Conference Paper

Hematology Analysis of Lead Exposure on Painting Workers (Case Study: Informal Automobile Painting Industries in Karasak, Bandung)

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Abstract

Lead is used as pigments in paint. Spray painting has been widely used in various industries, such as automobile painting. Exposure to dust and fumes containing lead compound needs a great concern of environmentalist who evaluates community in variety of occupational and environmental settings. This cross-sectional research analyzed lead exposure and hematologic aspect of informal automobile painting workers in Karasak, Bandung, Indonesia. Hematologic analytic used were Blood Lead Level (PbB), hemoglobin (Hb), hematocrite (Ht), erythrocyte count and basophilic stippling. The number of subjects was 30 male workers with particular criteria and 10 controls were used. Inhaled lead was analyzed by personal sampler and flame AAS, using NIOSH method 7082 issue 2 (1994). Blood lead level was analyzed by flame AAS based on NIOSH method 8003 issue 2 (1994). The measurement showed that painting had contributed in lead exposure to the workers. The average values were 1.241 µg/m^3 for lead exposure and 0.0026 µg/hour/kg BW for lead intake. PbB analysis gave result between 3.05 and 17.26 µg/100 ml blood. The result of Hb, Ht and erythrocyte count, respectively, were 11.4–16.2 g/dl, 34–51 percent and 3.89–5.77 x 106/mm. No basophilic stippling was found in peripheral blood slide. Subjects with low Hb, Ht, and erythrocyte count showed that lead in the occupational setting associated with hematology disorder, but not to acute toxicity, as there was no basophilic stippling detected.

Keywords: hematology, painting, lead, Blood Lead Level (PbB)

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1. Introduction

The determination of blood lead level is a part of health risk studies aimed at the population of workers and residents exposed to lead. The measurement of blood lead

concentration is often used as an indicator of lead exposure and part of the routine monitoring on workers in industry that deals with lead [1]. An overview of lead exposure can be obtained from a number of tissues and fluids in human body, such as blood, hair, teeth, bone, and urine. However, the measurement of lead concentration in blood is a widely accepted method as the most reliable one for lead exposure screening and diagnose yet can also be used as direct indicator related to amount of lead that came into the body [2, 3].

Generally, it has been known that lead exposure could have health risks, such as damage to central nervous and peripheral nerves, cardiovascular system, hematopoietic system, kidneys, digestive system, and reproductive system. It is also stated as carcinogenic element [4, 5]. Research of lead exposure hematology is very important because the erythrocytes in bone marrow and blood is the main lead toxicity target in adults [6].

Lead can cause erythrocytes haemolysis and inhibit the formation of hemoglobin [7]. Patrick [8] stated that lead can cause G-6PD enzyme deficiency dan pyrimidine-5'- nucleotidase enzyme inhibition in mature erythrocytes. This lead to the decline of the erythrocytes lifespan and increase the vulnerability of erythrocytes membrane, thus reduce the number of erythrocytes. According to Barbosa [2], the enzyme deficiency is characterized by the presence of basophilic stippling of erythrocytes. Study conducted by Richard [9] showed that lead could inhibit heme biosynthesis through the inhibition of δ-ALAD, coproporphyrinogen, and ferrochelatase enzyme, thus cause the reduction of hemoglobin concentration in blood. To complete the result of study, the measurement of enzyme concentration should be performed [10].

Paint is one source of lead exposure [11]. The compound of Pb with Cr (chromium), Mo (molybdenum) dan Cl (chlor) has been extensively used as "chrome" pigment. $PbCrO_4$ compound is used in paint industry to obtain the yellow-chrome color, $Pb(OH)_2{\cdot}2PbCO_3$ is used to obtain white tin color, while Pb_3O_4 is used to obtain red tin color [12].

Lead can be inhaled by workers through painting activities, especially spray painting. According to Ng and Beedham [13], the main portal of entry of lead exposure was through the inhalation. The reduction of lead concentration in paint and related research is important to be performed [14]. Previous study conducted by Rizkiani [15] showed the presence of lead content in the painting workers' blood in the area of present study.

