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Health Risks Assessment and the Epidemiology Study of Lead Exposure among Communities along Youtefa Gulf in Jayapura

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A B S T R A C T

The impact of Lead (Pb) as heavy metal pollution on aquatic biota and humans can be a harmful. Some researchers have studied chemical substances at Youtefa Gulf in Jayapura revealed that the gulf waters and biota have been polluted by heavy metals. This study aimed to analyze the extent to which a health risk of communities due to exposure of Pb. Epidemiological study in how much risk of health problems generated by exposure of Pb. This observational epidemiology study applied a cross sectional analytic approach. Sampling was determined by purposive sampling. The results showed that the levels of corpoporphyrin found in 75 respondents or 100% > 20 ug / dl (plumbum poisoning), protoporphyrin levels in the urine of 75 respondents found 19 samples (25.3%) that protoporphyrin levels > 30 mg / dl (sideroblastic anemia secondary) and 56 samples (74.7%) were normal. Pb levels in the blood to 39 people (80%) were has high level of lead in their blood, and 1 sample (2.5%) has normal blood Pb levels. Risks level of some variables with consecutive secondary side roblastic anemia is Pb toxic with risk level of 95% CI = 0:54 (0:26 to 1:13) fish intake rate with risks level = 1.48 95% CI (1.75 1.26-), length of stay with risks level = 2 CI 95% (0.9-4.2), sex with risks level = 1.18 95% CI (0.52-2.4), age 95% CI with risks level 2:32 (1:19 to 4:53), Pb levels in blood with risks level = 0:53 95% CI (0.41-0.73), respectively. It can be sum up that all of the 75 samples or (100%) have a high levels of Corpoporphrinnya that mean lead poisoning.

Introduction

Implementation of development in Indonesia is essentially to produce benefits. However, the benefit development always generate risks, (Soemarwoto, 2004), When observed from day to day, more and more cases about the water contamination. Water pollution is happening everywhere, most often is polluting coastal areas. According to Sembel in 2010 that the coastal region is an area that is prone to contamination due to the miss leading in its management. some activities makes the coastal area as a dumping all kinds of waste from the mainland (Sembel, 2010). One of the pollutants that often

contaminate water and harm marine life is a heavy metal such as Pb. The main cause of Pb be dangerous pollutant because it cannot be destroyed (non-degradable) by living organisms in the environment. It accumulate in the environment, especially to the bottom waters to form complex compounds with organic and inorganic materials and combinations adsorption. Biota that live in waters contaminated heavy metals, heavy metals can accumulate in body tissues. The higher the metal contents in the water the higher the content of heavy metals in the body of the animal accumulated (Rochyatun and Rozak, 2003).

The impact of waste disposal in the form of heavy metals cause disruption of aquatic biota. Gulf Youtefa cannot be separated from the problem of heavy metal pollution, because it is a part city of Jayapura, the estuary into the Youtefa Gulf. In 2004 the results of the survey Bappedalda Jayapura City on water quality parameters of Youtefa Gulf that have been polluted by Pb has reached 0.03 mg/l (Arobaya & Pattiselanno, 2010). Based on the research results Manalu in 2012, found that an index of pollution in the waters of the Gulf of STORET Youtefa based index (a value of raw data on the quality of water which is then transformed into an index) are in moderate and severe polluted, (Manalu, 2012).

Exposure to heavy metals such as Pb on animals and humans and may provide acute toxic effects, sub-acute, subchronic and chronic. Chronic toxic effects occur when chemicals accumulate in biological systems (absorption exceeds excretion biotransformation) or if that does not produce toxic effects or if not recovered enough from biological systems to perform recovery of damages in the frequency interval of exposure, or presentation occurs repeatedly (Rukaesih Ahmad, 2004). Based on the facts above shows that today human life is threatened by environmental hazards due to toxic Pb pollution. There are several studies that have been conducted in the Gulf Youtefa associated with environmental pollution, such as research Bappedalda Jayapura City (2004), Manalu (2012), but previous studies have not assess epidemiologically about Pb material with secondary sideroblastic anemia, besides no studies testing of corpoporphyrin and protoporphyrin. This study tries to answer the health problems caused by exposure to test corpoporphyrin plumbum and protoporphyrin.

