



## **THE CORRELATION BETWEEN BLOOD LEAD LEVELS AND SMOKING HABITS AMONG RETAIL GASOLINE SELLERS**

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### **ABSTRACT**

Heavy metal lead (Pb) is a type of metal that can negatively impact both the environment and human health. With a melting point of 327.5°C, lead is a naturally occurring element in the Earth's crust. Lead can enter the human body through various means, including water, soil, and air. Inhalation is one of the primary routes of lead exposure. Lead levels in the body can be assessed through blood, bones, hair, and nails. Additionally, smoking habits can influence blood lead levels, as cigarette smoke contains small amounts of lead. This study aims to examine the relationship between blood lead levels and smoking habits among retail gasoline sellers. A descriptive-analytical research approach was employed, using a cross-sectional design and purposive sampling technique. The study subjects comprised retail gasoline sellers in Batu Ampar sub-district, Balikpapan City, who met the inclusion criteria. Blood samples were analyzed using the ICP-OES method at the Labkesda DKI Jakarta. Data analysis was conducted using the non-parametric Spearman test. The results from 20 respondents indicated no statistically significant relationship between blood lead levels and smoking habits among retail gasoline sellers in Batu Ampar sub-district, Balikpapan City (correlation value = 0.115, p-value = 0.628). The highest recorded blood lead level among daily smokers was 8.634 µg/dL, while the lowest was <0.228 µg/dL.

Keywords: blood; exposure; lead levels; retail gasoline

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## **INTRODUCTION**

The issues of safety, health, and human well-being are becoming increasingly critical and require urgent resolution (Rusmin & Pattimura, 2024). Rapid physical development and industrial expansion have led to deteriorating air quality (Yanti et al., 2020). Previously fresh air is now perceived as dry and polluted (Salasa et al., 2021). Motor vehicle emissions account for 60-70% of urban air pollution, with an additional 10-15% contributed by industrial activities and the remainder originating from household activities, forest fires, and waste burning (Ismiyati et al., 2014). A particularly concerning issue is the pollution of heavy metal lead (Dharmadewi & Wiadnyana, 2019). Currently, the maximum permissible lead content in gasoline, as regulated by the Directorate General of Oil and Gas, is 0.013 grams per liter (Pertamina, 2023). Lead is a toxic heavy metal that can significantly impact environmental and human health (Kelana Risfiardy, 2023). It is commonly introduced into the human body through exposure to contaminated water, soil, and air (Rosmiati, 2019). Inhalation is a major route of exposure, leading to lead accumulation in the bloodstream (Rosita et al., 2018). Lead levels in the body can be assessed using various biological samples, including blood, bones, hair, and nails (Sukar & Sukarjo, 2016).

Retail gasoline sellers are at high risk of lead exposure due to frequent contact with fuel products containing lead residues and motor vehicle exhaust emissions. Many of these sellers operate in high-traffic areas where they are continuously exposed to emissions from large vehicles such as buses, trucks, and trailers, as well as smaller passenger vehicles, public

transport, and motorcycles (Yenni et al., 2021). Research by Ruslinda et al. (2016) found that the number of gasoline-fueled vehicles was strongly correlated ( $r = 0.891-0.987$ ) with lead concentrations in ambient air. Another study highlighted that smoking habits can also influence blood lead levels, as cigarette smoke contains small amounts of lead (Prabandari et al., 2024). Previous studies have shown that heavy metal levels, including lead, tend to be higher in smokers (Hasan et al., 2013). The interaction between lead exposure from the work environment and smoking habits may exacerbate lead accumulation in the body, thereby increasing the risk of lead-related health conditions (Ardillah, 2016). A study by Altuno et al. (2023) identified that age, smoking habits, and inadequate personal protective equipment (PPE) use were associated with elevated blood lead levels in workers. Lead is easily soluble in fat and easily diffuses into soft tissues such as the liver and kidneys as well as into hard tissues such as bones (Nur lailatul Q. W. R. Wulandari, 2020). Chronic exposure to lead can have negative impacts on health, such as decreased cognitive, cardiovascular, digestive function, anemia, nervous disorders, and damage to body organs, such as the kidneys and liver as well as the reproductive system (Putra et al., 2023).

