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Lead Level Correlation (Pb) in Blood on Hb Level, Hematocrit, Cystatin C Serum, SGOT and SGPT Serum On Car Paint Workshop in Rungkut, Surabaya

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ABSTRACT

An industrial upgrading will result in a variety of wastes being released into the environment that ultimately impact on public health. One of the hazardous wastes is Pb. The purpose of this research is to know the correlation of Pb in blood to hb level, hematocrit, serum Cystatin C, SGOT and SGPT serum and health complaints on car paint workers of workshop in Rungkut Sub-district Surabaya. This research was an observational research with cross sectional design. Sampling method using simple random sampling. The study sample consisted of 24 people. The result of statistical test shows that there is a correlation of Pb exposure in air to blood Pb level with contribution amount 80% ($r = 0.527$; $p = 0.008$). Decreased levels of hemoglobin, hematocrit, elevated serum Cystatin C levels, SGOT and SGPT serum and health complaints of nerve and liver function were associated with blood levels of Pb with $p < 0.05$. Based on the results of this study it can be concluded that the exposure of Pb in the air has a relationship to the increase of Pb levels in the blood of car paint workers of workshop in Rungkut Sub-district, Surabaya.

Keywords: Paint workers of workshop, Pb in air, PB in blood, Hemoglobin, Hematocrit

INTRODUCTION

The industrialization of the central position in the modern societal economy and is the driving force that provides the basis for an unprecedented increase of prosperity and mobility of individuals in most of the world's population, in developed countries. For developing countries, the industry is essential to realizing the development foundation and the increasing need of society. The current industry is viewed from working capital that can be grouped into several groups, namely large industry (basic industry), industry (industry variation), and small industry. Small industries with simple technology/traditional and with a relatively limited amount of capital is a industry that moves a lot in the informal sector.

Industrial development is very rapid in recent years, especially industrial development of the car is very diverse both in quality and quantity. The rapid growth of car production led to the need for car maintenance also increased especially car paint workshop. A car paint workshop is a car painting service business that increasingly increasingly serves the needs of the community.

Paint is a material very close to human life, paint contains metal Pb, Pb is found in pigment which is used as material for color painting. Pb is toxic and Pb toxicity is chronic and acute. Exposure to heavy and long Pb that is more than 10 years will cause irreversible kidney damage and often accompanied by hypertension. Hematocrit or compressed erythrocyte volume (CEV) is the percentage of the volume of erythrocytes in the compressed blood by rotating at a given speed and at a given time. Hematocrit examination is used to measure the ratio of total erythrocytes to the total number of red blood cells, hematocrit examination associated with anemia disease suffered by a person.

Cystatin C Serum examination is used to measure the condition of the kidney in the body, the serum Cystatin C examination is very important because this examination is very important to evaluate the condition of a person's kidneys, especially the condition of the worker's kidneys painters are daily exposed to paint vapor containing Pb with a large concentration⁽¹⁾. The liver is a large and complex gland in the body, brownish red, which has a variety of functions, including its role in helping digestion of food and metabolism of nutrients in the digestion of SGOT and SGPT is a marker of enzymes residing in the liver, the increase of SGOT and SGPT indicates impaired liver function. SGOT is a liver enzyme that is present in the liver parenchymal cells and increases levels in the blood if there is liver cell damage. SGPT is an enzyme contained in liver cells, therefore SGPT is more describes a person's liver function, when liver cells are damaged due to something good is a virus disorder or other disorders will be the enlargement of SGPT enzymes from liver cells to blood.

The results of the first observation of the condition of the car paint workshop room was not organized neatly, many cars are done in one room with various process activities done in the workshop. The paint workshop performs the sanding work, painted the painted part, sanding again, painting the base, then sanded, painted in color, and finishing with color compound. Most did not use personal protective equipment in the form of a mask mask, this can increase the risk of exposure of Pb vapors from paint workshop workers, less ventilation and limited space and accumulation of work done in a room, causing accumulated Pb particles in car paint workshops.

METHODS

This research was a field research with observational design. The population in this study was all workers who were in the car paint workshop in Surabaya as many as 30 people, with the comparison is the laboratory staff of UPN language "Veteran" Rungkut Subdistrict Surabaya. The sample in this study was the number of workers in the paint workshop especially in the car paint section. The sample of this research was worker of car paint workshop in Rungkut subdistrict Surabaya with the following inclusion criteria: 1) male; 2) has no history of Diabetes Mellitus, Cardiovascular and Chronic Kidney; 3) having a duration of exposure > 2 years; 4) aged 20 - 50 years; 5) willing to be a respondent in research by signing informed consent.

RESULTS

Table 1. Correlation Pb level of air with Pb level in blood of car paint workers of workshop

Variables	r	p
Pb Exposure in the air	0.00	0.00*
Age	-0.32	0.30
Exposure period	-0.41	0.18
Smoking habit	0.05	0.87
Nutritional status	0.37	0.22
Use of personal protective equipment (PPE)	-0.45	0.13

There was a relationship between Pb exposure in the air to Pb levels in the blood with $p = 0.00$ and $r = 0.00$, correlation coefficient indicates a positive relationship means there was a positive relationship between Pb air and blood Pb, if there was Pb air then will increase levels of Pb in the blood. The amount of contribution of the relationship between Pb air with blood Pb is 80%, while the age variable, exposure period, smoking, nutritional status, use of PPE does not show any relation with Pb level in blood.

Table 2. Correlation Pb level of air with Pb level in blood of Library officer of UPN Veteran Surabaya

Variables	R	p
Pb Exposure in the air	0.00	0.00*
Age	-0.32	0.30
Exposure period	-0.41	0.18
Smoking habit	0.05	0.87
Nutritional status	0.37	0.22
Use of personal protective equipment (PPE)	-0.45	0.13

There was relationship between Pb exposure in air to Pb levels in the blood with $p = 0.00$ and $r = 0.00$, beta cofisien shows a positive relationship means there was a positive relationship between Pb air and blood Pb, if there is Pb air then it will increase Pb levels in blood . The amount of contribution between Pb and Pb was 80%, while age, exposure, smoking, nutritional status, use of PPE did not show any association with blood levels of Pb.

