Aloha International Journal of Health Advancement (AIJHA)
ISSN 2621-8224
Volume 2 Number 6, June 2019
http://journal.aloha.academy/index.php/aijha
RESEARCH
DOI: http://dx.doi.org/10.33846/aijha20603

# Analysis of the Environmental Health Risks of Lead (Pb) Pollution in Well Water around the Pakusari Jember Landfills

**Lisa Nourma Junita[1(corresponding author)], Ady Soesetijo[2], Isa Ma'rufi[3]**
[1(CA)]Postgraduate School of Public Health Science, Universitas Jember, Indonesia;
lisanourma@gmail.com
[2]Faculty of Dentistry, Universitas Jember, Indonesia
[3]Postgraduate School of Public Health Science, Universitas Jember, Indonesia

Submitted: January 1, 2019 -Revised: May 24, 2019 -Accepted: June 25, 2019 -Published: June 30, 2019

## ABSTRACT

Continuous landfilling in the Pakusari Jember landfills will produce pollutants in the form of leachate which is very risky to pollute well water belonging to residents living near the Pakusari Jember landfills. This study aims to analyze the environmental health risks of lead pollution (Pb) in well water around the Pakusari Jember landfills. This research was a descriptive study with a research design using the Environmental Health Risk Analysis method. People sample in this study were 64 people who were respondents to calculate the risk of respondents exposed to lead (Pb). The well water sample were 23 wells. The concentration of lead (Pb) in the well water of the population was analyzed using Atomic Absorption Spectrophotometer (AAS), while the body weight, intake rate, exposure frequency, and duration of exposure were obtained from interviews with 64 respondents to calculate (I) lead (Pb) and the level of health risk (RQ). The results showed that the average value of lead concentration (Pb) in the resident well water around the Pakusari Jember landfills was 0.058 mg/L. The results of the calculation of the maximum risk level (RQ) in the population is 2, this indicates that lead exposure (Pb) has a risk of health problems because of the value of RQ>1. If the value of risk level (RQ)>1, risk management is needed .
**Keywords**: risk analysis; lead (Pb); landfills

## INTRODUCTION

The increase population with all their activities is directly proportional to increase in the amount of waste. One national problem that requires special attention from the government is about waste management.(1) The location of the landfills in Jember Regency is carried out at landfills located in Kertosari Village, Pakusari Jember District. Pakusari landfills is the largest landfills in Jember Regency.

The process of continuous waste in the landfills produces pollutants in the form of leachate water. The composition of leachate is influenced by several factors such as the type of deposited waste and the amount of rainfall in the landfills area.(2) Heavy metals that can be found in leachate is lead (Pb). Heavy metal lead (Pb) is a cumulative toxin that can affect several body systems and very dangerous for children. About 600.000 new cases cause intellectual disability in children each year and an estimated 143.000 deaths per year with the highest number of cases in developing countries. About three by two of the diseases caused by heavy metal lead (Pb) occur in Southeast Asia.(3) Cases of poisoning due to heavy metal lead (Pb) in Indonesia in 2014 occurred in Cinangka Village, Ciampea District, Bogor Regency. Pollution of lead heavy metal (Pb) in Cinangka Village come from fsmelting of used batteries, with lead levels in the soil reaching 270.000 ppm (parts per million).(4) Heavy metal lead (Pb) can enter the human body in three ways, that is absorption in skin, respiratory tract, digestive tract.(5) Lead compounds (Pb) that enter the body through food and drinks will be included in the body's metabolic processes. The typical symptoms of lead poisoning (Pb) in children are different from adults. Symptoms seen in children are reduced appetite, abdominal pain, vomiting, stiff movements, weakness, do not want to play, the results of psychological tests look very low, brain growth disorders, and coma.(6) The quality standards value of lead concentration (Pb) in drinking water is based on Minister of Health Regulation 492/Menkes/Per/IV/2010 that is 0.01 mg/L.

