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Lead Contamination in Driver's Blood and Its Effects on Erythrocytes, Leukocytes, and Platelets as A Biomarker

Pra Dian Mariadi, Agnes Felicia Lubis*, Lidwina Septie Ch
*e-mail: agnesfelicia@ukmc.ac.id

Department of medical laboratory Technology, Faculty of Health,
Katolik Musi Charitas University
Palembang, Indonesia

ABSTRACT

Lead as a component of air pollution has broad toxic effects and can be detrimental to humans, such as causing abnormalities in kidney function, digestive tract, nervous system, and hematopoietic disorders. Many people carry out their activities on the highway, one of which is an Angkot driver. Drivers who work on the road daily get direct exposure to air pollution, especially from lead (Pb). Therefore they are very vulnerable to the negative effects of lead (Pb). This study aimed to measure blood lead levels as a biomarker of lead contamination in a driving group in Palembang City. The subjects were drivers who had been working for more than 20 years (average 28 years) and the average age was 58 years. Testing blood lead levels using the APHA method and examining erythrocytes leukocytes and platelets using the impedance method and correlation test using the Spearman test. Based on the results of this study, there is a relationship between blood lead levels and erythrocyte (significance: 0.0019) and leukocyte (significance: 0.002) values, but there is no relationship between blood lead levels and platelet values (significance: 0.4), while blood lead levels in drivers are still within the threshold limit (average: 14.9804 µg/L).

Keywords: Blood, Erythrocytes, Lead, Leukocytes, Platelet

INTRODUCTION

Lead (Pb) was among the first metals that humanity had ever found. Lead is widely utilized in a variety of industries, including automotive, paint, ceramics, plastics, and others, due to its characteristics of softness, high malleability, ductility, low melting point, and corrosion resistance. As a result, free lead has become much more common in biologically inert and biologically living situations (Flora, et.al 2012). Lead or lead (Pb) is reported to have an impact on health caused by increasing industrial activity, urbanization, population growth, and other human activities in recent years. (Basil, Ridgway, and Basil 2008). Moreover, the sources of pollutants from anthropogenic activities include the disposal of heavy metals in wastewater, production activities, the use of phosphate fertilizers, as well as burning of waste, coal, and fuel (Barsova et al. 2018). These harmful materials have polluted the water contents as well as the fish for human consumption such as *Channa sriata* (Mariadi et al. 2019), *Anas moscha, Cairina moschata* (K. Mariadi 2018), *Pangasius polyuranodon* or *Juaro* (P. D. Mariadi and Sebayang 2017) which live in Sekanak River (P. D. Mariadi et al. 2021)

The level of exposure to heavy metals such as lead can also be caused by lifestyle, food consumed, and the position of residential (Mezynska and Brzóska 2017). Lots of research has found that lead metal is neurotoxic. In addition, lead also has systemic and carcinogenic

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effects (Gusnita 2012). In women, there is a relationship between thyroxine levels in serum and blood lead levels. Specifically, thyroxine levels will decrease with increasing blood lead levels (Putri, Rosyada, and Sunarsih 2018). Further investigation revealed that lead increased the levels of leukocytes (Lily Gunawan, Onny Setiani 2013). Besides, the increased levels of heavy metals in the blood also indicate disruption of enzyme activity in the formation of hemoglobin decrease the number of reticulocytes, and increase levels of iron or *ferrum* (Fe) in the blood plasma. (Lailiyana, et.al. 2018)

