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Research Article

Lead (Pb) Levels in the Blood of Public Transport Drivers on the Citereup Cimindi Route in Cimahi City, West Java, Indonesia

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A B S T R A C T

Air pollution due to the heavy metal Pb is hazardous to body health. When lead enters the body, it is absorbed by the circulatory system, especially for individuals who work in areas with high exposure levels, such as public transportation drivers. The purpose of this study was to determine the picture of the blood lead levels of public transportation drivers on the Citereup Cimindi route in Cimahi City, West Java, Indonesia. The study was conducted using a descriptive method. Sampling was carried out by saturated sampling, obtaining 15 respondents. Where lead levels were measured using an Atomic Absorption Spectrophotometer (AAS) at a wavelength of 283 nm. In addition, data were collected through interviews and questionnaires, and then the data were analyzed using Microsoft Excel and presented in the form of data and graphs. The results of the study showed that the lead levels in the blood of public transportation drivers were still above the threshold value. 1 sample contained lead levels that exceeded the threshold value of 0.106 mg/L. And 14 other samples contained blood lead levels within normal limits. The blood lead levels of public transport drivers on the Citereup Cimindi route in Cimahi City ranged from 0.004 to 0.106 mg/L. According to the World Health Organization, the threshold for blood lead levels is 10 µg/dl or 0.1 mg/L.

Keywords: *Lead; public transport drivers; Atomic Absorption Spectrophotometer (AAS)*

1. Introduction

Air is one of the most basic environmental components for living things (Prabowo Dan Muslim., 2018). Air is a mixture of gases in the layers surrounding the Earth (Purba dan Harefa., 2019). But the problem is that the air is currently polluted. Over the past week, the concentration of particulate matter (PM 2.5) in the Bandung area of West Java has increased in the range of 13 - 71 µg/m^3 and the air quality index (AQI) reached 70-153 AQI US. These figures indicate that the lowest concentration is at noon, when people are still at work, and the highest concentration is in the morning or when most people go to activities/work (IQ Air, 2022). Meanwhile, the Particulate Matter (PM 2.5) value is at the limit of 15 µg/m^3 per 24 hours (World Health Organiazation, 2022). This shows that air quality in Bandung is getting worse due to air pollution.

Contamination from chemical substances and other pollutants into the atmosphere, which can cause changes to the composition of the air, is called air pollution (Seran et al., 2022). Pollution or contamination is a condition of change from its original form to a worse condition (Palar, 2012) . Air pollution can come from volcanic eruptions, dust, smelly gases originating from the decay of microorganisms and forest fires (Seran et al., 2022). Air pollution can also originate from various human activities, such as household, industrial, agricultural, and transportation activities. The impact of this air pollution leads to a decline in air quality, which has negative impacts on humans (Prabowo Dan Muslim, 2018). Environmental pollution is currently reaching a critical point and is hurting human health (Solihat, 2018). In 2021, Bandung City is estimated to have caused 2.2 million deaths (IQ Air, 2022). One of the dangerous air pollutants is lead (Pb).

Lead is a type of heavy metal that occurs naturally in the earth's crust and is distributed in nature in small quantities (Solihat, 2018). Lead occurs naturally in nature, is very toxic, and its use increases the risk of harm to humans. Lead is soft, blue-gray in color, has a high specific gravity, and is rust-resistant (Siwiendrayanti, 2016). Lead (Pb) is a non-biodegradable pollutant that is of major concern to human health (Andjelkovic et al., 2019). Lead (Pb) is a combustion residue produced between fuel and vehicle engines

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(Palar, 2012). Lead can also come from recycled batteries or accumulators (Annshar et al, 2020) and the use of synthetic dyes also triggers the emergence of lead (Pb) (Hastuti et al., 2018).

The impacts of lead exposure in the human body include stomach ache, weight loss, headaches, fatigue, insomnia, hearing loss, muscle weakness, difficulty concentrating, anemia, kidney damage, and can even cause death (Suryatini et al 2018). Among the most well-known and widely recognized "subclinical" effects of low-level Pb exposure are reduced IQ and impacts on other global measures of neurocognitive abilities (Grant, 2020). About 90% of lead particles in smoke and airborne particles are inhaled through the respiratory tract (Solihat, 2018). Lead that enters the body will be absorbed by the blood and then bind to red blood cells, and reduced hemoglobin levels are associated with high levels of lead in the body (Shinta Dan Mayaserli, 2020). Lead (Pb) is a toxic heavy metal and can affect all organs and systems in the body (Suryatini et al., 2018). The organs of the body where lead accumulates are the liver, kidneys and brain (Jayanti, 2018). Lead has a half-life in blood of less than 25 years, in soft tissue 40 days and in bone 25 days (Fadlillah et al., 2022).

