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ANALYSIS OF LEAD (PB) HEAVY METAL LEVELS IN HAIR OF EMPLOYEES OF CAR SHOWROOM 'X' WITH ATOMIC ABSORPTION SPECTROPHOTOMETER (AAS) METHOD

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Abstract

Background: Lead (Pb) is one of heavy metals that can cause poisoning. Exposure to air containing lead is caused by the use of fuel and paints that contain lead. Lead enters the human body through the digestive tract, respiration, and penetrates the skin where it accumulates in hair tissue.
Objective: Identify the element of lead in the body of car showroom employees and determine the effect of differences in the types of work of workshop and approachor employees's lead levels.
Methods: This research design used observational analytic with cross sectional design. Population and sample are 12 car showroom employees 'X' taken by purposive sampling technique. Statistic data were analyzed using Independent sample t-test with 95% of confidence level.
Results: The average lead level in workshop employees is 16,287 mg/kg and the average lead level for approachor is 20,56 mg kg^{-1}. Based on the analysis using the Independent sample t-test, the value of p = 0,220 (p> 0.05) showed that there is no effect of the type of employees's work on lead level in the hair of the car showroom employees 'X'.
Conclusion: The difference in the average lead level are caused approacher's employees is more expose to lead emmisions and lead paint compared to workshop's employees whose only exposed to lead emission.
Keywords: Hair, Approachor, Workshop , Lead

1. Introduction

Indonesia is one of the developing countries with the largest population in Southeast Asia, this makes Indonesia continue to develop development in all fields, one of which is development in the field of transportation. Development in the field of transportation is growing very rapidly, this is characterized by the continued increase in the number of motor vehicles such as passenger cars, bus cars, freight cars, and motorcycles. The increase in the number of passenger cars from 2016 to 2018 amounted to 1,860,321 units or an increase of 12.75% (Statistical Center Agency, 2018). This increase number of motorized vehicles has a positive impact, one of which is the creation of facilities and infrastructure that support human welfare, both in terms of ease of access to travel and in terms of the country's economy. However, the increase in the number of motorized vehicles also has a negative impact, one of which is the occurrence of air pollution. 66.34% of the total pollution comes from motor vehicle fumes (Noviyanti, 2012). In general, motorized vehicles in Indonesia still use lead-containing gasoline (Putra et al., 2015).

Lead is one of the dangerous elements found in vehicle fumes such as motorcycles, cars, buses, and other gasoline-fueled transportation (Noviyanti, 2012). Lead is used as a gasoline fuel mixture that

serves to increase the lubricating power, increase combustion efficiency so as to increase the performance of motorized vehicles. In the combustion process with gasoline in the engine, as much as 70% of lead comes out with exhaust gas emissions which are one of the pollutants in the air (Niman, 2019). The effects that are immediately felt after exposure to lead are coughing, heartburn, stinging eyes, and blurred vision. Other effects that will occur if exposed to lead continuously for a long time can cause disturbances in the hematopoietic system, nervous system, reproductive organs, gastrointestinal tract, and genitourinary system or kidneys (Soemirat, 2005). Lead can enter the human body through the digestive tract, respiratory tract, and also the skin where the absorption of the skin is so small that it can be ignored. When lead is absorbed in the body, as much as 95% of lead in the blood is bound by erythrocytes and will be transported to the organs of the body. Lead will be excreted in various ways, for example through the gastrointestinal tract and kidneys, but elements of lead in the body can be deposited in soft tissues (kidneys, liver, nervous system, bone marrow) and hard tissues (teeth, nails, bones, hair) (Putra et al. al., 2015). Hair is one of the parameters that is often used to determine the level of lead in the body because one of the places where lead is deposited in the body is in the hair. Analysis of lead levels in hair has advantages, it is easy implementation and simpler sample handling compared to analysis of lead levels in blood or urine (Mayaserli et al., 2018). Several community groups that fall into the high-risk category include traffic police, workshop workers, workers at Public Fuel Filling Stations (PFFS), street vendors, parking attendants, and others who are in direct and long-term contact with lead pollution. In workshops, motor vehicles are often tested because of testing activities that cause combustion and emission of gas emissions so that leaded air pollution occurs (Niman, 2019). Apart from workshops, car showrooms are also one of the places where leaded air pollution occurs. Not only car showrooms managed by large companies, but car showrooms managed by individuals can also be a place for leaded air pollution. One of the reasons is because in car showrooms that are managed by large companies and privately owned, both car decoration activities occur, such as painting where one of the components in the paint is lead. Lead in paint is used as a color pigment, a catalyst to accelerate the drying and spread of paint, and as an anti-corrosion agent on metal surfaces (Eka & Mukono, 2017). In addition, in the car showroom, engine heating activities are also carried out every day by the car showroom employees so that combustion often occurs and causes the car showroom employees to be potentially exposed to lead where the levels of lead in the employees' bodies will differ depending on the type of work (Suka, 2020).

