Calculating the Potential Risks of Environmental and Communities Health due to Lead Contaminants Exposure A Systematic Review

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Abstract

Lead (Pb) is a poisonous metal that large used worldwide and can cause widespread pollution and health problems. Today, Lead is significantly considered a serious threat because it can poison the air, get into the lungs, circulate in the blood, and cause long-side effects. Pb has been identified as metal poisonous with height concentration and its widespread use reported can damage the environment and lead to a serious epidemiological problem to global health. Materials for this literature review is collected from the official websites (i.e., Sciencedirect, Google Scholar, Ministry of Health Republic of Indonesia, and WHO) using the keywords: "lead (Pb) exposure ", "analysis of risk", and "health effect of lead (Pb) exposure". Based on the environmental health risk analysis results of each study, two studies are reported to have serious risks of Pb contaminant.

Keywords: lead (Pb) exposure; analysis of risk; health effect of lead (Pb) exposure.

INTRODUCTION

Heavy metal is natural component found on the earth's crust, can not be degraded or destroyed, and is dangerous substance due to bioaccumulation. It is significant pollutant whose toxicity is problem for ecology, evolution, nutrition, and the environment. The source can be divided into two that is natural and artificial. The natural source originates from the coastal supply, volcanic activity, mainland, and nearshore environments. Meanwhile, the artificial source is heavy metal liberated from industry or mining activity.1

Lead (Pb) is a metal poisonous that can cause widespread pollution and health problems worldwide. Nowadays, Pb is significantly considered a serious threat because it can poison the air, get into the lungs, circulate in the blood, and cause long-side effects.

Metal pollutants from vehicles with leaded gasoline can accumulate in the body, attack important organs, and even damage the quality of offspring. Pb poisoning from the air is found in people who are exposed to large amounts and for a long time. The effect of this exposure on health can be acute or chronic.2

Pb is a cumulative toxin that affects several body systems and is especially dangerous for children. It is estimated that around 600,000 new cases of intellectual disability in children each year and an estimated 143,000 deaths per year with the highest number of cases in developing countries.

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About one-half of lead-caused disease occurs in Southeast Asia, with about one-fifth in the Western Pacific and Eastern Mediterranean regions.3

Pb has been identified as metal toxic at high concentrations. The extensive use of Pb has been identified as metal toxic at high concentrations. The extensive use of Pb reported can result in widespread environment pollution and the epidemiological problem of global health. Pb as a cumulative toxicant can damage the nervous, kidneys, and blood circulation, particularly in children, infants, and fetuses. Pb is distributed in the brain, liver, kidneys and bones. Pb can accumulate from time to time in teeth and bones. Pb can also influence brain development and intellectual capacity in children, and induce apoptosis in organ tissues. In several cases reported can cause neurologically irreversible problem. Pb is considered responsible for over 540,000 deaths worldwide in 2016, and Pb exposure is estimated to be accounted for 0.6% of the global burden of disease. The reduction of use of Pb in gasoline (petrol), paint, plumbing, and solder resulting substantial subtraction in level Pb exposure.4

The negative impact of Pb pollution is significantly high on people who have frequent and long contact with sources of lead pollution, called high risk groups. These groups include gas station employees, workshop workers, traffic police, parking attendants, street vendors, motorists motorized and others. This study tries to review a number of previous studies about health risk analysis due to lead exposure and its epidemiological impact on health.

Materials and Methods

The source of review was collected from the official websites namely Sciencedirect, Google Scholar, Ministry of Health Republic of Indonesia, and WHO by using the keywords: "lead (Pb) exposure", "analysis of risk", and "health effect of lead (Pb) exposure". The exclusion criteria were articles that did not meet the study purpose. The selected articles filtered according to the inclusion criteria. The inclusion criteria were all open access articles about Pb exposure, analysis of risk and health impact of Pb exposure. A total of 28 references was successfully collected. However, only 15 articles were eligible for further reviewing.

