

Jurnal Info Kesehatan

Vol. 23, No. 3, September 2025, pp. 442-450

P-ISSN 0216-504X, E-ISSN 2620-536X

DOI: [10.31965/infokes.Vol23.Iss3.2143](https://doi.org/10.31965/infokes.Vol23.Iss3.2143)

Journal homepage: <https://jurnal.poltekkeskupang.ac.id/index.php/infokes>



RESEARCH

Open Access

Differences in Lead Levels on Doors and Walls of Children's Homes: A Cross-sectional Study in Java, Indonesia

Agus Kharmayana Rubaya^{1a*}, Sarjito Eko Windarso^{1b}, Haryono^{1c}, Sigid Sudaryanto^{1d}, Muchtaruddin Mansyur^{2e}, Tantut Susanto^{3f}

¹ Department of Environmental Health, Poltekkes Kemenkes Yogyakarta, Yogyakarta, Indonesia

² Occupational & Environmental Health Research Centre, Indonesian Medical and Education Research Institute (IMERI), Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia

³ Department of Community, Family & Geriatric Nursing, Faculty of Nursing, Universitas Jember, Jember, East Java, Indonesia

^a Email address: agus.kharmayana@poltekkesjogja.ac.id

^b Email address: windiarsa@gmail.com

^c Email address: haryono.kl@gmail.com

^d Email address: agustinus_sigid@yahoo.com

^e Email address: muchtaruddin.mansyur@ui.ac.id

^f Email address: tantut_s.psik@unej.ac.id

Received: 26 August 2025

Revised: 8 September 2025

Accepted: 11 September 2025

Abstract

Children are one of the most vulnerable groups to lead exposure. Exposure in children is primarily related to hand-to-mouth activities and environmental conditions. Studies on lead level in homes measurements, which are linked to blood lead levels in children, are still rare. The objective of the study was to identify lead levels on painted surfaces, consisting of doors and walls, in the homes of children aged 12-59 months who had high blood lead levels ($\geq 20 \mu\text{g/dl}$). The method was a cross-sectional study conducted in Java, Indonesia, comparing lead exposed and unexposed in areas with battery recycling activities to a demographically similar control area without such activities (Cinangneng-Bogor). The results showed among the 145 inspected homes in the exposed areas, 40 were measured on doors and 93 on walls; meanwhile among the 240 inspected homes in the unexposed areas, 35 were measured on doors and 36 on walls. In the exposed areas, the lead levels at the door ranged from $0.00 \mu\text{g/cm}^2$ – $891.36 \mu\text{g/cm}^2$ and it was not different ($p = 0,671$) from that in the unexposed areas, i.e. ranged from $0.00 \mu\text{g/cm}^2$ – $537.03 \mu\text{g/cm}^2$. Meanwhile, the lead levels at the walls in the exposed areas were measured ranged from $0.00 \mu\text{g/cm}^2$ – $279.21 \mu\text{g/cm}^2$ (median $0.65 \mu\text{g/cm}^2$), and it was significantly different ($p < 0.001$) from that in the unexposed area, i.e. ranged from $0.00 \mu\text{g/cm}^2$ – $45.64 \mu\text{g/cm}^2$ (median $0.00 \mu\text{g/cm}^2$). The findings of lead exposure in the children's homes lead to a strong recommendation to regulate the elimination of lead in the household paints, and to escalate community concern of domestic lead hazards.

Keywords: Blood Lead Level (BLL), Lead In Painted Door, Lead in Painted Wall, Used Lead Acid Battery Recycling (ULAB).

Corresponding Author:

Agus Kharmayana Rubaya

Department of Environmental Health, Poltekkes Kemenkes Yogyakarta, Yogyakarta, Indonesia

Email: agus.kharmayana@poltekkesjogja.ac.id



©The Author(s) 2025. This article is distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

