and Sediment Quality Assessment of the Meycauayan River Segment of the Marilao-Meycauayan-Obando River System in Bulacan, Philippines (Pleto, J. V., Migo, V. P., et al)	2020	Meycauayan River Segment in MMORS, Bulacan, Philippines	Lead in sediment Meycauayan River Segment: 947 ppm (upstream), 391 ppm (midstream), 783 ppm (downstream)	Heavy metal including lead exceeded the severe effect level of the National Oceanic and Atmospheric Administration, which could be detrimental to humans and aquatic life Source: rapid industrialization, urbanization, and population growth
Heavy Metal Contamination In Soil and Phytoremediation Potential Of Naturally Growing Plants In Bagong Silang Dumpsite, Talavera, Nueva Ecija, Philippines (Santos, AJ, Divina, C., Et Al)	2021	Bagong Silang Dumpsite, Talavera, Nueva Ecija, Philippines	lead in soil: 13.87 ppm US EPA regulatory standards: residential soil (4.0 ppm) industrial soil (8.0 ppm)	Soil analysis in Bagong Silang Dumpsite showed that lead concentration, which is 13.87 ppm, exceeded the permissible level set by the US EPA regulatory standards
Meycauayan, an industrial city in Bulacan, Philippines: Heavy metal pollution in soil and surface sediments and their relationship to environment indicators (Diwa, R. R., Deocaris, C. C., et al)	2021	Meycauayan , Bulacan	53.6% ecological toxicity level caused by lead	Lead contributed to the highest incidences of ecological toxicity at 53.6%; Significant input of lead and mercury mercury from ULAB recycling and from gold smelting industries Source: ULAB and goldsmelting activities
Exploring potential phytoremediation in the terrestrial and aquatic mined area in the Philippines: An integrative review (Emil D. Sumayaw and Jay P. Picardal)	2022	Philippines	No specific level given. Sources of lead in ecosystem are nature (naturally occurring lead), direct garbage dumping into water bodies and mining	The study identified the common heavy metals in the Philippines mined out areas. Lead is among the heavy metal pollutants in mined out areas as evident in the heavy metal accumulation data of the selected plants that are hyperaccumulators, phytostabilizers;

			As soil contaminant: Lead were from mining smelting activities, disposal of paints, gasoline, explosives, and municipal sewage sludges, coal-fired power plant	Sources of lead identified in the study were direct garbage dumping into water bodies and mining Source: mining activities
Health Risks Due to Metal Concentration in Soil and Vegetables from the Six Municipalities of the Island Province of the Philippines (Nolos, R. C., Agarin, CJ M., et al)	2022	Marinduque Province	Average lead concentration in range agricultural soil: 393 to 1291 mg/kg against 55 mg/kg SQS	All monitored metal concentrations (including lead) in the soil, except for Cd, exceeded the soil quality standard (SQS). Most of the metal concentrations in the vegetables analyzed also exceeded the maximum permissible limit (MPL). All health hazard indices (HHIs) were less than 1, which means potential low non-carcinogenic risk to human population by vegetable consumption.
Potential remediators in the rice production area of Zambales, Philippines contaminated with mine tailing (Perfecto S. Ramos and Oliver S. Manangkil)	2022	Zambales, Philippines	Lead in agricultural soil: 50.00 mg/kg against the maximal permissible concentration of 55 mg/kg	Lead was found in the shoots of *C. asiatica (2.8 mg/kg)* s and root in boot *S. juncoides* (15.00 mg/kg) *and F. miliacea* (15.00 mg/kg) indicating the potential use of these species as bioremediators of lead Source: mine tailings

Lead Contaminated Products

In the past decade, the studies on products containing lead in the Philippines clearly showed that there is indeed potential sources of lead exposure through: aluminum cookware, medicines (herbal tea drinks/medicinal plants), cosmetics (lipsticks), toys, paints, other food items (street foods, raw vegetables, packaged snacks and powdered fruit juices, rice, fish, water from restaurants and distilled water), and non-food items (personal protective equipment, cigarettes, water bottles, and crayons and other school supplies). Extensive research on the presence and concentration of lead in various products available in the Philippines particularly in Metro Manila was done by Solidum and associates from 2010 to 2014 as shown in Table 5.

