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Correlation Between Blood Lead Level (BLL) And Osteoporosis in Postmenopausal Women In Surabaya Indonesia

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ABSTRACT

Lead (Pb) compounds indicate that some toxic effects influence such as osteoporosis. This research was to identify the source of lead contamination and to analyze the association between blood lead level (BLL), a symptom of osteoporosis and occurrence of osteoporosis among post menopause women. A cross-sectional study was conducted in Surabaya City Indonesia. The sample size was 60 persons, randomly selected from post menopause women age 50-65 years. The observed variables were lead blood level, assessed using atomic absorption spectrophotometry (AAS) and bone mineral density of spine and hip, assessed using Dual X-Ray Examination Absorptiometry (DXA). The mean value of blood lead level was 11.135 μ /dL. Multiple regression showed that there was a significant correlation between the history of work and Blood lead level ($p=0.037$). There are significant association between fracture ($p=0.027$), bone fragility ($p=0.008$), spinal pain ($p=0.016$) with osteoporosis. Age ($p=0.002$), blood lead level ($p=0.055$), calcium consumption ($p=0.022$) and exercise regularly ($p=0.08$) were together significant correlation with the occurrence of osteoporosis. These variables increase the risk of osteoporosis, simultaneously. It implies that to prevent osteoporosis, the possible source of lead contamination should be avoided, meanwhile post menopause women shall improve calcium intake and doing exercise regularly.

Keywords: Blood lead level, Osteoporosis, Post Menopause Women

INTRODUCTION

All human being and the environment could not be separated from each other. The contaminated environment often causes The detrimental impact on the health. Otherwise, the human needs become more

complex in accordance with the national development and industrialization in a country. The health problems will arise since the development and industrialization is regardless of the environmental aspects. Eco-development and eco-Industrial

absolutely must be applied to protect the environment and human health.

Lead (Pb) is a heavy metal that is still widely spread in the environment as hazardous substance or element. It is due to this element is still widely used both in industrial activities and household supplies. Sources of lead exposure are obtained from industrial process and fuel utilization, as well as derived from household activities surround us. Some household items were also identified containing lead, such as paint batteries, ceramics, and some cosmetics.

In Indonesia, lead is still used as a gasoline fuel mixture in a type of fuel named "premium" from Marketing Unit V Surabaya which serves the most area of East Java, Bali, West Nusa Tenggara and East Nusa Tenggara is still using lead as an octane booster of 0.01 grams / liter (Tawafurrohman, 2008) The use of lead as a fuel mix as an octane booster actually has been banned by the world. This is due to the health effects caused by lead is very dangerous. There is one location with air lead contamination levels exceed the limit of Indonesian environmental law in Surabaya city (Prasasti, 2008). Regularly contact between human and heavy metals was dangerous. Lead will cause a variety of health effects because this element could not be degradable and persistent in the human body. The inhaled or ingested lead will circulate through the blood flow, and reabsorbed in the kidney and brain, or stored in the bones and teeth.

Osteoporosis is widely spread throughout the world and still as a public health problem. Lead exposure will increase the risk of osteoporosis (Campbell and Auinger, 2007). Lead enters into the human body and then follow the blood circulation, to the tissues and several organs such as the liver, kidneys, lungs, brain, spleen, and heart. After a few weeks, most of the lead in tissues and organs will be mobilized into the

bones and teeth. Lead present in the bones for decades but it can be mobilized back into the blood and organs under certain circumstances, especially during pregnancy, lactation, fractures, during osteoporosis, as well as during the growth spurt (ATSDR, 2007,2008,2009). In animal studies, it reveals that high exposure to lead was associated with reduced bone density (Escribano, 1997). It is also consistent with Grubber, *et al* (1996) who investigated the effects of lead exposure on rat's bone, that 3 months exposure of lead showed a significant relationship with decreasing of in bone density. The high exposure of lead from high emission vehicles might as a risk factor for osteoporosis in Surabaya. This research was to study whether lead exposure influences blood lead level in patients with osteoporosis.

