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# Preliminary Study on the Measurement of Cadmium Levels in Scavenger Hair at Sukawinatan Landfill Palembang

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## ABSTRACT

Cadmium (Cd) is a toxic heavy metal with the potential to contaminate the environment, particularly in landfill sites using open dumping systems, such as the Sukawinatan Landfill in Palembang. This study aims to measure Cd levels in scavengers' hair as an indicator of heavy metal exposure. A cross-sectional study design was conducted in January 2024, with hair samples collected from five respondents using purposive sampling techniques. Cd levels were measured using the Atomic Absorption Spectrophotometry (AAS) method. The results showed that Cd levels in the scavengers' hair ranged from 0.31 to 0.99 ppm, exceeding the normal limit set which is <0.10 ppm. The duration of work as a scavenger was identified as the dominant factor influencing Cd levels, although anomalies were observed in younger scavengers with high exposure intensity. These findings suggest that the working environment at the landfill significantly contributes to the accumulation of Cd in the body. This study provides preliminary insights into the health risks faced by scavengers at the Sukawinatan Landfill, which can serve as a basis for developing policies and mitigation measures to improve scavengers' occupational health and safety.

**Keywords**: Hair, Cadmium (Cd), Sukawinatan Landfill Palembang

## INTRODUCTION

Cadmium (Cd) is a heavy metal naturally present in soil, originating from both geogenic and anthropogenic sources (McLaughlin et al., 2021). It is extensively used in various industries, including battery production, plastics, pigments, metal plating, electronics (Orac et al., 2021), phosphate fertilizer manufacturing, and as control rods in nuclear reactors (Genchi et al., 2020). However, these applications generate waste that, if improperly managed, can contaminate the environment. One site significantly impacted by such contamination is the Sukawinatan Landfill (TPA) in Palembang.

The Sukawinatan Landfill employs an open dumping system (Firda et al., 2019), which has led to considerable environmental pollution (Pujara et al., 2019). This system contributes to air, water, and soil contamination (Osra et al., 2021) and poses health risks to nearby communities (Mohan & Joseph, 2021). The landfill accommodates various types of waste containing Cd, such as household waste, electronics, batteries, plastics, and industrial residues (Julius, 2018). Due to inadequate waste management practices, Cd—an element known for its cumulative nature—can accumulate in the human body, which is challenging to eliminate (Rahadian & Riani, 2018). Long-term exposure significantly increases the body burden of this toxic metal (Dewi, 2020).

Currently, approximately 100 waste pickers operate daily at the Sukawinatan Landfill (Sartika et al., 2021). These workers often face direct exposure to waste (Fitriana & Siwiendrayanti, 2019) without adequate personal protective equipment (Godwin et al., 2020). Cd exposure among waste pickers occurs through dermal contact, inhalation of dust, or ingestion of contaminated food and beverages in their work environment (Li et al., 2021). Prolonged and high Cd exposure can lead to severe health issues, including bone and kidney damage (Deng et al., 2019), respiratory disorders (Unsal et al., 2020), and an increased risk of cancer (Genchi et al., 2020).

Detecting Cd exposure in humans involves innovative techniques critical for assessing the health risks associated with heavy metal accumulation. Common methods include Atomic Absorption Spectroscopy (AAS), such as flame and graphite furnace AAS, known for their sensitivity and accuracy in detecting heavy metals in blood and urine samples (Fakayode et al., 2023). Additionally, cadmium levels in hair samples can be measured using Flame Atomic Absorption Spectrophotometry (Renza & Lestari, 2023).