Table 3. Correlation Blood Pb level with Hb Level in Blood of car paint workers of workshop

Variables	R	p
Pb Exposure in the air	-0.80	0.00*
Age	0.31	0.32
Exposure period	0.53	0.07
Smoking habit	-0.03	0.92
Nutritional status	-0.25	0.41
Use of personal protective equipment (PPE)	0.57	0.04

There was correlation of blood Pb with blood hb with p value = 0.00 and $r = -0.80$ with negative relationship direction. This shows that there is a relationship between blood Pb with Hb car paint workers of workshop . The magnitude of the contribution of blood Pb relationship with Hb is 80.5% which means there was a relationship between blood Pb with blood hb, the use of PPE also has a relationship with blood Hb as much as 57.8%, it shows the use of PPE has a relationship with the decrease in Hb blood while the age variable, smoking habits, nutritional status has no relationship with blood Hb.

Table 4. Correlation blood Pb level with Hb level in Blood of Library Officer of UPN Veteran Surabaya

Variables	r	p
Pb Exposure in the air	0.60	0.03*
Age	-0.46	0.12
Exposure period	-0.35	0.27
Smoking habit	0.95	0.00*
Nutritional status	-0.29	0.35
Use of personal protective equipment (PPE)	-0.11	0.28

There was correlation of blood Pb with Hb blood of library officer of UPN Veteran Surabaya with value $p = 0.03$ and $r = 0.60$ with positive relationship direction. This indicates a relationship of blood Pb with blood hb of library officer of UPN Veteran Surabaya. The magnitude of the contribution of blood Pb relationship is 60%, which means there is a relationship between blood Pb with blood clerk library officer UPN Veteran Surabaya. Smoking habit variables have a relationship with blood as much as 95.6%, while the age variable, exposure period, nutritional status, use of PPE has no relationship with blood hb.

Table 5. Correlation blood Pb level with hematocrit of car paint workers of workshop

Variables	r	p
Pb Exposure in the air	-0.80	0.00*
Age	0.31	0.32
Exposure period	0.53	0.07
Smoking habit	-0.03	0.92
Nutritional status	-0.25	0.41
Use of personal protective equipment (PPE)	0.57	0.04

There was relationship between blood Pb with hematocrit blood of car paint workers of workshop with value $p = 0.00$ and $r = -0.80$ with negative relationship direction. This indicates a relationship of blood Pb with blood Hb of car paint workers of workshop. Magnitude contribution of blood Pb relationship is 80% which means there was a relationship between blood Pb with hematocrit blood of car paint workers of workshop. The use of PPE has a relationship between blood Pb with hematocrit as much as 57.8%. Age variables, exposure period, smoking habit, nutritional status, use of PPE have no relation to blood hematocrit.

Table 6. Correlation blood Pb level with hematocrit of Library officer of UPN Veteran Surabaya

Variables	r	p
Pb Exposure in the air	0.20	0.51
Age	-0.46	0.12
Exposure period	-0.03	0.16
Smoking habit	0.95	0.00*
Nutritional status	-0.29	0.35
Use of personal protective equipment (PPE)	-0.24	0.15

There was not correlation between blood Pb with hematocrit of library officer of UPN Veteran Surabaya with value $r = 0.20$ and $p = 0.51$. Smoking habits have a significant relationship with hematocrit. Variables age, exposure period, nutritional status and use of PPE did not affect to the hematocrit level of Library Officer of UPN Veteran Surabaya.

Table 7. Correlation blood Pb level with cystatin C serum level of car paint workers of workshop

Variables	r	p
Pb Exposure in the air	0.67	0.01*
Age	0.31	0.32
Exposure period	-0.03	0.92
Smoking habit	-0.25	0.41
Nutritional status	0.57	0.04
Use of personal protective equipment (PPE)	0.67	0.01*

There was correlation between blood Pb with Cystatin C blood serum car workshop workers with $p = 0.01$ and $r = 0.67$ with positive relationship direction. This showed the presence of blood Pb relationship with Cystatin C blood serum car paint workers of workshop in Rungkut Surabaya. The magnitude of the contribution of blood Pb relationship is 67% which means there was a relationship between blood Pb Cystatin C serum workshop car paint worker in Rungkut Surabaya. Smoking variables were associated with serum Cystatin C. The use of PPE also has a relationship with serum Cystatin C whereas the age, exposure, nutritional status variables have no association with serum Cystatin C.

Table 8. Correlation blood Pb level with cystatin C serum level of Library officer of UPN Veteran Surabaya

Variables	r	P
Pb Exposure in the air	0.41	0.18
Age	-0.46	0.12
Exposure period	-0.01	0.19
Smoking habit	-0.29	0.35
Nutritional status	-0.26	0.21
Use of personal protective equipment (PPE)	0.41	0.18

There was no correlation between blood Pb with Cystatin C serum blood of library officer of UPN Veteran. Age factors, duration of exposure, smoking, nutritional status and use of PPE also had no association with serum Cystatin C.

Table 9. Correlation blood Pb level with serum SGOT level of car paint workers of workshop

Variables	r	P
Pb Exposure in the air	0.50	0.09
Age	0.31	0.32
Exposure period	0.53	0.07
Smoking habit	-0.03	0.92
Nutritional status	-0.25	0.41
Use of personal protective equipment (PPE)	0.57	0.09

The correlation between blood Pb with SGOT blood serum car paint workers of workshop with $p = 0.09$ and $r = 0.50$ with positive relationship direction. This showed the absence of blood Pb relationship with blood serum SGOT car paint workers in Rungkut Surabaya. Magnitude contribution of blood Pb relationship was 50% which means there was a relationship between blood SGOT serum workshop car paint workshop in Rungkut. Age variable, exposure period, smoking habit, use of PPE has no relation with SGOT serum car paint workers.