The results of the study (Eka & Mukono, 2017) regarding the relationship between blood lead levels and hypertension of car painting workers in Surabaya, it can be seen that the lead levels of car repair workers in the car painting section are greater than the levels of administrative and finishing workers with levels of 13.06 g dL^{-1}. The results of the study (Putra et al., 2015) regarding the analysis of lead (Pb) levels in the hair and nails of traffic police in the city of Pekanbaru and the city of Bengkalis, it can be seen that the average level of lead in the hair more than the level of lead found in the nails with the highest levels in hair is 25.29 ppm. The results of the study (Samsuar et al., 2017) regarding the analysis of lead (Pb) levels in the hair of tire repair shop workers and carp along Jalan Soekarno-Hatta Bandar Lampung by Atomic Absorption Spectrophotometer (SSA), it can be seen that the tire repair shop workers who working in a positive workshop has been contaminated with lead in low levels with the highest lead content of 4.813 ppm.

The results of the study (Ajang et al., 2015) regarding the determination of the levels of Pb (lead) ions in the hair of workshop employees in the city of Samarinda, it can be seen that the hair of workshop employees in the city of Samarinda is positive for lead with the highest level of 0.3665 ppm and there is a relationship between the age of a workshop employee on the lead ion content in hair with a coefficient of determination (r) is 0.839. The results of a study (Suka, 2020) regarding the analysis of heavy metal levels of lead (Pb) in bridge construction project workers in Kandui village using Atomic

Absorption Spectrophotometer (SSA), it can be seen that the levels of lead (Pb) for this type of concrete work's hair are higher than the iron work's hair with the highest level of 11.48 mg kg^{-1}. One method that can be used for the analysis of lead levels in hair is Atomic Absorption Spectrophotometer (AAS). The advantages of the AAS method are high accuracy, speed in analyzing, the number of samples used is relatively small, and it does not require the separation of the elements to be determined if there are other elements provided that there is a hollow cathode (Khopkar, 2008).

Based on the results of a preliminary study conducted by researchers on November 11, 2020, it is known that the 'X' car showroom which sells new cars and used cars was founded in 2010 and is led by 1 person and has 12 employees with different types of work, which are 2 employees in the promotion section; 3 employees who work directly in the field as supervisors and work in the administration department; 4 employees in the workshop which includes heating or testing, moving, and cleaning cars and 3 employees in the decoration section which includes painting and repairing cars. Based on the results of previous studies regarding air pollution containing lead caused by the combustion of gasoline-fueled motor vehicles and because one of the mixtures used in car paint makes researchers interested in conducting research on car showroom employees based on different types of work using the Atomic Absorption Spectrophotometer (AAS) method with the proposal title "Analysis of Lead (Pb) Heavy Metal Levels in Hair of Employees of Car Showroom 'X' with Atomic Absorption Spectrophotometer (AAS) Method".

2. Material and Methods

In this study, an analytical observational research design was used with a cross sectional research design for the sample where this research will be carried out in a laboratory with the aim of analyzing and knowing the levels of lead in the hair of the 'X' car showroom employees. The sampling technique in this research is purposive sampling.

Tools and materials

The tools that will be used in this research are stir bar, beaker, hot plate, label paper, filter paper, analytical balance, dropper, spatula, Atomic Absorption Spectrophotometer (AAS), plastic clip, oven, test tube, erlenmayer 100 ml, hair clipper and comb. The materials that will be used in this research are acetone, hydrochloric acid (HCl), nitric acid (HNO_3), perchloric acid ($HClO_4$), sodium hydroxide (NaOH), potassium iodide (KI), and hair samples from 6 participants.

3. Methods

Sampling.