Hair serves as a biomarker for detecting heavy metal exposure, reflecting long-term contamination levels (Rohmah et al., 2021). It absorbs elements introduced into the body (Roffah & Lestari, 2023), with Cd distributed through the bloodstream and ultimately deposited in tissues, including hair (Baloch et al., 2020). Hair sampling is non-invasive, well-accepted by respondents compared to blood or tissue sampling (Garcia-Munoz et al., 2023), and allows for repeated collection in longitudinal studies (Hsu et al., 2024). Hair captures chronic metal exposure, representing accumulated levels rather than short-term fluctuations observed in blood (Feisal et al., 2019). The normal concentration of Cd in hair samples is < 0.10 ppm (Biolab Medical Unit, 2012). A study by Zhou et al. (2021) analyzing 42 hair samples from residents aged 6 to 63 years in Lanping, Southwest China, revealed elevated Cd concentrations of 0.75 mg/kg. Similarly, Goncalves et al., (2023) examined Pb, Cd, and Hg exposure in the hair and nails of waste pickers in Brasília, finding significantly higher metal levels compared to control groups.

This study aims to measure Cd concentrations in the hair of waste pickers at the Sukawinatan Landfill as an indicator of heavy metal exposure. This preliminary research is crucial for understanding Cd exposure levels among waste pickers at the site. The findings are expected to serve as a foundation for further research and inform policies aimed at improving the safety and health of waste pickers.

## MATERIAL AND METHOD

The research was conducted in January 2024 at the Sukawinatan Landfill (TPA) in Palembang, using a cross-sectional study design. The study subjects consisted of waste pickers operating at the landfill. A purposive sampling technique was employed to select respondents who met specific criteria, totaling 5 individuals. Hair samples weighing 50 mg were collected and measured using the Atomic Absorption Spectrophotometry (AAS) method.

### Research Procedures

#### Hair Sample Collection

Hair samples were collected from the back of the head, with the strands cut close to the scalp. The samples were stored in sealed, clean, dry plastic bags labeled with the respondent's name and sample code (following KEMENKES regulation No. 1406/MENKES/SK/XI/2002).

**Cadmium (Cd) Analysis in Hair Samples**

Weighing and Preparation: A 50 mg hair sample was accurately weighed. The sample was digested using a mixture of 10 mL nitric acid ($HNO_3$) and 2 mL perchloric acid ($HClO_4$).

Digestion: The mixture was heated until complete evaporation, producing a clear aqueous solution.

Dilution and Homogenization: The digested sample was transferred into a 50 mL volumetric flask, diluted to the mark with deionized water, and homogenized.

Measurement: The prepared sample was aspirated into a Flame Atomic Absorption Spectrophotometer (AAS). Absorbance was measured at a wavelength of 229.11 nm, and the results were recorded (as per SNI 6989.16:2009 standards).

**RESULT AND DISCUSSION**

The measured concentrations of cadmium (Cd) in the hair samples of waste pickers at the Sukawinatan Landfill Palembang, are presented in the following table :

Table 1. Cadmium (Cd) Levels in Hair Samples of Waste Pickers at Sukawinatan Landfill, Palembang

| No. | Sample Code | Gender | Age (Years) | Duration of Employment (Years) | Smoking Status | Cd Levels (ppm) |
|---|---|---|---|---|---|---|
| 1 | A1 | Female | 68 | 25 | No | 0,38 |
| 2 | A2 | Female | 53 | 25 | No | 0.31 |
| 3 | A3 | Male | 68 | 30 | Quitted smoking for 10 years | 0,78 |
| 4 | A4 | Female | 63 | 24 | No | 0,70 |
| 5 | A5 | Male | 17 | 10 | No | 0,99 |

The results indicate that male waste pickers exhibited higher Cd levels compared to female waste pickers. Sample A3 (male), aged 68 years with 30 years of employment, showed a Cd concentration of 0.78 ppm. In contrast, samples A1 and A2 (female), aged over 50 years with 24–25 years of employment, displayed lower Cd concentrations ranging from 0.31 to 0.38 ppm. The highest Cd level was observed in sample A5 (male), aged 17 years with 10 years of employment, with a concentration of 0.99 ppm. This suggests that age and gender influence the accumulation of Cd in hair. Older individuals are likely to experience prolonged Cd exposure, either from occupational or environmental sources, resulting in higher Cd body levels compared to younger individuals. Unsal et al. (2020) noted that Cd levels in the human body tend to increase with age due to Cd's extremely long biological half-life of approximately 30 years. Conversely, younger individuals, despite shorter exposure durations, may exhibit higher Cd accumulation due to more efficient metal absorption owing to their faster metabolism (Armin & Soegianto, 2020). Moreover, gender differences in body fat distribution may play a role.