Continuous exposure to lead will hurt public health. One profession that has the potential for lead exposure is public transportation drivers. This profession has a high potential for lead exposure because the work area is on the road every day. Moreover, most public transportation drivers who work do not pay attention to the importance of using personal protective equipment, such as masks, which makes air pollution from exhaust gases, especially from vehicles, easy to inhale, making it very possible for lead concentrations in the blood to increase (Alimudin, 2021). Moreover, the current traffic conditions in Cimahi City are very dense. Several studies have confirmed the impact on professions that are close to exposure to blood lead levels. For example, in a study conducted by Baehaki et al. (2020), it was stated that the lowest blood lead level in public transportation drivers at the Soreang Terminal in Bandung Regency, West Java, was 0.889 mg/L, and the highest was 1,200 mg/L. The average blood lead level in these drivers was 1,032 mg/L. And in a study by Sofyan et al. (2020), most street vendors at the Kampung Rambutan Terminal had blood lead levels above the safe limit. A total of 18 respondents (60%) had blood lead concentrations >10 µg/dl. The average blood lead concentration of respondents was 22.03 µg/dl. Respondents with the highest lead concentration were 65 µg/dl and worked around 16 hours/day. Respondent characteristics that influence blood lead (Pb) concentrations include age and daily working hours. These data indicate that public transportation drivers are highly susceptible to exposure to lead pollution.

Lead levels can be measured using Atomic Absorption Spectroscopy (AAS), an analytical technique used to determine the levels of a metal in a compound by first atomizing it. Atomization can be performed using a flame (Solikha, 2019). Atomic Absorption Spectroscopy (AAS) is a chemical element analysis technique that utilizes the principle of energy absorption (radiation of a certain wavelength). The excited state of electron energy induced by atoms (Isnaeni, 2019).

Therefore, public transportation drivers are highly susceptible to exposure to lead pollution. Therefore, researchers were interested in conducting a study to assess the blood lead levels of public transportation drivers on the Citereup-Cimindi route in Cimahi, West Java, Indonesia.

2. Methods

The research used a descriptive method to determine the presence or absence of lead levels in the blood of public transportation drivers on the Citereup-Cimundi route in Cimahi, West Java, Indonesia. Prior to sampling, respondents were given a general overview of the study and its benefits. They then completed an informed consent form and a questionnaire.

Participants

The sampling technique used in this study was the Saturated sampling method, which is a sampling technique where all members of the population are used as samples (Sugiyono, 2017). The sample size taken was all public transportation drivers on the Citereup Cimindi route in Cimahi City, West Java, Indonesia, totaling 15 people.

Data collection

The data collection technique in this study was saturated sampling using interview sheets and informed consent instruments. After obtaining the sample data, blood lead levels were measured using an Atomic Absorption Spectrophotometer at a wavelength of 283 nm. Following the measurement results above, the data can be analyzed and conclusions drawn.

Research Procedures

According to Baehaki et al (2020), the procedures for examining lead levels are sample preparation, digestion, making a standard curve, and measuring lead levels.

Sample preparation

According to Baehaki et al (2020), the sample used in the study was venous blood. Sample preparation in this study involved pipetting 3 mL of EDTA blood into a cup, followed by the addition of 5 mL of concentrated nitric acid until the color changed to blackish brown.

Sample Destruction

According to Baehaki et al (2020), the prepared blood samples were then destroyed using a furnace for approximately 1 hour at a temperature of 500°C until they became ash. The resulting ash was dissolved using 3 mL of 0.5 M nitric acid solution, after which the solution was filtered using filter paper into a 10 mL volumetric flask, then diluted using distilled water to the limit mark or obtained 10 mL of the volumetric flask.

Making a Standard Curve

According to Baehaki et al (2020), the standard curve was prepared by creating concentrations of 0.00 mg/L, 0.05 mg/L, 0.10 mg/L, 1.5 mg/L, 0.20, and 0.25 mg/L. The solution was prepared by diluting 10 ml of standard $Pb(NO_3)$ solution. 0.5 mL of distilled water was added to each solution to the mark on a 10 mL volumetric flask. Absorbance measurements were performed at a wavelength of 283.3 nm. The curve was created by plotting the concentration value (x-axis) and the absorbance value (y-axis). This curve was used to calibrate the instrument and calculate the lead concentration in blood samples.

