

CORRELATION BETWEEN BLOOD LEAD EXPOSURE, BLOOD PRESSURE, AND HEMOGLOBIN LEVELS AMONG ONLINE MOTORCYCLE TAXI WORKERS

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Abstract

Background: Lead or Pb is a byproduct of fuel combustion in vehicle engines used as an anti-knock additive. Lead exposure can worsen the quality of air contaminated by motor vehicle emissions, which can affect the performance of online motorcycle taxi drivers. **Aims:** This study assesses the relationship between blood lead levels, blood pressure, and hemoglobin levels in online motorcycle taxi drivers in Dauh Puri Kelod Village. **Methods:** This study is an observational study using a cross-sectional design. The sample consisted of 30 respondents selected based on their length of work, age, and daily cigarette consumption. Data were collected through questionnaires, direct measurements, and lead examinations using the AAS method. The data were analyzed using Spearman rank correlation and multiple linear regression. **The results** The results showed a significant relationship between age and blood lead levels ($p=0.000$ and $r=0.989$); there was a significant relationship between the length of work and blood lead levels ($p=0.000$ and $r=0.683$); there was a relationship between the number of cigarettes consumed and blood lead levels, although the relationship was not very strong with a correlation of ($p=0.038$ and $r=0.381$); there was no significant relationship between blood lead levels and hemoglobin levels in online motorcycle taxi drivers ($p=0.369$ and $r=-0.170$); there was a significant relationship between blood lead levels and systolic blood pressure ($p=0.000$ and $r=0.975$) and diastolic blood pressure ($p=0.000$ and $r=0.810$). **Conclusions:** It is recommended to use personal protective equipment (masks) when working in gas stations and to monitor health at least once a year regularly.

Keywords: Lead, Online Motorcycle Taxi, Hemoglobin, Blood Pressure

1. Introduction

Lead or Pb is one of the byproducts formed during the combustion process in internal combustion engines. Its primary function is to boost the octane rating of the fuel and is used as an anti-knock additive in

vehicle engines. However, not all lead compounds burn during the operation of the vehicle engine, so the amount of lead released into the air through vehicle exhaust gases can be very high. Most of the heavy metal lead, approximately 75%, pollutes the air as exhaust fumes, while the remaining 25% is still inside the vehicle engine (1).

Lead emissions from motor vehicles can cause air pollution in various locations. Approximately 10% of lead emissions will contaminate areas within a distance of less than 100 meters from the vehicle, 5% will pollute areas within a 20-kilometer range, and the remaining 35% will be carried by the atmosphere, contaminating places far from the vehicles (2). Lead oxide dust particles released by motor vehicle exhaust can be inhaled by humans and enter the lungs. Premium gasoline used in motor vehicles contains Tetra Ethyl Lead (TEL) or tetraethyl-Pb and Tetra Methyl Lead or tetramethyl-Pb, which can release lead (3). Lead exposure can have chronic effects due to the progressively increasing cumulative dose over time. Rahayu noted that in 2012, the U.S. Centers for Disease Control and Prevention (CDC) set a normal limit for lead levels in adults that should not exceed 10 µg/dL (4).

Exposure to lead in the air can have serious implications for human health. This is due to the air pollution capability of lead, which can be inhaled and spread throughout the human body via the respiratory system. The higher the lead content in the air, the greater the risk of various health issues, such as brain damage, kidney damage, and even death. Therefore, it is crucial to take preventive measures to reduce lead emissions and minimize their adverse impact on human health and the environment (5).

The process of lead removal from the human body is slow, with a half-life of about 25 days in soft tissues and 40 days in bones. Therefore, lead tends to accumulate in the human body, whether related to occupation or not. Chronic lead accumulation can lead to lead poisoning due to continuous exposure over several months to years. Continuous exposure to organic or inorganic lead can affect the hematopoietic or blood-forming system in the human body. This condition can impact a decrease in hemoglobin levels, which should normally range between 13-16 g/dL in men and 12-14 g/dL in women⁶. If hemoglobin levels fall below the normal range, it can cause anemia characterized by symptoms such as fatigue, weakness, dizziness, difficulty concentrating, and vision problems (7).