1. INTRODUCTION

Lead (Pb) is still a significant environmental health problem in developing countries, including Indonesia (Albalak et al., 2003; Haryanto, 2016; Haryanto, 2020; Lestiani et al., 2023; Simatupang, et al., 2024). Lead is a toxic heavy metal that has no physiological function in the human body and even at low levels can cause serious health impacts, especially in children (Wani, Ara, & Usmani, 2015; Rehman et al., 2018; Debnath, Singh, & Manna, 2019; Ericson et al., 2019; Balali-Mood et al., 2021; Lafta et al., 2024; Afandi et al., 2025). Children are the most vulnerable group to lead exposure because their nervous system is still developing, their frequent hand-to-mouth behavior, and their higher lead absorption rate compared to adults (Sample, 2024; Hammer et al., 1985; Xue et al., 2007). One source of lead exposure that is often overlooked is lead-based paint that is still used in various household products, including paint on doors and walls of houses. Although several regulations have begun to be implemented to limit the use of lead in paint, implementation and supervision at the local level are still weak (O'Connor et al., 2018; Lin et al., 2009). Java Island as an area with high population density and rapid urbanization has various types of settlements from industrial areas to densely populated housing that have the potential to have varying levels of lead exposure in the household environment (Ericson, et al., 2019; Budianta et al., 2012).

Previous studies in various countries have shown that home lead exposure can contribute to increased blood lead levels (BLL) in children, which are associated with impaired cognitive development, behavior, and other neurological functions. For instance, the first study that examined neural correlates of BLL in cognitive control and a systematic review about the effect of lead exposure on mental function among children (Barg et al., 2025; Heidari, Mostafaei, Razazian, 2022). Nevertheless, the evidence based by conducted research regarding the correlation between the presence of lead in household elements such as doors and walls with children's BLL remains still limited, especially in Indonesia.

Therefore, this study aims to compare lead levels in the doors and the walls of under-five-children's homes in areas with high and low exposure in Java, Indonesia, by using a cross-sectional design. This study is expected to provide scientific evidence to support policies to reduce lead in household paint and increase public awareness of the dangers of lead exposure in the residential environment.

2. RESEARCH METHOD

This study employed a cross-sectional design and was conducted in several locations across Java Island, Indonesia. The study sites included Pesarean in Tegal Regency, Kadu Jaya in Tangerang Regency, Cinangka in Bogor Regency, and Dupak in Surabaya City. As a comparison, Cinangneng in Bogor Regency was selected because it has no used lead-acid battery (ULAB) recycling activities yet shares similar demographic characteristics with Cinangka. The study focused on comparing two distinct groups of children: those living in areas with lead exposure and those living in non-exposed areas.

The study was a follow-up analysis of a previously published investigation by Mansyur in 2024, which examined factors influencing blood lead levels (BLL) among children residing in areas with high and low exposure to lead. From a total of 564 children identified in both exposed and unexposed areas (320 and 240 children, respectively), only children under five years old with $BLL \geq 20 \mu\text{g/dl}$ were included in the final analysis. Eligible participants were children aged 12–59 months who had resided in the selected area for at least the past 12 months and had engaged in most of their daily activities there for at least the past six months.

Data collection began with preparatory steps such as obtaining research permits, coordinating with stakeholders, and training field staff. Information about the children was obtained from parents or guardians. Blood samples were collected through finger prick or venipuncture and subsequently analyzed in a laboratory to determine BLL, expressed in micrograms per deciliter ($\mu\text{g/dl}$). Environmental lead exposure was assessed by measuring lead

concentrations on doors and walls suspected to contain lead, particularly those painted in bright red. These measurements were conducted using the Thermo Scientific Niton™ XL3 handheld portable X-ray fluorescence (XRF) analyzer, a non-destructive, fast, and accurate instrument for detecting heavy metals in the environment. Additional samples, such as air, soil, and dust, were also collected during household visits.

From the 564 children identified, 145 met the inclusion criteria of having BLL ≥ 20 $\mu\text{g/dl}$. After obtaining informed consent, 129 parents agreed for their children to participate in this study. Lead measurements on doors were conducted in 75 households, while lead measurements on walls were completed in all 129 participating households. Specifically, measurements on doors were obtained from 40 houses in exposed areas and 35 in unexposed areas, whereas measurements on walls were taken from 93 houses in exposed areas and 36 in unexposed areas.

This follow-up study was conducted under the same ethical approval as the original investigation, granted by the Health Research Ethics Committee of the Universitas Indonesia/Cipto Mangunkusumo National Hospital on May 22, 2023 (Approval Number: KET-622/UN2.F1/ETIK/PPM). Participation was voluntary, and written informed consent was obtained from parents or guardians prior to data collection.