Based on the results of a previous study, which used lead (Pb) levels in the hair and blood of motorbike repair shop workers as a bioindicator in Jombang district, it showed a directly proportional relationship, with a correlation coefficient of 0.965. The results showed that of the 25 samples, 17 blood and hair samples had lead levels above the threshold (Khanifah, 2022). Apart from that, in research by Kustiningsih et al., (2017) it was stated that of the 15 respondents who were selling telephones on the side of the road that were examined, there were 13 respondents (86.7%) whose lead metal content exceeded the blood lead threshold of 20 ug/dL or 0.20 ppm, with the highest lead level being 0.73 ppm. Lee et al., (2020) research on blood lead levels in relation to smoking and chronic obstructive pulmonary disease (COPD): a study from the Korea National Health and Nutrition Examination Survey (KNHANES) concluded that smoking status, occupation, and education level along with advanced age and male gender were independently associated with higher blood lead levels. This research was conducted with the aim of analyzing the relationship between blood lead levels and smoking habits among retail petrol sellers as a group that is vulnerable to lead exposure.

## **METHOD**

This study employed a descriptive-analytical approach with a cross-sectional research design. Blood lead levels were measured in the Batu Ampar sub-district, Balikpapan City. The study population included retail gasoline sellers who had been actively working for at least six months, were aged between 22 and 60 years, and were smokers. A purposive sampling technique was utilized. The equipment used for sample collection included ballpoint pens, permanent markers, labels, tourniquets, alcohol swabs, 3 cc needles, EDTA vacuum tubes, bandages, cool boxes, and the ICP-OES examination method. The research process involved obtaining ethical clearance, conducting interviews, obtaining informed consent, administering questionnaires on work habits. The questionnaire was distributed using form and tested for validity Correlation Product Moment, items with a total score of 0.612-0.899 so it can be said that all items are valid with a significance of 0.01. The reliability test used Cronbach's Alpha with a result of 0.899 so that the questionnaire was declared reliable. Next procedure labeling EDTA vacuum tubes, collecting venous blood samples, and storing them in ice boxes before sending them to Labkesda DKI Jakarta for analysis.

## RESULT

This study included 20 respondents, with the majority aged 41-50 years (45%). Most respondents had been working for less than three years (60%) and worked eight-hour shifts (55%). The majority had been smoking for over five years (70%), consumed fewer than one pack of cigarettes daily (80%), and smoked almost daily (75%). Additionally, 85% of respondents did not use PPE. Blood lead levels were detectable in 50% of respondents. The statistical analysis indicated that blood lead levels were undetectable in 15% of respondents who smoked infrequently and 35% who smoked daily. Conversely, 10% of respondents with detectable lead levels were infrequent smokers, while 40% were daily smokers. Table 1 presents the Spearman correlation value (0.115), suggesting a very weak relationship between smoking habits and blood lead levels. The p-value (0.628) exceeded the 0.05 threshold, indicating no statistically significant relationship between blood lead levels and smoking habits among retail gasoline sellers.

Table 1.  
Distribution of correlation between blood lead levels and smoking habits

| Description   | Undetected |    | Detected |    | Correlation value | P value |
|---------------|------------|----|----------|----|-------------------|---------|
|               | f          | %  | f        | %  |                   |         |
| Smoking habit | Seldom     | 3  | 15       | 2  | 0.115             | 0.628   |
|               | Everyday   | 7  | 35       | 8  |                   |         |
| Total         | 10         | 50 | 10       | 50 |                   |         |

The statistical distribution of lead levels in the blood of petrol sellers with a smoking habit, it was found that blood lead levels in the respondents were undetectable, namely 3 respondents (15%) with an infrequent smoking pattern and 7 respondents (35%) with an active daily smoking pattern. On the other hand, there were 2 respondents (10%) with detectable blood lead levels who had an infrequent smoking pattern and 8 respondents (40%) with an active daily smoking pattern.

Table 2.  
Lead Level Concentration

| No | Sample Code | Lead level (µg/dL) |
|----|-------------|--------------------|
| 1  | A1          | <0,228             |
| 2  | A2          | 5,442              |
| 3  | A3          | <0,228             |
| 4  | A4          | 6,610              |
| 5  | A5          | <0,228             |
| 6  | A6          | <0,228             |
| 7  | A7          | 6,240              |
| 8  | A8          | <0,228             |
| 9  | A9          | <0,228             |
| 10 | A10         | 7,584              |
| 11 | A11         | 7,064              |
| 12 | A12         | <0,228             |
| 13 | A13         | 6,998              |
| 14 | A14         | 8,634              |
| 15 | A15         | 6,574              |
| 16 | A16         | 7,982              |
| 17 | A17         | <0,228             |
| 18 | A18         | <0,228             |
| 19 | A19         | <0,228             |
| 20 | A20         | 6,000              |

Based on table 1, it shows that the correlation value of blood lead levels with smoking habits is 0.115, so the strength of the relationship between the 2 variables is very weak. The correlation was low (0.115), indicating smoking patterns did not significantly influence lead

levels. The p-value obtained is 0.628, because  $0.628 > 0.05$  means the hypothesis is rejected, so there is no statistically significant relationship between blood lead levels and smoking habits among retail petrol sellers in the Batu Ampar sub-district area, Balikpapan City.

