INDONESIA

A. Regulations on Lead

Sources of lead	Relevant legislation/regulation	Government Agencies	Data source
1. Used lead-acid battery recycling	1. Tuti Hendrawati Mintarsih, director general of hazardous waste in Indonesia's Ministry of Environment and Forestry, acknowledges the problem but says authorities can't close illegal smelters because too many people would lose jobs and the operators would move to new, hidden locations. 2. Prohibition of all hazardous waste imports, except for used lead car-battery, started in September 2002	a) Ministry of Environment and Forestry b) Joint Committee for Leaded Gasoline Phase-out (KPBB)	1. National Geographic, 2016. "The Toxic Toll of Indonesia's Battery Recyclers" 2. Haryanto B. Lead exposure from battery recycling in Indonesia. Rev Environ Health. 2016 Mar;31(1):13-6.
2. Standards for lead in food	1. Maximum standard set by the government in PP RI No. 41/1999, which is 2.0 µg/Nm3 2. Concentration often exceeds maximum standard level (0.008 µg/mL)	a) United States Food and Drug Administration b) Environmental Impact Management Agency of North Sumatra c) Environmental Ministry	1. Efanny, M. et al. 2019. Dietary exposure assessment and risk characterization of lead based onlead contaminant research (online) in Indonesia and Indonesian Individual Food Consumption Survey (IFCS). Conf. Ser.: Earth Environ. Sci. 278
3. Standards for lead in cookware	No regulations or legislations regarding cookware have been put into place in Indonesia.	a) Ministry of Health b) Ministry of Environment	N/A
4. Standards for occupational exposure	1. Many rural and urban informal sector workers suffer malnutrition and parasitic	a) Ministry of Mines and Energy	International Labour Organisation (2004). Occupational Safety and Health in Indonesia

	diseases. Specific diagnoses by medical doctors include: high lead levels in the blood among the battery workers, decreased lung function among wood cottage industry workers, dermatitis among soybean workers, pterigium among fishermen, and eardrum damage among the pearl divers. 2. The Primary Health Care (PHC) approach aims to increase: a. (i) availability of occupational health services; b. (ii) implementation of occupational health programmes and directing them towards the community c. participation; (iii) better collaboration between the health agencies and the working community; and d. (iv) inter-governmental coordination.	b) Ministry of Health c) International Labour Organisation	
5. Lead in paint	1. Indonesia has limited policies and regulations restricting the production	a) Ministry of Health b) SAICM	1) IISD, 2020. SAICM/GEF Project Aims to Help Indonesia Develop National Standard to Regulate Lead Paint

	and use of lead-based paints, although the government has enacted a voluntary national standard addressing soluble lead content in decorative paint for various uses. 2. SAICM/GEF Project Aims to Help Indonesia Develop National Standard to Regulate Lead Paint 3. Indonesia will establish a standard of no more than 90 ppm of lead in all types of paints, including decorative, architectural, and industrial paints.	c) National Government d) International Financial Institution	
6. Waste generated from mining and smelting	1. Indonesia will no longer permit mining waste to be disposed in the ocean to allay concerns about the environmental impact of processing nickel used in electric vehicle (EV) batteries	a) Ministry of Environment b) Maritime and Investment Affairs Coordinating Minister	Nangoy, F. and Ungku, F. 2021. Facing green pressure, Indonesia halts deep-sea mining disposal. *Reuters*, accessed 26th April 2021.

B. International Agreements

Agreement	Year Ratified
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	1993
Stockholm Convention on Persistent Organic Pollutants	2009
Minamata Convention on Mercury	2013
Rotterdam Convention	2013

C. Blood lead-level monitoring programs

No government-led implementation of a blood lead-level monitoring program, however small sample sizes have been investigated over time.