This study attempted to measure the lead exposure raised from the car painting activities and analyze the effect to the hematology condition of the workers. The

analysis was done using air sample at the workers' breathing zone to obtain lead exposure and intake concentration, and the workers blood to get blood lead concentration (PbB/ Blood Lead Level). Examination of hemoglobin level, hematocrit, and number of erythrocytes was done to obtain lead effect on the mature erythrocytes hemolysis and hemoglobin biosynthesis inhibition. Analysis of basophilic stippling in the erythrocytes was done to detect the presence of acute lead poisoning.

2. Methods

The research was conducted using cross sectional epidemiological study where agent (lead exposure) and response (PbB) were studied simultaneously. The sample was taken in Karasak area, Bandung, January 2012, from 30 painting workers based on interview and questionnaire to all of the workers (69 people). 10 people of local citizen who lived far from painting location and did not work as the painter became control. The research has got the permit to conduct the study and to take data and sample from *Badan Kesatuan Bangsa dan Pemberdayaan Masyarakat* from Bandung City Government, the permit to take residents' health data from Bandung City Health Office, and ethical clearance from KEPK – BPPK Hasan Sadikin Hospital Bandung.

Data collection was done to obtain information related to the number and location of workshops, number of workers, car painting capacity per day, number of painted vehicle per day, operational hour, shifting system, and types of paint often used. Questionnaire was used to choose the homogenous and proper sample from painting worker population, and classify them according to age, length of service, frequency of painting, smoking habits, nutritional status and others.

Air sampling was performed according to NIOSH (National Institute of Occupational Safety and Health) 7082 issue 2 [16] method to obtained lead concentration inhaled by workers, using Personal Sampling Pump with filter MCE (cellulose ester membrane) pore of 0,8 µm, diameter of 37 mm. The activity was done for two hours in accordance with the average duration of workers doing the painting process (pace of 2 L/min) [17]. The inspection of lead in the filter was carried out using flame AAS (Spectra AA 100–200) at the Laboratory of Occupational Safety and Health Bandung. The amount of lead exposed the workers' breathing zone was converted to the amount of lead exposure inhaled by human respiration (lead intake), using equation 1 [7]:

$$I = (C \times IR)/W \quad (1)$$

I = Intake (µg/hour/kg body weight)

C = Pb concentration from air that exposed the inhalation (µg/m^3)

IR = Human inhalation rate, 2 L/minute

W = Body weight (kg)

The blood lead (PbB/Blood Lead Level) examination was performed cross sectionally after the end of work shift according to NIOSH 8003 issue 2 [18]. Blood collection was done intravena by medical officer from Bandung City Health Office. Examination of hemoglobin, hematocrit, and erythrocyte counts were performed on whole blood samples using Auto Hematology Analyzer Mindray BC-3000 plus at Health Laboratory of Bandung City Health Office. Basophilic stippling examination was done through blood smears that were given Giemsa stain, assisted by clinical pathologist from Bandung City Health Office.

3. Results and Discussion

The average measurements of lead exposure suffered by painting workers obtained in this study were 1.241 µg/m^3 (Figure 1), and the average of lead exposure intake was 0.0026 µg/hr/kg (Figure 2). The threshold value of lead on air based on ACGIH 2010 is 0.05 mg/m^3, thus the result of this study was still below the threshold. However, this result was higher than previous research by Rizkiani [15] at the same location, which was 0.6459 µg/m^3 for lead exposure and 0.001906 µg/hr/kg body weight for lead intake. According to Budiono [19], the amount of exposure and lead intake depends on the paint color used, the painting position, location (open or closed air) and physical factors, such as wind direction, temperature, humidity, air pressure, and also subject's weight.

Based on each paint color, the measured lead exposure could be different, as shown in Figure 3. The yellow color gave the highest lead exposure. This was in accordance with the literature issued by the Australian Government, Department of Environmental and Heritage (2003) in Rizkiani [15] which stated that the lead content was very high in red, yellow and orange paint color.