METHOD

This is a cross-sectional study was conducted in Surabaya, Indonesia. The study sample was 60 postmenopausal women aged 50 to 65 years old, randomly selected from patients Mitra Keluarga Surabaya Hospital in Juli-Desember 2007. Blood samples and bone scan were collected from every respondent after signing the informed consent. About ± 3 cc of venous blood was collected by laboratory staff, and then analyze Pb blood (whole blood) conducted by Atomic Absorption Spectrophotometry method in the Balai Besar Laboratorium Kesehatan Surabaya (Indonesia accredited laboratory).

Bone density was assessed by scanning the low spine and both of the hips. Osteoporosis examination conducted by Dual X-Ray Absorptiometry (DXA) method for low spine and both of hip. DXA was analysis in the Mitra Keluarga satelit hospital in Surabaya.

Osteoporosis occurs when the bone density $T < -2.5$, Osteopenia when $-2.5 \leq T \leq -1$, Normal $T > -1$. Data were analyzed using SPSS version 16. Statistical analysis using linear regression and multiple Logistic Regression test. [2]

The ethics committee of the Airlangga University Surabaya Indonesia approved this study (No. 075/PANEC/LPPM/2009). The blood lead level test was taken and analysis on April and May 2009.

The standard threshold of Pb content in blood according to the WHO is 20mg/dL in for adults and 10mg/dL for children (KPPB, 2000)

RESULT

Characteristics of Respondents

There were 14 respondents (23,3 %) in the 65 years old, 7 respondents (11,7%) in the 62 years old. The youngest age of the respondents was 50 years old and the oldest was 65 years old, the mean age was 58,75 years old. There were 28 respondents (46,6%) finished their senior high school. The most of the respondents (88%) had their income $> \text{Rp.}2000,000,00$ per month and there was 46,6 % respondents hadn't work anymore.

Respondents in this study were postmenopausal women in the age group 50-65 years. Women have a higher risk of developing osteoporosis than men. Menopausal status was also closely associated with the incidence of osteoporosis. Age is increasingly found osteoporosis ($p < 0.05$) (9). Most respondents were in the age group of 65 years (23.3%), with 4 respondents (28.6%) do not suffer from osteoporosis, 10 respondents (71.4%) with osteoporosis.

Most of the respondents educational background is senior high school or the equivalent, as many as 28 respondents (46.7%) with 15 persons (53.6%) did not

have osteoporosis and 13 respondents (46.4%) had osteoporosis. Respondents in this study most of which 53 respondents (88.3%) have incomes of more than Rp. 2000.000, - per month. A total of 46.7% of respondents in this study had been retired.

Education can influence the understanding of a variety of health problems. Statistical analysis showed no correlation between education ($p = 0.461$), income ($p = 0.752$), and the current work status ($p = 0.323$) and the incidence of osteoporosis. Although respondents mostly high school educated, but they relatively have high level of income so that access to adequate health care can be met, while those who are still actively working may be more mobile, where moving is a good activity for bone health as well as their socialization allows them to have access to better health information. [2]

The Relationship between the Source of Lead Exposure (Work History, History of residence, vehicle usage history, Canned Food Consuming Habits, Smoking Habit History, Calcium Consumption with Blood Lead Levels (BLL)

There were two groups in work history, they were indoor and outdoor. There were 76,6 % of respondents work indoor. The history of residence showed that 45% of respondents stayed on 500-1000m from the source of pollution. The vehicle usage history from the respondents showed that 48,3 % often use the car (closed vehicle). Canned food identified as the source of Pb. There were 53% respondents had canned food consumption habits more than once a year. All respondent wasn't the smoking habit history, because they were women and it didn't the culture. The data showed that there were 50 % of respondents usually consume the calcium supplements or drink a calcium milk more than once in a year. [2]

The mean blood lead level in the respondents are 11.135 $\mu\text{g}/\text{dL}$ with a maximum lead content of 28.95 $\mu\text{g}/\text{dL}$. Regression test showed that work history significantly related to blood lead levels ($p=0,037$; $< 0,05$). Work outdoor allows respondents to get more contact with the sources of environmental lead pollution. Potential sectors affecting air quality in Surabaya city, in general, is the transportation sector.

Respondents' residences were mostly in the range of 500-1000 meter distance. from the pollution source, riding a motorcycle, not in the heavy traffic, rarely consumed canned food, no smoking. Although Pb absorption will increase if there is a deficiency of calcium (10-12), thus Pb metabolism associated with hormones (13), in this study the source of calcium measured in the frequency. The result of BLL completely saw in table 1.