Details	Data Source
Danish Aid Agency DANIDA funded phase one Pure Earth's project, which includes an environmental and health assessment of the village, and the design of remediation options along with cost estimates. (More about potential solutions in Part 2.) 60% of adults have blood lead levels over 25 and lead levels in soil have been measured at over 54,000 ppm in some spots.	Sim, M. 2016. Breaking the Cycle of Extreme Lead Poisoning in Pesarean, Indonesia. *Pure Earth.* Accessed here.
To assess the blood lead levels (BLLs) and potential health impacts among the population surrounding used lead acid batteries (ULABs) recycling smelters, a research group evaluated health effects reported from year 2003 to 2013, conducted focus group discussions with metals smelter owner/workers and a group of 35 female partners of smelter owners or workers not actively engaged in smelter work, and retook and measured BLLs .	Haryanto, Budi. 2016. Lead exposure from battery recycling in Indonesia. *Reviews on Environmental Health*. 31(1).
A 2011 Mer-C study found that 88 per cent of 400 adults tested had blood lead levels about of 10 µg/dL and 16 per cent had blood lead levels at or greater than 45 µg/dL,87 the level at which the US Centers for Disease Control recommend urgent medical intervention with chelation therapy. A 2013 study of women of child-bearing age found an average blood lead level of 28 µg/dL among the women, with a maximum BLL of 45.8 µg/dL	UNICEF. 2020. The Toxic Truth: Children's Exposure to Lead Pollution Undermines a Generation of Future Potential.

D. Inventory of Toxic Sites (all data from https://www.contaminatedsites.org/)

Site	Province/Region	Details
Dusun Kalapan, Hargorejo, Kokap	Yogyakarta	Gold and other mining activities have contaminated this community with lead and other metals.
Gunung Rega, Hargorejo	Yogyakarta	Abandoned mining (included artisanal gold) has contaminated the area with metals including lead.
Papak, Kalirejo	Yogyakarta	There is an artisanal gold mining that does not have a good tailing processing. The discharge goes to the river and this water is used for washing and bathing.
Sangon 2, Kalirejo (Muhlasin)	Yogyakarta	Ore processing has contaminated this community with a variety of metals including lead.
Dusun Gunung Sari, Prambanan	Yogyakarta	This location was used by PT GE Lighting for 10 years to discharge unused lamps. It is now a manual recycling plant for commercial copper with no safety standards, and is contaminating the soil with lead.
Jenes River, Solo	Jawa Tengah	The Jenes River has been polluted by several upstream industries, include textile, printing, and pharmaceutical units. Lead is the key pollutant, and high levels of cadmium have also been detected.
Lead Smelter PT Muktomas, Jababeka	Jawa Barat	An active Used Lead Acid Battery recycling facility/sec smelter is contaminating the local village with lead (in soil).
Bekasi - Citarum River	Citarum River	The Citarum River is considered by some to be the most polluted river in the world. Industrial and household waste is dumped directly into the river, which is the main water supply for many cities and towns.
Lead Smelter Haji Udin, Kelapa Gading	Jakarta Raya	Secondary lead smelting of auto batteries has contaminated this community with lead in soil.

		Revisit on 10/30/2014 Investigator: Nickolaus Hariojati. The smelter is fully protected with high wall and security officers
PT. Trimitra Baterai Prakasa	Jawa Barat	Lead-acid battery recycling has polluted the area soils with lead.
Lead Smelter Ben Cao, Tangerang	Jawa Barat	This lead smelter is contaminating local soil and water with lead.
Lead Smelter Kel Dadap, Kec Kosambi, Tangerang	Jawa Barat	An active Used Lead Acid Battery recycling facility/sec smelter is contaminating the local village with lead (in soil).
Lead Smelter Warto-Tongsin, Tangerang	Jawa Barat	Two adjacent closed lead smelters now operate as a jeans factory. Soil in the area is contaminated with lead. from the last visit on 09/10/2014 the smelting activity is now inactive for since 2 months ago because of the lack of ULAB supply to this area
Lead Smelter Tongsin, Lebakwangi	Jawa Barat	Secondary lead smelter emissions have contaminated this area. Revisit on 09/18/2014 Investigator:
Lead Smelter Ocoy, Tangerang	Jawa Barat	An active Used Lead Acid Battery recycling facility/sec smelter is contaminating the local village with lead (in soil).
Lead Smelter Haji Narawi, Tangerang	Jawa Barat	Active secondary lead smelter and ULAB facility has contaminated this local village.
Lead Smelter Imis, Tangerang	Jawa Barat	Informal used acid battery recycling / secondary lead smelting has contaminated this community.
Lead Smelter PT Non Ferindo Utama, Tangerang	Jawa Barat	Secondary lead smelting of auto batteries has contaminated this community with lead in soil which can lead to human exposure via inhalation/ingestion of lead dust.
PT. Yuasa Battery	Jawa Barat	This ULAB recycling facility is contaminating local soil and water with lead.
Cinangneng, Bogor	Jawa Barat	A former lead smelter was converted to a private home, farm land and fish ponds after it ceased operations. Main pathways are consumption of

		food crops grown on contaminated soil and inhalation of lead dust.
Cinangka	Jawa Barat	Numerous local secondary lead smelters and ULAB facilities have contaminated the town with high levels of lead.