Based on table 2, the lead (Pb) levels obtained from this study showed that 10 respondents had undetectable lead levels and 10 other respondents were detected with the highest results obtained at 8.634  $\mu\text{g/dL}$  in sample A14 while the lowest lead levels were  $<0.228 \mu\text{g/dL}$  in samples A1, A3, A5, A6, A8, A9, A12, A17, A18, and A19.

## **DISCUSSION**

To mitigate exposure, increased awareness of lead toxicity is essential. Education on lead-related health risks, proper PPE usage, and hygiene practices can help reduce lead absorption. The government should enforce stricter regulations on fuel quality and workplace safety to limit occupational exposure. The blood lead levels in the blood of retail petrol sellers studied by researchers were still below the threshold. Research by Dewi et al. (2015) found that the maximum limit for lead content in gasoline is 0.013 g/L. Utami's research (2021) found that the lead metal content in gasoline circulating in Bandung reached approximately 0.117 g/L. In the retail gasoline business, frequent blending practices (for example, with old leaded fuel, kerosene, or industrial solvents) can increase the lead content. Contamination from storage in containers that previously contained leaded fuel can also be a source of higher lead levels. Lead in gasoline, especially leaded gasoline, can pollute the environment through motor vehicle exhaust emissions. When leaded fuel is burned, lead is released into the air in the form of fine particles or aerosols (Olowoyo et al., 2024). About 75-90% of the lead in leaded gasoline will be released into the atmosphere through vehicle exhaust. These lead particles can remain in the air for a long time, especially in areas with heavy traffic, before finally settling into soil or water. This causes significant air pollution and increases the risk of exposure for humans, especially those who work or live near highways such as retail gasoline sellers.

Blood lead levels in this study could come from various sources of exposure, both those directly related to the work activities of petrol sellers and other sources from the surrounding environment. The primary source of exposure for gasoline sellers is gasoline vapors and lead particles that may be inhaled during the refueling process, especially if they are exposed to leaded gasoline or contaminated gasoline. In addition, vehicle exhaust containing lead residue from exhaust emissions can also be a contributor, especially in areas with high traffic levels. Apart from that, smoking and exposure to cigarettes also have the potential for lead exposure. The results suggest that occupational exposure, rather than smoking habits, may be the primary factor influencing blood lead levels among retail gasoline sellers. Other potential exposure sources include direct inhalation of gasoline vapors, prolonged contact with lead-contaminated surfaces, and environmental pollution from high-traffic areas. Lead exposure is cumulative, meaning that even if initial blood lead levels are low, continued exposure can result in significant health risks over time (Nur Laili, 2019). Blood levels will decrease gradually with a half-life of 30–40 days when lead exposure stops (Nur Laili, 2019). It is important to minimize exposure from the start because the cumulative nature of lead can cause toxic effects even if initial levels are low. Reducing blood lead levels in this study can begin by increasing awareness of the risks of lead exposure. Education about the health risks of lead, such as nerve damage, anemia and kidney problems, should be given to petrol sellers. They also need to be given training on the proper use of personal protective equipment (PPE), such as masks and gloves, to minimize contact with gasoline vapors and lead particles (Lathifah et al., 2022). In addition, education about personal hygiene, such as washing hands after work and before eating, can help prevent lead from entering the body through food or

drink. This can be seen from the minimal use of level 1 PPE (low risk), namely the use of masks and gloves among respondents in this study, at least respondents were required to wear masks (Hasrianto et al., 2024).

Petrol sellers are also advised to keep their distance from sources of vehicle smoke and refuel in open areas. Regular checks of lead levels in retail gasoline must be carried out to ensure that the fuel sold meets standards and is free from lead. In addition, the government needs to tighten regulations against illegal fuel mixing and ensure that only unleaded gasoline is on the market. This research was carried out using the Spearman rank test, the results of which show that the p-value or significance value for the variables of smoking habits and blood lead levels is with a correlation value of 0.115 and a p-value of 0.628. A correlation value of 0.115 indicates that there is a very weak relationship between smoking habits and blood lead levels. This means that changes in smoking habits were not significantly associated with changes in blood lead levels of retail gasoline sellers. The p-value is 0.628, which means the p-value is more than 0.05, which shows that there is no significant relationship between blood lead levels and smoking habits among retail petrol sellers. The results of this study contradict previous research, namely research conducted by Shinta (2020) showing that there is a relationship between smoking habits and blood lead levels.

