Health Risk Analysis of Lead Exposure in Selected Paint Industry Workers in Indonesia

Background

Until 2021, about 77% of decorative paints manufactured and sold in Indonesia contain high lead concentrations above the global achievable safe level of 90 ppm. Lead is a toxic heavy metal and is classified as a probable human carcinogen.

This study was conducted in Indonesia from 2022 to 2023 and aimed to assess the health risks faced by paint manufacturers' workers in three factories grouped as follows:

- Industry A: a facility that eliminated lead paint (20 workers);
- Industry B: a facility that more recently eliminated lead paint (12 workers); and
- Industry C: a paint manufacturer still making lead paint (20 workers total).

Methodology

The research subjects were recruited from the population of all paint industry workers (n=52). They were selected based on a purposive sampling technique. The inclusion criteria were male, between 25-50 years of age, having worked in the industry for at least 2 years, and willing to sign the informed consent form. The exclusion criteria include workers residing near landfills and/or industrial areas.

Samples matrix

This study collected various samples to assess workplace exposure risks, including indoor air samples, dust lead levels, intra-venous blood, inhaled lead dust, and lead absorption from skin contact. Respondents were divided into two groups: directly exposed and indirectly exposed.

Samples analysis method

Prodia Clinical Laboratory in Jakarta analyzed the blood samples using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Lead captured in low-volume sampler filters and dermal patches were taken to the National Research and Innovation Agency (*Badan Riset dan Inovasi Nasional* or BRIN) for further analysis using benchtop EDXRF (Energy Dispersive X-ray Fluorescence). Dust floor samples were analysed by an SGS laboratory in the US using a flame atomic absorption spectrometer (Flame AA), following NIOSH 9100/EPA 7082.

Key findings

Based on the workers' blood lead levels and current Indonesian health standards, the study found clear evidence of more significant risks of cancer and non-cancer health conditions for workers in Industry C. Specifically:

- 75% of Industry C's respondents have high blood lead levels greater than 5 µg/dL, compared to Industry A and B, only 5-8% of respondents, respectively.
- 55% of respondents in Industry C had blood lead levels that showed an increased non-cancer risk, and another four workers of Industry C had levels above the safety standard that would prompt regular blood level monitoring.
- 10% of Industry C workers had blood lead levels linked to a significant increase in their lifetime cancer risk, four times higher than for workers in Industry A and 2.5 times higher than for workers in Industry B.
- Workers in Industry C have an elevated lifetime risk for non-cancer health conditions related to lead exposure, almost 3.5 times higher for workers in Industry A and almost 2 times higher than those in Industry B.
- Dust lead levels in Industry C are 5 times to 410 times higher than the CDC dust lead clearance level of 10 $\mu g/ft^2$.
- The lead captured in dermal patch filters of Industry C's respondents is 5 to 6 times higher than that of Industry A and B respondents.
- Lead exposure via skin contact or the dermal exposure pathway was significantly higher among workers in Industry C, more than four times higher than among Industry A workers and more than five times higher than among Industry B workers.
- Some respondents in all three groups had high blood levels of arsenic, cadmium, nickel, thallium, or chromium, which had elevated lifetime risks for cancer related to the inhalation pathways.

Recommendations

For Paint Industry

Since 1919, the ILO has warned women and children about the hazardous exposure of lead. In 1921, the first lead convention was adopted and restricted the use of white lead for paintings. Eliminating lead paint is the best way to protect workers from lead exposure. Our study shows companies can protect their workers and consumers from harmful lead exposures by eliminating lead paint. For decades, alternatives to lead paint have demonstrated that they are as effective and safer than lead paint. There is no advantage to continuing the use of lead in paint.

While transitioning to lead-safe paint, companies can take steps to minimize worker exposures, including providing systems so workers can:

- Use tools and equipment with dust collection systems to keep lead out of the air.
- Provide changing room for workers and adequate washing basins.
- Clean surfaces using wet methods and HEPA vacuuming instead of dry sweeping or blowers.
- Avoid shaking out, brushing off, or blowing off dusty clothing.
- Scrub hands and nails and wash faces thoroughly before eating and drinking. The use of lead-removal soap or foam should be provided, as studies show that regular soap and water may not adequately remove lead particles.

Studies have also shown that workers can bring lead contamination home from their workplace. To reduce risks, employers should have systems so workers can:

- Reformulate the paint production and replace lead-based pigments and driers with safer alternatives.
- Change the solvent-based paint to water-based paint.
- Communicate the risk of chemical exposure in the factory regularly.
- Use separate working clothes, shoes/boots while at work that they do not take home.
- Launder lead-contaminated clothing at work, if possible. When it is not possible, workers should be provided with plastic bags to store their soiled work clothes and advised to wash and dry work clothes separately from other clothes.
- Avoid taking home tools, materials, or anything contaminated with lead.

For the Government of Indonesia

Experts noted that occupational and non-occupational exposures to metals are most severe in low- and middle-income countries where mining, waste processing, and rapid industrial development are taking place but weak occupational and environmental safeguards.

Interventions to prevent exposure to metals should be based on the “hierarchy of controls” concept, where the most effective priority is reducing and preventing exposure at the source. The reduction measure requires the identification, evaluation, control, and, if possible, elimination of the sources of exposure. In some cases, exposure reduction is achieved by changes in industrial processes or raw materials.

The key elements of exposure prevention are Hazard Identification and Hazard Control, as recommended by experts, as follows:

- Prohibit the use of lead-based pigments and driers for all paint manufactured in Indonesia.
- Apply Extended Producer Responsibility (EPR) regulation and oblige paint manufacturers to take back lead-paint cans from consumers, classifying them as hazardous waste.
- Adopt and make a mandatory regulation with a protective lead content standard for all paints below 90 ppm based on SNI 8011:2022.
- Hazard Identification is an essential factor in the prevention process. It includes recognizing potential sources and routes of exposure and identifying the full range of health effects, including those in children's early development.
- Evaluation involves regular workplace environment, biological aspects, and workers' health monitoring.
- Hazard Control involves reducing environmental exposure at the workplace using better or best available technologies, best environmental practices, and safer alternatives. The control measures also include administrative controls, biomonitoring of at-risk workers, and applying personal protective equipment.
- Eliminating exposure at its source or primary prevention is the most effective and cost-effective prevention measure.