Analysis of lead in blood (PbB) showed an average value of 6.56 µg Pb/100 ml of blood. The value of Biological Exposure Indices (BEIs) of PbB is 30 µg/100 ml of blood based on US EPA 2010 and 25 µg/100 ml of blood based on WHO, so that lead concentration in blood of all subjects were still below the threshold. However, this result was higher than previous research by Rizkiani [15] in the same location, which was on average of 3.1336±1.2372 µg/100 ml of blood (before painting) and 4.3061±1.1767 µg/100 ml (after painting). Figure 4 shows the average blood lead levels in the painting

workers were higher than the control (2.46 µg/100 ml of blood). This illustrates that painting works had a risk to increase the concentration of lead in the blood.

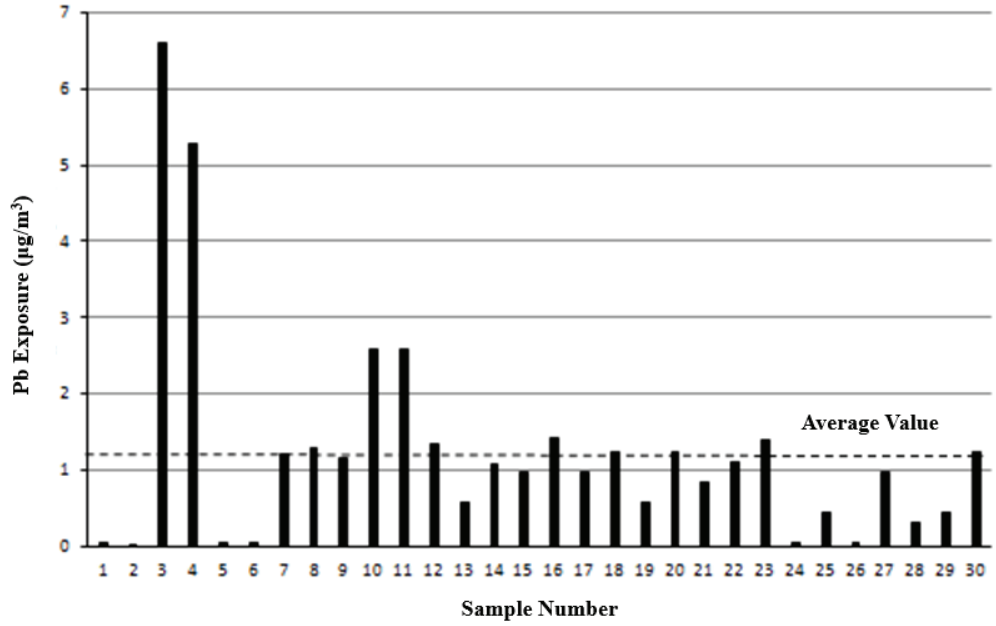

Figure 1: Lead exposure analysis result.

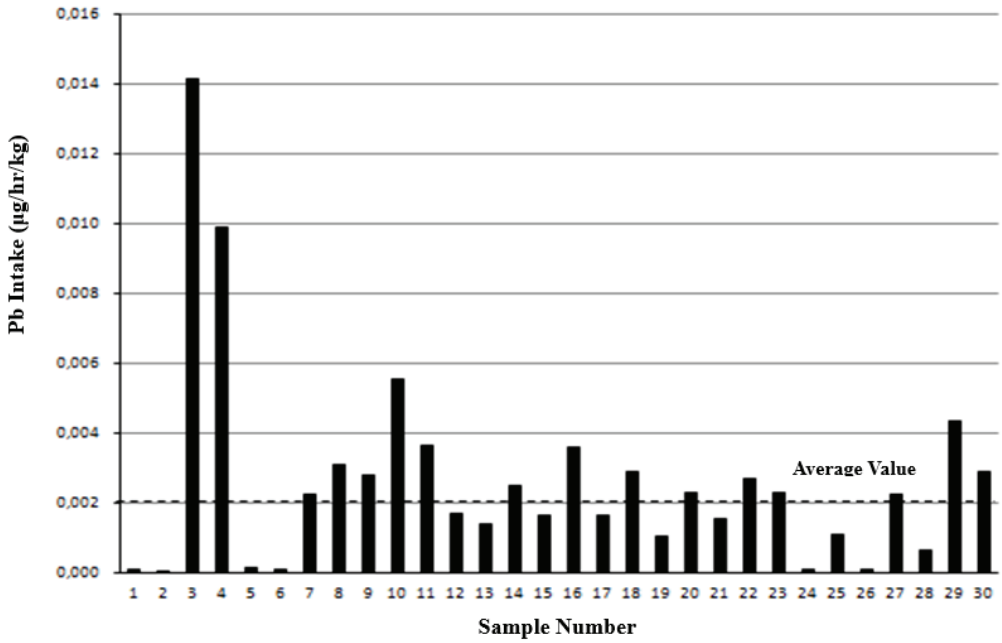

Figure 2: Lead intake calculation result.