Samples were obtained from cutting hair segments, hair was cut to a length of 0.5 cm – 1 cm from the root, then weighed 2 mg. After that, the sample was washed thoroughly. Then, the sample was dried and put into a plastic clip (Suka, 2020).

Wet Destruction

A total of 2 mg of the sample will be put into a 250 ml beaker and added a solution of $HClO_4$:HNO_3 (1:5). The sample was destroyed on a hotplate with a temperature of 100ºC until the solution was almost clear and produced white smoke. Then filter the solution using whatman paper number 42, dilute the filtered solution using a 50 ml volumetric flask with the addition of distilled water to the mark (Hidayati, 2014).

Qualitative Analysis

Each solution of the 6 samples that have been destroyed will be put into a 1 ml test tube. If 2-3 drops of KI reagent are added, a yellow precipitate will form, this indicates a positive sample containing lead. If 2-3 drops of NaOH reagent are added, there will be a change to white color, this indicates a positive sample containing lead. If 2-3 drops of HCl reagent are added, there will be a color change to white, this indicates a positive sample containing lead (Suka, 2020).

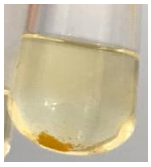
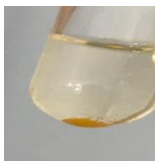
Quantitative Analysis

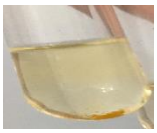
1. Preparation of lead mother liquor
   Preparation of 1000 ppm lead mother liquor will require 100mg/100ppm. A total of 100 mg of $Pb(NO)_3$ was weighed using an analytical balance. After that, put it into a 100 ml volumetric flask and dilute the $Pb(NO)_3$ with the addition of 1M HNO_3 to the volumetric flask limit mark (Suka, 2020).
2. Preparation of 100 ppm . lead standard solution
   A total of 10 ml of 1000 ppm mother liquor will be put into a 100 ml volumetric flask using a pipette. Then add 1M HNO_3 to the volumetric flask with the aim of dilution (Suka, 2020).
3. Preparation of standard 10 ppm . lead standard solution
   A total of 10 ml of 100 ppm mother liquor will be put into a 100 ml volumetric flask using a pipette. Then add 1M HNO_3 to the volumetric flask with the aim of dilution (Suka, 2020).
4. Preparation of 0.2 ppm standard solution; 0.5 ppm; 1 ppm; and 2 ppm
   A total of 2ml, 5ml, 10ml, and 20ml of the 10 ppm mother liquor, respectively, will be put into a 100 ml volumetric flask using a pipette. Then add 1M HNO_3 to the volumetric flask with the aim of dilution (Suka, 2020).
5. Analysis of lead content by Atomic Absorption Spectrophotometry
   Analysis of lead content in AAS used a wavelength of 283.3 nm. The instrument was first tested with a blank solution. After that, measure the absorbance of the Pb standard solution from low concentration to high concentration. Then take measurements on the sample solution resulting from wet digestion until the lead content is obtained (Suka, 2020).

4. Result and Discussion

Qualitative test

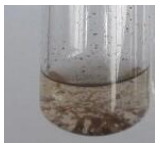
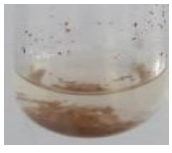
Table 1: Qualitative test result with KI reagen

Sample code	Reagen	Figure	Description	Result
A1	KI		Clear	-
A2	KI		Clear	-
A3	KI		Yellow precipitate	+
B1	KI		Yellow precipitate	+

B2	KI		Yellow precipitate	+
B3	KI		Yellow precipitate	+

(Source: Independent, 2021)

Table 2: Qualitative test result with NaOH reagen

Sample code	Reagen	Figure	Description	Result
A1	NaOH		Brown precipitate	-
A2	NaOH		Brown precipitate	-
A3	NaOH		Brown precipitate	-
B1	NaOH		Brown precipitate	-
B2	NaOH		Brown precipitate	-
B3	NaOH		Brown precipitate	-

(Source: Independent, 2021)

Table 3: Qualitative test result with HCl reagen

Sample code	Reagen	Figure	Description	Result
A1	HCl		Clear	-
A2	HCl		Clear	-
A3	HCl		Clear	-
B1	HCl		Clear	-
B2	HCl		Clear	-
B3	HCl		Clear	-

(Source: Independent, 2021)

Information:

- The positive symbol (+) indicates the reaction results from the study are considered in accordance with the literature (Description).
- The negative symbol (-) indicates the reaction results from the study are not in accordance with the literature (Description).