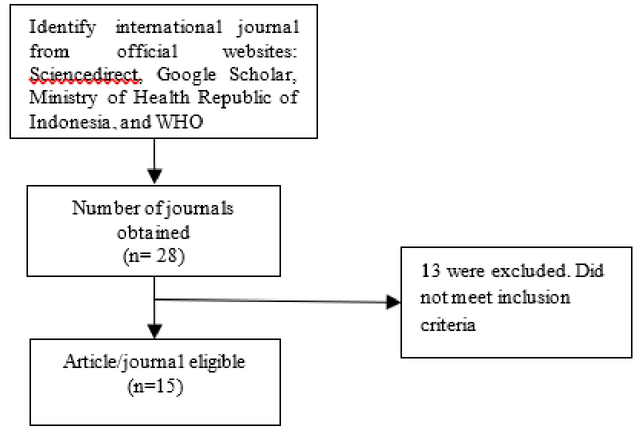

Figure 1. Literature search and selection process

Results

a. Lead (Pb)

Pb includes heavy metal group IVA in the chemistry periodic system. it has an atomic weight of 207.21, a density of 11.34, a soft character, colored blue or silver-gray with luster metal, atomic number 82, and a melting point of 327.4ºC and boiling point of 1,620ºC. Pb includes heavy metals or “trace metals” because it has a density five times more than the water density. The chemical form of Pb compounds that get into the body through food will settle on the body tissues and the rest will be excluded from the body together with other metabolism waste. Pb is an element that usually can be found in rocks, soil, plants, and animals. 95% of Pb is inorganic and generally in form of non-water-soluble inorganic salt. The rest is the inorganic lead form.

Organic Pb is found as Tetra Ethyl Lead (TEL) and Tetra Methyl Lead (TML) compounds. This compound type almost not soluble in water; however, it can be easy to dissolve in solvent organic for example lipids. Pb duration is affected by several factors such as current wind and rainfall rain. Lead is not experience evaporation however could found in the air as a particle because it is an element which not experience degradation (decomposition) and could not be destroyed.

Research by Nag et al. describes Pb composition in the topsoil layer including fertile land, grass fields, and water surface.4 The following picture shows the spatial Pb concentration.

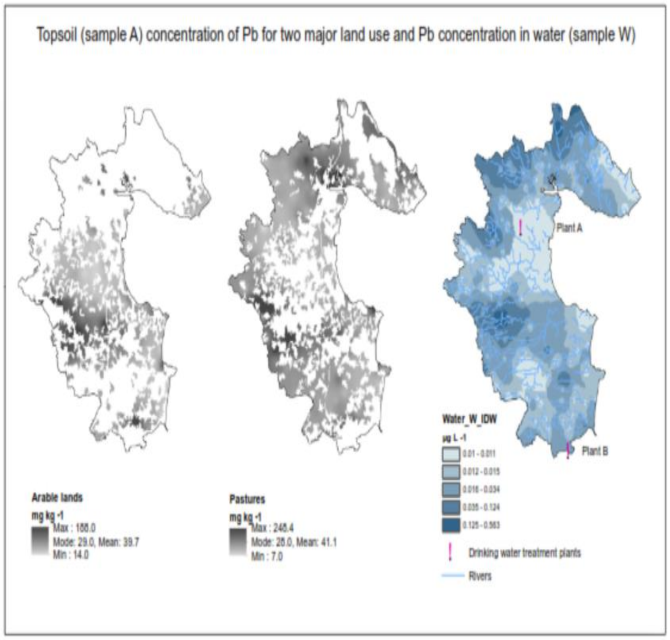

Figure 2. Distribution of regional variability and topsoil Pb concentration data (Sample A) of fertile land, grass fields, and water surface.4

b. Exposure to Lead (Pb)

Pb is a very dangerous metal toxic to humans. Pb can enter the human body in three ways: through absorption in the skin, absorption through the respiratory tract, and absorption through the digestive tract. If it is limited only to the contact area, it is then called a local effect; However, if these substances are absorbed into the blood circulation, then the substance will be carried to various organs in the body and cause systemic effects. The general impact of Pb heavy metal exposure is dizziness, loss of appetite, headache, sleep disturbance, and fatigue.5

The air polluter of Pb heavy metal produced from incomplete combustion of vehicles machine, industrial and mining activities. Pb metal pollutes the air in two forms that are in gaseous and particulate forms. Pb is not dissolved in water but in the fluid digestion channel.