In the bodies of living things, lead-based substances can ingest and build up. Smoking practices consequence in exposure to heavy metals in the body (Hao et al. 2014). Lead can enter the body via eating food that has been cultivated in an environment contaminated with lead, breathing in dust that has been blown in by the wind, ingesting lead-infected water, or swallowing lead-contaminated soil. When Pb builds up in food, it can be extremely dangerous for human health, especially when eating meat from animals (Kumar, et.al. 2020). In addition to food, lead can enter the body by inhaling vehicle fumes or being contaminated with lead-containing environments such as roads. Several studies have shown that the taxi driver profession has a positive correlation with the level of exposure to pollutants. The path of entry of these pollutants comes from the respiratory process (Brucker et al. 2013). Other studies have shown taxi drivers are at higher risk of exposure to heavy metals such as Hg, As, Pb, and Cd (Brücker et al. 2014). Pb metal in car exhaust can harm the environment and provide a health risk. Every day breathing in by humans will cause the metal Pb to be absorbed, stored, and eventually deposited in the blood. One significant element influencing the characteristics of lead in the body is its chemical form. Tetraethyl Pb and other organic Pb components can be instantly absorbed by the body through the skin and mucous membranes. The primary sources of lead in the body are the digestive and respiratory systems, where organic Pb metal is mostly absorbed (Koosgiarto, et.al. 2015). According to studies (Zhang Yingfei 2020). The presence of lead metal in the fuel and paint industries is the main determining factor. Besides, other things that cause an increase of lead metal in blood lead levels are industrial activities, traffic jams, and waste.

The presence of heavy metals in the form of lead will result in disturbances of several hematological parameters such as leukocytes, erythrocytes, and platelets. Lead that enters the body can affect the number of erythrocytes because it can increase protoporphyrin in erythrocytes, thereby reducing the number of erythrocytes (Cut Juliana, Nurjazuli 2017). Based on these earlier studies, the researchers are interested in learning more about the extent of Pb contamination in the blood of the research participants who are drivers as well as hematological variables like leukocytes, erythrocytes, and platelets.

MATERIAL AND METHOD

This type of research is analytic observational research, namely research that advances the study of health problems with a community or social group approach. Researchers did not perform any treatment or manipulation of the variables studied (Siswanto et al 2013). The subjects of this study were drivers with more than 20 years of service and used a cross-sectional research design intending to study risk factors with the emergence of effects and take and examine samples at one time (Notoatmojo, 2018).

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Examination of lead levels in the blood was carried out using the APHA 3120: 2017 method in the Palembang Health Laboratory Center (BBLK) laboratory and examination of erythrocytes (RBC), leukocytes (WBC), and platelets (PLT) using the impedance method utilizing the XP 100 tools in the Faculty of Hematology Laboratory Health Sciences of UKMC.

RESULT AND DISCUSSION

The subjects of this study are drivers both within and outside the city with work experience of over 20 years. The characteristics of the research subjects can be seen in Table 1.

Table 1. Characteristics of research subjects

No	Description	Mean
1	subject	5
2	Subject Age	58 y.o. (46-65 y.o.)
3	Experience as a driver	28 years (24-35 years)
4	Number of daily cigarette consumption	12 sticks (8-16 sticks)

Based on table 1. It can be seen that the research subjects were drivers who had more than 24 years of experience with an average of 28 years of experience both as intra-city and inter-city drivers. All research subjects were active smokers with an average daily consumption of 12 cigarettes.

Checking the condition of the research subjects begins with method verification and Internal Quality Assurance (PMI) which aims to ensure that the methods used get valid results and are suitable for use. This study has limitations because it can only provide verification and PMI from hematological examinations, while blood lead levels are only displayed in the form of blood lead levels according to Table 2.

Table 2 Method Verification Test Results

No	Test	Normal RBC Control	Acceptance	Normal PLT Control	Acceptance	Normal WBC Control	Acceptance
1	Precision	0.12%	< 2%	1.5 %	< 6%	1.16 %	< 3.5 %
2	Accuracy	-0.79 %	± 2%	0.54 %	± 5%	1.74 %	± 3%
3	Tea	-0.55 %	± 6%	3.54 %	± 6%	4.06 %	± 15%

Verification of the method for examining the count of Erythrocytes (RBC), Platelets (PLT), and Leukocytes (WBC) obtained accuracy, precision, and TEa values. From the results of this study, it can be seen that the value of precision and accuracy is within acceptable limits, meaning that the accuracy and thoroughness of the method can be continued for sample examination. The TEa value is within acceptable limits because the total error in the examination of the count of erythrocytes is smaller than the provisions. According to (Jemani 2019) if the precision and accuracy results are within acceptable limits, it can be continued for examination of the sample.

