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Research Article

Blood Lead Levels in Pregnant Women and the Source of Exposure in Northern Coastal Area of Brebes Regency

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Abstract

***Background*:** Lead has no advantage for health, pregnant women are vulnerable to lead exposure. Blood Lead Levels (BLLs) in pregnant women that exceed the quality standard in accordance with Center for Disease Control (CDC) (>5 µg/dL) can encounter spontaneous miscarriage and fatigue easily during pregnancy, BLLs in pregnant women < 10 µg/dL can induce health problem during pregnancy such as hypertension, preeclampsia, and eclampsia which is the cause of mortality in pregnant women and high maternal mortality. The aim of study to measure BBLs and the source of exposure.

***Methods*:** Pregnant women in 2nd and 3rd trimester were recruited in 4 Subdistricts. Cross sectional study is used with 86 pregnant women located in Wanasari Subdistrict, Bulakamba Subdistrict, Losari Subdistrict and Tanjung Subdistrict with purposive sampling method. BLLs during pregnancy were determined by Atomic Adsorpiton Spectrometer.

***Results*:** The results shows that mean of BLLs in pregnant women in this study were 42.437 ± 19.758 µg/dL. The source of lead exposure are the habit of consuming seafood (44.2%), wrapping food using newspaper (80.2%), being involve in agricultural activity (37.2%), and passive smoking (70.9%).

***Conclusions*:** To recapitulate, BBLs in pregnant women in the northern area of Brebes Regency have exceeded the standard set by the CDC of 5 µg/dL. The dominant source of lead exposure are the habit of wrapping food using newspaper and passive smoking.

***Keywords*:** Pregnant women; blood lead levels; coastal area

Background

Lead (Pb) belongs to class IV-A (halogen) which has non-biodegradable properties. Lead could be produced by human activities such as industrial activities, mining activities, and agricultural activities that can spread by air, water, and land.[1] The entry of lead in human blood can be affected by lifestyle, diet habits, and nutritional status. Lead enters human body through the respiratory tract, digestive tract, and absorption by the skin. Lead has no function in human body. Lead has a negative effect on human health. Lead can affect the central neural system, cardiovascular system, urinary system, bone, and reproduction system.[2-3]

Pregnant women are vulnerable to lead exposure. Pregnant women who are exposed to Pb can be affected during pregnancy. Blood lead levels (BLLs) of

0.8 μg/dL can cause maternal disorders. When BLLs reaches 2.57 μg/dL, it can cause stress and fatigue levels in pregnant women.[4] BLLs of <5 μg/dL may cause pregnant women to have pre-eclampsia and endanger the mother's kidney, while BLLs of <10 μg/dL can increase blood pressure or hypertension. According to Bayat in 2016, there was an increase in systolic blood pressure (0.014 mmHg) and diastolic (0.013 mmHg) following the increase of 1 μg/dL of BLLs (p=0.04).[5]

The blood lead levels in pregnant women can be transfused into the placenta through the blood. BLLs in pregnant women may lead various health problems, especially to the fetus. Mothers who have been exposed to lead will have it is accumulate in bone and it will be spread from bone tissue during pregnancy and lactation.[6]

Pregnant women with high exposure have the potential for premature birth, miscarriage, fetal or spontaneous abortion, birth defects, neurologic effects, and impaired fetal growth (<10 μg/dL), low birth weight (<5 μg/dL) and small head circumference.[7]

Brebes Regency has an area of 1.662,96 km^2 which directly borders the Java Sea in the north, crossed by the Pantai Utara route of $\pm$ 32 km and has a large agricultural area.[8] According to research conducted by Suhartono, et. all in 2016 it is stated that the BLLs in pregnant women in Brebes Regency amounted to 19.74 μg/dL which has exceeded the threshold value set by the CDC of 5 μg/dL.[9-10]

This study is conducted to describe the BLLs in pregnant women and the possible source of exposure to lead in the blood of pregnant women in the northern coastal area using a questionnaire.