Pb can accumulate in the food chain. Pb absorption in the body is very slow so it will accumulate and become the basis of progressive poisoning. This Pb poisoning causes high lead levels in the aorta, liver, kidneys, pancreas, lungs, bones, spleen, testes, heart, and brain.6 Based on the source, Pb can be found in two major sources:

1. Natural Pb

Pb is naturally can be found in rocks at about 13 mg/kg, in the soil at about 5-25 mg/kg. Pb is also present on the water surface. The levels of Pb in lake water and river water are 1–10 ug/L while in seawater lower compared to fresh water.

2. Pb from human activity

a. Mining activity. Pb seed from mining activity contains about 3% to 10% lead that further will be concentrated again to obtain pure Pb metal.

b. Pb in gas form mainly originates from the combustion of additive fuel in motor vehicles.

c. Pb in particle forms is generally sourced from factories, burning charcoal.

To determine the metal content of Pb in the human body, an accurate method is determined in the form of analysis of the concentration of Pb in blood or urine. The level of metal Pb in the blood can be a direct indication of the amount of metallic lead (Pb) that actually enters the body. Pb measurement is carried out with the use SSA method which is Pb metal in blood be measured using Spectrophotometer Atomic Absorption (AAS).7

In Rosita et al., the association of Pb toxicity in blood with motorcycle painting worker's hemoglobin in Pekanbaru showed the sample with a working period of 10 years and average time work 8 hours/day, had a rate of lead in the blood of 0.027 mg/dl. The working time >10 years with average time work 8 hours/day had a lead level in the blood of 0.042 mg/dl, higher than the threshold score. The result can be implied that the sample who had a working period of fewer than 6 years were not at risk compared to those more than or equal to 6 years in the same average time work to expose by Pb.8

Table 1 . Pb Concentration in Blood and Hb level of Klepon Seller

No	Sample	Working Period	Average length of work	Pb concentration in blood	Hb levels in m blood
			Day	(Mg/Dl)	(g/dl)
1	Sample I	2 years	8 hours	0.000	15.0
2	Sample II	3 years	8 hours	0.000	14.5
3	Sample III	4 years	8 hours	0.000	15.0
4	Sample IV	6 Years	8 hours	0.019	15.9
5	Sample V	10 Years	8 hours	0.027	15.5
6	SampleVI	>10 Years	8 hours	0.042	14.0

A study had examined Pb levels in blood of Klepon seller at Banjarmasin City. The effect of Pb poisoning in blood occurred when Pb content is more than 70 ug/dl or 0.07 ppm that causing anemia. In this research, there were 2 people (13.3%) whose levels of lead metal in the blood were ≤0,20 ppm and 13 people (86.7%) ≥0.20 ppm. The highest Pb content in blood was found at 0.73 ppm. According to WHO, the threshold of Pb in the blood is 20 ug/100ml or 0.20 ppm.

The use of tool protector self (PPE)/mask when work only by 3 people (20%). 2 people (13.3%) had blood Pb levels of <0, 20 ppm, and 1 person (6.7%) had >0.20 ppm. Respondents who sometimes use PPE (4 people or 26.7%) had Pb levels >0.20 ppm. Respondents who do not use PPE when working there were 8 people (53.3%) and had Pb level of 0.20 ppm.7

Table 2. Laboratory and Questionnaire Analysis Results

Sample Code	Type Sex	Age Year	Working Period (Years)	Time (Hour)	Use of PPE			Pb Level (ppm)
					Y	N	S	
1	F	30 yrs	7	8		X		0.73
2	M	31 yrs	7	5		X		0.66
3	F	40 yrs	3	6	X			0.15
4	F	32 yrs	4	6			X	0.37
5	F	38 yrs	3	6	X			0.10
6	F	38 yrs	5	6	X			0.47
7	M	55 yrs	11	10			X	0.60
8	F	31 yrs	4	12			X	0.38
9	F	44 yrs	4	8			X	0.25
10	M	50 yrs	5	7		X		0.53
11	M	40 yrs	4	7		X		0.48
12	M	30 yrs	2	9		X		0.25
13	F	34 yrs	3	7		X		0.25
14	M	45 yrs	5	6		X		0'55
15	F	45 yrs	2	7		X		0.26