Resident well water around landfills is the main water source for residents because all water needs come from well water for drinking, cooking, bathing, washing, giving livestock drinking, and other needs. Changes in water quality because influence of leachate from landfills will affect the health of well water users. Wells have long been used as a source of water for various household needs, small, medium and large industries.(7) Water exposed to heavy metals is one of the factors that play a role in influencing the quality of clean water.(8) Environmental Health Risk Analysis is an assessment health risks that can occur at some time in at risk populations. Environmental Health Risk Analysis is used to assess human health risks caused by exposure to environmental hazards. Hazards are a potential risk.(9) The assessment of exposure is an important part of risk

Aloha International Journal of Health Advancement (AIJHA)
ISSN 2621-8224
Volume 2 Number 6, June 2019 RESEARCH
http://journal.aloha.academy/index.php/aijha DOI: http://dx.doi.org/10.33846/aijha20603

assessment. Exposure is a process that causes organisms to come into contact with environmental hazards in the form of physical agents.[11] Environmental Health Risk Analysis can be used as a reference for determining decisions in improving population health.[11] This method is very suitable to be used to study environmental impacts on the health of the population. The calculation of the risk level of heavy metal lead (Pb) in well water which is consumed by humans can be determined by conducting an Environmental Health Risk Analysis. Heavy metal lead (Pb) contained in water consumed continuously can cause health problems for humans.[12] The purpose of this study is to analyze the environmental health risks of lead (Pb) pollution in well water around the Pakusari Jember landfills.

## METHODS

The type of research used was descriptive by using the Environmental Health Risk Analysis method. The time of the research was held from November to December 2018. Analysis of lead (Pb) concentration was carried out at the Laboratory of Chemistry, UIN Malang. The sample size in this study were 64 people and 23 well water, selected using total sampling technique. The concentration of lead (Pb) in the well water of the population was analyzed using Atomic Absorption Spectrophotometer (AAS), while the body weight, intake rate, exposure frequency, and duration of exposure were obtained from interviews with 64 respondents to calculate (I) lead (Pb) and the level of health risk (RQ).

## RESULTS

### General Description of Pakusari Jember Landfills

The Pakusari Jember landfills located in Kertosari Village, Pakusari District, Jember Regency. The waste management system at the Pakusari Jember landfills implements a landfill control system, which is processing waste by means of a layered system alternating between soil and waste.[13]

### Characteristics of Respondents

Distribution of characteristic of respondents is shown in table 1.

Table 1. The Distribution of characteristic of respondents

| Characteristic | Frequency | Percentage |
|---|---|---|
| Age | | |
| - Children (5-11 years) | 6 | 9.4 |
| - Adolescent (12-25 years) | 17 | 26.6 |
| - Adult (26-45 years) | 21 | 32.8 |
| - Early Elderly (46-65 years old) | 19 | 29.7 |
| - Elderly (>65 years) | 1 | 1.5 |
| Gender | | |
| - Male | 32 | 50 |
| - Female | 32 | 50 |
| Work | | |
| - Housewife | 10 | 15.6 |
| - Farmer | 24 | 37.5 |
| - Student | 10 | 15.6 |
| - Entrepreneur | 4 | 6.3 |
| - Not working | 11 | 17.2 |
| - Scavengers | 5 | 7.8 |
| Weight | | |
| - < 50 kg | 24 | 37.5 |
| - ≥50 kg | 40 | 62.5 |
| Exposure duration | | |
| - 3-15 years | 18 | 28.1 |
| - 16-26 years | 46 | 71.9 |
| Intake rate | | |
| - 1 liter/day | 6 | 9.4 |
| - 2 liter/day | 58 | 90.6 |
| Exposure frequency | | |
| - 365 day/ year | 64 | 100 |

Aloha International Journal of Health Advancement (AIJHA)
ISSN 2621-8224
Volume 2 Number 6, June 2019
http://journal.aloha.academy/index.php/aijha
RESEARCH
DOI: http://dx.doi.org/10.33846/aijha20603

**Concentration of Lead (Pb) in Population Well Water Around Pakusari Jember Landfills**

The results of analysis of lead (Pb) concentrations in population well water around the Pakusari Jember landfills are shown in table 2.

Table 2. The concentration of lead (Pb) in well water around Pakusari Jember landfills

| Concentration of Lead (Pb) in Well Water | | | |
|---|---|---|---|
| Minimum (mg/L) | Average (mg/L) | Maximum (mg/L) | Quality standards (mg/L) (Minister of Health Regulation 492/Menkes/Per/IV/2010) |
| 0.012 | 0.058 | 0.094 | 0.01 |

Table 2 shows that the average of concentration of lead (Pb) in 23 population wells around the Pakusari Jember landfills was 0.058 mg/L. The highest concentration of lead (Pb) concentration was 0.094 mg/L and the lowest was 0.012 mg/L.

**Intake of Lead (Pb)**

The formula used to calculate the intake in the population, that is:

$$I_{nk} = \frac{C \times R \times f_E \times D_t}{W_b \times t_{avg}}$$

Based on the calculation results, it is known that the intake of all respondents (population) around the Pakusari Jember landfils every day until the time of this study was 0.0003 mg / kg x days to 0.002 mg / kg x days.