Data were analyzed using SPSS software. Numerical variables were presented as medians with interquartile ranges (25th and 75th percentiles), while categorical variables were summarized as frequencies and percentages. To test the hypothesis regarding differences in lead levels on doors and walls between exposed and unexposed areas, the Mann–Whitney test was applied at a 95% confidence interval. This non-parametric test was chosen because the data did not meet the assumption of normal distribution.

3. RESULTS AND DISCUSSION

Table 1 and Table 2 shows the description of sociodemographic features of the children. Meanwhile Table 3 shows that there is no difference in lead levels measured on the houses' doors between exposed areas and unexposed areas ($p = 0.671$), and in contrast, there is a difference in lead levels measured on the houses' walls between the two areas ($p < 0.001$).

Table 1. Characteristics of children's sociodemographic in the initial study ($n = 564$).

Variable	n (%)	Mean $\pm$ SD	Md (Q1-Q3)
Sex			
Boys	295 (52.3)		
Girls	269 (47.7)		
Age (Months)		35.24 $\pm$ 13.22	35 (24–47)
Exposed Area	324 (57.4)		
Pesarean (Tegal)	80 (24.7)		
Kadu Jaya (Tangerang)	84 (25.9)		
Cinangka (Bogor)	81 (25.0)		
Dupak (Surabaya)	79 (24.4)		
Unexposed area			
Cinangneng	240 (42.6)		

Table 2. Characteristics of selected children's sociodemographic with BLL ≥ 20 $\mu\text{g/cm}^2$ ($n = 145$).

Variable	n (%)	Mean $\pm$ SD	Md (Q1-Q3)
Sex			
Boys	72 (49.7)		
Girls	73 (50.3)		

Age (Months)	35.41 ± 13.76	36 (23–47)
Exposed Area	115 (79.3)	
Pesarean (Tegal)	43 (37.4)	
Kadu Jaya (Tangerang)	26 (22.6)	
Cinangka (Bogor)	30 (26.1)	
Dupak (Surabaya)	16 (13.9)	
Unexposed area		
Cinangneng	30 (20.7)	

Table 3. The difference blood lead level children between control and exposure in doors (n= 75) and in walls (n= 129).

Variable	n	Mean Rank	Md	Q1-Q3	Z	p-value
Lead level in doors						
Exposed	40	102.502	51.653	2.860-132.870	-0.425	0.671
Unexposed	35	107.722	51.805	0.442-153.367		
Lead level in walls						
Exposed	93	8.668	0.650	0.000-3.640	-4.160	<0.001
Unexposed	36	1.442	0.000	0.000-3.150		

DISCUSSION

Lead Exposure: Patterns and Health Imperative

Our findings indicate that houses in areas with informal ULAB recycling had significantly higher lead contamination on walls than control houses ($p < 0.001$), whereas painted doors showed similarly high lead in both groups ($p = 0.671$). This pattern suggests that ambient lead pollution from recycling sites is depositing on wall surfaces. Informal used-lead-acid-battery (ULAB) recycling releases lead dust into air and soil which can settle on exterior and interior walls. Indeed, WHO notes that lead-contaminated soil and dust from battery recycling have caused mass poisoning incidents in children. In contrast, the surface of doors is hypothesized to reflect the inherent paint content of the object rather than local pollution, therefore consistency of high lead levels detected on doors in both exposed and unexposed regions indicates the widespread presence of lead-based paint (Mansyur et al., 2024; Motamedrezaei, et al., 2024). Survey showed that most paints sold in low- and middle-income countries (including Indonesia) have very high lead levels because regulations are weak or voluntary. In Indonesia, there were some reports found that 73% decorative paints exceeded 90 ppm lead, with some colors far above this limit. These findings explain why door contamination did not differ by area, similar construction for the houses likely use similarly leaded paints on doors. Reiterating the fundamental scientific consensus, there is no known safe level of lead exposure for either adults or children. Even minimal levels of lead in the blood have been definitively shown to cause serious and irreversible neurological damage. This scientific reality means that any detectable lead, including concentrations around or above 90 ppm, inherently carries a risk to human health. The concept of "no safe level" creates a paradox when discussing "high" lead levels. According to American Academy of Pediatrics, the safe level for lead exposure on children need evaluation and need to be managed in a sophisticated way that can have short-term or immediate effects and long-term effects, too, as it's been exposed for an extended amount of time. Some common short-term symptoms include headaches, stomach pain, loss of appetite, and constipation. Then, long-term or chronic conditions can lead to cognitive impairment (American Academy of Pediatrics, 2022; Pure Earth, 2025). If any lead is harmful, then 90 ppm, while a regulatory benchmark, is still a concentration that poses a health risk. When actual lead levels in Indonesia exceed this 90 ppm standard, it means they are not just "high" relative to a policy goal, but dangerously high relative to the human body's physiological tolerance. The most direct indicator of human exposure to lead is children's blood lead levels