Table 10. Correlation blood Pb level with serum SGOT level of Library officer of UPN Veteran Surabaya

Variables	r	p
Pb Exposure in the air	-0.02	0.93
Age	-0.46	0.12
Exposure period	-0.22	0.33
Smoking habit	0.95	0.00*
Nutritional status	-0.29	0.35
Use of personal protective equipment (PPE)	-0.22	0.14

Absence of relationship between blood Pb with SGOT blood library officer of UPN Veteran Surabaya with value $p = 0.93$ and $r = -0.02$. there is a relationship between smoking habit with SGOT library officer UPN Veteran Surabaya while age variable, exposure period, nutritional status, use of PPE have no relation with SGOT serum.

Table 11. Correlation blood Pb level with serum SGPT level of car paint workers of workshop

Variables	r	p
Pb Exposure in the air	0.07	0.81
Age	0.31	0.32
Exposure period	0.53	0.07
Smoking habit	-0.03	0.92
Nutritional status	-0.25	0.41
Use of personal protective equipment (PPE)	0.57	0.04*

It can be seen that there is no relationship between blood Pb with SGPT blood serum of library officer of UPN Veteran Surabaya, this can be known by ($p = 0.81$, $r = 0.07$). The use of PPE has a relationship with SGPT. There is no age, exposure, smoking habit, nutritional status, to serum blood serum SGPT level of Library officer of UPN Veteran Surabaya.

Table 12. Correlation blood Pb level with serum SGPT level of Library officer of UPN Veteran Surabaya

Variables	r	p
Pb Exposure in the air	-0.03	0.91
Age	-0.46	0.12
Exposure period	0.22	0.33
Smoking habit	0.95	0.00*
Nutritional status	-0.29	0.35
Use of personal protective equipment (PPE)	0.22	0.12

There was no relationship between blood Pb and SGPT blood library officers of UPN Veteran Surabaya. There was a relationship between smoking habits with SGPT library officers of UPN Veteran Surabaya. Age variables, exposure period, nutritional status, use of PPE had no association with SGPT serum.

DISCUSSION

Correlation between Pb Level in Air and Pb Level in Blood

According to the Environmental Protection Agency about 25% of Pb heavy metals are on the engine and another 75% will pollute the air environment as emissions. Pb emissions from exhaust gases will cause air pollution wherever located, the stage is: as much as 10% will pollute the location within a radius of less than 100 m, 5% will pollute the location within a radius of 20 km and another 35% carry the atmosphere in a considerable distance⁽²⁾. Automobile paint industry is one industry that uses Pb pigment as the basic material of paint making. The most commonly used Pb are Pb chromate (PbCrO_4), Pb of molybdate chromate ($\text{Pb}_2\text{Cr}_2\text{H}_2\text{O}_{11}$), and Pb sulphate (PbSO_4). Pb chromate is made in a variety of crystalline structures to produce different colors, including "Chrome yellow", "yellow chrome" and "orange chrome" (orange).

Pb of molybdate chromate produces bright red pigments. The mixture of Pb chromate with Pb sulphate and other compounds produces many colors such as "promise chrome", "lemon chrome" (greenish-greenish yellow), and "chrome green" (mixture of Pb chromate with blue iron). The Pb compound can also be used as a drying agent and a catalyst in oil based paints, to allow the paint to dry faster and spread evenly. Pb-based anti-corrosion agents are sometimes used in paints that inhibit corrosion of metal surfaces, generally in the form of tetraoxide Pb, sometimes called red or minium Pb. Pb-free corrosion inhibiting compounds can be obtained.

Pb that contaminates the air in both the working environment and the ambient air can harm health and damage the environment. Pb inhaled by humans every day will be absorbed, stored and then accommodated in the blood. The chemical form of Pb is a factor affecting Pb in the body. Not all inhaled or swallowed Pb will be left in the body. An estimated 5-10% of the amount ingested will be absorbed through the gastrointestinal tract, and 30% of the amount inhaled through the nose will be absorbed through the respiratory tract and will accumulate in the body as it is affected by the particle size⁽³⁾.

The Pb emissions in the air can be either gas or particles as a by-product of incomplete combustion in a motor vehicle. Since leaded gasoline was removed in 2006, Pb is still an environmental issue that is a global issue because the use of Pb is still widely used in the used battery cell industry and pigment in the paint industry Lead Chromate (PbCrO_4), which causes various diseases such as encephalopathy, arteriolar and capillary deficiencies, cerebral edema, and increased blood pressure, neuronal degeneration, and the proliferation of glial cells accompanied by the appearance of ataxia, coma, seizures, hyperactivity.