F=Female; M=Male; Y=Yes; N=No; S=Sometimes

c. Pb Risk Assessment

Hazard quotient (HQ), Daily Dietary Index (DDI), Daily Intake of Metal (DIM), Health Risk Index (HRI), Target Hazard Quotient (THQ) and Cancer Risk (CR) were used to evaluate Pb risk by Rajat Nag and Enda Cummins.4

Table 3. The Steps for Risk Assessment

Method	Equality	Parameters and Units	Classification Risk
HQ	$HQ = DI \times \frac{C_{Mveg}}{RfDo \times BM}$	DI = Intake vegetable per day (kg/ day) C_{Mveg} = Concentration metal in vegetable BW= Average weight, adult (78.1 kg) $RfD_o = 1.4\times10^{-3}$ mg/kg/ day , 4×10^{-3} mg/kg/ day	HQ > 1 risk (non-cancer) HQ < 1 no there is effect health
DDI	$DDI = A \times B \times \frac{C}{BW}$	A = content metal in vegetables (mg/kg) B= weight dry vegetables consumed (kg) C= Estimate intake daily vegetables (kg/ day) BW= average weight human (78.1 kg)	HQ > 1 risk (non-cancer) HQ < 1 no there is effect health
DIM	$DIM = A \times C \times \frac{D}{BW}$	A = content metal in vegetables (mg/kg) C= factor conversion (0.085 is for convert heavy fresh vegetables to heavy dry) D= intake vegetable per day (kg/ day) BW= average weight human (78.1 kg)	DMI< 1 safe
HR	$HRI = \frac{DIM}{RfD}$	Idem	HRI < 1 safe
THQ	$THQ = \frac{EFr \times ED \times FI \times MC}{RfDo \times BW \times AT} \times 10^{-3}$	EF_r = frequency exposure (365 days / year) ED= duration exposure (70 years) FI= consumption food (g per person / day) MC= concentration metal in vegetables (μ/mg) $RfD_o = 1.4\times10^{-3}$ mg/kg/ day , 4×10^{-3} mg/kg/ day BW= average weight human (78.1 kg) AT= Average time to non- carcinogenic (365 days x total exposure in a year , assumed 70 years)	THQ < 1 no own effect
CR	$CR = ADD \times CSF$ $ADD = \frac{C \times IR \times EF \times ED}{BW \times AT}$	ADD= average dose daily (mg/kg/ day) CSF = cancer fall factor (0.0085 mg/kg/ day) ADD can calculated from equality C= concentration ingredients pollutant (mg/l, mg/kg) IR= average consumption (kg/day, l/ day) EF= frequency exposure (days / year) ED= duration exposure (year)	CR (for a single contaminant) > 1 $\times 10^{6}$ carcinogenic risk Adopted classification for the model based on Pipoyan et al. (2019) High risk 0.001; Moderate risk 0.0001 but <0.001; Low risk 0.000001 but <0.0001; Very low risk < 0.000001

		BW= average weight human , adult (78.1 kg) AT= average time (days)	

d. Health Impact

The entrance of Pb gets into the body through the respiratory tract (inhalation) or digestion tract (oral), then distributed into the blood circulation and binds with blood cells. Some of the Pb is stored in soft and bone tissue and partially excreted through skin, kidney, and colon. According to the WHO, the threshold of Pb in the blood is 20 ug/100ml or 0.20 ppm.

Pb is the air polluter element that has various toxic effects on humans by influencing the kidney function, digestive system, nervous system, and reproduction system. Pb in body tissue can be influenced by age and species and also by gender. The older the people, the higher Pb accumulated in the body. The type of tissue also affects Pb concentration such as bones, liver, lungs, kidney, spleen, heart, brain, teeth, and hair.

1) Poisoning

Poisoning due to Pb contamination can cause various things, including shortening the lifespan of red blood cells, decreasing the number of red blood cells and levels of young red blood cells (reticulocytes), as well as increasing the content of iron (Fe) in blood plasma.7 The first chronic impact of Pb poisoning before reaching the target organ is distract hemoglobin synthesis which can reduce hemoglobin levels. The effect of Pb poisoning in the blood occurs when Pb levels exceed 70 ug/dl or 0.7 ppm and can cause anemia. At the 0.3 ppm level, it will reach the step of inhibition action/binding active group of enzyme aminolevulinic acid dehydratase (ALAD) involved in hemoglobin formation. Pb affects the health of adults and children and can even be fatal or death if the Pb's blood levels exceed 100 mg/dl.5

