



The Effect of Lead Exposure through Drinking Water on Symptoms of Nervous System Disorders in Communities Around Pasir Sembung Landfill Cianjur, Indonesia, 2020

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Abstract

BACKGROUND: The nervous system is the system most sensitive to lead (Pb) toxicity, although the poisoning process occurs over a long period of time with a small absorption rate. Pb is a heavy metal that has toxic properties that can contaminate food, drinks, air, and water. Pb exposure to the human body can go through various routes, one of which is ingestion. Pb in the environment can come naturally as well as from the results of human activities, one of which is leachate produced from waste that is not managed properly so that the leachate can pollute the environment around the landfill, especially ground water.

AIM: This study aims to analyze the effect of intake of Pb exposure through drinking water on the symptoms of nervous system disorders in the community around Pasir Sembung Landfill, Cianjur, Indonesia on 2020.

METHODS: This study used a cross-sectional study design. The research sample consisted of 86 people who live in the ring around the landfill. Data collection was carried out by interview using a questionnaire and water sampling at 20 wells.

RESULTS: The results showed that there was an influence between the intake of Pb exposure through drinking water on symptoms of nervous system disorders ($p = 0.035$; OR = 3.150).

CONCLUSION: Based on these results, it is necessary to take quick steps and proper management efforts from the Cianjur Regency Government and the Pasir Sembung Landfill and related stakeholders in order to reduce the risk of health problems to the people living around the landfill.

Edited by: Sasho Stoleski

Citation: Hartono B, Pratiwi RSM. The Effect of Lead Exposure through Drinking Water on Symptoms of Nervous System Disorders in Communities Around Pasir Sembung Landfill Cianjur, Indonesia, 2020. Open Access Maced J Med Sci. 2021 Nov 28; 9(E):1413-1417. <https://doi.org/10.3889/oamjms.2021.7530>

Keywords: Lead; Nervous system; Landfill; Drinking water

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Received: 07-Oct-2021

Revised: 07-Nov-2021

Accepted: 18-Nov-2021

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Funding: This research was carried out of the grant "HIBAH PUTI 2020" program and was funded by the Directorate of Research and Community Engagement, Universitas Indonesia with contract number: NKB-4864/UN2.RST/HKP.05.00/2020.

Competing Interests: The authors have declared that no competing interests exist

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Introduction

The nervous system is the most sensitive system to lead (Pb) toxicity, although the poisoning process occurs over a long period of time with a small absorption rate [1]. Pb poisoning can occur without obvious symptoms and effects. The effects of Pb exposure are chronic, so the longer the exposure occurs, the cumulative dose increases progressively [2].

Pb is a heavy metal which in scientific language is plumbum [3]. Pb has toxic properties that can contaminate food, drink, air, and water. Pb exposure can be through the inhalation, ingestion, skin contact, and parenteral [4].

Pb absorption through the inhalation is $\pm 40\%$ and ingestion is $\pm 5-10\%$. Pb that enters through the mouth will enter the ingestion and will participate in the metabolic process so that it will be stored in the central nervous system, tissues, organs, and blood. Pb is excreted in the body through the skin, kidneys, and large intestine [5].

Pb cannot be destroyed, and cannot be broken down into other substances, and accumulates for a long

time in the soil so that the Pb that is present or pollutes the environment can be a threat to the environment and human health around it [6]. In the environment, Pb can be spread in water, soil, and air from natural processes and from human activities, but Pb pollution resulting from human activities is a major source of environmental pollution today compared to naturally occurring Pb [7].

Human activities that can be a source of Pb pollution it is the waste produces. Wastes are not managed properly will be a source of Pb pollution, it produces leachate which is causing pollution. Fard *et al.* [8] stated that leachate generally contains organic and inorganic compounds (heavy metals). The results of studies from MSW Landfill in Poland in 2011, the types of heavy metals found in leachate are timabl, copper, zinc, chromium, and cadmium [9].

Leachate is produced from of complex biochemical and physical processes or the decomposition of waste and/or infiltration of piled up waste so it can endanger the health of people living around the landfill [10]. Leachate discharge and quality's depends on rainfall and the character of the dumped waste. Dangerous leachate usually comes from landfills that use an open dumping process in its waste management.

Open dumping is an old method of waste management that has been practiced by 3/4 countries in the world [11]. In Indonesia, this method is still popular and used, out of 210 landfills in Indonesia, 86.7% still use the open dumping method [12]. One of them is the Pasir Sembung landfill which is located in Cilaku District, Cianjur Regency, West Java. Negative impacts from this open dumping are the contamination of groundwater due to the leachate it produces.