The relationship between Pb concentration in blood (PbB) and lead exposure (Pb) was shown on Figure 5. Some of small Pb exposure value could result in high PbB concentration, on the contrary high Pb exposure value did not always provide high

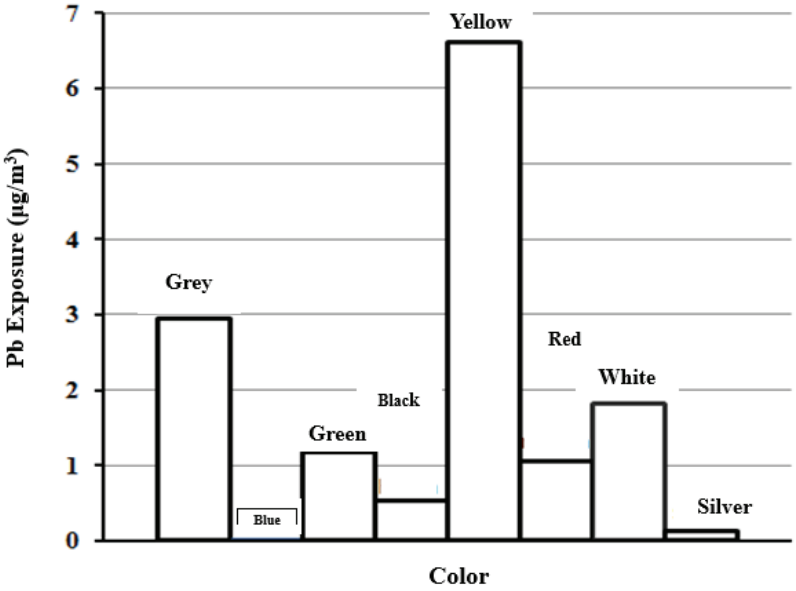

Figure 3: Lead exposure based on paint color.

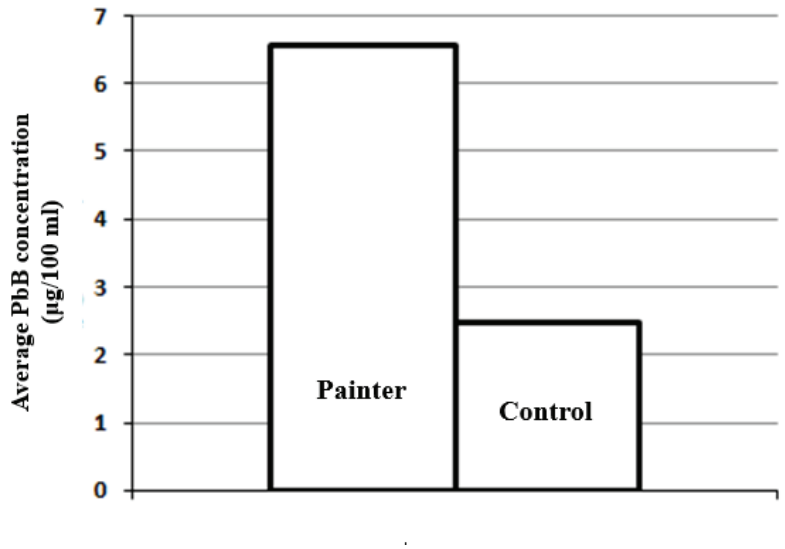

Figure 4: Average PbB concentration on painter and control.

PbB values. The relationship result of lead in blood and lead exposure was influenced by human factors that depend heavily on living habits, painting frequency, service life, and exposure level at the time of study.