E. Scientific papers on lead exposure

(Please contact **info@gahp.net** for information on studies not in the public domain)

Topic	Authors	Year	Title	Abstract/Description
Childhood Exposure	Prihartono, N. A., Djuwita, R., Mahmud, P. B.	2019	Prevalence of Blood Lead among Children living in Battery Recycling Communities in Greater Jakarta, Indonesia	This study aimed to assess the prevalence of blood lead levels (BLLs) among children 1 to 5 years old who reside near and distant to informally used lead-acid battery (ULAB) recycling locations and examine risk factors for elevated BLLs. A cross-sectional study was conducted in three greater Jakarta neighborhoods where informal ULAB recycling occurs. Venous BLLs among 279 children were analyzed using portable blood lead testing machines. Demographic, child activities, and sources of lead exposure inside and outside homes were assessed. Multivariate analysis was performed to evaluate factors associated with the prevalence of BLLs. Forty-seven percent of children had BLLs ≥ 5 µg/dL and 9% had BLLs ≥ 10 µg/dL. No differences in geometric mean BLLs were observed between children who lived near and distant to ULAB locations. Older child age groups [Prevalence Ratio (PR) 2.14, 95% Confidence Interval (CI) 1.16, 4.18) and low household income (PR 1.58, 95% CI 1.03, 2.40) were associated with BLLs 5–9 µg/dL. Low educational attainment of the child's father (PR 3.17, 95% CI 1.23, 8.16) and frequent outdoor child activity (PR 4.93, 95% CI 1.09, 22.21) were predictors of BLLs ≥ 10 µg/dL. This study shows the association between lead exposure among children and environmental sources. Public health officials can consider expanded surveillance, health care

				provider education, and development of strategies to reduce lead exposure.
Childhood Exposure	Caravanos, Jack and Kevin, Chatham-Stephens	2013	The burden of disease from paediatric lead exposure at hazardous waste sites in 7 Asian countries	**Background:** Identification and systematic assessment of hazardous wastes sites in low and middle-income countries has lagged. Hazardous waste problems are especially severe in lower income Asian countries where environmental regulations are non-existent, nonspecific or poorly enforced. In these countries extensive unregulated industrial development has created waste sites in densely populated urban areas. These sites appear to pose significant risks to public health, and especially to the health of children. **Methods:** To assess potential health risks from chemical contamination at hazardous waste sites in Asia, we assessed 679 sites. A total of 169 sites in 7 countries were classified as contaminated by lead. Eighty-two of these sites contained lead at levels high enough to produce elevated blood lead levels in surrounding populations. **Discussion:** We found that 189,725 children in the 7 countries are at risk of diminished intelligence because of exposure to elevated levels of lead in water and soil at hazardous waste sites. Depending on choice of model, these decrements ranged from 4.94 to 14.96 IQ points. Given the restricted scope of this survey and the conservative estimation procedures employed, this number is almost certainly an underestimate of the full burden of diseases. **Conclusion:** Exposure to toxic chemicals from hazardous waste sites is an important and heretofore insufficiently examined contributor to the Global Burden of Disease.