Table 1. Respondents Blood Lead Level (BLL)

Blood Lead Level		
	n	%
$\leq 20 \mu\text{g}/\text{dL}$	8	13,3%
$\geq 20 \mu\text{g}/\text{dL}$	52	86,6%
Σ	60	100%
Mean	11,135	
Min	1,932	
Max	28,95	

The Relationship between Age, Blood Lead Levels, Calcium intake, Alcohol consumption, Caffeine consumption, Exercise habits, Body Mass Index (BMI) with the occurrence of Osteoporosis.

The results of Multiple Logistic Regression test showed that blood lead levels (BLL) have a significant association with the occurrence

of osteoporosis ($p = 0.055$) along with variable of age ($p = 0.002$), the consumption of milk or calcium supplement ($p = 0.022$) and exercise habits ($p = 0.008$). The adult blood lead level standard of the World Health Organization (WHO) was 20 $\mu\text{g}/\text{dL}$. There are several women that exceed WHO regulation. The high of blood lead level showed that there are several risks for the health. The result of Dexa Bone Densitometer was completely seen in table 2, Fig 1 and Fig 2.

Table 2. The result of Dexa Bone Densitometer

Bone Mineral Density (T-Score hips and spine)	Status		
		n	%
$T > -1$	Not Osteoporosis (Normal and osteopenia)	35	58,3%
$T < -2,50$	Osteoporosis	25	41,6%
Σ		60	100%

In which any increase in blood Pb 1g/dL, the risk of osteoporosis increased 0,848 with increasing age, did not take calcium and exercise (table 3). The blood lead level together with other variables such as age, calcium consumption, and exercise habits had an association with the osteoporosis.

From the results of statistical analysis showed that each increase in age will increase the risk of osteoporosis by 1.5 times, people who never consume milk or calcium supplements had 1.6 times the risk of developing osteoporosis than those who frequently consume, and people who never do exercise have 30.8 times the risk of

developing osteoporosis than people who exercise regularly three times a week.

Table 3. Multiple Logistic Regression age, BLL, calcium consumption, exercise habits, BMI with osteoporosis. The Pearson and Spearman correlation between age, calcium consumption, exercise habits and BLL

Variable	Multiple Logistic Regression		Pearson and Spearman
	P	OR	P
Age	0,002	1,5	0,38
Blood lead level	0,055	0,848	
Calcium consumption	0,022		0,021
often		1,6	
Exercise habits	0,008		0,044
Rarely		30,8	
Body Mass Index	0,211

Fig 1. Spine Osteoporosis

Fig 2. Normal Spine Osteoporosis

The Relationship Between fracture, hunchback, reduced height, back pain with the Occurrence of Osteoporosis

Fracture, hunchback, reduce height, back pain was the sign of osteoporosis. The Multiple logistic regression showed that fracture, hunchback and back pain sign were correlated with osteoporosis. Bone loss increases the risk of fractures ($p = 0.027$), hunchback ($p = 0.008$) and back pain ($p = 0.016$). This is due to the decline in bone mass.

DISCUSSION

Lead (Pb) can enter the body through the respiratory tract, absorption and digestive tract (ingestion). Pb distributed into 3 main parts of the body, that is blood, Soft Tissue and Bone (EHC WHO, 2006). Pb deposited in bone. As much as 90-95% Pb that entered the body accumulated in bones, a little stored in the brain (Barry and Mossement, 1970). Pb has a long half-life in bone, especially in people who were exposed to lead in the past and for a long time.

The results of this study showed that blood lead levels were significantly associated with the occurrence of osteoporosis. Blood lead level for an adult was $\leq 10 \mu\text{g/dL}$ (ATSDR, 2013). The respondents were shown that their blood lead level was more than $10 \mu\text{g/dL}$ and they had osteoporosis. Pb absorbed by bone. Pb is known to have an effect on osteoblasts, osteoclasts and kondrocit, which affected by osteoporosis (Carmouche, 2005). Studies on animals showed that a rise in Pb exposure degraded bone density (Gruber, 1996), inhibited osteoblastogenesis and decreased bone strength (Ronis, 2001). There is a relationship between the Infant mean blood Pb, with mothers who have high blood lead levels in the median cohort $7.7 \mu\text{g/dL}$, which infant has a shorter body length of 2 cm at the age of 15 months, compared with mothers who not exposed to Pb (Shukla, 1989).