2) Risk of Anemia

A total of 533 worker data of lead-exposed men and 218 women were collected for compiling datasets that were sourced from 6 different factories (Table 1). The average age of men and women workers are 43.7 (SD=10.2) and 47.1 (SD=8.6) years. All 533 men workers worked in the lead battery factory, lead stearate, and tin bars. Meanwhile, 218 women workers worked in the lead battery factory. Inside of lead battery factory, the manufacturing area is classified as casting, grinding, powder, filling, formatting, cutting, assembling, charging, packaging, or other off-site positions. The specific exposure condition is calculated by work area for the main worker.9

The finding shows the possibility of serious hazards was highest in men workers at the grinding sites with a median HI of 1.00 (95% CI: 0.39-1.80). For women workers, the assembling and packaging group had a relatively higher hazard incident probability of 80% and 60% with median HI 1.48 (0.47–2.67) and 1.32 (0.43–3.16), respectively. The total risk in HI for workers exposed to Pb was 0.78 (0.50-1.26) with an 11% hazard probability. The risk contribution analysis shows that women workers in the assembling site give a significantly high-risk contribution to the total population, with a proportion of 31.5%. The proportion of contribution risk in the other group was less than 10%.9

3) Blood Pressure and Cardiovascular

The study by Soelistyoningsih found that Mean Arterial Pressure (MAP) in 18 parking staff has high diastolic pressure (>=100 mmHg) compared to 5 parking staff who has normal diastolic pressure. It may show that many parking staff suffers from pre-hypertension, hypertension stage I, II, or even III. From the odds ratio, table calculation was obtained the risk estimation of 12 (p=0.035) which means people with high blood Pb concentration twelve-time more risk to have high MAP. The high MAP value could show organ or tissue perfusion compared to blood systolic pressure and have a close value with blood diastolic pressure. MAP value can be used as a predictor of cardiovascular disease risk.10

Pb and its effect on markers related to cardiovascular were explored in a cross-sectional study of young adults (18-44 years old) and middle-aged adults (45-65 years old) from the United States using the National Health and Nutrition Examination Survey (NHANES) from 2009–2016. The level of exposure was determined by Pb level in the blood (BLL) as a biomarker of exposure based on an epidemiologically relevant threshold of > 5 g/dL. The other parameters were systolic blood pressure [SBP], diastolic blood pressure [DBP], gamma-glutamyl transferase [GGT], and nonhigh density lipoprotein cholesterol [non-HDL-C]). The possibility of Pb exposure by the increase of clinical marker concentration beyond the threshold was examined using biner logistic regression. There was a significant difference in each average of all clinical marker variables between young and middle-aged adults. Regression binary logistics show young and middle-aged adults who are exposed to lead were significantly more possible to have increased value on markers (regardless of DBP). Overall, Pb affects marker related cardiovascular in young and middle-aged adults in the US. 11

Another research was conducted to know the effect of chronic Pb exposure to lipids serum, lipoproteins, and liver enzymes with cohort studies among lead mine workers. The researcher observed 200 Iranian workers over 3 years (2018–2020). 100 workers were exposed to Lead and the rest were not exposed. Blood lead levels (BLL), lipids serum, lipoproteins, and liver enzymes from the exposed group for 3 years were measured and compared with workers who do not expose. The BLL rate of mine workers group were higher than control (non exposed group; 24.15 and 6.35 g/dL, respectively). The finding show the positive correlation between BLL and lactate dehydrogenase, aspartate transaminase, alkaline phosphatase, alanine transaminase, and bilirubin levels (P<0.01). Further, it was found negative correlation between BLL and triglycerides, total protein, albumin, and globulin levels (P<0.01). Those describe that the exposure of chronic Pb is risk factor for hematological, hepatic, and cardiovascular diseases. Regardless the parameter of liver function is in the normal range, 3-year follow-up had shown a significant relationship between BLL and change level of biochemical parameters. 12