Groundwater is a potential water resource as a source of water for consumption to meet daily needs. Provision of ground water as a source of drinking water is always associated with groundwater conditions that are healthy, cheap, and available in an amount that suits your needs. Groundwater resources are renewable in nature because they are an integral part of the hydrological cycle on earth. However, in reality, there are various factors that influence its utilization, both in terms of quantity and quality [13].

Research locations are Kandang Sapi Village, Mekarwangi Village, Baru Village, and Pasir Cabe Village from Cilaku District, Cianjur Regency, West Java, Indonesia where people still use groundwater, namely well water to meet their daily needs such as drinking, cooking, washing, bathing, and others. The four villages are also located in the vicinity of watercourses, which may cause contamination due to leachate generated from the landfill. Therefore, the people living in the vicinity of the Pasir Sembung landfill area are more at risk of health problems, especially due to Pb contamination of well water from leachate water [14].

Methods

This research used a cross-sectional study design, conducted in residential areas who live around the Pasir Sembung landfill. The locations were four villages who is close with the Pasir Sembung landfill and on stream with water flow so that contamination of groundwater could occur (Figure 1). The four villages are Kandang Sapi, Mekarwangi, Baru, and Pasir Cabe. This research was conducted from October to December 2020.

The sample size in this study was 86 people from four villages in Cilaku District, Cianjur Regency, West Java, Indonesia with the number of samples from each village as follows:

Number	Village	Desa	Samples
1	Kandang Sapi	Sirnagalih	24
2	Mekarwangi	Cibinong Hilir	20
3	Baru	Cibinong Hilir	24
4	Pasir Cabe	Rahong	18
Total			86

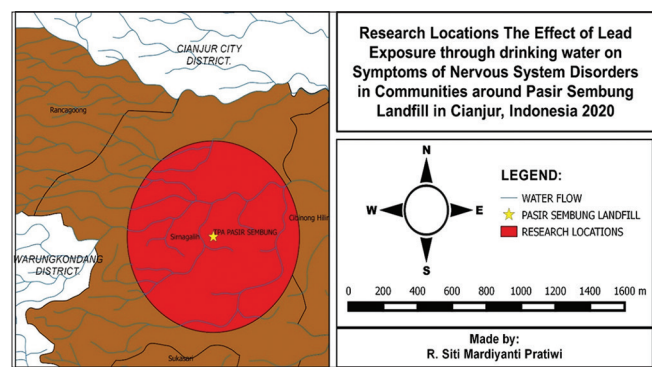


Figure 1: Research Locations. Source: Made by Author with Quantum GIS Apps, 2020

Groundwater samples are groundwater that used as drinking and cooking by respondents. Groundwater samples were taken using 1 liter sample bottle. Total sample taken for analysis was 20 groundwater. Analysis or inspection of well water for Pb parameters is carried out at an accredited laboratory. Exposure intake for each groundwater sample will be calculated using the following formula:

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

Informations:

- I_{nk} = intake (mg/kg/day)
- C = risk agent concentration (mg/L)
- R = consumption rate (L/day)
- f_E = frequency of exposure (day/year)
- D_t = duration of exposure (years)
- W_b = respondent's body weight (kg)
- t_{avg} = average time period (30 years x 365 days/year)

Results

Pb exposure intake

Pb exposure intake through drinking water consumed by 86 people around the Pasir Sembung landfill was made into a categorical with the cut-off point is median (0.0000655250 mg/kg/day). The categorization shows that people with Pb exposure intake >median and ≤median is the same, it is 43 people each. Pb exposure intake and Pb exposure categories through drinking water in people around Pasir Sembung landfill in 2020 are shown in Tables 1 and 2.

Table 1: Pb exposure intake through drinking water to community around Pasir Sembung Landfill, Cianjur, Indonesia, 2020

Variable	n	Mean	Median	Min – Max	Standard deviation
Pb Exposure Intake (mg/kg/day)	86	0.0000887462	0.0000655250	0.00000067–0.00038064	0.0000854918

Pb: Lead.

Table 2: Category of Pb exposure intake through drinking water to community around Pasir Sembung Landfill, Cianjur, Indonesia, 2020

Pb exposure intake	n	Percentage (%)
>0.0000655250 mg/kg/day	43	50
≤0.0000655250 mg/kg/day	43	50
Total	86	100

Pb: Lead.

Respondent Characteristics

Respondents are people who live in the ring around the Pasir Sembung landfill. The characteristics of the respondents studied were only general characteristics and were easy to ask or count. The characteristics of the 86 communities who were respondents in this study are shown in Table 3.