This can be caused by various factors that influence blood lead levels, where the main lead exposure may come from the work environment or other sources that are more dominant than the contribution from smoking habits. In this condition, exposure to gasoline vapors and air pollution from motorized vehicles is likely to be the main cause of lead accumulation in the respondent's blood. Although cigarettes contain small amounts of lead, their contribution to blood lead levels may be insignificant when compared with intense exposure in workplaces on the streets where there is a lot of vehicle fumes. In addition, smoking habits can have varying effects on blood lead levels depending on the number of cigarettes consumed and the duration of the habit. In this study, variations in respondents' smoking patterns may have prevented a consistent relationship between smoking habits and lead levels. Other factors such as work duration, use of personal protective equipment (PPE), and distance of the workplace from sources of vehicle pollution also need to be taken into account as factors that more dominantly influence blood lead levels. Despite the insignificant results, smoking habits still need to be reduced or avoided because they can increase exposure to other toxicants that are dangerous for retail gasoline sellers.

Blood lead levels in this study also have a relationship with other factors such as length of work, frequency of work, length of smoking, cigarette consumption, and the use of personal protective equipment (PPE) at retail petrol sellers is a complex issue, because these various factors can interact with each other and influence lead levels in the body. One factor that has a significant influence is length of work. Retail gasoline sellers who have been on the job for a long period of time tend to have higher lead exposure than those who are new to the job. The longer a person is exposed to gasoline vapors and vehicle pollution, the greater the chance of lead accumulating in the body. This continuous exposure worsens the level of lead contamination in the blood, considering that lead does not break down easily and can accumulate in the body. Apart from the length of work, the frequency of work can also affect blood lead levels. Gasoline sellers who work more frequently, especially those who work long hours or heavier shifts, are more frequently exposed to air pollution and fuel containing lead. The more frequently they are exposed to retail fuels and vehicle fumes, the higher the potential for lead to enter the body. A higher work frequency is associated with a greater level of exposure, which can ultimately lead to increased blood lead levels, especially if control of the work environment and use of PPE are not optimal.

Duration of smoking and cigarette consumption are also factors that can influence blood lead levels, although the influence may not be as big as occupational factors. Cigarettes contain small amounts of lead which can be inhaled and enter the body. The longer a person smokes and the greater the number of cigarettes consumed, the greater the likelihood of exposure to lead from these cigarettes. However, although smoking can increase blood lead levels, the effect is often smaller than exposure from the workplace. Retail gasoline salespeople who smoke may have slightly higher lead levels than those who don't, but occupational environmental factors remain a major contributor to lead exposure. However, in Restuaji's (2023) research, it was found that there was no influence between the duration of cigarette consumption and lead levels in active smokers. Other factors that need to be considered in this research are the conditions of the work environment and the work practices applied. Gasoline sellers who work in places that are directly exposed to vehicle fumes are more likely to be exposed to large amounts of lead. Additionally, inadequate work practices, such as mixing leaded fuel with other fuels, can also increase the risk of lead exposure. Therefore, the use of PPE, at least masks, needs to be applied.

The interaction between these factors may lead to more significant accumulation of lead in the blood. Workers with smoking habits who work in poor environmental conditions and without adequate PPE are at high risk of experiencing greater lead exposure. However, smoking habits can increase lead exposure, the effect tends to be smaller when compared to exposure that occurs in uncontrolled work environments. Therefore, a comprehensive approach to reducing lead exposure must involve improving working conditions, appropriate use of PPE, as well as stricter health monitoring for workers. Overall, to reduce blood lead levels in retail gasoline sellers, interventions focused on managing the work environment and increasing the use of PPE should be a top priority. The government and related parties must tighten regulations regarding the use of leaded fuel and ensure that workplaces meet adequate health and safety standards. Apart from that, education about health risks and prevention is also important to increase awareness of workers and the public regarding the importance of maintaining health through controlling existing risk factors.

## **CONCLUSION**

Most retail gasoline sellers in this study were smokers. Blood lead levels among respondents were evenly distributed between detectable and undetectable levels, with the lowest recorded lead level at  $<0.228 \mu\text{g/dL}$  and the highest at  $8.634 \mu\text{g/dL}$ . However, no statistically significant correlation was found between blood lead levels and smoking habits.

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