Plumbum (Pb) in Rainwater

by Khayan Khayan

	Nature Environment and Pollution Technology *An International Quarterly Scientific Journal*	p-ISSN: 0972-6268 e-ISSN: 2395-3454	Vol. 18	No. 4	pp. 1423-1427	2019

Original Research Paper **Open Access**

Plumbum (Pb) in Rainwater in West Kalimantan: Impact of Plumbum (Pb) in Community Blood

Khayan Khayan-Taufik Anwar-Slamet Wardoyo
Department of Environmental Health, Poltekkes Kemenkes Pontianak, 78124, Indonesia

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 27-03-2019
Accepted: 01-06-2019

Key Words:
Plumbum (Pb)
Rainwater
Zinc roof
Community blood
Drinking water

ABSTRACT

The low coverage of drinking water in the West Kalimantan-Indonesia region because of the limited availability of decent water as a source of drinking water is the main trigger for the community to use rainwater as a source of drinking water. The way of storing rainwater through zinc roofs and environmental pollution conditions results in rainwater being a health concern for the community because of the content of Plumbum (Pb). In this study, the characteristics of rainwater in the West Kalimantan region were investigated from rainwater collected by people from homes with zinc roofs. Rainwater samples from the collection results were analysed for the presence of Plumbum (Pb). The impact of consuming rainwater is carried out by blood Pb examination. The main problem can analyse the existence of Plumbum (Pb) in rainwater against the content of Plumbum (Pb) in the blood. The results showed that there was a correlation of Pb content in rainwater with Pb content in the blood of people who consumed rainwater as water drink ($p \leq 0.001$).

INTRODUCTION

Freshwater is abundant in the tropics, especially Indonesia, and can be used as a source of clean water and drink for the community. It is only about 20% of the 200 million people who have access to Regional Water Companies (PDAMs) (Peniwati & Brenner 2008). The rest use water sources that are not processed by Regional Water Companies, such as surface water and rainwater. Along with population growth, which is getting higher with increasingly poor environmental quality, results in high pollution of surface water and the community uses rainwater as a source of drinking water (Resosudarmo 2003, Wilopo et al. 2013).

Rainwater naturally has good quality physically, chemically and biologically except that its mineral content is low. Environmental conditions that are getting worse due to air pollution in the Industrial era can pollute rainwater (Water et al. 2017). These contaminants come from transportation, industry, and land burning activities, which often occur in the dry season (Afroz et al. 2003, Colvile et al. 2001, Harrison et al. 2009, Sastry 2002). Indonesia is a land area with peatlands with distribution in Sumatra, Kalimantan as a trigger for fires (Tacconi et al. 2007).

Characteristics of tropical communities that use roofs having zinc as roofs have their own risk of Pb content in rainwater (Meera & Ahammed 2018). Zinc roofs are made up of zinc metal using Pb coating as stainless. Due to the presence of air pollutants such as COx, SOx and NOx the rainwater becomes acidic and corrosive to metals (De la Fuente et al. 2007). In addition, contamination from burning fuel oil can result in Pb pollutants. Low pH of rainwater due to acid rain will increase the solubility of metals in water, so it will be riskier if the water is consumed (Chuan et al. 1996).

Pb content in rainwater aside from the zinc roof used to hold rainwater also occurs due to Pb exposure from the environment outside the zinc roof, for example, industrial activities, motor vehicle emissions, burning of agricultural land (peat), burning of charcoal and other materials (Sun et al. 2004, Al-Masri 2006). Furthermore, pollutants of Pb particles, especially organic Pb (tetraethyl lead and tetramethyl lead) in the air decompose rapidly due to sunlight. Tetra ethyl-Pb will decompose into triethyl-Pb, diethyl-Pb and monoethyl-Pb with the help of rainwater to become crystals and easily dissolve in water, and then enter into Rainwater Shelter (PAH) and used as a source of drinking water for the community (Zhang et al. 2015)

From several studies, the effects of long-term lead have been linked to various forms of cancer, nephrotoxicity, central nervous system effects, and cardiovascular disease in humans. Drinking water has a widely known metal exposure pathway. So that the risk as early as possible needs to be known before an acute effect occurs (Ryan et al. 2000). Detection of Pb exposure can be done through blood tests by comparing with the standards set by WHO (Edwards et al. 2009).