Mulyadi states that according to the WHO, lead is one of the hazardous metals as a pollutant because it can accumulate in the human body and cause damage to vital organs such as blood, nerves, and kidneys (8). One of the impacts of chronic lead exposure is a disruption in hemoglobin production that can affect the red blood cell formation system. Continuous exposure to lead can interfere with enzyme synthesis in the hemoglobin formation pathway, leading to an increase in protoporphyrin levels in red blood cells.

Although several previous studies have investigated the relationship between lead levels and hemoglobin in workers

exposed to heavy metals, no significant correlation was found between blood lead levels and hemoglobin levels in employees of PT PLN Gresik (8,9). On the other hand, Khairunisa found that the majority of respondents at gas stations in Pekanbaru had low hemoglobin levels, although there was no direct influence from lead levels (10). In the study it was reported that long-term exposure to gasoline could affect hemoglobin parameters in gas station attendants in the city of Mekelle (11). The Sysmex XP-300 instrument was used to measure hemoglobin levels in this research, while purposive sampling technique and lead level testing with Atomic Absorption Spectroscopy (AAS) were employed to collect and analyze data.

The lead level in the air at the car painting facility reached 0.065372 ppm, while the average lead level in the blood of the workers reached 11.20 ppm (8). A relatively low lead level, between 5-35 µg/dL, can affect blood pressure and cause damage to the kidney channels (8). This is because lead dissolved in the blood can spread throughout the body, including the kidneys. The kidneys themselves play a crucial role in regulating blood pressure through the renin-angiotensin system. "In a study conducted by Fenga et al. in 2006 on battery industry workers in Messina, Italy, it was found that continuous exposure to low levels of lead could increase blood pressure in workers (12).

The number of motor vehicles, especially private vehicles used for online motorcycle taxi transportation for passengers and drivers, has significantly increased. This can elevate the risk of lead exposure, especially for online motorcycle taxi drivers operating on high-traffic roads such as Jalan PB Sudirman, Jalan Dewi Sartika, and Jalan Diponegoro. Lead exposure can worsen the air quality contaminated by motor vehicle emissions, leading to the accumulation of lead in the body and affecting the physical activity and performance of online motorcycle taxi drivers (5). Therefore, a study was conducted to assess the relationship between lead levels in the blood and blood pressure, as well as hemoglobin, in online motorcycle taxi workers operating in the Dauh Puri Kelod Village.

2. Research Methods

This study is an observational research with an analytical approach and a cross-sectional design. The research involves blood sample collection and examination, interviews, and observations. It was conducted in Dauh Puri Kelod Village and in the Chemistry Laboratory, which serves as the location for blood sample examination and collection. The study took place from January to April 2023, with a sample size of 30 individuals. Respondents were purposively selected to ensure information richness. Thus, the researchers aimed to obtain sufficient

information about the analysis of lead exposure in the blood concerning blood pressure and hemoglobin levels in online motorcycle taxi workers.

The sampling technique considered factors such as the willingness of online motorcycle taxi workers to participate by signing informed consent, respondents aged 25 and above potentially exposed directly to lead, and having work experience of more than 1 year. Data obtained from blood hemoglobin examination were then analyzed statistically. The statistical analyses used were Spearman rank correlation and multiple linear regression to assess the relationship between lead exposure analysis in the blood and blood pressure and hemoglobin levels in online motorcycle taxi workers.

3. Results and Discussions

The samples in this study are homogenous, consisting of male individuals working as online motorcycle taxi drivers who willingly participated as respondents. The age range of the respondents is between 28 and 50 years, with an average age of 40 years. The youngest respondent is 28 years old, while the oldest respondent is 50 years old. On average, respondents have been working for 5 years, with the shortest work experience being 4 years and the longest being 6 years. Regarding cigarette consumption, the majority of respondents consume 10 cigarettes per day, while the least consume 5 cigarettes per day, with an average consumption of around 7-8 cigarettes per day.