The Pb threshold value in the workplace air is regulated by the Minister of Manpower and Transmigration of the Republic of Indonesia No. No.13/ MEN/X/2011 on the physics and chemical factor threshold values at the workplace of $0.05 \text{ mg} / \text{Nm}^3$. The average measurement result of Pb level in car paint workshop is $0.1 \text{ mg}/\text{Nm}^3$ while mean of Pb level in library of UPN Veteran Surabaya is $0.03 \text{ mg}/\text{Nm}^3$. The result of the measurement shows the level of Pb of air at work which is not exposed by Pb below the threshold value determined by Permenakertrans RI in 2011. Conversely the result of measurement of airborne Pb level in the work place that is not exposed to Pb is also below the threshold value (NAB). The results of the inspection are in line with research conducted by Mulyadi (2015) which states that Pb content in car painting is greater than airborne Pb levels in the administration section that are not directly exposed to the difference of $0.06485 \text{ mg}/\text{Nm}^3$ ⁽¹⁾. The airborne Pb concentration at the exposure site Pb is $0.065372 \text{ mg}/\text{Nm}^3$ whereas Pb in the unexposed location Pb is $0.000522 \text{ mg}/\text{Nm}^3$. Research by Hermianti *et al.*, (2012) also shows the average of Pb exposure by car paint workshop workers in Bandung for $1,241 \text{ ug}/\text{m}^3$. and mean worker intake of $0.0026 \text{ ug}/\text{hour}/\text{kg}$ body weight. This is in line with the research conducted by Selviastuti *et al.* (2016) on the analysis of health risk of exposure of Pb to the worker of the "X" Bus Body in Semarang City shows that the lead level in Epoxy interior = $0.0008 \text{ mg}/\text{Nm}^3$, primary = $0.0008 \text{ mg} / \text{Nm}^3$, stripping = $0.0077 \text{ mg}/\text{Nm}^3$, component = $0.0004 \text{ mg}/\text{Nm}^3$, and clear oven part = $0.0008 \text{ mg}/\text{Nm}^3$ where Pb air results are still below the Threshold Limit (NAB) $0.05 \text{ mg} / \text{Nm}^3$ ⁽⁴⁾.

Pb levels in blood obtained in this study ranged from 3.5 to $20.3 \text{ ug}/\text{dL}$ (standard deviation = 0) with a mean of $0.10 \text{ ug}/\text{dL}$. the average blood group Pb level exposed was $14.21 \text{ ug}/\text{dL}$, with respondents who had abnormalities of blood Pb level ($> 10 \text{ ug}/\text{dL}$) was 50%. While the mean blood Pb level in the unexposed group was $4.64 \text{ ug}/\text{dL}$ and the respondent had abnormalities of blood Pb level of 8.33%, the rest under normal condition ($<10 \text{ ug} / \text{dL}$).

According Palar (2008) an increase in Pb levels caused by Pb exposure in the air. This is because Pb entering into the blood through inhalation, ingestion and dermal will accumulate 95% into the blood and the largest Pb absorption is through respiration so that Pb accounts for most of the Pb levels in the blood⁽⁵⁾. Air contaminated with Pb particles can cause health problems of different levels and types depending on their size, size, and chemical composition. The main disorder occurs in the physiological functions of organs such as the lungs and blood vessels. Air pollution occurs because dust particles usually cause chronic respiratory diseases such as chronic bronchitis, pulmonary emphysema, bronchial asthma, and lung cancer.

The relationship of Pb exposure in air to blood Pb level based on Pb correlation in air to blood Pb level with $p = -0.008$ and $r = 0.002$. Coefficient of correlation showed a negative relationship means there is a relationship between Pb air with blood Pb, the amount of contribution of exposure of Pb in air to the increase of blood Pb level is 52.7% while the variable age, length of work, smoking habit, nutritional status, use of PPE no relation with Blood Pb. This shows that age, working period, smoking habit. Nutritional status, the use of PPE has no significant relationship with blood Pb, and the relationship can not be described and affects the Pb of air in the car paint workshop environment.

The parameters measured in this study were Pb in air while the parameters of heavy metals such as arsenic, copper, and selenium were not tested. The heavy metal content can be determined by the method of Atomic Absorption Spectrophotometry (AAS) which is one of the analytical methods that can be used to determine the levels of heavy metals in various materials. In the method of analysis of a sample required an appropriate method of analysis to obtain accurate results. Various process of destruction of sample of organic material and inorganic material is done to dissolve the desired sample component. This destruction process includes wet and dry processes, which have advantages and disadvantages. Destruction is the process of spraying a material used to determine the degree of heavy metals in a material, the process of destruction is widely used in the laboratory to determine a material containing heavy metals such as Pb, Cd, As, Hg and others.

Dry destruction is carried out by sampling 2 grams of samples in the furnace for 5 hours at a temperature of 500°C. samples that have become ash dissolved in aqua regia as much as 5 ml and heated above hot plate until soluble ash. The soluble ash is transferred into a 25 ml measuring flask and 5 mL of HNO_3 1 M is added and diluted with distilled water to the boundary line. Pb absorbance is measured by AAS at a wavelength of 283.3 nm.

Interference is generally defined as a disturbance that causes the analysis results to deviate from true results. Interference causes the measured value to be larger or smaller at its true value. When viewed from the cause interference can be categorized as spectra interference or chemical interference. Spectral interference results from the overlapping of the emitted line of the emitted element, since the element has spectral lines at various wavelengths. This spectral disorder can be overcome by increasing the resolution with prisms and filters or by either separation techniques of solvent deposition or extraction. Chemical interference is caused by the formation of stable compounds and ionization of gas atoms in the ground state. The formation of stable compounds causes the decomposition is imperfect, because the molecule is difficult to decompose into its atoms. This type of disturbance can be overcome by increasing the flame temperature by realizing agent and extraction, while the ionization of the analyte is not expected because it will reduce the emission of the spectra.

In this research, Pb analyzes using AAS with dry destruction which conceptually has better precision than wet destruction. So that can minimize interference of other metals. The measured heavy metals are only air Pb while the other heavy weight is not measured because of limitations of researchers.

The Relationship between Pb Levels and Blood Hb

The presence of Pb in the human body can disrupt the hemopoietic system of heme synthesis through three mechanisms that interfere with the unification of Glycine and Succinyl Co-Enzyme A, through depression of the ALAD delta and through the interference of ferrocatalase enzymes that serve to attach iron to heme as part of hemoglobin⁽⁶⁾. Hemoglobin is an important component of red blood cells that has the transport role of oxygen and carbon dioxide. Hemoglobin is an important component of red blood cells that has the transport role of oxygen and carbon dioxide⁽⁷⁾. Normal levels of hemoglobin in adult males are between 13-17g/dL whereas in unmarried adult women having normal hemoglobin levels of 12-16g/dL⁽⁸⁾.