While Cd accumulates at low concentrations in adipose tissues, these


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tissues serve as significant storage sites due to their large volume in the body. Men typically have more muscle mass, whereas women have higher fat tissue content, potentially influencing Cd distribution (Egger et al., 2019; Schorr et al., 2018).

A strong correlation between employment duration and Cd levels was observed in samples A1, A2, A3, and A4, all with employment durations ≥24 years. This supports the argument that long-term exposure to contaminated landfill environments significantly contributes to increased Cd levels in the body (Kunioka et al., 2022). The importance of using proper and comprehensive personal protective equipment (PPE) to mitigate Cd exposure risks is emphasized (Dewi, 2020). An anomaly was noted in sample A5, a young individual with the highest Cd level despite only 10 years of employment. This can be attributed to residing near the landfill and beginning work as a waste picker from an early age, leading to prolonged exposure. Early-life Cd exposure may occur through various environmental sources, including contaminated food, water, and air (Charkiewicz et al., 2023).

Smoking is generally recognized as a major source of Cd exposure. However, the data reveal that smoking status does not always directly correlate with measured Cd levels. For instance, sample A3, who quit smoking 10 years ago, had a relatively high Cd concentration of 0.78 ppm. Former smokers often exhibit higher Cd levels compared to non-smokers, though levels decrease over time after cessation. Cadmium (Cd) is a metal contained in cigarette tobacco whose biological function is unknown and has high toxicity. The higher the level and the longer the exposure, the greater the toxic effect (Ambarwati *et al.*, 2020). The average cigarette contains approximately. 2 μg Cd. After smoking 1 cigarette, the smoker's lungs receive about 0.1–0.2 μg Cd (Wroblewski *et al*., 2024). but the permitted level for humans is only 40 mg or 40,000 mcg. Therefore, if a person consumes 10 cigarettes every day, the amount of cadmium (Cd) deposited in the human body will exceed 40 mg or 40 mg in about 11 years (Mayaserli & Rahayu, 2018).

This is due to the significant absorption of Cd in tobacco smoke, which naturally accumulates in tobacco plants (Qing et al., 2021; Schiliro et al ., 2021). Mood et al. (2021) reported that Cd concentrations in smokers' blood are several times higher than in non-smokers. Non-smoking waste pickers (A1, A2, A4, and A5) also displayed high Cd levels, likely due to environmental exposure to waste, including electronic waste. Such waste releases hazardous substances, especially metals, at landfills (Houessionon et al., 2021; Fadhilah & Fitria, 2020).

Cd levels in all hair samples exceeded the Biolab (2012) threshold of <0.10 ppm, underscoring the high potential for Cd exposure at Sukawinatan Landfill. The particularly high Cd level in young sample A5 highlights the need for urgent attention to environmental exposure intensity and characteristics at the landfill. Improved workplace management and reduced contamination sources are critical to safeguarding worker health.

This study highlights the significant potential for heavy metal exposure, particularly Cd, among informal workers such as waste pickers. Routine health monitoring, education on minimizing Cd exposure, the use of PPE, and safer waste management practices are essential interventions to mitigate these risks.

## CONCLUSION

The results of this study indicate that the cadmium (Cd) levels in the hair of waste pickers at Sukawinatan Landfill in Palembang exceed the recommended normal limits, ranging from 0.31 to 0.99 ppm. These findings suggest significant exposure to the heavy metal Cd in the landfill work environment. The primary factor influencing Cd levels is the duration of employment as a waste picker, although anomalies were detected in younger waste pickers with high exposure intensity. This highlights the need for attention to working conditions and the health risks faced by waste pickers, as well as the importance of developing policies and mitigation measures to reduce Cd exposure and enhance occupational safety. This study serves as an initial step in understanding the impact of heavy metal exposure in landfills and can provide a foundation for further research and public health interventions.

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