Lead Level Measurement

According to Baehaki et al (2020), the ready lead solution was measured using Atomic Absorption Spectrophotometry at a wavelength of 283.3 nm.

Data Processing and Data Analysis

Data processing in this research was carried out using Microsoft Excel, which was then carried out using descriptive analysis to see lead data content such as minimum and maximum content which was then compared with the predetermined threshold value.

3. Results and Discussion

Respondent Characteristics

After conducting interviews and completing questionnaires with respondents, namely public transportation drivers on the Citereup-Cimindi route in Cimahi City, who will be the research subjects, the characteristics of the respondents in this study can be seen in Table 1.

Table 1. Respondent Characteristics

Sample number	Age (Years)	Length of service (Years)	Working period in a day (Hours)	Smoke	Distance from house to main road (km)
1	53	8	9	Yes	3
2	44	5	9	Yes	3
3	55	7	5	Yes	4
4	56	5	7	Yes	3
5	52	12	8	Yes	2
6	50	5	7	Yes	4
7	52	8	8	Yes	2
8	52	7	7	Yes	3
9	57	6	6	Yes	4
10	43	5	5	Yes	6
11	48	15	9	No	3
12	40	12	9	Yes	4
13	39	10	8	Yes	3
14	42	8	8	Yes	5
15	23	5	10	Yes	2

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In this study, respondents were analyzed from various perspectives. The first factor explored in this study was length of service. According to Sudarma (2020), a long work period can increase the accumulation of lead in the blood due to prolonged inhalation of air contaminated by vehicle emissions. In this area, many vehicles, such as public transportation and others, use gasoline. This causes air pollution due to the gases produced by fuel combustion. The next factor is smoking habits. Of the 15 respondents in this study, 14 had a habit of smoking, and 1 respondent did not have a habit of smoking. Smoking habits can also affect blood lead levels. As in the study by Wulandari et al (2021), it was explained that the higher the smoking habit, the higher the lead levels in the body. The next factor explored in this study was the distance from the house to the main road. Respondents in this study had an average distance from their houses. According to Putri et al (2023), the location of the residence is close to the main road. The closer the house is to the road, the closer it is to vehicle exhaust fumes, which can increase the level of lead in the air.

Making a Standard Curve

Before measuring lead samples, the research began with the preparation of a standard lead solution, the results obtained are seen in Table 2.

Table 2. Absorbance Value of Lead Standard Solution

Concentration (mg/dL)	Absorbance
0,00	0,000067
0,05	0,000422
0,10	0,000856
0.15	0,001267
0.20	0,001644
0,25	0,001987

The data in Table 2 is plotted into a curve to obtain the results of the data examined. The presentation of the standard lead solution calibration curve can be seen in Figure 1.

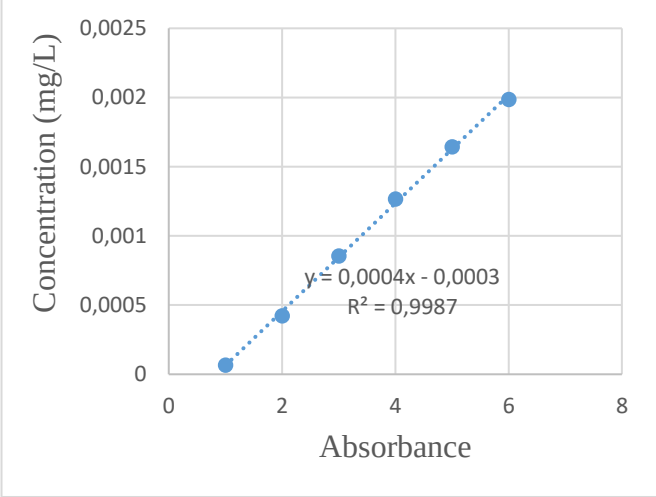


Figure 1. Standart curve

Based on Figure 1, which is a standard curve for lead concentration, the results are y = 0.0004x – 0.0003, and the regression line equation is R^2 = 0.9987. After obtaining the ideal value in the creation of the standard lead solution calibration curve, the examination continued with measuring the lead levels in the blood. In this study, the measurement line equation was obtained to determine the absorbance value and the standard curve of the lead solution. The standard curve equation obtained is the regression line equation y = 0.0004x – 0.0003. In addition to the line equation, there is another important value, namely the correlation value or called the R^2 value. The creation of this curve is used to calibrate the instrument and calculate the lead concentration in the sample. The closer the R^2 value is to 1 or -1, the closer the R^2 value is to the ideal value. Therefore, the obtained R^2 value indicates that the resulting line equation can be used to determine lead content (Baehaki et al., 2020). The correlation value in this study is R2 = 0.9987. This shows that the