Based on the results of hematological examination on the respondents showed that the blood Hb level of the car paint workshop workers 14.21g/dL lower when compared with the library officers of UPN "Veteran" Surabaya average Hb 14.96 g/dL. This is influenced by the influence of Pb inhaled by car paint workshop workers who cause a decrease in blood carbohydrate levels of car paint workers of workshop in Rungkut Surabaya. The result of correlation analysis shows that there is a relationship between blood Pb with blood Hb with $p = 0.002$ and $r = -0.805$, the correlation coefficient shows negative result which means there is a negative relationship, the higher Pb value will decrease the Hb value. The amount of contribution of blood Pb level to the increase of Hb level equal to 80,5%, this is in accordance with research conducted by Mulyadi (2015) which showed significant relationship between blood Pb level with blood Hb level ($p = 0.008$; $r = -0.609$)⁽¹⁾. Pb blood relationship with blood Hb shows the relationship between blood Pb with blood Hb, the higher the blood Pb level of the car paint workshop workers the lower the hemoglobin level of the car paint workshop workers.

In another study conducted Wagiu (2006) explained that there is a relationship between blood Pb levels with hemoglobin based on the results of statistical analysis showed a significant relationship with the value $p = 0.016$ ⁽⁹⁾. A study conducted by Adwijanti (2015) on the influence of blood Pb level on Hb level of printing workers in Ciputat obtained the result there is correlation between blood pb level with hemoglobin level with negative relation direction. It can be interpreted the higher the level of Pb in a person's blood will lower the person's Hb levels⁽¹⁰⁾.

The effect of Pb on the hemoprotic system causes a decrease in red blood cell production and decreased survival time due to cell membrane interference. The nature of anemia that occurs is normochrom-normocytic. However, the occurrence of influence on hemopoietic can occur chronic exposure with blood Pb 50 µg / dL or more⁽¹¹⁾. The results obtained in this study fit the theory that blood levels of Pb are <10 µg / dL, because there is a significant influence between blood Pb levels with hemoglobin.

Some studies have shown that exposure of 0.5 g/Kg BW/oral/day in mice for 16 weeks becomes anemia risk in children. Children with Pb > 10 µg/dL have anemia risk 1.7 times compared with Pb 10 µg/dL. The Hematopoiesis process is disrupted because Pb may cause ALAD enzyme inhibition in the early heme synthesis, the corprotoporphyrinogen oxidase enzyme and the ferrochelatase enzyme present at the end of heme biosynthesis, this disorder can cause a decrease in heme synthesis as a component of hemoglobin causing anemia. G-6PD enzyme deficiency also occurs in Pb exposure leading to shorter erythrocyte life and erythrocyte maturation disorders resulting in increased hematopoiesis. An increase in the number of reticulocytes occurs due to body homeostasis caused by excessive hematopoiesis.

The effects of Pb on the blood will bind to the ALAD (aminolevulinic acid dehydrase) an enzyme that is needed in the metabolism of red blood cell formation and throw it through urine and the lower ALAD in the blood, so the amount of blood Pb is responsible for the hemoglobin deficiency in the blood. The presence of Pb in the body can disrupt the hemopoietic system of heme synthesis through three mechanisms, interfering with the unification of Glycine and Succinyl Co-Enzyme A, through depression to delta-ALAD and through depression to delta-ALAD and through interference with Ferrochelatase- Fe) to protoporphyrin which then becomes heme as part of hemoglobin (Malacca 2012), and this is expressed by Lubis (2013), which states that Pb also inhibits delta-aminolevulinic acid enzyme dehydrase can not alter protoporphobilinogen, consequently iron can not enter the cycle protoporphyrin causes reduced synthesis resulting in anemia.

Age greatly affects the level of metal Pb in the blood, the more age a person has someone will decrease, this is not in accordance with research conducted by Mulyadi (2015) which explains that there is a relationship between age with blood Hb levels, this is due to the age of workshop workers paint the car is relatively young so that the amount of accumulation of Pb in the blood of the car paint workshop workers does not affect the blood of the workshop workers⁽¹⁾. Age of UPN Veteran library staff in control section has no relation with blood Hb, it can be explained that UPN library staff are in areas not exposed to Pb coming from the air that affect blood Hb. Hb levels in the blood of library officers of UPN Veteran Surabaya relatively normal so there is no significant relationship between blood Pb with blood Hb clerk library UPN Veteran Surabaya. This is not in accordance with the research conducted by Selviastuti *et al.*, (2016). The analysis of the exposure health risk of Lead (Pb) on the workers of the "X" bus charity in Semarang City explains that the characteristics of workers with anthropometry with age > 35 years have Pb levels in blood with the highest amount of Pb accumulation. Workers with age > 35 years old are generally car body workers who are in the painting section of bus "X" in Semarang City 2016 existing in each painting parts such as Epoxy interior space, Epoxy Primer (oven), stripping, Epoxy components and Oven Clear parts⁽⁴⁾.

A person's working period at a workplace exposed to heavy metals such as Pb may result in a health impact. This is due to the buildup of heavy metals in the blood. The longer the person works, the more exposure he gets⁽⁶⁾. Research on the association of Pb exposure in blood with Hypertension Occurrence At Industrial Workers Metal Casting In Ceper Klaten 2015 conducted by Ambarwati *et al.*, (2015) shows the existence of working relationship with heavy metal exposure, more and more years of work in industry related to Lead metal (Pb), Mercury (Hg), Arsenic (As), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), the more heavy metals accumulate in the body of the industrial worker. The period of work greatly affects the exposure of lead metal to the worker, the longer the working period, the more workers the car paint workshop is exposed to heavy metals⁽¹²⁾.