The relationship of painting frequencies per week to Pb in blood can be seen in Figure 6. Based on the measurements, workers who painted each day had a higher PbB value than the workers who only painted 2–4 x per week.

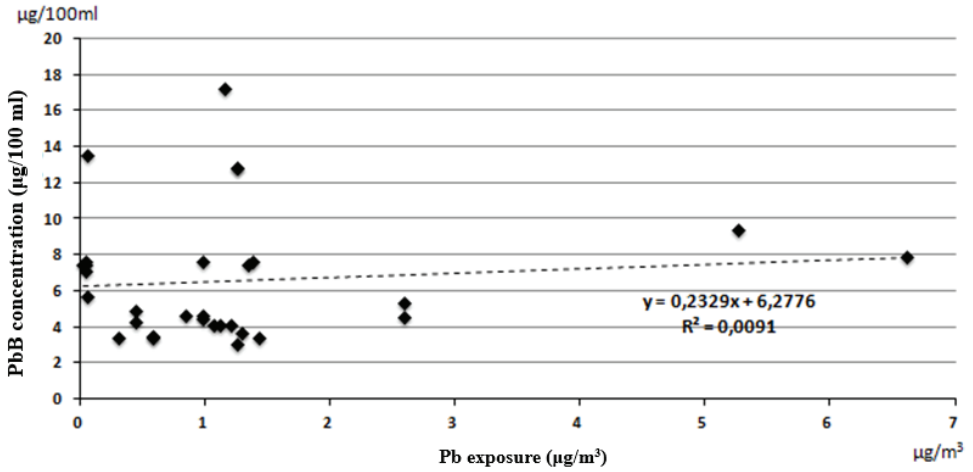

Figure 5: Relationship between PbB concentration and Pb exposure.

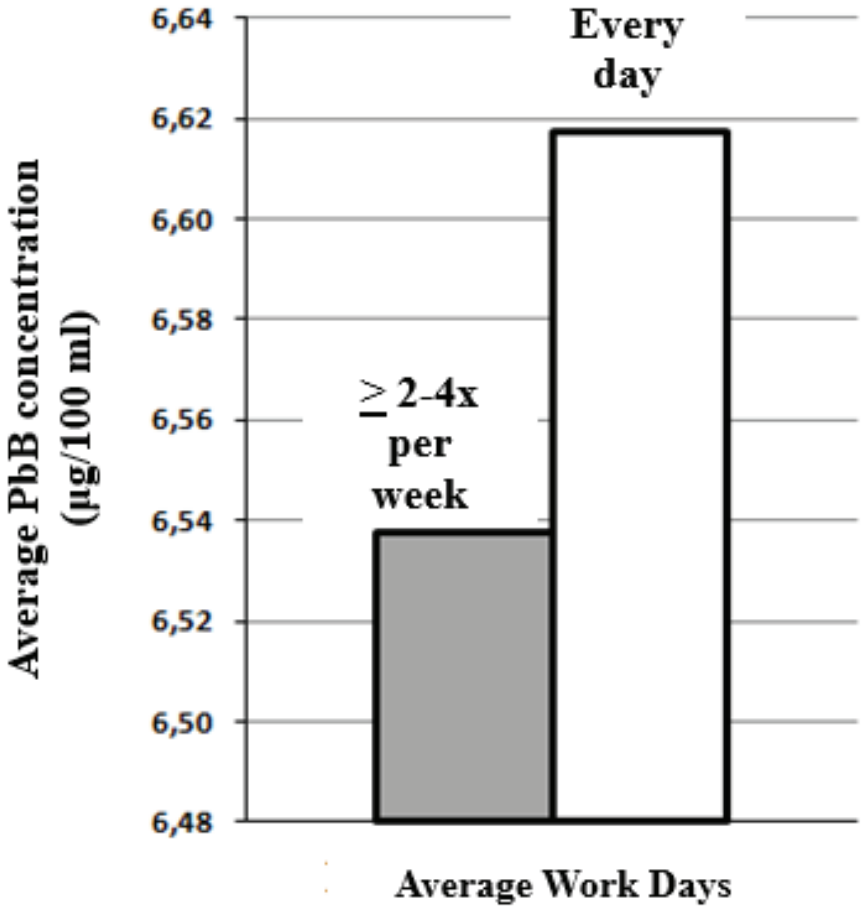

Figure 6: Average value of PbB based on painting frequencies.