Paint has been one EcoWaste has tested paints available in the market in 2014, when dangerously high lead concentrations greater than 10,000 ppm were detected in 63 enamel decorative paints (45 % of the paints). A lemon yellow quick-dry enamel paint contained the highest total lead concentration of 153,000 ppm.[38] In 2017, 24 out of 104 analyzed solvent-based paints for home use (23 % of paints) were lead paints, i.e., they contained lead concentrations above 90 parts per million (ppm, dry weight of paint). Moreover, 12 paints (12 % of paints) contained dangerously high lead concentrations above 10,000 ppm. The highest lead concentration detected was 100,000 ppm in a yellow Tri-Safe Paint sold for home use.[39] From 2019 to 2020, EcoWaste's study showed 37 out of 87 (43 %) analyzed spray paints representing 19 brands were lead paints, i.e., they contained lead concentrations above 90 ppm, dry weight. In addition, 29 (33% of the paints) contained dangerously high lead concentrations above 10,000 ppm.[40] Leaded paint can also cause exposures through brightly colored walls, gates, doors, furniture and fixtures, as well as the presence of chipping paint. A 2014 report presented the results from an analysis of lead in dust from 21 locations in the Philippines - homes, day-care centers, and preparatory schools, where children spend much time and might be exposed to high levels of lead. Samples from two preparatory schools contained lead dust levels equal to or greater than 40 µg/ft2 and the highest level detected was 110 µg/ft2.[24]

Potential Sources Based on 2021-2022 Rapid Marketplace Survey and Home-based Assessments

Pure Earth conducted a survey on potential sources of lead exposure in consumer products in selected countries. In the Philippines, 17 markets, 144 vendors and 856 samples of spices, ceramics/pottery, cookware from recycled aluminum, cosmetics, sweets, toys, paints, other food and non-food items were covered in representative markets in Luzon, Visayas and Mindanao. Indicative results are as follows: 24% of metal cookware, 13% of ceramic foodware, 16% of household paints, and 33 % of cosmetic samples gathered were above the threshold levels for lead. Piloting of home-based assessments for lead exposures in 21 houses indicated similar results: presence of lead in metal cookware samples (100%), ceramic foodwares (50%), toys (28%) and paints (22%). Summary of results for the rapid marketplace survey is presented in Table 6 while for the partial summary of results home-based assessment is presented in Table 7. Based on the results of the rapid marketplace survey and the home-based assessments, of potential concern are the lead in aluminum cookwares and in ceramics mugs and plates. The lead concentration ranges for the aluminum cookware samples in the rapid marketplace survey was from 0 ppm to 1,470 ppm while in the home-based assessment was from 9 ppm to 2,805 ppm. As for the ceramics, its lead concentration ranges were 0 ppm to 1,252 ppm for rapid marketplace survey samples and 36 ppm to 6,515 ppm for home-based assessment samples. These are of concern since aluminum cookwares and ceramics mugs and plates are frequently used at home and are usually subjected to heat and for the case of cookwares to contain acidic food. The presence of heat and the acidic conditions in certain food preparations will make the lead in the cookware and ceramics more leachable so that they can possibly be incorporated in the food. Further study is recommended to determine allowable levels of lead in these products so as not to harm the consumers and at best, have alternatives that will make the cookwares and foodwares totally lead-free.

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Table 5: Summary of Previous Studies on Lead in Consumer Products

Product Containing Lead	Location of Study	Pb Concentration (ppm)	Potential BLL upon ingestion (µg/dL)	Source
Spices	N/A	N/A	N/A	N/A
Ceramics/Pottery	N/A	N/A	N/A	N/A
Aluminum cookware	Asian countries including Philippines	270 ppm to 860 ppm (using XRF)	Lead leached per 250ml serving - ND to 406 µg	Weidenhamer, J.D., et al. (2016)
Medicines				
Herbal Tea/Drink	Manila	ND to 0.157±0.2332 (medicinal herbs)	NC to 7.85 (at 50% absorption) NC to 4.71 (at 30% absorption)	Solidum (2014b)
Medicinal Plants	Manila	0.632±0.0015 to 0.873±0.0001	31.6 – 43.65 (50% absorption) 18.96 – 26.19 (30% absorption)	Solidum (2014b)
Cosmetics				
Lipsticks	Metro Manila	186 ppm to 45,400 ppm (using XRF)		EcoWaste Coalition (2021)
Sweets	N/A	N/A	N/A	N/A
Toys	Manila	26,900 ppm (highest; using XRF)		Ranada (2013)
Paints				
Solvent-based paints for home use	Philippines	19,000 to 100,000 ppm (top 10 readings)		EcoWaste/IPEN (2017)