Materials and Methods

This type of research is an analytic epidemiologic study with cross sectional approach through a process approach of calculation or estimates the risk to a target organism, system or (sub) populations by measuring concentrations in humans. After the measurement is done on humans, then calculate the risk by calculating prevalence ratios (Sudigdo & Sofyan, 1995). The population in this study are all the people who live around the Youtefa Gulf. The sample is a portion of the population, sampling technique was purposive sampling, so that the determination of the sample, the researcher establishes the following criteria:

1. Willing to be a respondent
2. Live in Youtefa Gulf > 2 years

Exclusion criteria: Not willing to be respondent, Stay in Youtefa gulf < 2 years. Following the number sample size formula samples: Number of Samples

$$N = \frac{Z\ 1-\alpha\ 1/2^{2}\ [(P1(1-P1)+P2\ (1-P2)]}{d^{2}}$$

where :

P1: Annemia case number / population number

(1058/ 242.267) x 100 = 0.436 per 100 population

P2: (population number –cases)/pop. number (241209/242.267)x100=99,56 per 100 population

d^2 : 3%

$Z\ 1\text{-}\alpha\ 1/2^2 = 1,96$

So,

$$N = \frac{1,96^2\,[(P1(1-P1)+P2\,(1-P2)]}{0,03^2}$$

$$= \frac{3,84\ [(0,0043)(1-0,0043)+0,9956(1-0,9956)]}{0,009}$$

$$= \frac{3,84\ [(0,00428)+(0.00428)]}{0.009}$$

= 36,5 = 37 So the sample taken were

= n1+n2 = 37+37 = 74

The level of corpoporphyrin and protoporpirin in urine using a LCMSMS (Liquid Chromatography Mass Spectro-fotometri Detector)

Result and Discussion

Corpoporphrin levels in urine

According to Kee in 2008 that Copoporphrin or if form of porphyrin koproporfirin is eliminated from the body through feces and urine primarily as korpoporfirin I and III. Normal excretion koproporfirin according to Kee is for adults 3-20 mg / dl and children: 0-80 mg / 24 hours. Increased korpoporphyrin lead to the Pb poisoning and liver damage. Based on the results of the study found that of the 75 respondents surveyed, 100% of respondents found high corpoporphyrin or > 20 mg / dl. Distribution of respondents according to tabel. 1 corpoporphyrin levels and age groups.

Table.1 The corpoporphyrin levels and age groups in the community in Youtefa Gulf of Jayapura city, 2014

Age group	Corpoporhyrin levels				Total	
	> 20 µg/dl		≤20 µg/dl			
	n	%	n	%	n	%
20-24	2	100	0	0	2	2,7
25-29	4	100	0	0	4	5,3
30-34	12	100	0	0	12	16
35-39	7	100	0	0	7	9,3
40-44	9	100	0	0	9	12
45-49	8	100	0	0	8	10,7
50-54	8	100	0	0	8	10,7
55-59	8	100	0	0	8	10,7
60-64	9	100	0	0	9	12
>64	8	100	0	0	8	10,7
Number	75	100	0	0	75	100

Protoporpirin levels in urine

Sudarmadji 2006 said that Pb poisoning can cause anemia due to decreased synthesis of globin, although the symptoms and signs of anemia does not appear to be any decrease in serum of iron levels. Mild anemia that occurs only accompanied by a slight

increase in the levels of ALA (Amino levulinic acid). Although it is difficult in the detection of initial symptoms, but according to Lopez that iron deficiency anemia status can be done for example by history and neighborhood socioeconomic, physical examination, laboratory and radiographic examinations. Laboratory testing deficiency iron can be known by looking erythrocyte protoporphyrin levels (erythrocyte protophorphyrin, EP), zinc protoporphyrin (zinc protophorphyrin, ZPP), iron deficiency anemia is associated with increased levels of protoporphyrin and reticulocytes. Protoporphyrin levels began to increase in a few weeks after Pb levels in the blood reached 20 mg / dL. Protoporphyrin levels > 35 mg / dL indicates iron deficiency anemia, or inflammation of the old. The decrease protoporphyrin showed decreased levels in the Pb blood. Erythrocyte morphology similar to lead poisoning and iron deficiency conditions, but basophilic stippling of erythrocytes often found in lead poisoning conditions (Lopez, et al., 2013).

The same thing is expressed by Malacca that influence Pb in humans can be measured by examining the erythrocyte Zn-P rotoporphyrin (ZPP) with FI techniques uorometry. In addition, the stimulation can be performed with a Ca-EDTA chelating that could mobilize from the bone, causing plumbum excretion in the urine (Malacca & Iriyani, 2012). Study of 75 samples of urine were taken from the people living around the Youtefa Gulf revealed that protoporpirin levels in urine are in the range of 0.001 to 0008 mg / l. Protoporpirin levels in the urine, if the reference refers to protoporphyrin levels according to Kee is said to be normal or high if > 30 mg / dL in this study found there were 19 samples or 25% were high grade or exposed protoporphyrinnya sideroblastic secondary anemia as seen in the following table 2.