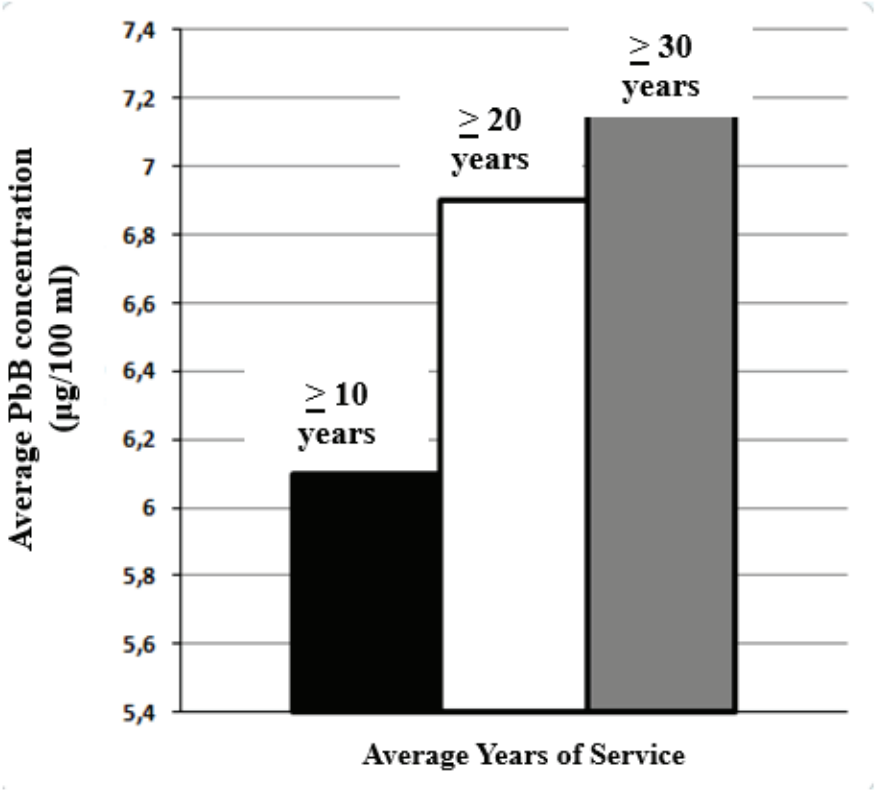

Figure 7: Average value of PbB based on years of service.

PbB relationship with the years of service is shown on Figure 7. The longer the service period, the higher the PbB value. This result was in accordance with Needleman [5] which stated that lead in blood is cumulative according to the duration of exposure.

The results of hemoglobin analysis in the study showed concentration range of 11.4–16.2 g/dl. The normal hemoglobin concentration for adult men is 14–18 g/dl, thus there were subjects that had the value below the normal limit. The relationship of lead in blood and hemoglobin was shown in Figure 8. The result was in accordance with Harrison and Laxen [20] which stated that although in small amounts, that is, <10µg/100ml, an increase in Pb concentration in blood may interfere hemoglobin formation by inhibition of δ ALAD enzymes. There was a tendency when the concentration of lead in the blood was increasing, the hemoglobin level was decreasing.

Levels of hematocrit obtained from the study had a range of 34–51 percent. The normal hematocrit level for adult men is 40–54 percent, thus there were subjects that have hematocrit value below the normal limit. The relationship of lead in blood and