4) The impact of Pb on Children

Research by Nakata et al. investigated the impact of Pb poisoning in childhood on the maternal health-related quality of life (HRQoL) in Kabwe. HRQoL was measured by a 36-Item Short Form Survey for 404 mothers who came from 40 regions randomly selected using the standard enumerator area (SEA). Blood lead level (BLL) of house members including mothers showed a positive correlation between mother and their children (R 0.6385, $p < 0.0001$), whereas BLL in aged-preschool and aged-school children was significantly higher than their mothers and father. By using variables including BLL of house member, age of mother, income, and strategic environmental studies (KLHS), the researcher did a multilinear regression analysis. The results showed a significant negative association between the representative household child's BLL and aged-preschool and aged-school children's BLL with vitality score and mental health score of their mother. Besides, aged-school children's BLL has only significantly associated with their mother's mental health score. On the other hand, there was a significant negative association between the mother's BLL with the function of social role score. Those imply that the increase in BLL in children may negatively impact the mental health condition of their mother regardless of the mother's BLL itself.

e. The Overview of Environmental Health Risk Analysis Due to Lead (Pb) Exposure

The environmental health risk analysis of Pb exposure is carried out by viewing various research results from relevant published journals as follows:

Table 4. Health Risk Analysis Study of Lead (Pb) Exposure Consequences from Various Research

No	Author/Year	Article Title	Results
1.	Rehman, ZU, et al (2016)	Lead and Cadmium Contamination And Exposure Risk Assessment Via Consumption of Vegetables Grown in Agricultural Soils Of five-Selected Regions of Pakistan	Pb concentration for all land is below the maximum limit permitted (MAL 350 mg/kg) by SEPA. The average Pb concentration in consumed vegetables was about 1.8 to 11 mg/kg. Pb concentration for leaved vegetables was higher than fruity and fleshy vegetables. Pb concentration exceeded the MAL (0.3 mg/kg) for leaved vegetables and 0.1 mg/kg MAL for fruity and root/tuber vegetables defined by FAO/WHO-CODEX. HRI values exceeded the limit permitted (>1) reported for a number of vegetables. Consumption of vegetables was a potential risk to cause health problems for the local community.[14]
2.	Nag , Rajat and Cummins, Enda (2022)	Human health risk assessment of lead (Pb) through the environmental-food pathway	The daily average HE of Pb through choice food product was found of 0.073 mg/day, whereas weekly exposure was estimated as 0.0065 mg/kg body weight. A number of estimation risks were used: Hazard Quotient (HQ), Daily Diet Index (DDI), Daily Intake of Metal (DIM), Health Risk Index (HRI), Target Hazard Quotient (THQ) and Risk Cancer (CR), found as 0.234 to 0.669, 0.002, 0.0002, 0.020 to 0.057, 0.234 to 0.669, and 0.00001, respectively. Those indicate low to medium risk. The calculation of limit Pb return in soil (51 mg/kg) confirmed the low threshold of Pb (50-300 mg/kg) on the agricultural land by European Union to reduce potential bio-transfer into the food product in the northern Ireland.[4]
3.	Hasmi and Mallongi, Anwar (2016)	Health Risk Analysis of Lead Exposure from Fish Consumption among Communities along Youtefa Gulf, Jayapura	The result showed the Pb concentration in fish from 12 stations was 2.46 mg/kg on average, the level that was considered to indicate pollution because was above the 0.3 mg/kg threshold by ISO 7387 in 2009. Of 75 respondents, 66 respondents (88%) were found to have RQ>1, which was considered to show a high risk of Pb exposure. The average RQ of 75 respondents who consumed fish was 6.03. Based on this high RQ value, the risk for the individual need to be controlled.[15]
4.	Raharjo, Puspito., et al (2018)	Health Risk Analysis and Blood Lead Levels: (Study on Communities Consuming Mangrove Oysters *(Crassostrea gigas)* in the River Site of Tugu District,	The results of the analysis showed that the risk level of Pb (HQ Pb) was 0.053, the value (HQ Pb) <1 which means the society of Tugurejo Village that consumes oysters was still safe and did not cause a health risk for real-time conditions. The results of blood Pb measurements in 10 respondents showed an average of 46.3 g/dl. There was no relationship between the level of risk (HQ Pb) with blood lead levels, but it had a positive correlation, therefore, it can be interpreted that the higher the HQ Pb value, the higher the blood