**Risk Level of Lead**

The formula used to calculate the level of risk in the population is:

$$RQ = \frac{I}{RfD}$$

The minimum risk level (RQ) calculation shows the value of RQ = 0.3, this means that the value of RQ <1. While the results of calculating the level of risk (RQ) maximum indicates RQ = 2, this means that the value of RQ> 1.

**Management of Risk of Lead (Pb) Exposure**

Risk management that can be done is to reduce exposure concentration (C) and intake rate (R).[14]

Determination of Safe Concentration (C)

The formula used to calculate safe concentration is:

$$C_{nk(aman)} = \frac{RfD \times W_b \times t_{avg}}{R \times f_E \times D_t}$$

From the results of calculations, it can be seen that the value of safe concentration of lead (Pb) in well water for the population (population) is the concentration of lead (Pb) below 0.04 mg / L.

Determination of Safe Consumption Rate (R)

The formula used to calculate the rate of safe consumption is:

$$R_{nk(aman)} = \frac{RfD \times W_b \times t_{avg}}{C_{maks} \times f_E \times D_t}$$

From the results of calculations, it can be seen that the value of the safe consumption of drinking water from well water can be consumed by the population, which is less than 0.8 liters / day.

Aloha International Journal of Health Advancement (AIJHA)
ISSN 2621-8224
Volume 2 Number 6, June 2019 RESEARCH
http://journal.aloha.academy/index.php/aijha DOI: http://dx.doi.org/10.33846/aijha20603

## DISCUSSION

### Characteristics of Respondents

Based on the results of the study, the most age is adult; the most gender is female, the most work is farmer, the most weight is 50.39 kg; the most exposure duration is 20 years; the most intake is 2 liters / day; and the most exposure frequency is 365 days / year.

A very young person is generally more susceptible to heavy metals than adults due to a greater level of sensitivity and absorption in the digestive tract.(15) One characteristic variable that is very important in calculating intake is weight. The greater a person's weight, the smaller the dose received.(16) The greater a person's weight, the less risk a person may experience due to heavy metals.(17)

In theory, the intake value is influenced by the concentration of the risk agent, the rate of intake, the frequency of exposure, the duration of exposure, and weight. The intake value is inversely proportional to the value of body weight, so the greater the value of the respondent's weight, so the smaller the value of the respondent's intake of heavy metals. Respondents with weight above average have a smaller risk than respondents who weigh below average.(18)

The duration of exposure is the length of time the respondent begins to live in a settlement reduced by the initial establishment of the Pakusari Jember landfills (1992) until the research took place, that is until November 2018. This was intended to determine the level of risk experienced by respondents consume well water containing lead (Pb) as drinking water which is possible to pollution by leachate water from the Pakusari Jember landfills. Heavy metal poisoning caused by toxins carried

by heavy metals occurs in very long intervals.(15) This event occurs because the heavy metals that enter the body in small amounts can still be received by the body at that time. However, because the process of entry takes place continuously in a continuous manner, at a certain time the body is no longer able to tolerate the toxic forces carried by heavy metals.

The average respondent's intake rate is 2 liters / day. The difference in consumption of drinking water is caused by the need for drinking water intake by respondents in carrying out their daily activities. The intake rate is a variable that also determines the magnitude of risk.(17) The greater intake rate, the greater the level of risk, taking into account the duration of exposure, frequency of exposure, and weight of the respondent. The intake rate affects the risk level value.(19)

The average value of exposure frequency of respondents in this study is 365 days / year. The higher the exposure frequency of the respondents, the higher the respondents exposed to lead (Pb). The frequency of exposure will affect heavy metal intake in the body.(15) The longer a person lives in a polluted environment, the greater the risk or impact received.(16)

### Concentration of Lead (Pb) on Population Well Water Around Pakusari Jember Landfills

The first step taken in Environmental Health Risk Analysis is to identify hazards. The hazard identification in this study is the presence of lead (Pb) contained in the well water around the Pakusari Jember landfills. The source of the contamination is possible from the high concentration of lead (Pb) in leachate from the garbage in the landfills so that it is possible to enter into the soil and pollute the well water around the landfills. The residents' well water is used by residents as clean water facilities to fulfill their daily needs, especially as a source of drinking water. The high concentration of pollutants can affect the quality of groundwater around the industry through seepage and groundwater flow, especially during the rainy season.(20)

Based on the research that has been done, it is obtained that the average lead (Pb) concentration in the resident well water around the Pakusari Jember landfills is 0.058 mg / L. This shows that the lead concentration (Pb) in the well water exceeds the quality standard by the Minister of Health Regulation No. 492 / Per / IV / 2010 which is 0.01 mg / L.