MATERIALS AND METHODS

Research Methods

This study uses analytical observational methods. With the aim of analysing the utilization of rainwater as a source of drinking water that passes through the roof of zinc to the content of blood Pb in the people of West Kalimantan, Indonesia. The study design used was cross-sectional. The number of research samples were from 40 houses. The research was conducted through three research objectives, namely knowing the Pb content in rainwater that passes through the zinc roof, the Pb content of the blood levels of that consume rainwater, and to analyse the risk of exposure to Pb of rainwater that is passed through a zinc roof with the content of Pb in the blood of the community of West Kalimantan, Indonesia.

Study Site

Samples come from the two targeted areas in the West Kalimantan region, Indonesia to represent urban and rural areas, namely Pontianak City and Kubu Raya Regency. Urban areas were chosen by two target locations, namely Siantan Hulu and Central Siantan Districts. Whereas Kubu Raya Regency is taken from the locations of Limbung Village and Arang Limbung Village. This research was conducted for 12 months from January to December 2016. This study was approved by the Ethics Committee for Health Research at the Ministry of Health Polytechnic Makassar (303/ KEP-PTKMKS/VII) and informed consent was given directly to the respondents to get approval and participation in this study. Rainwater samples were taken from homes with zinc roofs and rainwater storage was used as a source of random drinking water. Rainwater samples were taken with a 0-20 minute rain interval of 2.5 litres of rain. A blood sample of 5 mL was taken from the occupants of the house whose duration of residence was longest at home with the consumption of the most drinking water from rainwater. The collected samples were processed and stored for brewing to the laboratory. Decision in research participation were voluntary.

Sample Analysis

Pb analysis in water was carried out using atomic absorption spectroscopy (AAS). Standard solutions were analysed using AAS and followed by empty solutions and sample solutions (urine and blood). The measurement results of atomic absorption were recorded and calculated to obtain Pb concentration in the sample solutions (Bai et al. 2015, Islam et al. 2016). Blood lead measurement uses a voltammetric stripping technique (Ahmad et al. 2014).

Data Analysis

Data were processed by computer programs and analysed descriptively and analytically. Correlation test was used to analyse the relationship between exposure to rainwater Pb and Pb in the blood of people who consume rainwater as drinking water, to see the strength of the relationship carried out by looking at the value of r (Hedberg et al. 2011).

RESULTS

From the results of Pb examination in rainwater that was used by the people of West Kalimantan with four target locations, the study showed that rainwater used by the community as a source of drinking water was positive for the existence of Pb. The Pb is caused by the way the community keeps using zinc roofs and is aggravated by air pollution. The Pb level of rainwater in West Kalimantan has a mean of 137.55 µg/L with the highest distribution being in urban areas namely Upper Siantan and Central Siantan (201.34; 220.40 µg/L) compared to rural areas (56.57; 71.87) (Fig. 1a).

From testing blood samples taken from the people who consume rainwater, it shows that Pb in their blood is still at the permissible limit of ≥ 40 µg/dL. Lead levels in the blood of people who consumed rainwater as drinking water had an average of 21.79 µg/dL of drugs with the highest blood Pb in urban areas 27.48 µg/dL compared to rural areas of 16.11 µg/dL. The urban and rural areas are each represented by two target regions (Fig. 1b).

Table 1: Relationship of Pb levels in water with blood Pb.

		Pb in Blood
Pb in Water	Pearson Correlation	.674**
	Sig. (2-tailed)	.000
	N	40

** Correlation is significant at the 0.01 level (2-tailed).

From the examination, it was shown that the people who consumed drinking water came from rainwater, which was accommodated through zinc roofs which tended to have high blood lead levels. Test statistic obtained the value of $p \leq 0{,}001$. There is a correlation between Pb levels in rainwater consumed with blood levels of Pb blood. The relationship has a strong and positive relationship (r = 0.67) (Table 1). From the regression equation, it can be seen that the higher the Pb of rainwater, the higher the blood Pb of the community. Regression results from this study are shown in Fig. 2.