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Product Containing Lead	Location of Study	Pb Concentration (ppm)	Potential BLL upon ingestion (µg/dL)	Source
Playground equipment	Philippines	ND – 663,000ppm		EcoWaste/IPEN (2019)
Spray paints		29,300 to 82,100 ppm (top 15 readings)		EcoWaste/IPEN (2020)
Other foods list				
Street Foods	Metro Manila	0.5667 to 0.7924	17.001 to 39.620	Solidum (2010)
Raw Vegetables	Metro Manila	0.0086 to 0.7498	0.43 to 37.49	Solidum (2011)
Shell Foods	Metro Manila	0.1699 to 0.4802	8.495 to 24.01	Solidum (2011)
Packaged Snacks	Manila	0.1289±0.0003 to 1.0653±0.0005	6.445 to 53.265	Solidum, (2012)
Powdered Fruit Juices	Manila	0.0759±0.0001 to 0.2075±0.0007	3.795 to 10.375	Solidum, (2012)
Junk Foods	Metro Manila	0.0093±0.0006 to 8.5398±0.5524		Solidum, Parel, Pascual, and Tiga (2013)
Canned Fruits (*Litchi chinensis, Prunus persica, Ananas comosus*)	Metro Manila	0.0839 – 0.1649 (solid fruit) 0.1316 – 0.5011 (syrup)		Solidum (2013a)
Rice	Metro Manila	All 10 varieties of rice tested contain lead but only Malagkit and National Food Authority (NFA) rice brands exceeded 0.5ppm.	BLLs of children (50% absorption) showed amounts greater than the safety limit of 10µg/dL with NFA having the highest BLL	Solidum (2014a)

Product Containing Lead	Location of Study	Pb Concentration (ppm)	Potential BLL upon ingestion (µg/dL)	Source
			estimated value followed by Malagkit (regular and violet) and Dinorado.	
Fish	Metro Manila Manila Bay Laguna de Bay	0.1299±0.0023 to 0.2195±0.0016 (head) 0.1252±0.0013 to 2.5029±0.0013 (meat) 0.1005±0.0023 to 0.1871±0.0015 (internal organs) 0.1242 (wet); 0.2223 (dry) (tilapia) 0.1986 (wet); 0.1384 (dry) (milkfish) 0.38 (dry) – 0.67 (wet)		Solidum, De Vera, Abdulla and Evangelista (2013); Solidum (2014a) Perelonia et al (2017) Tingson et al (2018)
Restaurant Drinking Water	Metro Manila	0.193	9.65	Solidum (2011)
Distilled Water	Manila	0.1919±0.0004 to 0.3180±0.0005	9.595 to 15.9	Solidum, (2012)
Other non-food items list				

Product Containing Lead	Location of Study	Pb Concentration (ppm)	Potential BLL upon ingestion (µg/dL)	Source
Face Masks	Manila	0.1644±0.0005 to 0.2498±0.0003 (mid part) 0.2696±0.0002 to 9.6784±0.0004 (edge part)	16.44 – 24.98 (inhalation 100%) 26.96 - 967.84 (inhalation 100%)	Solidum and Solidum (2014)
Surgical Gloves	Manila	0.5326±0.0006 to 10.4477±0.0003	53.26 – 1044.77 (dermal absorption)	Solidum and Solidum (2014)
Cigarettes	Manila	0.8672±0.0003 to 1.2003±0.0010	86.72 – 120.03 (inhalation) 17.344 – 36.009 (ingestion)	Solidum (2013b)
Water Bottles	Manila	1,319 to 93,380 (using XRF)		De Vera-Ruiz (2020)
Crayons and other school supplies	Ozamiz City, Misamis Occidental Manila	126 to 13,700 ppm		Hallare (2019) Castillo (2018)