		Semarang City)	Pb level.[6]
5.	Khairunnisa and Indirawati, Sri Malem (2021)	Health Risks of Lead Exposure to Community Drinking Water in the Ex-Eruption Area of Sunabung, Simpang Empat Karo . District	The results showed that the Pb concentration was 0.0012 mg/l which was still below of environmental quality standard. The average intake for the real-time duration of exposure was 0.000005 mg/kg/day with an RQ≤1 value of 0.013. The intake of non-carcinogenic Pb did not pose a health risk. The estimated intake value for the next 50 years of exposure is 0.0024 with an RQ≤1 value of 0.6 which means the intake of Pb that had a non-carcinogenic effect did not pose a health risk to the people of Lingga Julu Village for the next 50 years.[16]
6.	Lu Lu., et al (2015)	Assessment of Regional Human Health Risks from Lead Contamination in Yunnan Province, Southwestern China	The research showed Yunnan Province which locates in the east Yunnan sea including Kunming, Qujing, and Zhaotong areas had the highest health risk cause of Pb. In this region, Pb was present at a high level in the air, food, water, and soil, and the high density of residents elicit the potency of high risk to the population. This research also revealed that most of the regional health risks came from children aged above 3 years) 4.3 times of children under 3 years old, and consumption of lead-contaminated rice was found as a most significant contributor to health risk (for more than 49% of the total health risks).[17]
7.	Gyasi ,Emmanuel Screwdriver (2019)	Lead Exposure and Cardiovascular Disease among Young and Middle-Aged Adults	Regression binary logistics showed young adults and middle-aged people who are exposed to Pb were significantly more possible to have increased markers (i.e, systolic blood pressure [SBP], gamma-glutamyl transferase [GGT], non-high-density lipoprotein cholesterol [non-HDL-C]). Overall, Pb affects marker related cardiovascular in adults young and middle-aged in the US and thus we should monitor lead exposure to improve health.[11]
8.	Ervianti, Tetti., et al (2021)	Environmental Health Risk Analysis of Lead (Pb) on *Weighing* in balance on Jl. Urip Sumoharjo Makassar City.	The highest concentration of Pb was at the measurement point that is in front of the Awal Bros Hospital where the result in the morning was 0.4690µg/Nm and in the afternoon was 0.4605 g/Nm. Analysis of Pb exposure on Pa'limbang-limbang was through inhalation, with an intake rate of 0.83 m3/hour, and the safe concentration of Pb for respondents with a bodyweight of 40kg and with a duration of exposure for 2 years was 0.46 mg/m3. There was one person who is at risk of having a non-carcinogenic health disorder RQ> 1 due to Pb exposure.[2]

From the table above, it can be concluded that there were 5 studies that discuss about risk analysis of lead exposure through digestion or food consumption.4,6,14,15,16. One journal discussed about the exposure through inhalation2, one journal discussed Pb exposure in relation to cardiovascular disease11 and onejournal discussed lead exposure in air, food, water and soil.17

Of the 5 studies that discussed Pb exposure through digestion or food consumption, based on the results of environmental health risk analysis conducted by each study, 2 studies found a risk of lead exposure. First, research by Rehman et al. in 5 selected agricultural areas in Pakistan found that HRI values exceed the limit safe (>1) reported for a number of vegetables. Consumption of those vegetables can be a potential cause of risk to health for the local public14. Second, Hasmi and Mallongi in Youtefa Bay Jayapura also found that the average RQ of 75 respondents who consumed fish was 6.03. Based on a very high RQ value, the risk for individuals needs to be controlled.15

Research by Lu Lu., et al. in Yunnan Province of China also found that consumption of lead contaminated in rice found as a most significant contributor to health risk (for more than 49% of the total health risks).17 While the analysis of Pb exposure (Pb) on Pa'limbang-Limbang limbang at Jl. Urip Sumoharjo Makassar City was found through inhalation with an intake rate of 0.83 m3/hour, and a safe concentration of Lead (Pb) for respondents with a body weight of 40 kg with a duration of exposure for 2 years was 0.46 mg/m3. There was one person who was at risk of having a non-carcinogenic health disorder RQ> 1 due to lead (Pb) exposure.2

Discussion

The source of Pb is divided into two: natural and artificial sources. Pb can pollute the land, water, and air. Further, it can enter the human body in three ways: absorption in the skin, absorption through the respiratory tract, and absorption through the digestive tract. Those can lead to bioaccumulation in organisms which expose to Pb.