Pb has a half-life in the blood less than 25 days, in soft tissue 40 days while on bone 25 years. Slow expressions will cause Pb to accumulate easily in the body in both occupational and non-occupational exposure. From the results of this study did not obtained a significant relationship between blood Pb and Hb blood. This study found that long working variable has no significant effect on Hb level. Abnormalities of Hb level did not affect the length of work because in this study the average exposure period of the exposed group that is 4680 hours, while the mean of the control group of UPN Veteran Surabaya library officers showed the number zero, and the correlation result obtained no significant relationship between the exposure period with Hb blood, this can be explained not always more and more worker workshop of car paint worker then cause high blood Pb and influence to the decrease of blood Hb because there are other factors that influence blood Hb, so in this research cause cause exposure of workshop of car paint workshop with blood Hb can not be described according to existing theory.

Smoking habits also affect hemoglobin. In this study obtained the results of smoking habits have no relationship with blood Hb. This is because the number of cigarettes consumed by car workshop workers in Rungkut not too much that can reduce blood hemoglobin level of car painting workers in Rungkut Surabaya, although it was found that there are more than 50% of car paint workshop workers who have a habit of smoking with brikman index above > 100, an important factor in cigarettes that causes a decrease in hemoglobin levels did

not find a relationship between smoking habits with decreased blood Hb levels. It is explained that the relationship of smoking habits have no relationship with the decrease in hb levels because it is influenced by other factors such as age, nutritional status, use of personal protective equipment (PPE).

Smoking habits can cause damage to the cilia in the respiratory tract that filter out the substances that enter the respiratory tract. Smoking can cause damage to the cilia in the respiratory tract that filters the substances that enter the respiratory tract. Smoking can cause stunted air flow, damaged alveoli and decreased lung capacity, smoking can irritate mucus cells and cause increased mucus, mucus can cause infection and lung damage. Damage to the lungs can cause more chemicals contained in cigarettes such as heavy metals into the body that also affects the decrease in blood hemoglobin levels such as lead, boron, cadmium, selenium, arsenic and antimony⁽¹³⁾.

Cigarettes contain many toxic substances and components that cause cancer and are harmful to health, such as nicotine, nicotine oxidants carbon monoxide, hydrogen cyanide and free radicals⁽¹⁴⁾. Nicotine substances and heavy metals contained in cigarettes are highly polluting the environment, car paint workshop workers who have smoking habits also have high levels of Pb, thus affecting the Hb worker level of the car paint workshop. In various studies conducted by Mulyadi (2015) there is no influence between smoking with blood Hb levels⁽¹⁾.

In this study, there was no significant effect of smoking habit variable on Hb level. This happens because the exposed group has a milder smoking habit than the unexposed group. Administrative library staff at UPN Veteran Surabaya have higher smoking habit compared to car paint workshop workers because they are accustomed to smoking while working so that the number of cigarettes smoked in a day is more than the average of car paint workers of workshop. Smoking habits also affect blood hemoglobin at library officer UPN Veteran Surabaya, while for workshop of car painting habit of smoking does not affect blood hemoglobin this is also caused by age of worker of car paint workshop which is relatively young so that Pb exposure caused by smoking habit is relatively small compared to with library officers of UPN Veteran Surabaya, who has an aged age, smoking habits of people at older age are more at risk of exposure to Pb in the blood.

Nutritional status has no relation with hb blood of car paint workshop workers, it can be seen from the test of correlation between nutritional status with blood hb of car paint workshop workers in Rungkut Surabaya. From the result of questionnaire of nutritional status of workshop workers obtained the average of nutrition status of car paint workshop workers obtained result of 22.65 which showed in the interval of Body Mass index 18,5-25 kg/m² and only got 1 person (8.33%) who have Body Mass Index (BMI) of more than 27 kg/m². This can be explained by the nutritional status of a good car workshop workers so there is no decrease in hb so there is no correlation between nutritional status with Hb car workshop worker, while nutrition status of library officers of UPN Veteran Surabaya also there is no significant correlation between nutritional status and hb blood control library officers of UPN Veteran Surabaya. The use of Personal Protective Equipment (PPE) has no relation to the decrease of hemoglobin Officers of UPN Veteran Surabaya and car painting workshop. It can be explained that only a few people workshop car painters who use PPE with the number of users of PPE amounted to 1-6 people, although the use of PPE workers low car paint workshop has no significant relationship with blood Hb, meaning the use of PPE does not affect blood Hb. For library officer of UPN veteran Surabaya there is no relationship between the use of PPE and the decrease of blood Hb.

The Correlation between Pb and Hematocrit

Pb has a high affinity for hematocrit, about 95% will bind erythrocytes. Pb has a very slow half-life of about 25 days, in soft tissue 40 days and on bone 25 years. With the very slow excretion of this Pb easily accumulated in the body, in addition to hemoglobin Pb high blood content can also reduce hematocrit levels, because high levels of Pb in the blood can inhibit the process of hematocrit⁽⁵⁾. Hematocrit is the ratio of red blood cells with total blood cells. If the ratio of hematocrit value is smaller then it can be concluded that blood red blood value also decreases. Exposure to paint vapor containing Pb can diffuse in the air, and inhaled by car paint workshop workers in Rungkut causing decrease in blood erythrocyte value of car paint workshop workers and have an effect on decreasing hematocrit blood value of car workshop workers in Rungkut.

Pb may cause G-6PD enzyme deficiency and inhibition of the pyrimidine-5 nucleotidase enzyme. This results in a decrease in erythrocyte life span and increased erythrocyte fragility that causes hematocrit impairment⁽⁶⁾. This hereditary enzyme deficiency is characterized by basophilic stippling in erythrocytes⁽¹⁵⁾.