Information regarding the levels of lead in the blood, hemoglobin levels, and blood pressure can be seen in Table 1 below.

Table 1. Measurement Results of Lead Levels in Blood, Hemoglobin Levels, and Blood Pressure in Online Motorcycle Taxi Drivers

Variable	n	Min.	Max.	Mean	Std. Dev
Blood Lead	30	1.60	5.70	2.7833	0.79571
Blood Hemoglobin	30	12.40	18.10	16.2000	1.38813
Systolic Blood Pressure	30	100	170	148.3333	18.8155
Diastolic Blood Pressure	30	60	100	84.3333	12.2286

Based on the data in the table, it can be concluded that the average blood lead level in the research subjects (2.7833 µg/dL) is below the threshold set by the Ministry of Health, which is 5 µg/dL. Therefore, it can be interpreted that the majority of online motorcycle taxi drivers in the study have blood lead levels that are

still considered safe. Meanwhile, the average hemoglobin level in the blood (16.2000 g/dL) falls into the normal category, with a minimum value of 12.40 g/dL and a maximum of 18.10 g/dL. Thus, overall, online motorcycle taxi drivers in this study demonstrate a relatively good

health profile in terms of blood lead levels, hemoglobin, and blood pressure.

Lead is a heavy metal that can have negative effects on human health when accumulated in dangerous amounts. Workers exposed to lead over a long period fall into the high-risk group for experiencing these health impacts. Online motorcycle taxi drivers fall into this category because they often spend time on busy roads with motor vehicles, making them susceptible to exposure to motor vehicle exhaust and gasoline vapor containing lead. Inhaled lead enters the

lungs, is then absorbed by the blood, and is distributed throughout the body's tissues. To measure the concentration of lead in the human body, samples can be taken from blood, soft tissues, as well as mineral tissues such as bones, teeth, nails, and hair. Lead bound to red blood cells can accumulate in various organs such as the liver, kidneys, nerves, as well as mineral tissues like bones and teeth. Workers exposed to lead may experience various health problems, including disorders of the nervous system, organ damage, and a decrease in immune system function (13).

Table 2. Relationship Between Respondent Characteristics and Blood Lead Levels in Online Motorcycle Taxi Drivers

Variable	p-value	r	Conclusion	Correlation Strength
Age*Blood Lead Levels	0.000	0.989	Correlation	Very Strong
Work Experience*Blood Lead Levels	0.000	0.683	Correlation	Strong
Number of Cigarettes/Day*Blood Lead Levels	0.038	0.381	Correlation	Weak

The results of the statistical analysis indicate a significant relationship between age and blood lead levels with a p-value of 0.000 and a correlation coefficient of 0.989. This signifies that blood lead levels are significantly influenced by age, where the older someone is, the higher the likelihood of exposure to toxic substances such as lead. This can be attributed to the prolonged exposure to toxic substances throughout a person's life. Additionally, in older age, the immune system, metabolism, and organ

functions tend to decline, making these organs potentially less effective in extracting lead from the body compared to younger ages. This condition allows lead to accumulate more easily in the body tissues and may cause organ damage over an extended period (14).

The study conducted by Grandjean et al. in 2006 stated that lead exposure can cause various diseases in the nervous system, cardiovascular system, and immune system (15). Therefore, this research

emphasizes the importance of limiting human exposure to lead. Additionally, a study conducted by Lee et al. in 2014 also supports the finding that age can affect the levels of heavy metals in the blood (16). The research indicates that the older a person is, the higher the levels of heavy metals found in their body.

From the results of this study, it supports the theory that age can affect the lead content in the body. As age increases, the activity of biotransformation enzymes and the organ's ability to eliminate lead decrease, allowing lead to accumulate in body tissues, including the blood. Lead absorption into the body can occur through the respiratory tract and then enter the lungs. Lead can accumulate in red blood cells, extracellular fluid, and some soft tissues such as the liver, kidneys, nerves, as well as mineral tissues like bones, nails, hair, and teeth (13).