Methods

This research use observational study with a cross-sectional design. Research subjects were pregnant women in 2^{nd} and 3^{rd} trimester of pregnancy in north coastal area of Brebes Regency (Wanasari, Bulakamba, Tanjung, and Losari subdistricts). The research subjects have no history of cancer and stay permanently in the study area for at least 2 years and are willing to be the subject of research (blood drawn and in-depth interviews).

Total respondents in trimesters 2 and 3 in 4 subdistricts were 116 pregnant women with 26 respondents refused to be interviewed and 4 refused their blood to be taken, so the total subject of research is 86 pregnant women. Examination of lead levels in the blood of pregnant women using AAS method (Atomic Absorbance Spectrometer) conducted by laboratory officer of CITO, Tegal. The results of examination of blood lead levels are expressed by μg / dL units.The source of lead exposure to be reviewed is the habit of consuming seafood every week, the habit of using newspaper as a food wrapper, involvement in agricultural activities, and exposure to cigarette smoke. Sources of exposure were excavated using questionnaires with in-depth interviews. Univariate analysis is used to indicate the mean, standard deviation, minimum and maximum values and the value of proportion.

Results

Characteristics of pregnant women are shown in Table 1. The characteristics of the study sample are illustrated by mean, standard deviation, minimum, and maximum values. The age of pregnant women in this study range from 19 years old to 41 years with an average age of 30 + 5 years. The average height of pregnant women is 152.65 + 4.61 cm (range 143-164 cm), while the average body weight of pregnant women is 66.82 + 12.99 kg (range 37.4-101.6 kg).

	n	Proportion (%)	Mean±SD	Minimum	Maksimum
Age (year)	86		30±5	19	41
Height (cm)	86		152.65±4.61	143	164
Weight (kg)	86		66.82±12.99	37.4	101.6
Education					
No school	4	4.7			
Graduated from elementary school	50	58.1			
Graduated from junior high school	20	23.3			
Graduated from high school	10	11.6			
Graduated from university	2	2.3			
Occupational					
Housewife	67	77.9			
Private employees	1	1.2			
Farm workers	11	12.8			
Others	7	8.1			

Table 1 Characteristics of Pregnant Women in the northern coastal area of Brebes district

The mean blood lead levels in pregnant women are shown in Table 2. The mean blood lead levels in pregnant women in the north coast are 42,437 + 19,758 μg / dL with the minimum values of 3.60 μg / dL and maximum values of 114.80 μg / dL. From 86 respondents who were the subject of the study, there was only 1 with BLLs under the standard set by the CDC (5 μg / dL). There are 15.1% of pregnant women who have BLLs of 5-24 μg / dL, 45.3% pregnant women who have BLLs of 25-44% and 38.4% pregnant women who have BLLs of > 45 μg / dL.

	n	Proportion (%)	Mean±SD	Minimum	Maksimum
BLLs (μg/dL)			42.437±19.758	3.60	114.80
<5	1	1.2			
5-24	13	15.1			
25-44	39	45.3			
>45	33	38.4			

Table 2 The deep lead level in pregnant women (n = 86) in the northern coastal area of brebes district (μg / dL)

Table 3 shows the source of lead exposure in pregnant women. Pregnant women in the north coast have a habit of consuming seafood each week of 44.2% while pregnant women who do not have a habit of consuming seafood each week is by 55.8%. 80.2% of pregnant women have a habit of using newspaper as food wrappers, while 19.8% of pregnant women do not have a habit of using newsprint as a food wrapper.

Pregnant women in the north coast often engage in agricultural activities by 37.2% while 62.8% of pregnant women are not involved in agriculture. 70.9% of pregnant women are exposed to secondhand smoke while 29.1% are not exposed to secondhand smoke.