DISCUSSION

West Kalimantan region, Indonesia is a region that has a tropical climate with the intensity of rain throughout the

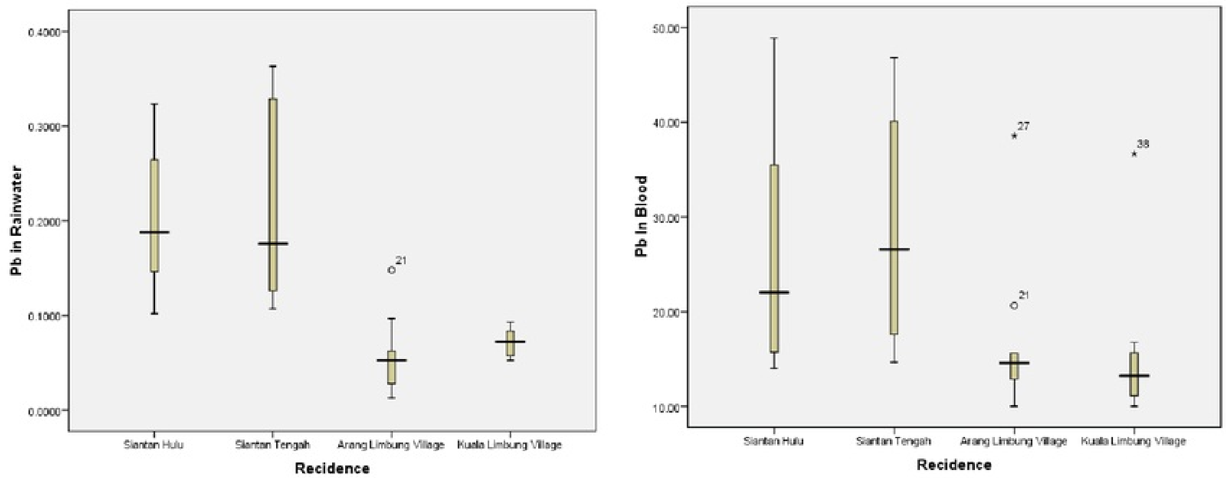

Fig. 1: a. Pb content in rainwater is utilized by the community b. Pb content of the blood of people who consume rainwater

months. The abundant amount of rain in addition to the quality of surface water and poor soil triggers the community to use rainwater as drinking water (Kido et al. 2009). From the research conducted, the quality of rainwater which is considered by the community as good quality turns out to have a high lead content of 137.46 µg/L. Urban areas with higher levels of Pb in rainwater are higher than rural areas because urban areas have higher pollution levels than rural areas.

The inclusion of Pb in rainwater is caused by the presence of Pb contamination in the air from natural and human activities. Natural activities, for example are from Mount Merapi explosions and land fires. Non-natural sources or human activities are such as lead emissions from industrial and transportation activities (Zhang et al. 2015). Because of the use of leaded fuel, car and motorcycle vehicles are the main sources of lead (Pb) emissions in the air. Lead emission (Pb) released in the ambient air will be bound by

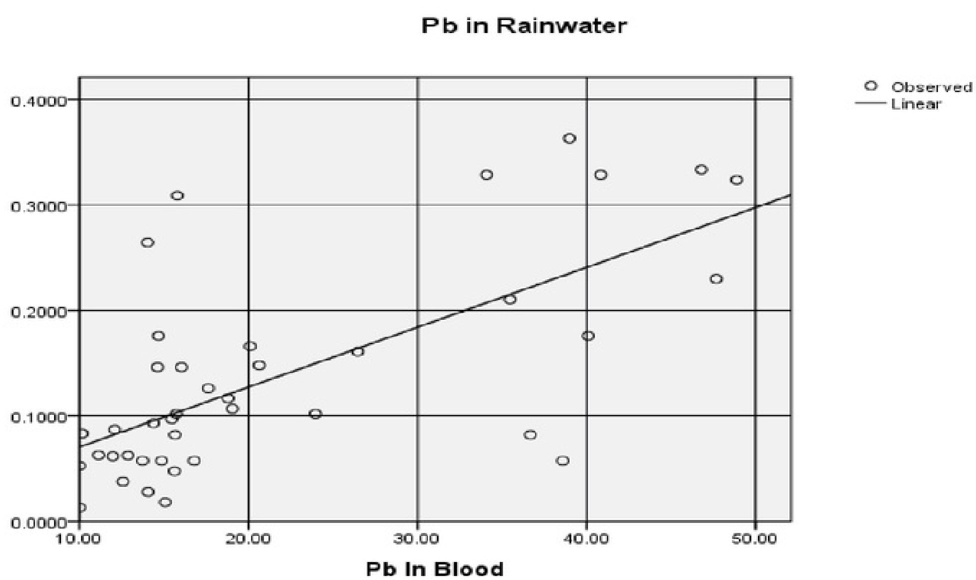

Fig. 2: Linear PB in rainwater and blood Pb.

the simultaneous decrease in rainwater. Rainwater whose natural conditions do not contain lead can be polluted by lead (Pb) (Khayan et al. 2017).