Childhood Exposure	Iriani, Dewi U.; Matsukawa, Takehisa; Tadjudin, Muhammad K.; Itoh, Hiroaki; Yokoyama, Kazuhito.	2012	Cross-sectional Study on the Effects of Socioeconomic Factors on Lead Exposure in Children by Gender in Serpong, Indonesia	To elucidate the socioeconomic factors influencing lead exposure in elementary school children by gender, 108 children (56 male, 52 female), aged 6–7 years, were randomly selected from 39 elementary state schools in Serpong, Banten, Indonesia. Their parents were interviewed to obtain information on sociodemographic characteristics. Their blood lead (BPb) levels were measured by atomic absorption spectrophotometry. BPb concentrations were significantly higher in males than in females, *i.e.*, 6.8 ± 2.0 (2.9–12.5) µg/dL and 5.9 ± 1.9 (3.1–11.7) µg/dL, respectively ($p <$ 0.05). Lower socioeconomic status and well water use were associated with increased BPb concentrations, especially in females. The proportion of well water use was related to lower socioeconomic status. Lower socioeconomic status linked with well water drinking seemed to be associated with increased lead exposure in children in Serpong. Their exposure levels possibly varied according to gender differences in behavior. An intervention should be instituted among children in Serpong with BPb concentrations of 10 µg/dL or above.
Childhood Exposure/ Environmental Exposure	Mallongi, A., La Anel, R., Birawidal, B.	2017	Spatial Lead Pollution in Aquatic Habitats and The Potential Risks in Makassar Coastal Area of South Sulawesi, Indonesia	**Background:** Lead can be a poison to the environment which may affects all body systems. Lead can also affect human health especially children, lead potentially lowering level of intelligence, growth, loss, causing anemia, and disorder among children as lead is neurotoxin and accumulative. In addition lead can cause a decrease in the ability of the brain, whereas in adults may cause interference of high blood pressure and other tissue toxicity. Any increase in the levels of lead in the blood of 10 ug / dl led to a

				decrease in IQ of 2.5 points or 0.975 IQ. The research aims to produce a special model of health risk among elementary school children due to lead exposure in the coastal city of Makassar. **Methods:** This study investigate the distribution of toxic lead in Makassar coastal area namely; sea water, sediments, shells and crab. Then investigate lead toxins around the school such as lead in soil, dust, paint, snacks and air. After create distribution maps lead risks we create analysis of environmental health risks for children. **Results:** Result revealed that the analysis of spatial distribution of Lead in the sediment shows that the high distribution was in station 3 in Mariso districts then coastal Tallo area and the lowest was in Tamalate District. While the analysis of the spatial Pb distribution in mussels seen that the highest distribution Pb was in station 4 of districts Mariso then coastal waters Tallo area and the lowest was in Tamalate District 5.00 to 7.20 mg / g. **Conclusion:** In conclusion, it revealed the concentration of Lead at all stations of those four districts have exceeded the level of allowed standard and may potentially lead to a hazard both to environment and human being who are living in the surround area.
Food Exposure	Efanny, M., Andarwulan, N. and Yuliana D.	2019	Dietary exposure assessment and risk characterization of lead based on lead contaminant research (online) in Indonesia and Indonesian Individual Food Consumption Survey (IFCS)	An exposure assessment was performed to estimate the potential of lead dietary intake in the Indonesian population. Dietary exposure assessment requires information on lead concentration in food and food consumption data. The data of lead concentration in food was a secondary data obtained through online research from several online scientific resources with

				keywords "lead in food, lead contamination". Food consumption data were obtained from Indonesian Individual Food Consumption Survey. Lead dietary intakes were estimated with a deterministic approaches that used lead concentration in food and maximum level (ML) of lead in food based on Indonesia Nation Agency of Drug and Food Control (INA-DFC) regulation with the average value of food consumption. Risk characterization was conducted by comparing dietary intakes with a Provisional Tolerable Weekly Intake (PTWI). The results have shown that the infant group (0-59 months) had highest lead dietary intakes. Lead dietary intakes of mean concentration of lead from references are lower than lead dietary intake of INA-DFC ML of lead in all age groups. Risk characterization results showed that lead dietary intake of average level data and ML are at high risk (>100% PTWI) in all age groups. Major contributors to lead dietary intakes are fish and seafood.
Environmental Exposure	Mathee, A.	2020	Recycled aluminium cooking pots: a growing public health concern in poorly resourced countries	**Background:** Lead exposure remains a significant public health problem, particularly in the informal sector. Recycling of scrap metal into artisanal pots is a growing concern in poorly resourced countries. Owing to the relatively light weight and low cost of the artisanal pots, as well as good conductivity which equates to lower usage of wood fuel, the pots are widely used. The aim of this article is to describe current insights and emerging evidence of health risks associated with artisanal pot making and usage. This thriving industry, particularly in poorly resourced communities, has multifaceted occupational, environmental and human health