Examination of the research sample can be seen in Table 3.

Table 3. Research Data

No	Variable	Mean	Normality Test	SD	Significance	Person Correlation
1	Lead Level	14.9804 µg/L	0.119	13.8594	-	-
2	Leukocytes (WBC)	8.17 x 10^3/ µL	0.544	0.7328	0.002	0.988
3	Erytrocytes (RBC)	5.09 x 10^6 / µL	0.688	0.5757	0.0019	0.937
4	Platelets (PLT)	245 x 10^3 / µL	0.081	49.9	0.4	-0.492

The results of testing the four variables above, namely Pb levels in the blood, Leukocytes (WBC), Erythrocytes (RBC), and Platelets (PLT) showed that
The data were normally distributed so that the parametric test was continued, namely the Pearson correlation test. The results showed that there was a relationship between Pb levels and the number of erythrocytes and leukocytes

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with a high affinity in a positive direction. and there is no relationship between Pb levels in the blood and the number of platelets in a negative correlation direction.

In this study, there was a relationship between PB levels in the blood and the number of erythrocytes, supported by research conducted by In this study there is a relationship between the content of Pb in the blood with the number of erythrocytes. Similar to research by Juliana et al. (2017), which also states that there is a relationship between blood Pb content and erythrocytes. According to Prasetya (2021), Lead metal is toxic can accumulate in the body, and can have an impact on human health. One of the effects of exposure to lead is to interfere with heme production which affects the hematological system and shortens the life of red blood cells (erythrocytes) so that it can cause anemia. Lead binds to erythrocytes after entering the bloodstream. Because lead is harmful, it will cause erythrocytes to lyse or break down before they have a chance to rebuild. Depending on the level of exposure and the time of regeneration of erythrocytes, the type of damage varies. In this study, no one had an erythrocyte count below normal values. This could be possible because the exposure to lead (Pb) levels in the respondents was not too high so that it did not cause severe hematopoiesis disorders.

Lead also has an impact on the process of hematopoiesis, namely by preventing the production of blood cells, differentiation of leukocytes, and platelets from myeloblasts in the bone marrow. Exposure to lead will cause leukocytes and platelets to become more in need of oxygen and produce superoxide. As a result of the spontaneous dismutation of superoxide, hydrogen peroxide (H_2O_2) and oxygen peroxide (O_2) are produced. Due to the action of the enzyme Superoxide Dismutase (SOD), this process is noticeably enhanced (Farmand et al. 2005).

The number of erythrocytes in the body can be disrupted due to various factors such as drugs, dehydration, physical activity, smoking, and the presence of heavy metals (Kiswari, 2014; (Permenkes RI No 43 TAHUN 2013). The process of entering leads through the stages of absorption, and distribution. At the absorption stage, lead enters the body through inhalation, skin (dermal), and digestion (oral) (Fibrianti, 2015; Rosita, 2018). In this study, lead enters the body through the skin. Heavy metals in the blood that enter the body can trigger an increase in protoporphyrin in erythrocytes so that it can reduce erythrocytes, thereby inhibiting heme synthesis (Cut Juliana, Nurjazuli 2017). Furthermore, the blood lead levels of the respondents were still within the allowable range indicating normal blood lead levels. According to the researchers, this has not affected the number of erythrocytes in the blood.