Based on the statistical test analysis, it was found that there is a significant relationship between the duration of work and the level of lead content in the blood, with a p-value of 0.000 and a correlation coefficient r of 0.683. This indicates that the longer someone works, the greater the likelihood of exposure to vehicle exhaust fumes that can increase the accumulation of lead in the human body. These results are consistent with previous research, such as that conducted by Gidlow et al. in 2015 and

Gomes et al. in 2015, which showed a correlation between the duration of work and lead levels in the blood of workers exposed to hazardous chemicals (17,18). The principles of accumulation and carcinogenicity of lead in the human body also support these findings. Gidlow et al. in 2015 reported that lead exposure in the industrial environment can increase the risk of an increase in lead concentration in the blood and organ damage (17). Therefore, workers who have been employed in industries with high lead exposure have a greater risk of an increase in lead levels in the blood.

From the statistical analysis results, it was found that there is a correlation between the number of cigarettes consumed and the concentration of lead in the blood, although the relationship is not very strong. The correlation coefficient of 0.381 and the p-value of 0.038 indicate that there is a relationship between the two variables, but the strength of the correlation is low. Lead in cigarette smoke is recognized as a major source of exposure in humans, which can explain the correlation. Cigarettes contain a significant amount of lead, and high cigarette consumption can increase the risk of lead exposure in the body. Lead in the human body can have adverse effects, such as organ damage, damage to the nervous system, and damage to the reproductive system. Therefore, reducing the number of

cigarettes consumed per day can help reduce lead exposure in the body and prevent adverse effects.

Based on the findings of this study, a weak correlation was found between cigarette consumption and lead concentration in the blood. This finding is consistent with previous research, such as the study conducted by Ahmad et al. in 2014, which showed a correlation between the number of cigarettes consumed per day and lead content in the blood of battery industry workers in Bangladesh (19). This study employed statistical tests that yielded a p-value of 0.012, indicating a significant

relationship between cigarette consumption and the level of lead in the blood.

Several previous studies also support these findings. For example, research conducted by Flora et al. in 2006 found a relationship between the number of cigarettes smoked and the level of lead in the blood of industrial workers exposed to hazardous chemicals (20). Additionally, a study by Lee et al. in 2014 showed a correlation between the number of cigarettes smoked and the level of heavy metals in the blood in the general population(21).

Table 3. Relationship Between Blood Lead Levels and Hemoglobin Levels in Online Motorcycle Taxi Drivers

Variable	p-value	r	Conclusion	Correlation Strength
Blood Lead Levels*Hemoglobin Levels	0.369	-0.170	No Correlation	Weak

Based on the statistical analysis results in Table 3, a relationship is observed between blood lead levels and hemoglobin levels in online motorcycle taxi drivers. However, the statistical test results show a p-value of 0.369 and a correlation coefficient (r) of -0.170, indicating no significant relationship between blood lead levels and hemoglobin levels in online motorcycle taxi drivers. Furthermore, the correlation strength between the two variables is also considered weak. These findings are consistent with several

previous studies that suggest a connection between blood lead and anemia, but not always a significant one.

Heavy metal lead has harmful effects on human health because it can accumulate in the body and cause damage to vital organs such as the brain, nerves, and kidneys. In the hematopoietic system, the negative impact of lead is disrupting the formation of hemoglobin, a protein containing iron that functions to carry oxygen from the lungs throughout the body²². According to the theory, blood lead

levels can affect hemoglobin levels because lead can interfere with the synthesis and metabolism of red blood cells. If exposed to a large amount of lead, it can lead to a decrease in hemoglobin levels and anemia. However, this study found no significant relationship between blood lead levels and hemoglobin levels in online motorcycle taxi drivers.