Concentration of lead (Pb) and cadmium (Cd) in the rainy season tends to increase compared to the dry season.(21) This is because in the rainy season, the rainwater entering the groundwater flow increases, resulting in increased discharge and volume. In conditions of rain, the discharge of leachate becomes large so it can overflow.(22)

### Intake of Lead (Pb)

Calculation of intake values in populations consuming drinking water from well water around the Pakusari Jember landfills is based on lead (Pb) concentration data and respondent characteristics. Lead (Pb) concentration is calculated based on minimum and maximum concentration, while for body weight, intake

Aloha International Journal of Health Advancement (AIJHA)
ISSN 2621-8224
Volume 2 Number 6, June 2019 RESEARCH
http://journal.aloha.academy/index.php/aijha DOI: http://dx.doi.org/10.33846/aijha20603

rate, exposure frequency, and duration of exposure use the average value. Based on the results of calculations, it is known that the value of intake lead (Pb) in the population in around Pakusari Jember landfills between 0,0003 mg / kg x days to 0,002 mg / kg x days. The intake value is directly proportional to the risk agent concentration value, intake rate, duration of exposure, and frequency of exposure.(23) This means that the greater the values, the greater the value of intake. The greater a person's weight, the smaller the health risk. Based on the explanation above, it can be concluded that the amount of intake is influenced by concentration, duration of exposure, frequency of exposure, intake rate, and body weight.

**Risk Level of Lead (Pb)**

The risk level (RQ) is used to determine the level of risk of the risk agent that enters the human body whether it has a risk to health or is still within safe limits. The level of risk is obtained from the comparison between intake and reference dose (RfD). The greater the intake value, the greater the risk of health.

The results of calculating the maximum risk level (RQ) in the population show the value of RQ>1. This means that exposure to lead (Pb) has a risk of health problems. Lead (Pb) exposure is

0.094 mg / L (maximum concentration) or more, in populations with an average body weight of 50.39 kg is not safe for the exposure frequency of 365 days / year for 20 years. Based on the explanation above, it can be concluded that the magnitude of health risks in the population (population) is caused by exposure to lead (Pb). According to the results of observations and interviews with respondents that the average population around the Pakusari landfills has insufficient knowledge of the chronic effects of lead (Pb) pollution. Therefore, it was suggested to the Jember Health Office to map the community groups at risk of health effects due to exposure to lead (Pb). If the value of the risk level (RQ)>1, it is necessary to carry out risk management.(14)

**Risk Management of Lead (Pb) Exposure to Population Well Water Around Pakusari Landfills**

Risk management is a follow-up that must be done if the risk level value (RQ) shows a value >1 (the level of risk that is not safe). Risk management is intended to ensure that individuals or populations at risk of being exposed to risk agents remain safe from health problems. Risk management that can be done is to reduce exposure concentration (C) and intake rate (R).(14)

Determination of Safe Concentration (C)

From the results of calculations, it can be seen that the value of safe concentration of lead (Pb) in well water for the population is the concentration of lead (Pb) below 0.04 mg / L.

Determination of Safe Consumption Rate (R)

From the calculation results, it can be seen that the value of the safe consumption of drinking water from well water can be consumed by the population, which is less than 0.8 liters / day.

**CONCLUSION**

The risk level of lead (Pb) in resident well water around the Pakusari Jember landfills is RQ> 1; the average body weight is not safe; and risk management of lead (Pb) pollution in the population around the Pakusari Jember landfills by reducing lead concentration (Pb) in community well water below 0.04 mg / L and determining the rate of safe consumption of drinking water from well water that can be consumed by the population is less than 0.8 liters / day.

**REFERENCES**

1. Ahmad AA. Environmental Health Risk Analysis with a Total Agent of Suspended Particulate (TSP) in the Probolinggo City Industrial Zone. Jember: FKM-UNEJ; 2014.
2. Almunjiat S, Ainurafiq. Health Risk Analysis Due to Lead (Pb) Exposure through Inhaled Pathways at Operators at Public Fuel Stations (SPBU) in Kendari City in 2016 (Study at Tipulu Gas Station, Wua-Wua, Anduonohu, and Lepo-Lepo Gas Station).Kendari: FKM, Universitas Halu Oleo; 2016.
3. Agustina. Analysis of Health Risks for Exposure to Chromium Cr6 + in the Biringere Village Community and Taraweang Bungoro District, Pangkep Regency, South Sulawesi Province. Makassar: PPS-UNHAS; 2012.