Table 3: Frequency distribution of respondent characteristics around Pasir Sembung Landfill, Cianjur, Indonesia, 2020

Respondent characteristics	Total	Percentage
Age		
>41 years	42	48.8
≤41 years	44	51.2
Sex		
Male	18	20.9
Female	68	79.1
Working		
Not working/housewife	54	62.8
Farmer	4	4.7
Laborer	8	9.3
Self-employed/teacher/working in landfill	8	9.3
Trading	12	14.0
History of diabetes		
Yes	4	4.7
No	82	95.3
History of hypertension		
Yes	17	19.8
No	69	80.2
History of nervous disease		
Yes	3	3.5
No	83	96.5
Smoking		
Yes	20	23.3
No	66	76.7
Home distance from landfill		
≤1100 m	42	48.8
>1100 m	44	51.2

Symptoms of nervous system disorders

The variable of symptoms of nervous system disorders is divided into two categories, namely, there are symptoms if you have ≥ 1 symptom and <1 or no symptoms if you do not have any symptoms of nervous system disorders.

The results of the interview show that many people experience symptoms of nervous system disorders, with the most symptoms that are complained of is numbness in the hand and headache. Symptoms category and the percentage of nervous system disorder symptoms by 86 communities around the Pasir Sembung landfill is shown in Figures 2 and 3.

Discussion

Effect of Pb exposure intake on symptoms of nervous system disorders

In the study, there was an effect of Pb exposure intake through drinking water on symptoms of nervous system disorders in the community around Pasir Sembung landfill, Cianjur, Indonesia, 2020. The p = 0.035 with an OR = 3.150. The OR indicates that people with Pb exposure intake through drinking water

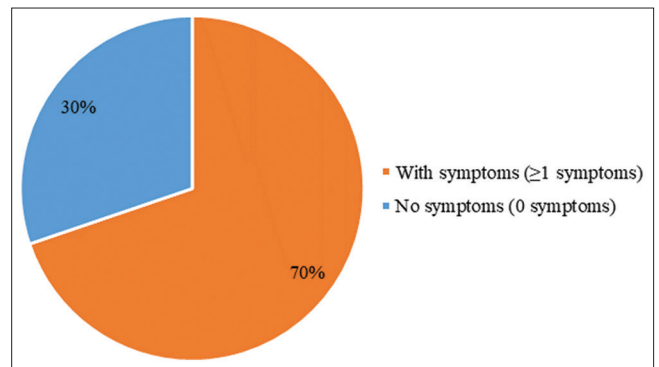


Figure 2: Category of symptoms of nervous system disorders in community around Pasir Sembung Landfill, Cianjur, Indonesia, 2020

>0.0000655250 mg/kg/day have 3.150 times greater risk of experiencing symptoms of nervous system disorders than people with Pb exposure intake through drinking water ≤0.0000655250 mg/kg/day.

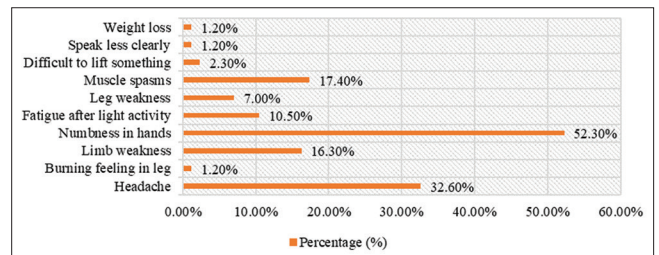


Figure 3: Percentage of symptoms of nervous system disorders in community around Pasir Sembung Landfill, Cianjur, Indonesia, 2020

The results of the analysis of the effect of Pb exposure intake on symptoms of nervous system disorders in 86 communities around Pasir Sembung landfill, Cianjur, Indonesia, 2020 are shown in Table 4.

Table 4: Pb exposure intake to symptoms of nervous system disorders in community around Pasir Sembung Landfill, Cianjur, Indonesia, 2020

Pb exposure intake	Symptoms of nervous system disorders				Total	p-value	OR	
	Yes		No					
	n	%	n	%				
>0.0000655250	35	81.4	8	18.6	43	100	0.035	3.150
≤0.0000655250	25	58.1	18	41.9	43	100		
Total	60	69.8	26	30.2	86	100		

Pb: Lead.

Regulation of the Minister of Health of the Republic of Indonesia No.416/Menkes/SK/IX/90 concerning Clean Water Quality Requirements states that the maximum Pb concentration is 0.05 mg/L. In contrast to the Indonesian regulations, it is known that the requirements of the WHO for Pb concentration in clean water are even more stringent, namely 0.03 mg/L [15], [16]. Based on these two regulations, from the 20 sample points examined, it is known that all samples still have Pb concentrations below the required quality standard so that based on the quality of 20 samples still considered feasible.