(BLLs) estimated 8-12 million children in Indonesia are reported to have BLLs exceeding 5 µg/dL. This level is recognized by the WHO as an action level, indicating that intervention is required to prevent further health damage (Pure Earth, 2025; World Health Organization, 2021). The age of 2 years, when lead levels often peak, is the same age at which a major reduction in dendrite connections occurs, among other events crucial to development. It's possible that lead exposure at that time interferes with a critical development process in the CNS, but what that specific process is has not been clearly identified. Imaging studies of adults who had elevated blood lead levels in childhood have demonstrated region-specific reductions in the brain's volume and alterations of its microstructure, as well as a significant impact on brain reorganization.

Residential Environmental Risks of Lead Exposed and Unexposed in Java, Indonesia

The significantly higher lead levels on walls in homes near battery recycling operations suggest airborne dispersion and soil resuspension as secondary contamination routes—mechanisms confirmed in similar studies in Vietnam and Bangladesh (Nguyen, 2021). These processes allow lead dust from smelting or dismantling activities to enter homes through windows, on clothing, or via contaminated soil tracked indoors (Barg, et al., 2025). Children under five are especially vulnerable due to their increased respiratory rates, frequent hand-to-mouth behaviors, and ongoing neurological development (Sample, 2024; Heidari, et al., 2022). This is exacerbated by the fact that many parents are unaware of environmental lead risks. In our study, nearly all homes exceeded international safety thresholds, confirming household surfaces as critical sources of chronic exposure. Our findings demonstrate with statistical rigor that indoor surfaces, particularly painted walls in areas near battery recycling, harbor significantly higher lead concentrations ($p < 0.001$). These findings are in line with those of a study by Ng et al. (2024), who found that more than 70% of paints sold in Jakarta exceeded global safety thresholds. Interestingly, no significant difference was found in door lead levels between exposed and unexposed areas, with both exceeding the 1 µg/cm² standard. This suggests that doors may be painted with similar high-lead products across Java, regardless of industrial pollution proximity. This pattern strengthens the case for urgent, enforceable regulations banning the sale of decorative lead-based paint in Indonesia, as recommended by the Global Alliance to Eliminate Lead Paint (Del Rio et al., 2023; UNEP, 2021). Public awareness campaigns are thus essential to shift community behaviors. Programs similar to those conducted by UNICEF and Pure Earth in Java, which combine educational outreach with home remediation support, have proven effective in increasing risk perception and encouraging preventive practices like regular wet cleaning and repainting with lead-free coatings (UNICEF, 2022). Lead-based paint and household dust account for the majority of these exposures (Ministry of Environment, 2022). This study implies that the contaminated walls and doors in these homes are likely contributing to children's blood lead, compounding the impact of contaminated soil and foodware identified by other studies (Nguyen, 2021). Notably, we found that children living near these same recycling sites had nearly four times the odds of BLL ≥ 20 µg/dL compared to controls, underscoring how environmental lead sources translate into high child exposures. These findings have clear public health implications. The persistence of lead paint in homes and high dust contamination mean that children are being chronically exposed in their daily environment. First, regulatory action on paint is needed. Indonesia's old standard allowed 600 ppm lead in decorative paint; only recently a voluntary 90 ppm standard was introduced (World Health Organization, 2021). In practice, most paint sold still contains far more lead than recommended. We support global recommendations to ban lead in residential paint by enforcing a strict 90 ppm limit (or lower) and removing non-compliant products.