Table.2 Distribution of respondents according to Protoporphrin levels and age groups in the community in the Youtefa Gulf, 2014

Age group	Protoporphyrin levels				Total	
	High		Normal			
	n	%	n	%	n	%
20-24	0	0	2	100	2	2.6
25-29	1	0	3	100	4	5.3
30-34	1	7.6	11	92.4	12	16
35-39	4	57.1	3	42.9	7	9.3
40-44	2	22	7	78	9	12
45-49	2	25	6	75	8	10.6
50-54	1	14.2	7	85.8	8	10.6
55-59	1	22	7	78	8	10.6
60-64	3	28.5	6	71.5	8	10.6
>64	4	50	4	50	8	10.6
Number	19	25,3	56	74,7	75	100

Levels of Pb in Blood

Of those 40 people who checked the Pb levels, 39 people or 97.5% of people living in the Youtefa Gulf have a high level of Pb in their blood, as seen in the following table 3.

Table.3 Distribution of respondents according to blood Pb levels by age group of respondents

Age group	Pb levels in blood				Total	
	High		Normal			
	n	%	n		n	%
20-24	0	0	0	0	0	0
25-29	1	100	0	0	1	2,5
30-34	4	100	0	0	4	10
35-39	5	100	0	0	5	12,5
40-44	5	100	0	0	5	12,5
45-49	5	100	0	0	5	12,5
50-54	4	100	0	0	4	10
55-59	4	80	1	20	5	12,5
60-64	5	100	0	0	5	12,5
>64	6	100	0	0	6	15
Number	39	97,5	1	2,5	40	100

a. Corpoporphyrin levels (Pb Toxicity)

Pb poisoning have occurred in Europe due to the water pipes. Results of this study found that 33 or 44% of the samples were poisoned because of high levels of corpoporphyrinnya, then Plumbum toxicity. It could be attributed to the presence of sea water in the pipe which causes sea water polluted by Pb which eventually led to the majority of shellfish and fish samples also contains Pb and the average rate exceeds the threshold of Indonesia National Standard.

Pb pollution has also been reported to occur in the alcoholic beverages (whiskey) produced as a home industry, and in the beverage stored in a ceramic container covered with glaze. In 1969, it was reported that 30% of the samples produced whisky as a home industry that is not legal in Atlanta contain Pb more than 1 mg per liter, which is 20 times higher than the limit of Pb in water established by the Public Health Service. Pb pollution sources in the whisky was derived from Pb solder used in the tubes in the distillation unit and a car radiator containing Pb which is used as a condenser. Ceramic glaze containing Pb poisoning is a source of dangerous if used to coat food containers made of ceramic.

b. Protoporphyrin levels (secondary sideroblastic anemia)

Pb is a danger metal to humans not only causes sideroblastic anemia, Han Hui Ye research in Namgu Daegu Republic of Korea, found that workers exposed to materials that contain Pb apparently suffered from poisoning, and poisoning is very dangerous because Pb together with other risk factors can cause Acute hepatitis (Ye et. al., 2013). Another danger of Pb exposure also found by Nazar S Haddad, et. al., in Iraq in 2012, who examined 46 people, in which the sample is composed of 26 men and 20 women, the results showed that Pb found in the human eye. Haddad concluded that there were differences in Pb levels of the eyes of the samples and it is highly dependent on the characteristics of the person being investigated. Based on research

done by Haddad, it is known that people who smoke have a higher levels Pb with (1.5 mg / g) than those of non-smokers (1.00 mg / g) and the people who live in the city center have a higher levels Pb (2.6 mg / g) than those living in the suburbs (1.8 mg / g) (Haddad, Alasadi, & Haddad, 2012). According to I Made Bakta, anemia with ring sideroblasts in the bone marrow is a type of anemia that arises as a result of exposure to Pb or so-called secondary sideroblastic anemia. Pathophysiological changes in sideroblastic anemia occurs essentially a failure of iron incorporation into compounds on mitochondria resulting in mitochondrial iron settles so if painted with metal paint will appear as specks surrounding the nucleus is called a ring sideroblasts. This led to the failure of the formation of hemoglobin which accompanied eritroesis ineffective and cause hypochromic anemia mikrositer, (Bakta, 2013).