Based on the results of hematological examination on the respondents of this study that the number of hematocrit workers car paint workshop is lower than the administrative staff UPN Veteran Surabaya. The average number of hematocrit in the group of car paint workshop workers is lower when compared with the administrative staff of the language lab UPN Veteran Surabaya. Average number of exposed hematocrit 43.38% with range 37.5 - 48.5% while the average number of unexpanded hematocrit 45.13% with range 40.7 - 48.9%. Most of the Pb-exposed groups had less than normal hematocrit counts of <40%

The result of the analysis showed that there was a correlation between blood Pb and hematocrit number of car paint workshop workers with $r = -0.800$ and $p = 0.002$, r coefficient showed negative direction that there was a negative correlation, ie blood Pb can cause decrease of blood hematocrit, blood hematocrit decreased by 80.0% blood hematocrit is also associated with the use of PPE in car paint workshop workers, while age, exposure,

cigarette, nutrition have no relation to blood hematocrit. The effect of Pb toxicity on hemopoietic is reflected in the change in hb, and hematocrit occurs through the interruption of heme synthesis and causes shorter erythrocyte life to affect hematocrit levels. Pb may cause erythrocyte hemolysis and inhibit hemoglobin formation. Pb may cause G-6PD enzyme deficiency and inhibit pyrimidine 5 nucleotidase enzymes. This causes a decline in erythrocyte life and increases the fragility of erythrocyte membranes, resulting in a decrease in the number of erythrocytes⁽⁶⁾.

The erythroid precursor cells that have been committed are all of erythrocyte cells through growth and maturation processes. The erythropoietin hormone produced by renal peritubule interstitial cells stimulates CFU-E progenitor cells to speed up growth and maturation. The level of erythropoietin is influenced by the decreased distribution of oxygen to the tissues, anemia and hemoglobin disorders. The lower the oxygen to the tissue, the higher the erythropoietin level. The erythropoietin capacity to produce erythropoiesis depends on the adequacy of the supply of nutrients, minerals (iron, folic acid and vitamin B12) to the bone marrow. When the bone marrow is able to reproduce, the production of erythrocyte cells increases⁽¹⁶⁾.

Eritoproteins accelerate almost all stages of cell formation, especially BFU-E and CFU-E to divide and differentiate into cell production. Eritoproteins also increase the rate of cell division. Accelerate the incorporation of iron into the burgeoning erythrocyte cell, shorten the maturation time of the cell, accelerate the entry of immature erythrocytes (reticulocytes) into the circulation calculated as the number of reticulocytes. Under normal circumstances 10-15% of developing erythrocyte cells in the bone marrow are called ineffective erythropoiesis.

Pb into the blood circulation 90% will lead to erythrocytes. In the erythrocyte membrane occurs compounds or chemical reactions that can produce potentially toxic oxygen species called pro oxidants. If the amount of pro-oxidant increases can also cause oxidative stress. Pb may also cause G-6PD enzyme deficiency and inhibit pyrimidine-5-nucleotidase enzyme that leads to RNA (Ribo Nucleid Acid) accumulation as well as erythrocyte ribosomes characterized by basophilic stripping in erythrocytes. Oxidative stress Pb may cause membrane damage and shorten erythrocyte life, and G-6PD deficiency may inhibit erythrocyte maturation in bone marrow^{(17),(18)}.

An increase in the number of reticulocytes can be caused by the decreased amount of erythrocytes in the circulation. A decrease in the amount of erythrocytes may be due to shorter erythrocytes due to Pb exposure that can cause membrane damage. Bone marrow as a place of immature erythropoiesis called reticulocytes has increased in the circulation. The amount of reticulocytes can be calculated by Brilliant Cresyl Blue painting that can repaint the residual RNA in the cytoplasm. The normal reticulocyte value is 0.4-2.5%^{(16),(19)}.

Increased proportion of immature red blood cells in the blood (reticulocytes and basophilic stripping cells) caused by Plumbum poisoning to describe erythropoiesis in the bone marrow, by counting the number of reticulocytes in peripheral blood is an excellent indicator of increased erythrocyte activity.

Effect of Pb on Cystatin C serum

Cystatin C is constantly synthesized by all nucleated cells, and is found with high levels in various human body fluids, with a half-life of 2 hours later excreted only through the kidneys. Cystatin C is a substance that is produced by body cells regularly, filtered through the glomerulus, not secreted through the kidney tubules. This substance is not affected by food, age, muscle mass and body surface area so that Cystatin C is used as a sensitive indicator to determine the decline in kidney function⁽²⁰⁾.

High exposure of inorganic Pb compounds can damage the kidneys ie damage to the renal proximal tubules, whereas subsequent effects on prolonged exposure lead to interstitial fibrosis, sclerosis of the vessels and glomerular atrophy⁽²¹⁾. Kidney organs have a higher capacity in binding chemicals, so more chemicals are concentrated in kidney organs when compared to other organs⁽²²⁾.

Average of 1.16 mg/L with range 0.85-1.47 mg/L while at library officer of UPN Veteran Surabaya obtained serum Cystatin C level 0.83 mg/L with range 0.69-1.12 mg/L. The relationship of Pb with serum Cystatin C to the worker specimens. Blood Pb association with serum Cystatin C. Coefficient of correlation shows a positive relationship means elevated blood Pb levels will increase serum Cystatin C levels. The amount of contribution of blood Pb level to increase serum Cystatin C level was 67%. The higher blood Pb level may result in abnormalities of serum Cystatin C levels. While age, exposure, smoking, PPE have no correlation with serum Cystatin C, it is in accordance with Mulyadi (2015) study that there is a blood Pb effect on serum Cystatin C⁽¹⁾. Kidney organs have a higher capacity of binding chemicals, so more chemicals are concentrated in vital organs than other organs. The kidneys receive blood flow about 20-25% of the cardiac output through the renal artery causing various chemicals bound in the blood to be sent to the kidneys in large quantities. Chemical substances have toxic effects and accumulate in the kidneys in large amounts may cause proximal tubular damage resulting in decreased glomerular filtration rate, characterized by increased Cystatin C serum enzyme, then exposure to Pb in high concentrations and long leads to Interstitial fibrosis sclerosis of the vessels and glomerular atrophy⁽²²⁾.