Regulation, Remediation, and Community Action: Strategic Recommendations

Regulatory reform to reduce ongoing exposure to lead in household environments, a mandatory lead limit of 90 parts per million (ppm) should be enforced for all paints used in homes, schools, and childcare facilities. This threshold aligns with the recommendations from international health organizations and has been adopted by many countries as a protective standard (Ministry of Environmental, 2022). Equally important is the mandatory labelling of lead content on all commercial paint products to ensure consumer awareness and aid in the selection of safer materials. Moreover, market surveillance and regulatory enforcement should be significantly strengthened. Although Indonesia has introduced voluntary standards, non-compliance remains common due to inadequate monitoring. The Ministry of Environment has highlighted the need for comprehensive oversight mechanisms to remove high-lead paints from the market and ensure safer alternatives are prioritized. Remediation was particularly critical for homes located near used lead-acid battery (ULAB) recycling sites, where airborne and soil-borne lead contamination is prevalent. In these settings, interventions should focus on the removal or encapsulation of lead-painted surfaces, especially in areas frequented by children. In addition, regular monitoring of lead in air, soil, and household dust should be institutionalized. These environmental assessments are vital to track contamination trends and evaluate the effectiveness of interventions. The World Health Organization's Lead Toolkit (UNEP, 2021) offers practical guidance for implementing such surveillance programs. At the community level, blood lead level (BLL) screening should be integrated into routine pediatric care, particularly in areas identified as high risk. Early detection enables timely intervention to prevent the progression of lead-induced health effects. Public education campaigns are also essential. Providing caregivers with accessible information on simple but effective exposure-reduction practices, such as regular wet cleaning, ensuring clean play areas, and avoiding repainting with lead-based products, can significantly reduce children's contact with lead-contaminated surfaces.

The limitations of this study were only conducted in several places on Java Island, which was identified have high level of lead exposure, therefore it cannot provide a more complete picture of the overall conditions in Indonesia. The applied threshold value of BLL (20 µg/dl) as the selection criteria, according to some references is relatively high, therefore consideration of lower threshold value should be cautiously taken for similar further study.

4. CONCLUSION

The persistence of lead paint in homes and high dust contamination mean that children are being chronically exposed in their daily environment. First, Indonesia's old standard allowed 600 ppm lead in decorative paint only recently a voluntary 90 ppm standard was introduced. Second, source control at battery recyclers is essential. UNICEF recommends formalizing and regulating ULAB recycling: simplifying permitting, enforcing emission and waste limits, and relocating or engineering smelters to prevent lead escape. In the interim, education for communities near recyclers should stress handwashing, wet-cleaning of floors, and keeping children away from dusty work sites. The uniformly high contamination of doors across both exposed and unexposed areas further implicates the widespread use of lead-based paints. This study provides strong evidence in support of policies aimed at eliminating lead from household paints and increasing public awareness of domestic lead hazards. To protect the neurodevelopment of future generations, integrated regulatory and community-based responses are urgently needed. Further research in other parts of Indonesia, and with strong design is needed to provide strong evidence about lead exposure in children's home environment.

ACKNOWLEDGMENTS

The authors thank the following people and institutions that contributed time, expertise, services, suggestions and/or other support for the study and writing of the manuscript: Pure Earth; the Government - especially the Health Services-of Tegal Regency, Bogor Regency, Tangerang Regency and Surabaya Municipality; the Head and staff of primary health centers of Pasir Orai, Adiwerna, Curug, Dupak, Tembok Dukuh and Tenjolaya; the Head, staff, community leaders and community health workers in the study areas; Vigo Agustilano Salim & Dhimas Rizky Handoko; especially all subject participants, without their support this study would have not been done.