correlation coefficient value is close to ideal and the equation produced by the standard curve to determine the lead concentration in the blood of public transport drivers on the Citereup Cimindi route in Cimahi city, West Java, Indonesia.

Lead Level Measurement Results

Results of lead levels in the blood of public transport drivers on the Citereup-Cimindi route, using an Atomic Absorption Spectrophotometer (AAS) examination with a wavelength of 283.3 nm. The data can be seen in Table 3.

Table 3 Lead Level Examination Results Data

Sample Number	Consentration (mg/L)	Threshold limit value by the WHO (mg/L)	Information
1	0,072	0,1 mg/L	Normal
2	0,044		Normal
3	0,039		Normal
4	0,032		Normal
5	0,069		Normal
6	0,004		Normal
7	0,075		Normal
8	0,036		Normal
9	0,029		Normal
10	0,006		Normal
11	0,106		Abnormal
12	0,086		Normal
13	0,051		Normal
14	0,058		Normal
15	0,089		Normal

Table 3 shows the levels of lead in the blood after measurement. The highest level was found in sample number 11, at 0.106 mg/L, and the lowest level was found in sample number 6, at 0.004 mg/L. Based on the data in Table 3, the lead levels ranged from 0.004 to 0.106 mg/L. Of the 15 lead samples, one sample contained lead levels above the normal limit, and 14 samples were within the normal limit. According to the World Health Organization, the threshold value for lead levels in the blood is 10 µg/dl or 0.1 mg/l (Pusparini et al., (2016).

The levels of samples number 6 and 11 have a significant difference in levels, even though if viewed from the distance of their residence from the source of exposure it is not much different even if viewed from the age of the two samples there is not much age difference, but if viewed from the length of work factor here there is a difference between samples number 6 and 11. Based on the results of the analysis sample number 11 may have a higher level. This is caused by a longer length of work, in line with research conducted by Putra et al (2020), explaining that high levels of lead in the blood of respondents can be caused by the length of time worked.

The levels of samples number 7 and 8, have a significant difference in levels, even though if viewed from the length of work and work period each day it is not much different and even viewed from the age difference is not different, but if viewed from the location of residence here there is a difference between sample number 7 has a distance of approximately 2 km while sample number 8 has a distance of approximately 5 km. based on the results of the analysis of these factors, sample number 7 may have a higher level, due to the distance of the residence to the source of exposure that is close, in line with research conducted by Putri, et al (2023), explaining that the closer the distance of the house to the highway means the closer to vehicle fumes, which allows higher levels of lead in the air.

In this study, most of the sample levels were within normal limits, even though, based on their characteristics, they could have levels above the normal limit. This is most likely due to errors during the examination process. One example is dry digestion, which is why researchers chose dry digestion because it is simple, safe, generally requires no reagents, and is the most common procedure for determining total minerals (Faqihuddin dan Ubaydillah, 2021). However, when compared to wet digestion, wet digestion is preferred over dry digestion. According to Asmorowati et al, (2020), the wet digestion method is superior to

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the dry digestion method. This is because the temperature used in wet digestion does not exceed the boiling point of the solution, and carbon generally decomposes more quickly than in dry digestion. Therefore, this is the most likely cause of the levels in these 14 samples being within normal limits.

4. Conclusion

Based on the results of research on lead levels in public transportation drivers on the Citereup – Cimindi route in Cimahi City, there is a picture of lead levels in the blood of 15 samples with a range of 0.004 and 0.106 mg/L. Of the 15 samples, there is 1 sample that exceeds the normal value of 0.106 mg/L and the other 14 samples are still in the normal range of 0.004-0.089 mg/L. Based on the World Health Organization, it states that the threshold value for lead levels in the blood is 10 µg/dl or 0.1 mg/l.

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