Table 6: Summary of results of the rapid marketplace survey

Sample Category	Standard for Lead, ppm	Lead concentration Range, ppm	Mean Lead Concentration, ppm	Remarks
Metallic cookware / foodware	90*	0 – 1,470	210	High readings in locally made cookwares
Cosmetics	10 – 20**	0 – 1,252	53	Varied; one sample was with exceptionally high lead concentration of 42k ppm
Spices	10**	0 - 2	0.07	Saffron and others
Toys	90*	0 – 2,123	29	Varied
Paints	90*	0 – 41,800	3,351	Varied
Ceramic cookware / foodware	90*	0 – 1,159	106	Varied
Main starch	-	0 - 17	0.36	Varied
Other food	-	0 - 1	0.13	Varied
Other non-food items	-	3 - 2,050*	tbd	Kids' footwear

Note: *CCO for Lead; **US FDA

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Table 7: Summary (partial) of results for the home-based assessment

Select Sample Type	No. of Samples	Pb range, ppm	Remarks
Cookwares	14	9 - 2,805	Thick cookwares from local manufacturing relatively registered high lead content
Ceramics	8	36 - 6,515	Lead content in ceramic mugs were consistently high
Toys	25	ND – 1, 692	Except for 1,692 reading, other toys have below 90 ppm
Paints	2	302 – 3,555	
Dust	21	To follow	Some dust samples have lead readings, others none

Efforts to Mitigate Lead Contamination and Exposures

Government initiatives

Lead and lead compounds are considered hazardous in the Philippines under RA 6969 (Toxic Substances and Hazardous and Nuclear Wastes Act of 1990) and one of the six (6) hazardous substances included in the Chemical Control Orders (CCOs). CCOs are issued to regulate, limit, gradually phase out, or ban those chemical substances that are determined to pose unreasonable risks to public health and environment. Since its enactment, the DENR-EMB serves as the implementing agency of RA 6969 while other agencies including the DTI-Bureau of Product Standards (BPS), DA-Fertilizer and Pesticide Authority (FPA), DOH, DOST, Bureau of Customs (BOC), and the Philippine Coast Guard (PCG) are also mandated to enforce its specific requirements.

For manufactured products, the use of lead and lead compounds are strictly prohibited in the production/manufacturing of packaging for food and drink, fuel additives, water pipes, toys, school supplies, cosmetics, and paints (as pigment, a drying agent or for some intentional use) with more than 90 ppm threshold limit beyond three (3) years (2013-2016) for architectural decorative, household applications, and six (6) years (2013-2019) for industrial applications. The DENR-EMB also develops standards or threshold limits relative to existing uses of lead (DAO 2013-24). Moreover, DAO 2000-81 or the Implementing Rules and Regulations of RA 8749 (Philippine Clean Air Act of 1999) stipulates that the manufacture, importation and use of leaded gasoline is prohibited.

On the other hand, wastes with a total of >1mg Pb/L based on analysis on extract are considered as hazardous wastes (DAO 2013-22). Moreover, waste electrical and electronic equipment (WEEE) and lead-acid batteries are also classified as hazardous. As such, Pb-laden wastes must be managed according to DAO 92-29 (Implementing Rules and Regulations of RA 6969) and DAO 2013-22 (Revised Procedures and Standards on the Management of Hazardous Wastes). It should be properly identified and accounted for by the waste generator, transported, and treated/stored/disposed based on the HW transport requirements and procedures, and Manifest System.

Monitoring of lead in the environment is also done by water quality monitoring of freshwater, marine waters and groundwater. Discharges from any point source are also measured to meet the water quality criteria per water body qualification. As per DAO 2016-08 (Water Quality Guidelines and General Effluent Standards), lead concentrations of effluents must not exceed 0.02 mg/L for Class A, B and SB; 0.1 mg/L for Class C and SC; and 0.2 mg/L for Class D and SD waters. Moreover, no discharge of lead is allowed in Class AA and SA waters. Likewise, the National Ambient Air Quality Guidelines specifies that lead in ambient air should not exceed 1.5 μg/NCM for short-term averaging time of 3 months and 1.0 ug/NCM for long-term averaging time of 1 year. For point sources, emissions from any trade, industry or process should not exceed 10mg Pb/NCM based on the National Emission Standards for Source Specific Air Pollutants (NESSAP) while for industrial sources/operations, lead levels must not exceed 20 ug/NCM for 30 minutes averaging time using AAS while total lead should be below 0.5 mg/NCM for treatment facilities using non-burn technologies (DAO 2000-81 Implementing Rules and Regulations of RA 8749).