REFERENCES

- Afandi, A., Suhartono, S., Budiyono, B., Margawati, A., & Kartini, A. (2025). High Blood Lead Levels As A Risk Factor Of Stunting: A Study Of Children In Agricultural Areas. *Journal of Environmental Health*, 17(1), 45-53. <https://doi.org/10.20473/jkl.v17i1.2025.45-53>
- Albalak, R., Noonan, G., Buchanan, S., Flanders, W. D., Gotway-Crawford, C., Kim, D., ... & McGeehin, M. A. (2003). Blood lead levels and risk factors for lead poisoning among children in Jakarta, Indonesia. *Science of the Total Environment*, 301(1-3), 75-85. [https://doi.org/10.1016/S0048-9697\(02\)00297-8](https://doi.org/10.1016/S0048-9697(02)00297-8)
- American Academy of Pediatrics. (2022). *Lead Exposure in Children*. American Academy of Pediatrics. Retrieved from: <https://www.aap.org/en/patient-care/lead-exposure/lead-exposure-in-children/>
- Balali-Mood, M., Naseri, K., Tahergorabi, Z., Khazdair, M. R., & Sadeghi, M. (2021). Toxic mechanisms of five heavy metals: mercury, lead, chromium, cadmium, and arsenic. *Frontiers in pharmacology*, 12, 643972. <https://doi.org/10.3389/fphar.2021.643972>
- Barg, G., Menéndez, J. A., Friedl, J. A., Hoyos, S., Queirolo, E. I., Mañay, N., ... & Kordas, K. (2025). Lead exposure, peripheral neurotransmitter levels and cognitive control: A neurobehavioral study in children from Montevideo, Uruguay. *NeuroToxicology*, 108, 159-168. <https://doi.org/10.1016/j.neuro.2025.03.009>
- Budianta, W. (2012). Lead contamination in soil of Yogyakarta city, Indonesia. *Journal of Applied Geology*, 4(2), 90–98. <https://doi.org/10.22146/jag.7200>
- Debnath, B., Singh, W. S., & Manna, K. (2019). Sources and toxicological effects of lead on human health. *Indian Journal of Medical Specialities*, 10(2), 66-71. https://doi.org/10.4103/INJMS.INJMS_30_18
- Del Rio, M., Obeng, A., Galkaduwa, B., Rodriguez, C., Costa, C., Chavarria, C. A., ... & Sobin, C. (2023). An interdisciplinary team-based approach for significantly reducing lower-level lead poisoning in US children. *Toxicology Reports*, 10, 76-86. <https://doi.org/10.1016/j.toxrep.2022.12.004>
- Ericson, B., Hariojati, N., Susilorini, B., Crampe, L. F., Fuller, R., Taylor, M. P., & Caravanos, J. (2019). Assessment of the prevalence of lead-based paint exposure risk in Jakarta, Indonesia. *Science of The Total Environment*, 657, 1382-1388. <https://doi.org/10.1016/j.scitotenv.2018.12.154>
- Hammer, L. D., Ludwig, S., & Henretig, F. (1985). Increased lead absorption in children with accidental ingestions. *The American journal of emergency medicine*, 3(4), 301–304. [https://doi.org/10.1016/0735-6757\(85\)90051-8](https://doi.org/10.1016/0735-6757(85)90051-8)
- Haryanto, B. (2016). Lead exposure from battery recycling in Indonesia. *Reviews on environmental health*, 31(1), 13-16. <https://doi.org/10.1515/reveh-2015-0036>
- Haryanto, B. (2020). Indonesia: country report on children's environmental health. *Reviews on Environmental Health*, 35(1), 41-48. <https://doi.org/10.1515/reveh-2019-0088>
- Heidari, S., Mostafaei, S., Razazian, N., Rajati, M., Saeedi, A., & Rajati, F. (2022). The effect