The Correlation between Pb Levels and SGOT

The association of Pb to SGOT was found in this study ranging from 18-50 ug/dL (standard deviation = 10.43 ug/ dL) with mean of 27.71 ug / dL. result of laboratory examination for SGOT parameters to blood

specimen of worker of car paint workshop was obtained SGOT level on car paint worker worker 32,92 ug/dL with range 20-50 ug/dL whereas administration officer of UPN Veteran Surabaya library obtained SGOT rate of 15-28 ug/dL with range 14-28 ug/dL.

The association of Pb level of blood with personal protective equipment (PPE) has a significant relationship with 50.9%, while the age variable, exposure period, smoking habit, and nutritional status have no relation with blood Pb. Abnormalities of SGOT levels do not show any association with blood Pb.

The Correlation between Pb Levels and SGPT

The association of Pb to SGPT was found in this study ranging from 11-77 ug/dL (standard deviation = 16.01 ug/dL) with mean of 29.96 ug/dL. the result of laboratory examination for SGPT parameters on blood specimens of car worker workers were obtained SGPT level on car paint workshop workers 34.08 ug/dL with range 11-77 ug/dL whereas Library officers of UPN Veteran Surabaya obtained SGPT average of 25.83 ug / dL with range 15-40 ug/dL.

The association of blood Pb level of age, exposure period, smoking habit, nutritional status, showed that there was no correlation between blood Pb level with liver function disorder in car paint workshop workers. Evidence of liver function impairment was weakened by liver enzyme measurements at the time of the study was seen to see chronic exposure alone. Meanwhile, before the workers exposed to Pb is not done measurements of blood Pb levels and liver enzymes so that in this study cause and effect can not be described.

The Correlation between Pb Level and Health Complaints

Pb is a toxic substance that readily accumulates in human organs and may cause health problems to the hemopoietic system, the nervous system, the digestive system, the reproductive system, impaired liver function and impaired renal function. According to AOEC (2007) the health effects that occur in a person with blood levels of Pb (10-19 ug/dL) include the possibility of spontaneous abortion, low birth weight (LBW), changes in blood pressure and renal impairment.

This research is based on health complaint question done by Mulyadi (2015) that there is influence of Pb level to health complaint of car paint workshop workers in Surabaya. The result of the respondent's complaint indicated that the dominant symptom complained were nerve and renal complaints (100%), hematology (95,5%), reproduction (87.5%), liver (83.33%), digestion (75.5%)⁽¹⁾.

This is in line with the research conducted by Mulyadi et al. (2015) on the effect of Pb level on car paint workers of workshop in Surabaya 2015 which analyzed the effect of Pb level on health complaints of car paint workshop workers obtained by the influence of Pb level on hematologic complaints (81.6 %) and kidney (57.2%)⁽¹⁾. The high levels of Pb in the blood will cause hemopoietic complaints, because Pb has a high affinity for hb and hematocrit causing erythrocyte hemolysis and inhibits hemoglobin formation, in accordance with the amount of Pb contribution in the blood to hb decrease is 80.5% while the amount of Pb contribution to the decrease hematocrit by 80%.

Nerve and kidney complaints of 100%. It shows that high concentrations of Pb in the blood can also cause nervous and kidney complaints, as for symptoms that arise from nerve complaints is easy fatigue, fatigue, lethargy, muscle pain, ringing ears. Insomnia and kidneys are excessive urination, painful bowel movements, leg swelling. Kidney health complaints experienced by car workshop workers in Rungkut Surabaya in accordance with the theory that high blood flow to the kidneys cause various chemicals contained in the blood will accumulate and have an effect on kidney damage⁽²³⁾. The proximal tubule is the most commonly damaged part of exposure to nephrotoxic substances. A predisposing factor that results in proximal tubular cells is easily damaged is the role of proximal tubules that reabsorb 60-80% of glomerular filtration results. Other predisposing factors are the area of the surface of tubular reabsorption, the active transport system for ions, organic acids, low molecol-weight proteins, peptides and heavy metals mostly occur in the proximal tubules resulting in accumulation of toxicity to the proximal tubules which ultimately result in proximal tubular damage⁽²³⁾.

In addition to causing tubular damage directly, toxic substances also have the ability to damage the kidneys through external effects by affecting the hemodynamic, immunological systems, or metabolites of a substance. Some toxic substances can alter intrarenal hemodynamics that trigger vasoconstriction. Prolonged vasoconstriction results in decreased perfusion pressure, decreased glomerular hydrostatic pressure, decreased Glomerular Filtration Rate (GFR) and tissue hypoxia due to reduced oxygen and nutrient flow which eventually cause tubular damage^{(23),(24)}.

CONCLUSION

Pb level of car paint workers of workshop has exceeded the threshold value, while the level of Pb of administrative space at UPN Veteran Surabaya library is still below the threshold value set by the Ministry of Manpower. Pb blood level of car paint workshop workers have relationship with hemoglobin and blood pb level of library officers of UPN Veteran Surabaya has relationship with hemoglobin. Blood Pb levels of car paint workers of workshop have relationship with blood hematocrit and blood Pb level of library officer UPN Veteran Surabaya has no relation with hematocrit. Blood Pb level of car paint workers of workshop have relationship with

serum Cystatin C and blood pb level of Library officers of UPN Veteran Surabaya have no correlation with Cystatin C serum. Pb blood level of car paint workshop workers do not have relationship with serum SGOT and blood pb level of library officers of UPN Veteran Surabaya has no relation with serum SGOT. Blood Pb level of car paint workshop workers have no relationship with serum SGPT and blood pb level of library staff of UPN Veteran Surabaya has no relationship with serum SGPT. Increased levels of blood Pb can cause the risk of hemopoitik, nervous and kidney health, reproduction, liver, and digestive complaints.

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