	N	Proportion (%)
The habit of consuming seafood every week		
Yes	38	44.2
No	48	55.8
The habit of using newspaper as a food wrapper		
Yes	69	80.2
No	17	19.8
Involvement in agricultural activities		
Yes	32	37.2
No	54	62.8
Passive smoking		
Yes	61	70.9
No	25	29.1

Discussion

The potential health effects associated with exposure to lead during pregnancy are an important public health concern. In general, lead in the blood can disrupt the nervous system, the cardiovascular system, the urinary system, and the reproduction system.[11]

Pregnant women are particularly vulnerable to lead exposure.[12] The knowledge of lead's danger is poorly known by pregnant women in the northern coastal area of Brebes Regency. High blood lead levels is serious health problem that may harm the mother and fetus. The health risks of pregnant women who get lead exposure during pregnancy have been investigated by previous studies.

Pregnant women with lead levels in their blood could get affected during pregnancy by their stress levels.[4] The lead level of 2.57 μg / dL affects the level of stress and fatigue in pregnant women.[12] The results of the study shows that there were 15.1% pregnant women with lead levels of 5-24 μg / dL. Blood lead levels of 5 μg / dL in pregnant women leads the potential of preeclampsia during pregnancy and kidney damage.

In the previous study, it is stated that there is a relationship between blood lead levels and the incidence of preeclampsia ($p = 0.028$) blood lead levels of 10 μg / dL potentially increase blood pressure. There was an increase in systolic blood pressure (0.014 mmHg) and diastolic (0.013 mmHg) with 1 μg / dL increase in blood lead levels ($p = 0.04$).[5]

Studies of the effects of heavy metals on pregnant women and fetuses vary greatly. The lead level in the blood plasma of pregnant women and lactating mothers can enter the fetus and baby's blood through the umbilical cord and breast milk so that it can attack the baby's body as well as the fetus and lead can accumulate in the infant's bone.[2] The lead in blood (both plasma and erythrocyte) is greater than in the placenta.[13]

Lead levels in pregnant women can be transfused into the placenta through the blood. Blood lead levels in pregnant women put them at risk for various health problems, especially in the fetus they contain. Pregnant women with high exposure have the potential to have premature infant, fetal or spontaneous abortion, birth defects, neurologic effects and fetal growth inhibited (<10 μg / dL) low birth weight (<5 μg / dL) and head circumference the little ones.[7]

Lead can enter the blood of pregnant women through several ways such as inhaled, swallowed, or absorbed. The amount of lead levels in the blood of pregnant women depends on lifestyle, consumption habits, and others. Seeds that contain lots of vitamins and nutrients these days contain heavy metals that are harmful to the body including lead. Lead comes in and is absorbed directly by phytoplankton and zooplankton as producers of the food

chain. So consumers at the highest level have the greatest lead levels. Some studies suggest that fish in the Java sea area are contaminated with lead (Pati, Semarang, Tegal).[14] According to research conducted by Brigissdottir, et al in 2013, there is a significant relationship between the amount of consumption of marine products with lead levels in the blood in Norway (p = 0.007). [15]

One of the lead pathways is the mouth. Apart from consuming food free of lead contamination, the media used for food wrappers should not contain harmful ingredients for the body such as the use of newspapers or magazines as food wrappers. According to research conducted by Hartanti, there is a difference of average blood lead levels between women of childbearing age who use newspaper as food wrapper with the ones who never use newspaper as a food wrapper.

The use of newspaper as food wrapper is related to blood lead levels in pregnant women. Lead derived from the ink present in the newspaper is able to contaminate the food with Pb release rate of 5.56 x 10-5 ppm / hour. [16] The involvement of pregnant women in agricultural activities may affect the lead level in their blood. According to research results, there are only 37.2% of pregnant women involved in agricultural activities, while 62.8% of pregnant women are not involved in agricultural activities.