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Lead and lead compounds are also included in the scope of wastes considered as hazardous in the Basel Convention. The Philippines is a signatory to the Convention. It was ratified by the Philippine Senate in 1993 and entered into force in 1994. The Convention specifically aims to prevent the transfer of hazardous wastes in response to the public outcry on the discovery of deposits of toxic wastes imported to Africa and other parts of the developing world. It also aims to ensure Environmentally Sound Management (ESM) of hazardous materials from generation to disposal. RA 6969 stemmed from the Philippines' agreement to the Basel Convention. Hence, importation of recyclable materials including scrap metals (ULAB and metal bearing sludge), solid plastic materials, electronic assemblies and scraps, used oil and fly ash is allowed as long as follows the requirements and procedures of the Basel Convention (i.e. notification and consent between Parties; wastes to be imported must have a definite receiving facility with the essential environmental permits and clearances) (DAO 2013-22).

The standards for lead instituted in the Philippines is summarized in Table 8.

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Table 8: Summary of the standards for lead instituted in the Philippines

Item/Medium	Standard	Source/Reference	Monitoring Issues
Consumer Products			
Food	0.01 – 0.05 ppm	Philippine National Standard, Bureau of Agriculture and Fisheries Standards 194:2017	Enforcement, Local Consumption
Drinking Water	0.01 ppm	Philippine National Drinking Water Standards, 2017	Enforcement, Self Monitoring
Cosmetics	20 ppm	Department of Health, Bureau of Food and Drugs, Bureau Circular 2006-012	Customs, Informal Sector
Children's Articles (Toys, School Supplies), Paint, Packaging Materials, Fuel Additives, Pipes	90 ppm	DAO 2013-24: Chemical Control Order for Lead and Lead Compounds	Customs, Informal Sector, Spray Paints
Environment			
Water	0.01 – 0.1 mg/L	DAO-2016-08: Water Quality Guidelines and General Effluent Standards	Enforcement, Self Monitoring
Air	1 – 1.5 ug/NCM	National Ambient Air Quality Guideline Values (NAAQGV) based on the Clean Air Act	Enforcement, Self Monitoring
Soil	400 ppm play areas, 1200 non-play areas	EPA	Enforcement, No Soil Quality Law
Blood	3.5 – 5 ug/dL	US CDC/WHO	Typically underreported for companies; Mainly independent studies for communities

While the DENR EMB is mainly responsible for monitoring lead in water and wastewater, sediments and biota, ambient air, stationary source emission, and lead compounds, the Bureau of Product Standards of the Department of Trade and Industry (DTI BPS) implements mandatory product certification schemes for certain products divided into three groups: mechanical/building and construction, electrical and electronics, chemical and other consumer products systems. Among products of concern are lead acid batteries and water pipes. The DOH FDA also conducts monitoring and issues standards and advisories to ensure the safety, efficacy or quality of health products which include food, cosmetics, and household/urban hazardous substances, including pesticides and toys, or consumer products that may have an effect on health.

In the Philippines, the Department of Health (DOH) is mandated to be the overall technical authority on health. DOH chairs the Inter-Agency Committee on Environmental Health (IACEH) was institutionalized by Executive Order No. 489 Series of 1991 to better protect the health of the people from the growing health problems related to environmental degradation. The Inter-Agency is composed of the DOH Secretary as Chairman, DENR Secretary as the Vice-Chairman, and secretaries/director general of the following departments: DPWH, DILG, DA, DTI, DOTC, DOST, DOLE, NEDA, and PIA. It serves as a venue for technical collaboration, effective monitoring and communication, resource mobilization, policy review and development on matters related to the effects of the environment on population health. Collaborative policies and actions within the IACEH are tackled under the five multi-sectoral task forces on water, solid waste, air, toxic and chemical substances and occupational health to ensure that environmental and occupational hazards and risks are mitigated; and that diseases, disabilities and deaths from environmental factors are prevented (NEHAP, 2010 as cited by Dayrit et al, 2018)

It is worth noting that FNRI is continuing the BLL screening in the 2023 – 2024 ENNS, which has the potential to finally set the country's national baseline BLL for children ages 6 through 9. Furthermore, addressing lead exposures has been prioritized as expressed in at least 10 of the strategic actionable items in the latest NEHAP 2023 – 2030.