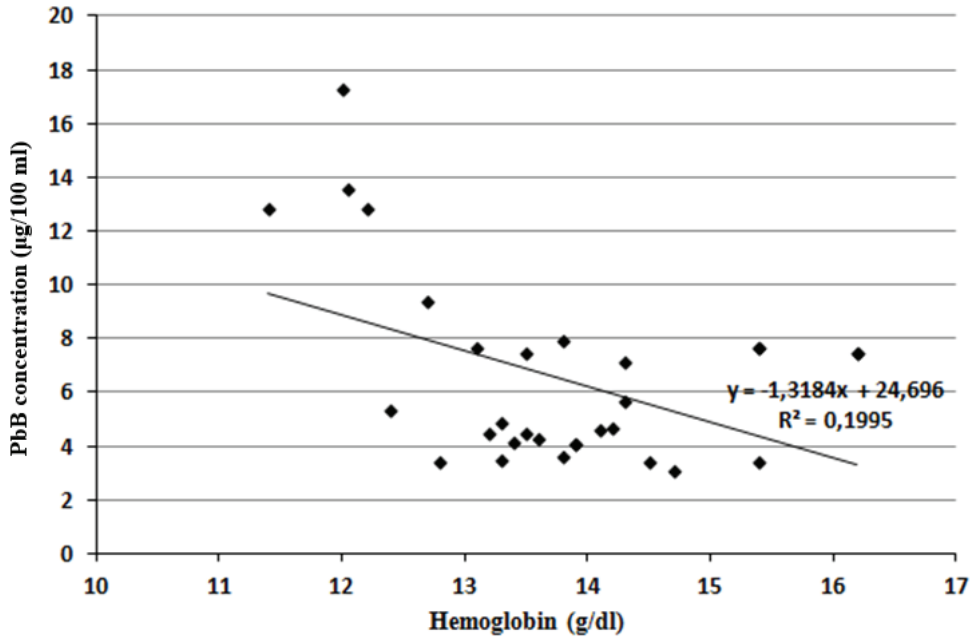

Figure 8: Relationship between blood Pb and hemoglobin.

hematocrit was shown in Figure 9. Hematocrit describes the percentage of mass (volume) of erythrocytes from whole blood. The amount of normal hematocrit is usually three times more than the volume of hemoglobin and can be used as an indicator of anemia [7]. Based on this study it could be known that there was a tendency that the hematocrit level would be decreasing when the concentration of lead in the blood was increasing. This was in accordance with the research of Barbosa [2] which stated that lead can decrease the amount of erythrocytes in total blood, which is described by depletion of hematocrit levels. Further statistical analysis was needed to test the association of this reduction in hematocrit levels with anemia as stated in Williams and Bursom [7]. The results of hematocrit and erythrocyte measurements would be linked to the results of questionnaires and health data from nearby community health center (*Puskesmas*) to obtain anemic features. At the time of the interview, most subjects complained experiencing some signs of anemia, such as dizziness, nausea, fatigue, lethargy and dizziness.

The results of the erythrocyte count analysis in this study showed a range of 3.89–5.77 $\times$ 10^6/mmk. The normal erythrocyte count for adult men is 4.5–6.5 $\times$ 10^6/mmk, thus there were subjects that have erythrocyte value below the normal limit. Figure 10 showed the relationship between lead in blood and the amount of erythrocytes. It could be known that there was a tendency that the higher concentration of lead in the blood, the lower the number of erythrocytes. According to research by Patrick [8], lead