Several previous studies have also found similar results to this research. For example, the Central Statistics Agency conducted a study and found that there is no significant relationship between blood lead levels and hemoglobin levels in informal sector workers, including online motorcycle taxi drivers (23). This finding aligns with the research conducted by Rumende et al.

in 2017, indicating no significant relationship between blood lead levels and hemoglobin levels in tin mine workers in Bangka Belitung (24). However, a study conducted by Mulyadi in 2015 on automotive painters in Semarang showed a significant relationship between blood lead levels and hemoglobin levels, with a correlation value of 60.9% and a p-value of 0.008, and a correlation coefficient of $r = -0.609825$. Blood lead levels can inhibit heme synthesis by blocking the formation of porphobilinogen and the absorption of Fe^{2+} into hemoglobin, leading to an increase in the levels of d-aminolevulinic acid, coproporphyrin in urine, and protoporphyrin in erythrocytes (25).

Table 4. Relationship Between Blood Lead Levels and Blood Pressure in Online Motorcycle Taxi Drivers

Variable	p-value	r	Conclusion	Correlation Strength
Blood Lead Levels*Systolic Blood Pressure	0.000	0.975	Correlation	Strong
Blood Lead Levels*Diastolic Blood Pressure	0.000	0.810	Correlation	Strong

Based on the analysis in Table 4, it was found that both variables showed a p-value of 0.000, indicating a significant relationship between blood lead levels and systolic and diastolic blood pressure. Furthermore, the high correlation coefficients of 0.975 and 0.810 indicate a very strong relationship between these two variables. Previous studies have shown a

connection between exposure to heavy metals and an increase in blood pressure. According to a study conducted by Navas-Acien et al. in 2002, there is a correlation between lead and cadmium exposure and an increase in blood pressure in the general population (26). This can occur because lead can affect the cardiovascular system's function and stimulate the release of

aldosterone hormone, which can increase blood pressure. From the results of this study, it can be concluded that there is a significant relationship between blood lead levels and blood pressure in online

motorcycle taxi drivers. Therefore, it is important to reduce lead exposure in online motorcycle taxi drivers to prevent an increased risk of hypertension.

Table 5. Results of Multiple Linear Regression Analysis Between Potential Variables and Blood Lead Levels

Variable	B	Beta	t	p-value
Work Period	0.552	0.578	3.187	0.004
Number of Cigarettes/Day	-0.094	-0.148	-0.815	0.422

Table 5 contains the results of multiple linear regression analysis between potential variables, namely work period and the number of cigarettes consumed per day, with blood lead levels. In regression analysis, the beta coefficient is used to indicate how much influence an independent variable has on the dependent variable, while controlling for the effects of other variables. The analysis results show that the work period variable has a beta coefficient of 0.578 with a p-value of 0.004, indicating a positive and significant influence between the work period and blood lead levels. This means that the longer someone works, the greater the likelihood of lead exposure, and their blood lead levels are higher. Conversely, the variable of the number of cigarettes consumed per day has a beta coefficient of -0.148 with a p-value of 0.422, indicating that there is no significant influence between the number of cigarettes consumed per day and blood lead levels. In other

words, cigarette consumption does not significantly contribute to lead exposure.

The theory suggests that lead exposure primarily occurs in the workplace, such as in industries, construction, or mechanics. Prolonged work periods in these places can increase the risk of lead exposure and lead accumulation in the body. Lead accumulated in the body can damage the autonomic nervous system and disrupt the regulation of blood pressure. Additionally, lead can affect the renin-angiotensin system, responsible for blood pressure regulation. This can lead to increased blood pressure and the risk of cardiovascular diseases (27). Furthermore, smoking can also contribute to cardiovascular issues by affecting blood pressure. However, in this study, no significant relationship was found between the number of cigarettes consumed per day and blood lead levels. It is possible that the limited sample size may not be sufficient to detect a significant relationship, or there

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may be other uncontrolled factors in this study (28).

4. Conclusions

Based on the results of this study, it can be concluded that there is a significant correlation between age, work experience, and daily cigarette consumption with blood lead levels in online motorcycle taxi drivers. However, there is no significant relationship between blood lead levels and hemoglobin levels in online motorcycle taxi drivers. Furthermore, a significant relationship was found between blood lead levels and blood pressure (systolic and diastolic) in online motorcycle taxi drivers.

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