While there is no current program specific to lead yet, DOH Department Order No. 2021-0001 "Establishment of Specialty Centers for Toxicology" aimed to provide toxicology services including the management of heavy metals poisoning among individuals in the 13 DOH Poison Control Centers. Also, opportunities for addressing lead exposures may be potentially integrated in the Omnibus Guidelines for Child, Adolescent and Reproductive Age, Adult and Elderly which will identify the health services mainly provided by the government. Such guidelines are categorized according to prevention, control and support of high-burden diseases and with public health importance. Under the Universal Health Care (UHC), the delivery of healthcare services is inclusive as it is anchored on a life-stage approach; thus, includes children and women as well.

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Civil Society initiatives

Bantay Baterya Project and Balik Baterya Project

Bantay Baterya of ABS-CBN Foundation (now ABS-CBN Lingkod Kapamilya Foundation Inc. or ALKFI) and Balik Baterya of Philippine Business for Social Progress (PBSP) collect ULABs for recycling into raw materials for the production of new batteries, consequently helping remove pollutants which can harm our lives and the environment".

EcoWaste Coalition

EcoWaste Coalition is a public interest and advocacy network of more than 150 community, church, school, environmental and health groups. We envision a Zero Waste society in the Philippines by 2020 by pursuing sustainable solutions to waste, climate change and chemical issues facing the Philippines and the world. EcoWaste Coalition organizes and supports various citizens' efforts addressing waste, climate and chemical safety issues through: research and evidence building approach; information dissemination; skill shares and workshops; policy development and advocacy; and demonstration projects of ecological alternatives and strategic campaigns and alliances, locally and internationally. The coalition has actively monitored products containing lead and advocated for lead-free art supplies, ceramics, cosmetics, furniture, playgrounds, schools, toys, and utensils among others. Their campaign against lead in paint with IPEN has been instrumental for the country's policy on eliminating lead-based paints.

Trash to Cash Programs

The National Solid Waste Management Commission (NSWMC) has partnered with SM malls and Ayala malls for the collection and recycling of wastes. This monthly waste trade program held in malls nationwide encourages customers to segregate recyclable wastes and trade these wastes for a fee or in exchange for a usable item. Ayala malls advertises this program as "Sell Your Trash for Cash", wherein ULABs as well as e-wastes are accepted. On the other hand, SM Malls "Trash to Cash" program, which is an open-to-all recycling market, is held every first Friday and Saturday of the month in all SM Supermalls. Recyclable wastes accepted include unused paper and cardboard, empty ink toner cartridges, plastic bottles and scraps, used lead batteries from cars, aluminum, tin cans and other discarded items. Recyclables fairs are also organized by the United Recyclers Organization of the Philippines (UROP). UROP is a duly organized organization of recyclers and consolidators of traditional and non-traditional wastes. Their "Cash for Scrap" program is more targeted towards the household sector and on the collection of solid and special wastes same as with SM and Ayala malls.

International Lead Poisoning Prevention Week (ILPPW)

The ILPPW aims to raise awareness and promote actions to address the human health effects of lead exposure particularly from lead paint, especially for children. It was initiated by the Global Alliance to Eliminate Lead Paint (or the Lead Paint Alliance), which was established in 2011 under the joint leadership of the United Nations Environment Program (UNEP) and the World Health Organization (WHO). The Lead

Paint Alliance's primary goal is to promote the global phase-out of lead paint through the establishment of appropriate legally binding measures to stop the manufacture, import, export, distribution, sale and use of lead paints in every country. During the ILPPW, various sectors including the government, civil society organizations, health partners among others organize campaign activities in line with the goal of the Alliance. The elimination of lead paint is envisioned to contribute to the achievement of Sustainable Development Goals (SDGs) particularly (1) to substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination (Goal 3.9), and (2) achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water, and soil in order to minimize their adverse impacts on human health and the environment (Goal 12.4) (https://www.who.int/campaigns/international-lead-poisoning-prevention-week/2020/about).