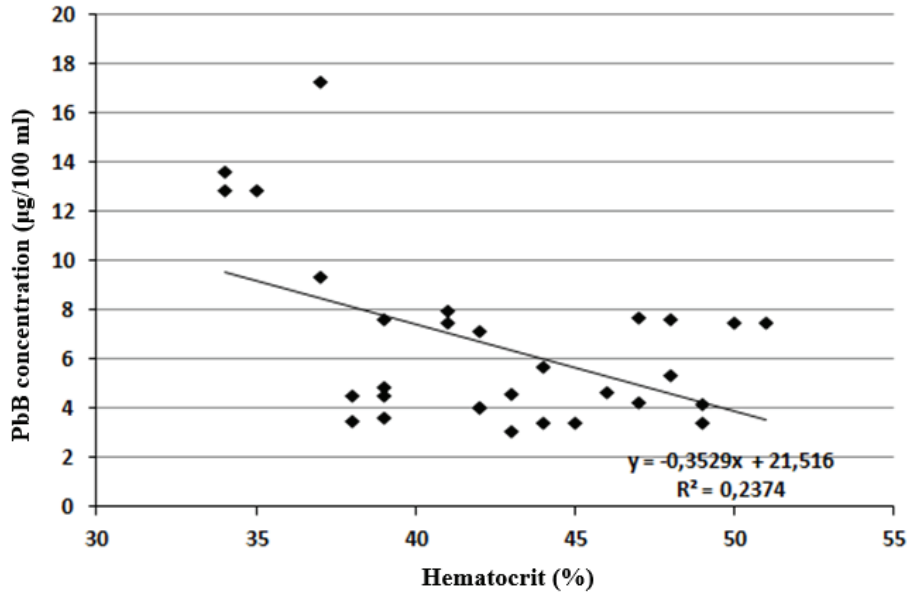

Figure 9: Relationship between blood Pb and hematocrit.

could cause hemolysis in mature erythrocytes, so the amount of erythrocytes would decrease.

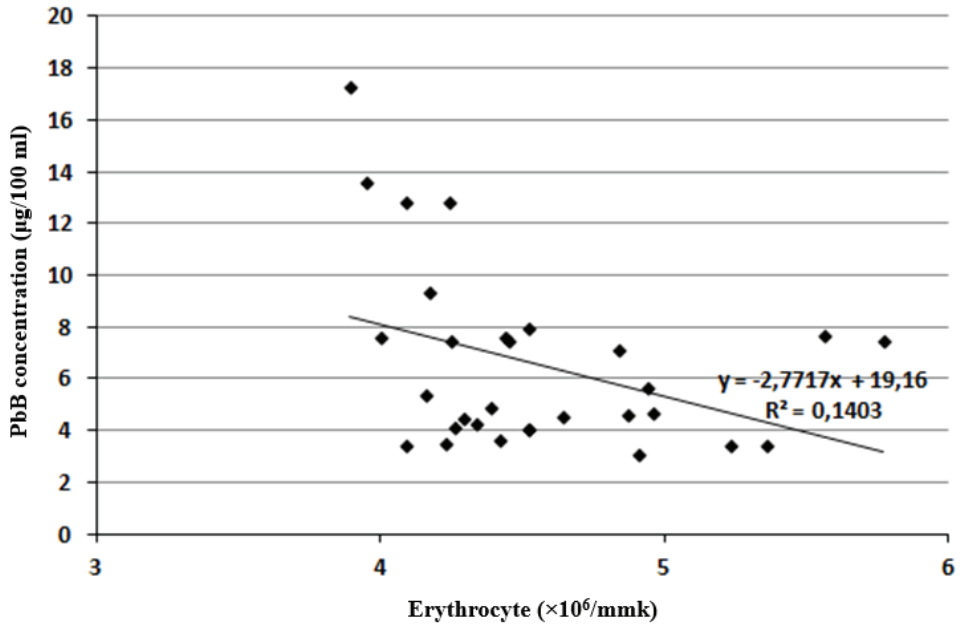

Figure 10: Relationship between blood Pb and erythrocyte.

The results of the analysis on blood smear showed that there was no basophilic strippling in all samples. Basophilic strippling is an indicator of acute poisoning for PbB concentrations above 60 µg/100 ml of blood [1]. However, the mean value of PbB

concentration obtained from this study was 6.56 µg Pb/100 ml of blood thus all subjects in the study did not experience acute lead poisoning.

4. Conclusions

The average measurement of lead exposure to painting workers obtained in this study was 1.241 µg/m^3 while the lead exposure intake was 0.0026 µg/hr/kg body weight. The average PbB value obtained was 6.56 µg Pb/100 ml of blood. The results of this study, whether lead exposure, lead intake, or lead concentration in blood, have values below the threshold, but higher than previous research results in the same location.

There was a tendency that the higher PbB value, the lower the concentration of hemoglobin, hematocrit and erythrocyte count. The presence of subjects with hemoglobin, hematocrit and erythrocyte counts below normal suggested that lead in the painting work environment associated with hematological abnormalities, a disturbance in the hemoglobin synthesis process and cause erythrocyte hemolysis. The absence of basophilic stippling showed no signs of acute lead poisoning in the blood of the subjects. According to OSHA standard (1997), based on PbB measurement results obtained, it is advisable to conduct medical surveillance in the working environment every 6 months.

Conflict of Interest

The authors declare no conflict of interest.

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