According to the results of in-depth interviews of activities conducted by pregnant women including mixing pesticide (7%), spraying pesticides (12.8%), washing pesticide tools (14.0%), planting onions (nandur) (18.6%), looking for pests (nguleri) (20.0%), plucking grass (20.9%), harvesting (22.1%), looking for crop residue (15.1%), removing onions from the stem (mbrodoli) (22.1%), clearing the soil from onion bulbs (membutik) (10.5%). Pesticides that contain lead can harm pregnant women. According to Hartanti's research in 2010, there are few lead pesticides used in Brebes Regency such as Antracol 70 WP with 70% propineb active ingredient containing Pb of 12.48 mg / kg, Dithane M 45 80 WP as a fungicide with active ingredient mankozeb 80% contained 19.57 mg / kg of lead, and Buldog 25 EC as an insecticide containing propinebic active ingredient 25 g / liter with a Pb content of 2.04 mg/kg.[17]

Cigarette exposure can contribute to the presence of lead in the blood. In 1 pack of cigarettes (20 bars) there is a lead content of 1.33-3.61 μg/g with average net weight of 2.46 μg/g. While the average of lead levels inhaled by smokers is 1.98-3.37 $\mu g/m^3$.[18] The results showed that there were 70.9% of pregnant women exposed to cigarette smoke. Based on in-depth interviews results, cigarette smoke comes from families who smoke and are near pregnant women.

According to research Brigisdottir et all in 2013 it is stated that there is a relationship between the habit of smoking with lead levels in the blood (p <0.001) [15] and this is also supported by the research conducted by Chekchowska et.al in 2012 which stated that there is a correlation between mothers who smoking during pregnancy with lead levels in blood (p <0.001) (r = 0.54). [19] However, according to Darsun study in 2015, there was no correlation between passive smokers with lead levels in the blood of pregnant women (p = 0.874).[20]

There are other factors that affect the lead level in pregnant women such as new house wall paint less than year (p = 0,029; OR = 2,641), cosmetic usage (p = 0,043; OR = 3,109); mother's work related to lead (p = 0,021; OR = 4,032); while the consumption frequency of Ca, Fe, and Zn supplements (p = 0.020; OR = 0.317) and milk consumption (p value = 0.021; OR = 0.234) are protective factors.[21] The presence of lead in the blood may be affected by the consumption of vitamins and micronutrients which can inhibit lead to replace the ions that should be required by the body. Mothers who rarely consume food containing calcium, zinc, and iron tend

to easily absorb lead ions into the blood.[10] Due to that fact, pregnant women are strongly encouraged to consume food which is rich in calcium, zinc, and iron as a factor coefficient in some enzyme reactions.[22]

The consumption of calcium supplements at a dose of 1200 mg per day during pregnancy may reduce blood lead levels in pregnant women.[23] 45.3% of pregnant women have a blood lead level between 25-44 µg / dL requiring monthly blood checks and limiting self from work that has a high risk of lead exposure [6] Chelation therapy or chelators therapy such as CaNa2EDTA can reduce the presence of lead in the human body.[23] Consuming food that contain Ca, Fe, Zn, vitamin D, vitamin C, and vitamin E are necessary to reduce lead absorption.[10] Avoiding the lead exposure is needed either.

There are limitations in this study in which the researcher does not investigate the presence of lead exposure in soil, water, air, and food that may be a factor in the entry of lead into the blood of pregnant women. Researchers only measure the consumption habits and history of exposure to pesticides and exposure to secondhand smoke through questionnaires and field observations.

Conclusions

Blood lead levels in pregnant women in the northern coastal area of Brebes district have exceeded the standard set by the CDC (<5 µg/dL). The dominant source of exposure is the habit of consuming food with newspaper wrapper every week and passive smoking.

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Ethics approval and consent

Ethical clearance was obtained from Ethic Commission of Health Research, Faculty of Public Health UNDIP (664/EC/FK-RSDK/XI/2017). All subjects signed informed consent to join the study

Competing interest

The author reports no conflicts of interest in this work.

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