IPEN Programs

The International Pollutants Elimination Network (or IPEN) is a non-profit organization registered in Sweden that advocates a "toxics free" environment through their global network of public interest organizations improving chemical policies and raising public awareness to ensure that hazardous substances are no longer produced, used, or disposed of in ways that harm human health and the environment. The Asian Lead Elimination Project (part of the Global Lead Paint Elimination Campaign) was established by IPEN to eliminate lead paint in Asia and raise widespread awareness among business entrepreneurs and consumers about the adverse human health impacts of lead-based decorative paints, particularly on the health of children under six years old. The project includes (1) periodic testing of lead in paints; (2) information and technical support to small and medium paint manufacturer, dealers, and retailers to help them to shift from lead-based to no-added lead paints; (3) third party certification and labeling that includes information on lead; (4) help to government institutions to enact a lead paint standard; and (5) awareness raising programs about lead paint and its impact, especially on children's health and the environment.

Pure Earth

In the case of Pure Earth, projects and programs in the past, awareness raising and capacity-building activities, along with the initial site assessments and exposure risk mitigation efforts in lead contaminated sites, have been conducted in order to solve pollution at source and/or cut the pathway of pollution to the population in the interim. Site assessment and monitoring (soil, water, fish, blood lead levels) results have been presented to government; lectures have been conducted in communities (residents mostly mothers, children and workers at ULAB recycling facilities) on the sources and impacts of lead and how they can protect themselves from further exposures; trainings have been conducted for government on how to conduct initial site assessments, benchmarking of ULAB recycling facilities and getting BLLs; and technical assistance on business operators regarding the pollution hotpots in their processes and how these could be addressed by alternatives among others. The most recent efforts have been the pilot inclusion of BLL in a national survey, the rapid market screening of consumer products, conduct of home-based assessments, and the following advocacies: establishment of a lead action group, development of national guidelines for lead exposures, and piloting of active and passive lead surveillance systems at the national and local levels respectively.

An Appeal to Address Childhood Lead Poisoning in the Philippines

Children are the future of any nation. Children also have enshrined rights. Yet children are also the most vulnerable in the midst of threats posed by lead poisoning especially in low and middle income countries like the Philippines. In this time of post-pandemic, these vulnerabilities are even more exposed. Overall health, education and economics have been on a downhill. It is strategic to invest in the welfare of the children in the country to survive and thrive not just now but in the future.

Health

Looking at the risks posed by lead and the vulnerability of children and the unborn babies, it is a must to look into the overall status of children which include health and nutrition, education, and their access to public health and water, sanitation and hygiene among others. It is important to look at this vulnerable sector because they would help define the future of a country's workforce. The Philippines is the twelfth most populated country in the world. An archipelago of 7,107 islands, it has 100.98 million people and is characterized by, among others, high numbers of children with almost 40% of the population was under 18 (almost 40 million) based on 2010 census.[41] The Philippines has very high levels of stunting (33 %) and underweight (21.5 %) among children under 5 years (2015), which have actually increased in recent years – marking a worrying reversal of overall downward trends in past decades. Childhood anemia prevalence remains very high at 39.4 % in 2013. In the 2014/2015 school year, average student scores on National Achievement Tests were 69 % (primary) and 49 % (secondary). Rates continue to improve however, with 90.3 % of people aged 10-64 years functionally literate (2013).[42] However, 2018 Programme for International Student Assessment (PISA) results revealed that the Philippines scored 353 in Mathematics, 357 in Science, and 340 in Reading, all below the average of participating Organization for Economic Co-operation and Development (OECD) countries. This is a reality that the Department of Education enjoined all sectors to urgently contribute and help address.[43]

Although the WHO guideline (2021) has recommended some interventions at blood lead levels of > 5 ug/dL, it would still be prudent that the Philippine government takes the appropriate action even for BLLs that are even below the CDC action level (3.5 ug/dL). This is because of the non-threshold nature of lead's effect on human health. The government should adapt strategies to identify potential exposures and implement appropriate plans to reduce and prevent these exposures.

The first critical and necessary step is the development and implementation of the Lead Monitoring and Surveillance System in the Philippines. This would deliver the national baseline data on the BLL in Filipino children that would therefore inform the next steps as to the identification of sources of exposure and development of strategic interventions in those areas geographically and in terms of concerned industries.