Sideroblastic anemia is a heterogeneous group of disorders with a common defect, the disease is not able to use the iron in hemoglobin synthesis even if iron stores are available in adequate quantities. Anemia can be akuisita (acquired). Shape akuisita (idiopathic), known as persistent anemia with ringed sideroblast cells resistant to therapy and is usually fatal within 10 years after the onset of complications with other diseases that accompany. This form is most commonly found in the elderly. Generally this form akuisita often thrombocytopenia or leukopenia as part mielidisplasia syndrome. Secondary sideroblastic anemia usually occurs due to the consumption of foods that contain Pb (Pb poisoning) (Kowalak, et al., 2013)

c. Pb levels in the blood

Based on the survey results revealed that of the 40 people who checked the Pb levels, 39 people or 97.5% of people who stay in the Youtefa Gulf have a Pb high blood levels. The results of this study illustrate that the communities who live around the Youtefa Gulf have actually been exposed to Pb. The result of this study was consistent with the results of research from Meiri Iriyani and Tan Malaka in Jakarta who found Pb levels in the blood of the officers were high range in Jagorawi with 8.5 mg% - 22.9 mg% (standard deviation = 1.1) with a mean of 20 mg% (Malacca & Iriyani, 2012).

Revelation similarly found that the average blood lead levels in motor vehicle mechanics in Pontianak was 1.828 g / dl blood profile where Pb levels in the blood are associated with higher levels of mechanic leukocytes and platelets with a p-value 0.034 and 0.022 with the value rho 0.341 and 0.365, respectively (Kurniawan, 2008). The similar figure was found by the Supreme Lieu et al, in health centers Purwokerto twins in 2012 which found that blood Pb levels in pregnant women is high. Same result of the research found that of the 93 respondents who studied a total of 88.2% of respondents have high levels of Pb, with an average Pb content of 28.68 mg / dl (Lieu, Widiastuti, & Indriani, 2012).

This study is consistent with the results of research conducted by the Department of Biomedical Sciences at Tufts University School of Veterinary Medicine, found that there were 70 incidents of high levels of Pb in cats due to exposure Pb (Kazuhiko, 2013). It was more distribution lead levels in women of childbearing age then found were in 10 women (25%) of people who have high Pb levels. It is a matter that needs attention because according to the American Conference on Governmental Industrial Hygienists (ACGIH) that for women of childbearing age, when blood lead levels

exceeding 10 ug / dl, can give birth to a child with the risk of cognitive disorders. According to the Occupational Safety and Health Administration (OSHA), that if the content of Pb in the working environment at 40 ug / dl of workers exposed for 30 days or more, the compulsory health surveillance. Health surveillance included blood tests including for Pb and zinc protoporphyrin (ZPP). If exposure to Pb quite low, ie below 40 mg / dl in the blood of the monitoring carried out every 6 months. If the blood Pb a worker reaches more than 40 mg / dl then it must be monitored every 2 months until the decline of less than 40 mg / dl. If the Pb levels in the blood reached 60 mg / dl or more, the US-OSHA requires that workers be moved or rested then conducted surveillance of each month and should only be working again after Pb level in the blood falls below 40 mg / dl (Malacca & Iriyani, 2012).

According to Fardiaz 1992, the organic component such as tetraethyl Pb, can be absorbed by the body through the skin or mucous membranes. This is a problem for fishermen who settled in the Youtefa Gulf because based on interviews with fishermen and citizens, in their day exposed to Pb polluted seawater, on average 180 minutes per day or 3 hours per day. In the human body, Pb activities can inhibit enzymes involved in the formation of hemoglobin, which can lead to anemia (Rangkuti, 2009). Pb existence in the body can interfere the synthesis of heme hemopoetik system through three mechanisms, which may interfere with the union first Glycine and Succinyl Co-Enzyme A. Both through the delta - ALAD depression, and the third through the disruption of the functioning enzyme attaches Ferrochelatase iron (Fe) to protoporphyrin which later became part of the heme as hemoglobin (Malacca & Iriyani, 2012).

Heavy metals can be absorbed through the skin in addition can also enter the body through food and drink and will be digested in the duodenum and will be transported by plasma (albumim). Albumim associates with the protein to be distributed to certain body parts that need and accumulates in the liver, kidney, hair and nail tip. Heavy metals can also be excreted through feces, urine and respiratory remainder Gibson 1990 and 1992 in Linder (Saeni & Wuryandari, 1995. If we look at the results of this research in the Youtefa Gulf found that levels of Pb in the blood is quite high and exceeds USEPA standards. The results of this study need a respond seriously by Jayapura government to find a way out of this problem, given the high levels of lead in the blood, and high levels of Pb in fish, shellfish and sea water, it needs an urgent solution is realistic, given the waters Youtefa Gulf by some communities serve as a source of livelihood, contaminated fish has been the source of protein and omega-3 is good for health, but the protein content and a high omega-3 into a dilemma due to the of heavy metal pollution on the fish.