- of lead exposure on IQ test scores in children under 12 years: a systematic review and meta-analysis of case-control studies. *Systematic reviews*, 11(1), 106. <https://doi.org/10.1186/s13643-022-01963-y>
- Lafta, M. H., Afra, A., Patra, I., Jalil, A. T., Mohammadi, M. J., Baqir Al-Dhalimy, A. M., ... & Asban, P. (2024). Toxic effects due to exposure heavy metals and increased health risk assessment (leukemia). *Reviews on Environmental Health*, 39(2), 351-362. <https://doi.org/10.1515/reveh-2022-0227>
- Lestiani, D. D., Syahfitri, W. Y. N., Adventini, N., Kurniawati, S., Damastuti, E., Santoso, M., ... & Mukhtar, R. (2023). Impacts of a lead smelter in East Java, Indonesia: degree of contamination, spatial distribution, ecological risk, and health risk assessment of potentially toxic elements in soils. *Environmental Monitoring and Assessment*, 195(10), 1165. <https://doi.org/10.1007/s10661-023-11745-1>
- Lin, G. Z., Peng, R. F., Chen, Q., Wu, Z. G., & Du, L. (2009). Lead in housing paints: An exposure source still not taken seriously for children lead poisoning in China. *Environmental research*, 109(1), 1-5. <https://doi.org/10.1016/j.envres.2008.09.003>
- Mansyur, M., Fitriani, D. Y., Prayogo, A., Mutiara, A., Fadhillah, R., Aini, R., ... & Bose-O'Reilly, S. (2024). Determinant factors of children's blood lead levels in Java, Indonesia. *International Journal of Hygiene and Environmental Health*, 261, 114426. <https://doi.org/10.1016/j.ijheh.2024.114426>
- Motamedrezaei, O., Lotfi, H., Jahani, F., Sharifzadeh, G. R., Mohammadian, F., & Laal, F. (2024). Occupational exposure to lead fume among automobile welders. *Epidemiology and Health System Journal*, 11(2), 81-87. <https://doi.org/10.34172/ehsj.26123>
- Ministry of Environment. (2022). National Strategy to Phase Out Lead Paint in Indonesia. Jakarta: MoEF.
- Nguyen, T. H. (2021). Soil Contamination from ULAB Facilities in Vietnam. *J Environ Qual*, 50 (3), 650–659.
- O'Connor, D., Hou, D., Ye, J., Zhang, Y., Ok, Y. S., Song, Y., ... & Tian, L. (2018). Lead-based paint remains a major public health concern: A critical review of global production, trade, use, exposure, health risk, and implications. *Environment international*, 121, 85-101. <https://doi.org/10.1016/j.envint.2018.08.052>
- Pure Earth. (2025). *Global Lead Program - 2024 Results and Achievements*. Pure Earth. Retrieved from: https://www.pureearth.org/wp-content/uploads/2025/04/Pure-Earth-Global-Lead-Program-Report-2024_final_April29.pdf
- Rehman, K., Fatima, F., Waheed, I., & Akash, M. S. H. (2018). Prevalence of exposure of heavy metals and their impact on health consequences. *Journal of cellular biochemistry*, 119(1), 157-184. <https://doi.org/10.1002/jcb.26234>
- Sample, J. (2024). Lead exposure in children: failure to protect the most vulnerable. *The Journal of Pediatric Pharmacology and Therapeutics*, 29(3), 212-214. <https://doi.org/10.5863/1551-6776-29.3.212>
- Simatupang, M. M., Veronika, E., Irfandi, A., & Azteria, V. (2024). Potential impacts of lead on health: a review of environmental exposure, population at risk, and toxic effects. *Journal of Environmental Health*, 16(3), 277-288. <https://doi.org/10.20473/jkl.v16i3.2024.277-288>
- UNEP. (2021). *Global Elimination of Lead Paint: Toolkit for Policymakers*. United Nations Environment Programme.
- UNICEF. (2022). *Reducing Childhood Lead Exposure in Indonesia: Policy Brief*. UNICEF.
- Wani, A. L., Ara, A., & Usmani, J. A. (2015). Lead toxicity: a review. *Interdisciplinary toxicology*, 8(2), 55–64. <https://doi.org/10.1515/intox-2015-0009>
- World Health Organization. (2021). *WHO Guideline for Clinical Management of Exposure to Lead*. World Health Organization. Retrieved from: <https://www.who.int/publications/i/item/9789240037045>

Rubaya, A.K., Windarso, S.E., Haryono, H., Sudaryanto, S., Mansyur, M., & Susanto, T. (2025). Differences in Lead Levels on Doors and Walls of Children's Homes: A Cross-sectional Study in Java, Indonesia. *JURNAL INFO KESEHATAN*, 23(3), 442-450. <https://doi.org/10.31965/infokes.Vol23.Iss3.2143>

| 450

Xue, J., Zartarian, V., Moya, J., Freeman, N., Beamer, P., Black, K., ... & Shalat, S. (2007). A meta-analysis of children's hand-to-mouth frequency data for estimating nondietary ingestion exposure. *Risk Analysis: An International Journal*, 27(2), 411-420. <https://doi.org/10.1111/j.1539-6924.2007.00893.x>