Levels of Pb blood describe the movement of Pb from the bones into the bloodstream. If there is a process of bone resorption, Pb from the bone will be released into the blood. Pb Blood is also an indicator of exogenous Pb exposure that is happening and Pb exposure in the past that stored in bones (Hu et al, 1998). Although 90-95% Pb stored in bones (Campbell and Auinger, 2007), Pb will lead to blood flow in certain conditions such as pregnancy, lactation, osteoporosis etc (Squib, 1997).

This results of this result also consistent with the results other research that there is a relationship between lead exposure in the past with the occurrence of osteoporosis (Campbell and Auinger, 2007), Bone Mineral Density was significantly associated with the amount of lead in the blood (Nash, 2004), and low bone mineral density in children associated with Pb blood serum (Riedt, 2009).

There was a relationship between lead exposure in the past with the occurrence of osteoporosis (Campbell and Auinger, 2007). The Bone Mineral Density (BMD) was significantly associated with the amount of lead in the blood (Nash, 2004), and The a low BMD in children associated with Pb blood serum (27).

From these results, there are possibilities that in the past, respondents had been exposed by Pb, furthermore, Pb deposited into bones. Then when they get older, in line with the weakening of the balance in the bone remodeling process, Pb mobilized into the blood. Pb is toxic to soft tissues and organ systems (4-6). At the low level of toxicity, Pb has been able to influence the body's biochemical processes.

The risk of osteoporosis will increase with increasing age, but indeed it also influenced by other factors. Bone remodeling process in a young adult is on balance and will be

declined in line with increasing age so that the risk of osteoporosis will be higher.

Nutrition plays an important role in health including bone mass and fracture risk. Pb has a role as a calcium antagonist, which is calcium intake will reduce the absorption of Pb in adults and animals(4-6). There is a relationship between calcium intake with the decrease of blood Pb ($P = 0.02$) (Yuan et al, 2004).

Exercise dosage must be appropriate because if it is too light it will not be used and if it is too heavy it will be dangerous. Cooper et al 1988; Snelling et al 2001 said that Physical activity is proven to lower the risk of hip fractures (Campbell and Auinger, 2007). People who are too lazy to move or exercise will obstruct the process of its osteoblast (the process of bone formation). In addition, bone mass density will decrease. The more movement and exercise, the muscles will spur bone to form a mass. Bass et al said that Observations conducted on athletes showed that athletes had higher BMD than the people that did a rare exercise (WHO, 2003).

Pb levels $< 20\text{mg/dL}$ are supposed to influence the metabolism of vitamin D in the body, while $\text{Pb} > 30\mu\text{g/dL}$ has been able to interfere with bone metabolism (Brasslow et al, 2002).

Osteoporosis can be called as a thief in the night, people who suffered from osteoporosis do not feel a specific soreness. It will be felt when the bones are fractured that will cause pain, deformity, and impaired function.

A detailed history of patient risk factors is helpful in establishing the diagnosis. Analysis of risk factors is important to determine whether the examination of bone mineral density (BMD) needed or not, which is important to establish the diagnosis.

Fractures, hunchback, back pain, reduced height are the signs of osteoporosis. If the

bone density is greatly reduced, the bones will be crushed, so that will develop bone pain and deformity. The destruction of the spine will cause chronic back pain. Fragile spine might be destroyed spontaneously or due to minor injuries. Pain will arise suddenly and felt in certain areas of the back, and the pain will be increased if the patient standing or walking. If some spine shattered, it will form an abnormal curvature of the spine (Dowager's hump), which causes muscle tension and pain.

CONCLUSION AND SUGGESTION

Work history is associated with blood lead levels. Fracture, humpback, and back pain are the sign of osteoporosis. Age, blood lead level, calcium consumption and exercise habits were together significant correlation with the occurrence of osteoporosis. Age, Blood lead Level, calcium consumption and exercise habits were the factors to increase the risk of osteoporosis.

Keep a healthy lifestyle such as avoiding contact with the sources of Pb pollution, meet the needs of calcium, and regular exercise to prevent osteoporosis.

CONFLICT OF INTEREST

The author declares there is no conflict of interest regarding the publication of this paper.

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