				impacts. Given the complexity, innovative solutions need to be prioritized, evaluated and scaled up in relevant settings. **Discussion:** Addressing sources of lead exposure from the manufacturing and use of artisanal aluminium cookware is likely to be highly complex because of the relatively low cost of the cookware and lower usage of wood fuel, ease of use and the role of artisanal pots in the generation of household livelihoods. However, given the widespread and frequent use of artisanal pots in affected countries, likely constituting a chronic source of lead exposure to large numbers of people, and the concomitant impacts on public health, it is imperative that innovative solutions be prioritized, evaluated and scaled up as appropriate. With regard to research priorities, it is important to gain a deeper understanding of the extent of artisanal pot production in resource-poor countries, concomitant exposure to toxic metals amongst pot makers, their household members and consumers (including pregnant women and young children), the local environmental consequences of pot making and the costs and benefits of a range of protective interventions.
Environmental Exposure	Krisnawaty, Endang; Hermawati, Ema; Hartono, Budi	2020	Lead Exposure in Community Well Water of Open Dumping Solid Waste Cipayung, Indonesia.	**Background:** Lead is a heavy metal toxic can causes environmental contamination and health problems. It is accumulative and can affect to several body systems. Lead can be sourced from nature and human activities. It is can remain attached to soil particles or sediments in water for a years. The movement of lead from soil particles into groundwater may occur if it is exposed to acid rain. One source of lead exposure is the activity at solid waste treatment (TPA: Tempat Pemrosesan

				Akhir Sampah), which is to be sourced from waste processing leachates which still use the open dumping system. Leachate can infiltrate into shallow groundwater (well) consumed by nearby residents and potentially pollute the shallow groundwater. **Material and Method:** This research aims to calculate the risk (RQ and ECR) of lead exposure in well water consumed by residents living around to Cipayung landfill, uses the EHRA (Environmental Health Risk Assessment) method with a cross-sectional study design. The Respondents was 104 people with a total environmental sample of 49 wells. **Findings:** The results of risk quotient (RQ) on 104 respondents is RQ real time ≤ 1, RQ lifespan for 40 years indicates RQ>1 and ECR (Excess Cancer Risk) value for 50 years show smaller than 10-4. **Conclusion:** Well water nearby the Cipayung landfill is still safe from lead exposure for the risk of noncarcinogenic health problems. However, in the 40 years later there will be risks if the population continues to consume the well water nearby the Cipayung landfill. While the carcinogenic risk for the 50 years later is still within safe limits.
Environmental Exposure	Haryanto, B.	2016	Lead exposure from battery recycling in Indonesia	In Indonesia, more than 200 illegal used lead acid battery (ULAB) smelters are currently operating. Only a few health studies support the finding of lead-related symptoms and diseases among populations living near the smelters. To assess the blood lead levels (BLLs) and potential health impacts among the population surrounding ULAB recycling smelters, we evaluated health effects reported from 2003 to 2013, conducted focus

				group discussions with lead smelter owner/workers and a group of 35 female partners of smelter owners or workers not actively engaged in smelter work, and retook and measured BLLs. It was found that many children in the areas were having difficulty achieving high grades at school and having stunting or other problems with physical development. The average mean of BLLs increased by almost double in 2015, compared with in 2011. The risk of having hypertension, interference in the ability to make red blood cells in females occurred among 24% of respondents; Elevated blood pressure, hearing loss, and interference in the ability to make red bloods cell occurred in 20% of males; Kidney damage, infertility in male, nerve problems, including decreased sensation and decreased ability to move quickly occurred in 13%; Decreased ability to make red blood cells (20%), and; Frank anemia, decreased life-span, coma/seizures were experienced by 22%. The populations living in areas surrounding ULAB smelters are experiencing severe chronic health problems. It is recommended that the smelters must be moved and placed far away from the municipality.
Occupational Exposure	Oginawati, K., Sidhi, R., Susetyo, S. H.	2020	Lead Exposure in Trader Communities in Industrial Area of the Battery Recycling Plant: Tangerang, Indonesia	The aim of this study was to look at the risk of community around the battery recycling plant in terms of the exposure to lead dust. The number of respondents amounted to 60 people from an industrial area and a residential area. The sample of the industrial area included 30 respondents with a composition of 15 men and 15 women. The same number of respondents was also examined in the residential area as a control area, located 5 km from the industrial area. Respirable dust was