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To this end, the following health interventions are recommended:

1. Update and adopt the national health guidelines for lead exposure among vulnerable populations, particularly children and pregnant women
2. Establish a lead poisoning prevention and surveillance program that will include:
    2.1 Regular national blood lead screening among children of different age groups, and pregnant women as part of maternal and child health services to identify those at risk to lead poisoning, and to institute appropriate and timely interventions; to include in the blood lead screening, levels of serum Vitamins C and D, iron and calcium be determined so as to provide guidance on further interventions that will prevent lead absorption by the human body.
    2.2 Create and adopt clinical diagnostic tools (such as environmental exposure history, clinical manifestations) for early detection of lead exposure and poisoning
    2.3 Build capacity to monitor exposure of children and pregnant women to lead by assessing the current government and private sector capacity to monitor, test and treat lead poisoning and providing the trainings, manpower, equipment and resources to operationalize such.
    2.4 Determine the data set, the frequency and the manner by which it will be gathered. The tool to be developed maybe three-pronged: identifying population at risks, enabling early detection and subsequent case management, and identifying potential sources of exposure.
    2.5 Establish an integrated data system drawing on BLL surveillance, industrial and agricultural activity and sources, open burning of waste, management and incineration of hazardous waste, consumer products, and other relevant ministerial data, consisting of a SQL-Server back-end linking data by geographic and demographic characteristics, and a front-end enabling data exploration, mapping, and reporting to data interpretation and decision making.
    2.6 Develop and disseminate awareness campaigns on current issues related to lead exposure and poisoning to relevant stakeholders such as policy makers, industry, educational institutions, health sector and the general public
3. Build up an effective feedback and referral system for the clinical management of lead exposure and poisoning

Environment

As documented by previous studies, there are lead contaminated sites in the country that directly put at risk their surrounding communities. There is also a national inventory of lead-handling businesses and establishments that need to be assessed for environmentally sound management of lead. These are starting points for a more thorough system of environmental monitoring and surveillance. The recent national nutrition survey of FNRI and rapid marketplace survey and home-based assessments of Pure Earth also showed potential sources of lead exposures among children and pregnant women. As such, the following environmental interventions are recommended:

6. Review, finalize and institutionalize the national action plan (NAP) on the environmentally sound management of used lead acid batteries (ULABs) in the Philippines (please see attached).
7. Design and implement an environmental health monitoring program on lead following the exposure pathway model. The program will identify and assess major sources contributing to lead exposure in households and communities. The program will aim to establish the environmental exposures to health status of vulnerable populations, especially children and pregnant women, as evidenced by their blood lead levels.
8. Develop and implement strategies in the prevention of lead exposure among vulnerable populations, especially children and pregnant women
9. Establish a directory of experts in the industries of concern for developing benchmarking assessment tools and interventions in order to eliminate and find alternatives to specific lead contamination/pollution-causing segments of the industrial processes.
10. Regularly publish advisories on the results of the environmental monitoring with recommended action to continually raise awareness and thus, equip the public with information to employ exposure mitigation measures

*Conduct a pilot implementation of both the health and environmental monitoring and surveillance system in order to further improve the system before full implementation, a phased approach based on risk and/or vulnerability (per area or region) might be cost-effective and strategic than a full deployment at the same time.

Economics

The economic benefits of reducing childhood lead exposure in the USA alone is estimated between $110 billion and $319 billion annually.[44] Decreases in blood lead levels have been linked to significant reductions in crime rates.[3,4,5] Soil remediation is cost-effective and provides excellent return on investment.[45] Lead contamination is solvable. In terms of commercial interventions, the following are hereby recommended:

Regulation of consumer items production, commercialization and waste management specifically cookware, paints, toys, cosmetics, and ceramics as well as the battery industries, specifically

5. Develop standards for cookware, ceramics and other cooking and eating utensils.
6. Tap industrial associations in agreeing to uphold established standards and protocols in ensuring lead/toxin-free inputs, processes and outputs/products.
7. In the case of batteries, refer to detailed recommendations in the draft NAP.
8. Given that locally manufactured products should be under the environmental monitoring mentioned above, the same monitoring should be applied to imported products before release in local markets.

Finally, the above prevention strategies best position the country to ensure the Filipino children's potential. It clearly complements and supports the attainment not only of national goals but even the sustainable development goals of: 1. No poverty; 3. good health and well-being; 4. quality education; 8. decent work and economic growth; 11. sustainable cities and communities; 13. climate action; and 17. partnership and goals among others.

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