Pb exposure intake is influenced by the concentration of Pb in the water, consumption rate of drinking water, body weight, duration of living, and the frequency of exposure of respondents in the

Table 5: The effect of other variable on symptoms of nervous system disorders in community around Pasir Sembung Landfill, Cianjur, Indonesia, 2020

Other variable	Symptoms of nervous system disorders				Total		p-value	OR
	Yes		No		n	%		
	n	%	n	%				
Age								
>41 years	34	81.0	8	19.0	42	100	0.049	2.942
≤41 years	26	59.1	18	40.9	44	100		
Sex								
Male	9	50.0	9	50.0	18	100	0.078	-
Female	51	75.0	17	25.0	68	100		
Duration of living								
>30.52 years	27	71.1	11	28.9	38	100	1.000	-
≤30.52 years	33	68.8	15	31.2	48	100		
Working								
Not working/housewife	39	65.0	15	57.7	54	100	0.310	-
Farmer	4	100.0	0	0.0	4	100		
Laborer	3	37.5	5	62.5	8	100		
Self-employed/teacher/working in landfill	5	62.5	3	37.5	8	100		
Trading	9	75.0	3	25.0	12	100		
History of diabetes								
Yes	4	100.0	0	0.0	4	100	0.310	-
No	56	68.3	26	31.7	82	100		
History of hypertension								
Yes	14	82.4	3	17.6	17	100	0.334	-
No	46	66.7	23	33.3	69	100		
History of nervous disease								
Yes	3	100.0	0	0.0	3	100	0.550	-
No	57	68.7	26	31.3	83	100		
Smoking								
Yes	11	55.0	9	45.0	20	100	0.173	-
No	49	74.2	17	25.8	66	100		
Home distance from landfill								
≤1100 m	29	69.0	13	31.0	42	100	1.000	-
>1100 m	31	70.5	13	29.5	44	100		

environment. The results of the calculation show that the highest exposure intake is 0.0003806382 mg/kg/day, with a Pb concentration 0.0029483 mg/L, consumption rate of drinking water is 2.8 L/day, bodyweight is 40.9 kg, duration of living in that location for 59 years (from birth), and never left that location. Whereas the smallest exposure intake was 0.0000006728 mg/kg/day with a Pb concentration is 0.0000293 m/L, consumption rate of drinking water 1.6 L/day, bodyweight 49 kg, duration of living in that location for 22 years (from birth), and also never left the location.

Symptoms of nervous system disorders by 86 communities around Pasir Sembung landfill, Cianjur, Indonesia were obtained from the results of interviews using a questionnaire based on the Adult Pb Poisoning Medical Provider Questionnaire found in the California Department of Public Health in 2009 [16]. People who were respondents in this study were not subjected to physical examinations to strengthen the symptoms of nervous system disorders they were experiencing, researchers only observed visually. The results of the interviews and observations show that the average person experiences numbness in hand.

Effect of other variable on symptoms of nervous system disorders

The other analyzes revealed that another variable that had an influence on symptoms of nervous system disorders in 86 communities around Pasir Sembung landfill, Cianjur, Indonesia in 2020 was age, while other variable had no effect. The $p = 0.049$ and an OR = 2.942. The OR indicates that people

aged >41 years have a risk of 2.942 times greater to experience symptoms of nervous system disorders than people with age ≤41 years. The results of the analysis of the effect of other variable on symptoms of nervous system disorders in 86 communities around the Pasir Sembung landfill, Cianjur, Indonesia, 2020 are shown in Table 5.

In this research, age is one of the factors that influence nervous system disorders experienced by the respondents studied. According to a neuroscientist from the Neurology Department of the Hasanudin University Makassar, Dr. Abdul Muis Sp. S, aging is one of the factors that can affect the occurrence of neuropathy or conditions that affect the nervous system, in which nerve fibers become damaged as a result of injury or disease. This happens a lot in patients who are over 40 years old. Neuropathy generally affects about 26% or one in four who are 40 years and over [18].

Conclusion

The results of the study show that the intake of Pb exposure through drinking water affects the symptoms of nervous system disorders in the communities around Pasir Sembung landfill, Cianjur, Indonesia in 2020. Besides that, another factor that also affects it is age. The results of calculations using the existing equations show that the factors that most influence a person's Pb intake are the concentration of Pb in the water consumed, the rate of drinking water

intake, length of stay, body weight, and frequency of residence. However, what is most likely to be done to control these factors is the rate of water consumption and the concentration of Pb in the water consumed by the community.

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