The relationship between lead and leukocyte levels is supported by research conducted by Gunawan et al. (2013), Lorenzo (2006) dan Soleman et al. (2020). This study concluded that a relationship between lead levels and leukocyte counts. This causes a low leukocyte count to interfere with the development of leukocytes to be inhibited, while a high leukocyte count shows an increase, especially in monocytes and neutrophils which function as phagocytic cells. Leukocytes that carry out phagocytic functions need to consume more oxygen quickly and are involved in explosive respiration (oxygen burst/respiration burst) (Murray Robert K et al., 2003). Lead enters through inhalation and is absorbed into the blood which can change the structure and number of leukocytes. This can result in a

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rapid intake of oxygen followed by a pause lasting between 15 and 60 seconds and the creation of significant amounts of reactive oxygen derivatives. Leukocytes are involved in phagocytosis, which results in the production of free radicals and reactive oxygen species (ROS), which interfere with SOD function (Murray Robert K et al., 2003).

Meanwhile, there is no significant relationship between lead levels and platelet counts. This is in line with research conducted by Gunawan et al. (2013), Hasanah et al. (2018) dan (Tyas 2021). In this study, lead exposure had a milder impact on platelet disorders than on leukocyte disorders. The enzymes Superoxidase Dismutase (SOD), Catalase (CAT), and Glutathione peroxidase (GPx) are part of the body's defense system which neutralizes the free radicals produced. A situation known as oxidative stress occurs when the body's defense mechanisms are overwhelmed by free radicals. This occurs when the balance between free radicals and antioxidant activity is disturbed, leading to tissue damage. Cell membrane degradation occurs before free radicals destroy cells. Platelet disorders require interactions between stimuli and receptors, G protein activation, phospholipase C stimulation, inositol triphosphate production, which increases intracellular Ca^{2+} ion levels, and protein kinase activation (Murray et al., 2013).

In addition, heavy metal lead is one of the toxic and toxic pollutants (Setianto and Fahritsani, 2019). Lead (Pb) from motor vehicles comes from the combustion of Pb additives in gasoline-fueled vehicles that will produce Pb in organic emissions. Gasoline-fueled vehicles that will produce Pb in organic emissions. Pb in the form of alkyl-pb compounds is used as a gasoline mixture that serves to increase the octane number of the fuel. Pb heavy metal mixed with fuel and oil, through processes in the engine, produces heavy metal. through the process inside the engine, produces heavy metals.

Pb that will escape through the exhaust along with other exhaust gases (Popescu, 2011). The entry of lead into human blood is due to long-term exposure to lead, when the amount of lead accumulated in the body will increase and can endanger health. This can happen because the exhaust fumes of motor vehicles emit lead particles which pollute the air and smokers, while consumption of food contaminated with lead, water, and dust seeps into the body and accumulates (Kumar et al., 2020).

In the body's tissues, the rest will also be wasted through metabolic waste such as urine and feces. Lead enters the body through inhalation, food contact, skin contact, and drinking water contaminated with lead. Lead is absorbed into the human body, and some is excreted through sweat, urine, and feces. Some will build up in hard tissues like teeth, nails, and hair as well as soft tissues like the kidneys, liver, spleen, and brain (Widowati, 2008). Blood lead (Pb) level is the amount of lead (Pb) in the blood which is an indicator when carrying out an examination.

In this study, the mean blood lead level was 14.9804 µg/L and the standard deviation was 13.8594. According to Rosita (2018), lead levels that are still within acceptable limits in human blood are around 10-25 µg/dl. Based on these data it can be seen that blood lead levels in drivers are still within the threshold. A lead level < 10 µg/dl does not yet indicate lead poisoning, a lead level of 10 – 14 µg/dl is considered a threshold, and a lead level > 14 µg/dl requires little intervention. Symptoms of acute lead poisoning generally do not become apparent until the lead level reaches 50 µg/dl or more. Lead poisoning is considered chronic if lead has

accumulated for more than 3 months (Betz, 2009).

CONCLUSION

Based on the results of this study, there is a relationship between blood lead levels and erythrocyte and leukocyte values, but there is no relationship between blood lead levels and platelet values, while blood lead levels in drivers are still within the threshold limit. Despite daily exposure to vehicle fumes, drivers do not experience lead poisoning and have no blood cell abnormalities.

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