According to Devi Nuraini, up to promote the development of environmentally sound pollution is one of the important factors to consider. In accordance with national development is complete Indonesian human development and the development of Indonesian society. Human interests such as health, safety, welfare and comfort. To reach the above programs, needs to be maintained harmony, balance and roundness that are intact in all development activities. Pollution is a complicated problem, because it involves matters relating to the physical characteristics, sources of pollutant emissions (of sources, the rate of pollution, high speed and emissions, climate elements that influence the spread of contaminants at the site where the emitted pollutants and

climatic conditions local air pollution in the receiving area). Air as one resource that cannot be renewed, a primary requirement for humans, animals and plants to be survive. Therefore, according to Devi environment needs to be maintained, through monitoring, regulation and restriction of its use so as not to exceed the limits that still allowed for life. Air pollution can be caused by human activities, among other things by industry, transportation, power plant, household activities and in offices.

Pb in the body can cause acute poisoning and chronic poisoning. Minimum number of Pb in the blood which can cause poisoning range from 60-100 micro-grams per 100 ml of blood. In acute poisoning usually occurs due to the inclusion of lead compounds soluble in acid or inhaling the vapors Pb. The symptoms that arise include nausea, vomiting, abdominal pain great, brain dysfunction, severe anemia, kidney damage and even death can occur within 1-2 days. Abnormalities of brain function occurs because Pb is competitively replacing key minerals such as zinc, copper, and iron in regulating our mental functions. Chronic lead poisoning cause symptoms such as depression, headache, difficulty concentrating, restlessness, decreased memory, insomnia, hallucinations and muscle weakness. Central nervous system is the major target organs of lead. According to Dr. M. Erikson's research shows that pregnant women who have high levels of lead in their blood turns out 90% of the deposits of lead in the body is passed to the fetus through the placenta, where fetal toxicity and intellectual influences the child's behavior later in life. From the World Bank notes, URBAIR 1994, it appears that the effects of air pollution by lead in Indonesia has caused 350 cases of heart disease (Santi, 2001).

The relationship between lead poisoning and iron deficiency anemia has been widely studied, especially in high risk populations, such as people living in the lead smelting area. Previous lead poisoning is associated with neurotoxic effects compared to the effects on heme synthesis. Several studies have found that lead levels increase with iron deficiency anemia. Several other studies showed a significant increase in the proportion between plumbum in the blood of 100 to 199 mg / dL and> 200 mg / dL with iron deficiency anemia. Increased blood lead levels can interfere with erythropoiesis inhibits the synthesis of protoporphyrin, and interfere with the absorption of iron which increases the risk of anemia. On the condition of lead poisoning, the most visible effect is the formation of heme pathway. Lead inhibits the enzyme δ-aminolevulinic acid and ferrokelatase dehidrase, so the enzyme δ-aminolevulinic acid dehidrase cannot change porphobilinogen, consequently cannot enter the iron heme protoporfirin. Perkursor cycle, protoprofi erythrocytes rin rin protoporfi changed to zinc, be increased and decreased heme formation, causing severe anemia.

According to WHO, heavy metals such as Pb is including heavy metals that do not provide biological benefits to the human body. Too many Pb can damage various systems of the body including the nervous and reproductive systems as well as the kidneys, then may cause high blood pressure and anemia. Pb can accumulate in bones and it poisoning can be diagnosed from a blue line around the gums and corpoporphyrin levels. Pb is very harmful to fetal brain development and children and for pregnant women. Pb can interfere with the metabolism of calcium and Vitamin D. Pb high levels in children can cause irreversible consequences may include learning disabilities, behavioral problems, and mental

retardation. At very high levels, Pb can cause seizures, coma and death (WHO, 1993).

Conclusion

a. All of the 75 samples or (100%) have a high levels Corpoporphrinnya (lead poisoning).
b. Of 75 respondents, there were found 19 samples (25.3%) that have a protoporphyrin levels > 30 mg / dl. (secondary sideroblastic anemia) in the urine and 56 samples (74.7%) were normal.
c. 39 people (80%) have a Pb levels in the blood were high or above the standard Quantum Magnetic Resonance Analyze > 0.643 mg / dl, and 1 sample (2.5%) has a normal Pb blood levels.

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