4. Basri, Bujawati, Amansyah, Habibi, Samsiana. Environmental Health Risk Analysis (Model of Measurement of Air Pollution Risk to Health). Makassar: FKM, UIN Alauddin; 2014.
5. Daud, Dullah, Malongi. Risk Management of Cadmium (Cd) due to Liognathus sp, Portunus Pelagicus, Anadara sp, and Penaeus sp compsumton among community in Tallo Subdistric Makassar, Indonesia; 2013.
6. Djafri D. Principles and Methods of Environmental Health Risk Analysis. Padang: FKM, Universitas Andalas; 2014.
7. Harjanti, Hanani, Astorina. Analysis of Environmental Health Risks for Exposure to Ammonia Gas ($NH_3$) to Scavengers at Jatibarang Landfill, Semarang. Semarang: FKM UNDIP; 2016.
8. Haryoto, Setyono, Masykuri. Ammonia Gas Fate of the Risk of Health Problems in the Community Around Putri Cempo's Landfills. Surakarta; 2014.
9. Irfandi, Ashar, Chahaya. Analysis of The Content of Cadmium (Cd) and Lead (Pb) in Well Water Digging Residents Around the Industry Battery Recycling and Health Disorders in the Bandar Khalipah Village Community Deli Serdang Regency; 2013.
10. Ministry of Health Directorate General of PP and PL. Guidelines for Environmental Health Risk Analysis. Jakarta: Kemenkes RI; 2012.
11. Committee on the Elimination of Leaded Gasoline. Ecological Genocide: Impact of Air Pollution from Smelting of Used Batteries; 2013.
12. Lain, Hanani, Joko. Environmental Health Risk Analysis of Mercury Exposure to Residents in the Unlicensed Gold Mining Area (PETI) of Kayeli Village, Buru Regency, Maluku Province. Semarang: FKM UNDIP; 2016.
13. Mursidi, Ahmad. Risk Analysis of Hexavalent Chromium Metal Content ($Cr^{6+}$) and Arsenic (As) in Drinking Water. Jawa Tengah: Pandeglang District Health Office; 2015.
14. Nasution HI, Silaban S. Analysis of Pb and Cd Heavy Metals in Well Water Around the Landfills. Medan: Department of Chemistry, Faculty of Mathematics and Natural Sciences, USU; 2017.
15. Palar H. Heavy Metal Pollution and Toxicology. Jakarta: PT. Rineka Cipta; 2008.
16. Jember Regency Government Public Works Agency Cipta Karya and Spatial Planning. Profile of the Office of Public Works Cipta Karya and Spatial Planning. Jember: Public Works Agency Cipta Karya and Spatial Planning; 2012.
17. Rezagama A. Allowance for Organic Waste of Leachate Water of Jatibarang Landfills Using Chemical Coagulation.Semarang: Environmental Engineering Department, Faculty of Engineering, UNDIP; 2016.
18. Rini, Daud, Ibrahim. Risk Analysis of Chromium (Cr) in Bloated and Blood Shellfish in Makassar Coastal Area Residents. Makassar: FKM UNHAS; 2014.
19. Satria, Apriani, Utomo. Analysis of Lead (Pb) and Cadmium (Cd) Content at TPA Rasau Jaya, Kubu Raya Regency. Pontianak: Universitas Tanjungpura; 2015.
20. Sianipar RH. Risk Analysis of Hydrogen Sulfide Exposure to Communities Around TPA Garbage Falls in Medan District in 2009. Medan: USU; 2009.
21. Tejokusumo B. Industrial Liquid Waste and Its Impact on Shallow Ground Water Quality in Gumpang Village, Kertasura District. Surakarta: FKIP UNS; 2007.
22. WHO. Lead Poisoning and Health [Internet]. WHO. 2015 [cited 2018 May 13]. Available from: http://www.who.int/gho/phe/chemical_safety/ lead_exposure_ text/en/
23. Yudhyarto B, Utomo B, Sulastoro. Effect of Putri Cempo Surakarta Landfills on the Quality of Shallow Ground Water Surrounding Residents. Surakarta: UNS; 2015.