The previous research of risk analysis reviewed in this study had examined the exposure of Pb originates from the soil that found there was Pb bioaccumulation in agricultural food products such as vegetables, wheat, and rice. This can enter the human body if consumed and can be accumulated in the blood or other organs that can damage for human.

For non-smoking population, the higher daily Pb intake is through food consumption including cereals and vegetables. The other sources include the use of can in packaging for food, ceramic as eat equipment or Pb-plated pottery, piping system in household, solder and fittings, dirt and dust. Smoking increases Pb intake. Consumption of fruit and vegetables (not potatoes and other root foods) is recommended to prevent heart disease, cancer, diabetes, obesity, some micronutrients deficiency especially in under developing countries.4

However, it has been proven that leaf and lower stem of vegetables can be a higher of heavy metal accumulation. Therefore, the steps should be carried for minimize heavy metal accumulation, for example, limit the growth of plant particularly on contaminated soil. Wheat (Triticum aestivum L.) is the third of most important cereal in the world after rice and corn and the concentration of heavy metal including Pb reported decrease in order by root > leaf > stem > grain on wheat.14 Another source of Pb exposure research was through water media that is the research on fish in Youtefa Bay, Jayapura and Mangrove Oysters in Tapak River, Tugu District, Semarang City. The result showed, the average RQ of 75 respondents who consumed fish was 6.03 or the risk was very high and need to be controlled.15 Although there was no relationship between the level of risk (HQ Pb) and blood lead levels of respondents in Sungai Tapak, Tugu District, it has a positive correlation that can be interpreted the higher the HQ Pb value, the higher the blood lead level.4

In contrast to other research, research on Health Risks of Lead Exposure in Community Drinking Water in the Ex-Eruption Area of Sunabung, Simpang Empat Karo District, lead exposure that occurs was a natural source. The results showed the intake of Pb which has a non-carcinogenic effect did not pose a health risk to the people of Lingga Julu Village for the next 50 years through the ingestion.16

Exposure to Pb from air that was studied on Pa'limbangs in Urip Sumoharjo street, Makassar City, through inhalation showed an intake rate of 0.83 m3/hour, and the safe concentration of Pb for respondents with a body weight of 40 kg with a duration of exposure for 2 years is 0.46 mg/m3. There is one person who is at risk of having a non-carcinogenic health disorder RQ> 1 due to lead (Pb) exposure. If there is one population at risk (RQ>1), then a risk management is needed to protect the population.2 Gyasi and Emmanuel Screwdriver research, by overall, Pb affects marker related cardiovascular in adults young and middle-aged in the US and thus, Pb exposure should be monitor for improve health.11

Based on the studies or journal reviews that have been carried out above, exposure assessment and hazard characterization are important parameters of human health risk assessment. Several parameters used in various risk analysis studies are Hazard Quotient (HQ), Hazard Index (HI), Risk Quotient (RQ), Daily Diet Index (DDI), Daily Metal Intake (DIM), Health Risk Index (HRI), Target Hazard Quotient (THQ), Cancer Risk (CR) and Total Cancer Risk (CR). These can be classified as end point analyzes in which the concepts of exposure assessment and hazard characterization are combined to assess the overall potential human risk to metal (loid) pollutants. There is no risk assessment with the most appropriate method for evaluating the risk of metals (loids). However, HQ, DDI, DIM, HRI, THQ, and CR have been identified as suitable for lead (Pb) risk assessment.4

Conclusion

Lead (Pb) is very serious pollutant for environmental and human health. Of the 5 studies, Pb can exposed to the body through digestion or food consumption. Based on the environmental health risk analysis results of each study, two studies are reported to have serious risks of Pb contaminant. First, research in 5 selected agricultural areas in Pakistan by Rehman et al., HRI values exceed limit safe (>1) reported for a number of vegetables. Second, Hasmi and Mallongi in Youtefa Bay Jayapura also found that the average RQ of 75 respondents who consumed fish was 6.03. The other studies also epidemiologically reported the impact of Pb exposure and its association on health risk. This review recommends serious attention on Pb exposure and its consequence on human health.

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