The qualitative test in this study used 3 reagents, which are KI, NaOH, and HCl. Qualitative test of lead heavy metal using KI reagent will form a yellow precipitate which indicates a positive sample containing lead (Pb) with the resulting reaction:

$Pb2+(aq) + 2KI \rightarrow PbI2 (\downarrow) + 2 K$

Qualitative test of heavy metal lead using NaOH reagent will form a white precipitate which indicates a positive sample containing heavy metal lead (Pb) with the resulting reaction:

$Pb2+(aq) + 2OH- \rightarrow PbOH (\downarrow)$

Qualitative test of heavy metal lead using HCL which can be seen in table 3, a white precipitate is formed if the sample is positive for heavy metal lead (Pb) with the reaction:

$Pb2+(aq) + 2Cl- \rightarrow PbCl (\downarrow)$

The qualitative test with KI reagent which can be seen in table 1 shows positive results for samples A3, B1, B2, and B3, while samples A1 and A2 show negative results. This negative result probably occurs because the lead (Pb) content in samples A1 and A2 is smaller than the other samples. The qualitative test with NaOH reagent which can be seen in table 2 and HCl reagent which can be seen in table 3 showed negative results for all samples. This result is probably due to the difference in sensitivity of the reagents where the NaOH and HCl reagents have a lower sensitivity than the sensitivity of the KI reagent to lead. This is reinforced by the results of previous studies conducted by (Suka, 2020) and (Martines et al., 2019) where both studies showed positive results on lead analyzed with KI reagents and negative results on lead analyzed with NaOH and HCl reagent.

Quantitative test

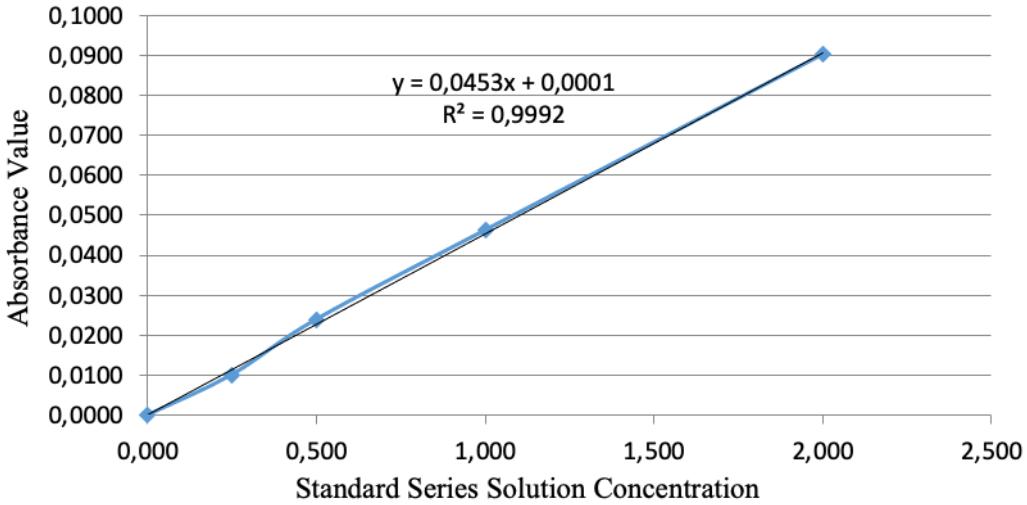
In the quantitative test, a calibration curve was obtained where this calibration curve was produced from measuring the absorbance of several lead standard series solutions, measuring the concentration using an atomic absorption spectrophotometer with a wavelength of 283.3 nm.