				measured using a personal dust sampler, the concentration of lead in dust was measured using GF-AAS, while as a biomarker of exposure, the lead content in urine was measured using GF-AAS. The average values for respirable lead in industrial and residential areas are 0.92 µg/m^3 and 0.92–1.34 µg/m^3. The analysis of the lead content in urine for the industrial and residential areas produced an average value of 119 ppb and 123 ppb. The average value of HI for the lead exposure on the industrial and residential areas are in danger (HI > 1) which is 3.6 ± 1.94 and 2.18 ± 1.49. The OR values for the respondents in the industrial area compared to the residential areas amounting to 1.17 for the category of HI lead exposure and 1.22 for the category of lead in urine.
Occupational Exposure			Relationships between Lead Contaminated Seafood Consumption and Blood Pressure among Fisherman Communities at the Makassar Coastal Areas, Indonesia	**Background:** Lead contaminated coastal areas have been widely studied in many cities both in high-income countries and in some developing countries. However, the related health disturbance outcomes due to the lead seafood consumption have not been well documented particularly in low- and middle-income countries such as in Indonesia particularly in Makassar city where no data available. This research aimed to investigate the relationships between lead seafood consumption, blood lead level (BLL), and blood pressure (BP) and the hypertension in the community-based study site of coastal areas Makassar city, Indonesia. **Method**: The number of respondents within this study was 35 adults male that randomly selected, and voluntary base. All respondents sign an inform consent without any force before involved in the research. Information of education, family income, lifestyle, occupational, dietary, smoking habit was

				gathered by administered household questionnaire interview. Then, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured as well as the BLL were measured by inductively coupled plasma mass spectrometry technique. In order to assess the relationships between BLL with SBP and DBP, with the hypertension possibility, multiple linier and logistic regressions were applied. **Results**: Pb levels in blood averaging of 27.6 µgr/dL with standard deviation 17,56 whereas the minimum value 2 and maximum value 89. In addition, the mean of systolic blood pressure 144.6, standard deviation was 17,56, minimum value was 89 mmHg and value maximum 123 mmHg, mean diastolic blood pressure 84.2, standard deviation 12.37, and the minimum value 54 mmHg and a maximum value of 154 mmHg. Chi square test resulted that there is a relationship between blood pressure and the level of lead in the blood, with p value was 0.01 significant. **Conclusion**: The Blood lead level was positively associated with diastolic blood pressure and with the odds for hypertension in adults aged 40 or older. It is necessary to have a monitoring of lead exposure among the fishery communities along the Makassar coastal area.

F. University Actors

University	Contribution
Department of Child Health, Sam Ratulangi University Medical School, Manado, Indonesia	Heavily researched lead poisoning in Talawaan and Wenang District, Indonesia. Found that there is a weak negative correlation between blood lead level and IQ in children living in a rural area, however, this correlation is not found in children living in an urban area Gunawan, L. and Masloman, N. 2014. Correlation of blood lead level and intelligence quotient in children. *Paediatr Indones,* 54(3), pp. 127 – 131.

G. Blood testing in National Health Surveys

National Health Survey	Indonesia Health and Nutrition Survey 2017	Source
Purpose	The 2017 Indonesia Demographic and Health Survey (IDHS) was carried out by the National Population and Family Planning Board (BKKBN), Statistics Indonesia (BPS), and the Ministry of Health (Kemenkes). The government of Indonesia provided funding for the local costs of the survey. ICF provided technical assistance under The Demographic and Health Surveys (DHS) Program, which is funded by the U.S. Agency for International Development (USAID).	The DHS Program, Demographic and Health Surveys, Indonesia 2017 DHS Final Report, accessed here.
Sample size	For the 2017 round, 47963 households and 59636 individuals were surveyed.	
Blood sample testing	Blood samples only taken for antenatal care.	
Latest round	2017	
Next round	2021 (ongoing)	