Table 4: Absorbance measurement results from standard solutions

Concentration	Absorbance
0.2500	0.0101
0.5000	0.0239
1.0000	0.0462
2.0000	0.0901

(Source: Baristand Lab, 2021)

After obtaining the absorbance results from the measurement of the lead standard solution, a calibration curve will be made as shown below:



(Source: Baristand Lab, 2021)

Figure 1: Calibration curve measurement results

Based on the results of the calibration curve of the relationship between the concentration and the absorbance value of the standard lead (Pb) solution above, the value of r (correlation coefficient) is 0.9992. The relationship between concentration (x) and absorbance value (y) forms a straight line. The linear regression equation for a standard solution of lead is:

Where:
Y= Absorbance/absorption
X= Concentration
A= Intercept
B= Slope

$$Y=bx+a$$

The quantitative test in this study begins with making a standard curve where this standard curve serves to determine the correlation between the concentration of the solution and its absorbance value. From the results of the standard series solution test listed in table 4, the linear regression equation is obtained as follows:

$Y = 0.0453x + 0.0001$

From the above equation, the correlation coefficient value (r) is 0.9992 where this value has met the predetermined requirements with a large correlation coefficient value or $r > 0.99$ in order to form a straight line on the standard solution curve, this shows the SSA tool used in good condition.

Lead level test

Table 5: Results of measuring lead levels in car showroom employees 'X'

Sample code	Sample mass (g)	Pb absorbance	Pb concentration (ppm)	Pb content (mg/kg)	Methode
A1	0,2594	0,0025	0,0540	10,409	SSA
A2	0,1664	0,0012	0,0250	7,512	SSA
A3	0,1519	0,0044	0,0940	30,941	SSA
B1	0,2272	0,0026	0,0560	12,324	SSA
B2	0,0809	0,0020	0,0410	25,340	SSA
B3	0,1832	0,0041	0,0880	24,017	SSA

(Source: Baristand Lab, 2021)

Information:

- Sample code A for employees with the type of workshop work.
- Sample code B for employees with the type of decoration job.

Testing the levels of heavy metal lead (Pb) in this study used atomic absorption spectrophotometry (AAS) with a wavelength of 283.3 nm. The results show that all samples contain heavy metal lead (Pb) with different levels between samples which can be seen in table 5 where the average lead content in the sample with the type of workshop work is smaller than the average lead content in the sample with the type of decorating work. The average lead content of the workshop employees is 16,287 mg kg^{-1} and the average lead content of the decorating employees is 20.56 mg/kg. The higher levels of lead (Pb) in this type of decoration employee are due to the activities carried out by employees who have the potential to be directly exposed to lead compared to employees with workshop activities. The type of car decorating work at the 'X' car showroom includes car repair and painting activities where usually in this activity the car will be updated regarding the inside and outside. Car paint is one of the important things in the decorating process because it will beautify the outer appearance of the car, but this car paint can cause exposure to the air because generally the composition in it contains lead compounds. The lead compounds in paints have different functions, for example as color pigments, catalysts, and as anti-corrosion agents (Eka & Mukono, 2017).

In addition, before or after the car decorating activity, employees will test or warm up the car first, which will cause exposure to leaded air due to exhaust emissions from cars that use lead-containing fuel. Exhaust emissions are a by-product of burning lead in the engine when heating and moving cars are carried out in the showroom. Lead that is often used in fuel is tetramethyl-Pb and tetraethyl-Pb

which are used for anti-knock on car engines (Mayaserli et al., 2018). The effects that are immediately felt after exposure to lead are coughing, heartburn, stinging eyes, and blurred vision. Other effects that will occur if exposed to lead continuously for a long time can cause disturbances in the hematopoietic system, nervous system, reproductive organs, gastrointestinal tract, and genitourinary system or kidneys (Soemirat, 2005). The results of the lead levels tested from several samples were analyzed using the SPSS system with an independent sample t-test which showed a p value of 0.220 where based on the theory if the p value > 0.05 then the hypothesis (H0) was rejected which means that there is no effect of the type of work on heavy metal content of lead (Pb) car showroom employee 'X'.

5. Conclusion

Based on the results of research conducted by researchers, it can be concluded that all hair samples of the 'X' car showroom employees, totaling 6 people, contained lead (Pb) heavy metal. Lead levels in each sample showed different results, which are: 10,409 mg kg^{-l}; 7.512 mg kg^{-l}; 30,941 mg kg^{-l}; 12,324 mg kg^{-l}; 25,340 mg kg^{-l}; and 24.017 mg kg^{-l}. The results of this lead content were analyzed using the SPSS system and obtained a p value of 0.220 so it can be concluded that there is no effect of the type of work (workshop and decoration) on the lead content in the hair of the 'X' car showroom employee so that the hypothesis is rejected.

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