Natural activities and human activities in addition to causing lead contamination (Pb), also cause other contaminating gases such as COx, NOx, and SOx which cause acid rain and increase the solubility of lead (Pb) in rainwater (Wondyfraw et al. 2014). Acidic rainwater is corrosive to metal roofs such as zinc roofs. Zinc roof is the roof of the house in the manufacturing process using a layer of lead (Pb). Acid rain causes the zinc roof to be corrosive and release Pb in the water flowing above it (Knotkova 1992).

The impact arising from consumption of rainwater containing high Pb results in high blood Pb levels in the community. This can be seen from the measurement of blood Pb levels in people who oxidize rainwater. There is a tendency between the high exposure of Pb of rainwater and the high Pb of the blood of people who use rainwater as a source of drinking water. The statistical test results showed a significant correlation (p≤0,001), with a moderate strength (r = 0.4) between the high concentration of Pb of rainwater and the amount of Pb content in the blood of the community.

The impact of lead exposure depends on how much lead (Pb) is exposed in the body. Lead (Pb) is a metal that is toxic to humans, which can enter the body through oral (digestive), such as food or drinking water consumed. Besides having toxic properties, Pb metal has cumulative properties in the body (Wani et al. 2015). Lead (Pb), which enters the body will be distributed throughout the body through the blood and accumulates in the bones and soft tissue will cause chronic toxicity. Lead (Pb) can cause neurological, liver, kidney, haematological, circulatory, immunological, reproductive, growth, hearing, gastrointestinal and cardiovascular disorders (Zhang et al. 2015). Pb concentrations more than 50 μg/dL can interfere with the production of haemoglobin even though the blood Pb of the community is still below the standard but continued monitoring needs to be done (Khotijah et al. 2017, Liu et al. 2015). Pb exposure, in general, is more detrimental to children than adults. Children are more sensitive to low lead levels than adults. Lead poisoning (Pb) in children can cause neurological effects that contribute to lower intellectual intelligence (IQ), learning deficits, cognitive deficits, lower vocabulary abilities and grammatical reasoning, longer reaction times, worse hand-eye coordination, deficits in psychological performance, hyperactivity, and behavioural problems (Wani et al. 2015).

High levels of lead in blood (BLL) in adults will have an impact on the emergence of several diseases. Common diseases are frequent headaches, numbness in the legs, nausea, colic, tremor, nausea, and lead lines on the gums. Timabk in the blood is also related to the incidence of hypertension and anaemia (Ahmad et al. 2014).

CONCLUSION

Rainwater that is used by the people of West Kalimantan, Indonesia has the presence of Pb. The presence of Pb in the rainwater increases the blood Pb content of the people who consume it. There is a correlation between the Pb of rainwater and the blood Pb of the community with rainwater consumption (p≤0,001) with a positive correlation (r = 0.67). The relationship shows that the higher the Pb in the water consumed, the higher the blood Pb.

ACKNOWLEDGMENT

Head of the Development Agency Health Human Resources of the Republic of Indonesia, as well as the Pontianak Ministry of Health Research and Technology, which supported and facilitated this research are gratefully acknowledged. We also thank the people of West Kalimantan who participated in this research.

REFERENCES

Afroz, R., Hassan, M.N. and Ibrahim, N.A. 2003. Review of air pollution and health impacts in Malaysia. Environmental Research, 92(2): 71-77.

Ahmad, S., Khan, M.H., Khandker, S., Sarwar, A.F.M., Yasmin, N., Faruquee, M.H. and Yasmin, R. 2014. Blood lead levels and health problems of lead acid battery workers in Bangladesh. The Scientific World Journal, 7-9.

Al-Masri, M.S., Al-Kharfan, K. and Al-Shamali, K. 2006. Speciation of Pb, Cu and Zn determined by sequential extraction for identification of air pollution sources in Syria. Atmospheric Environment, 40(4): 753-761.

Bai, D., Ying, Q., Wang, N. and Lin, J. 2015. Atomic absorption spectroscopy for the determination of heavy metals in polyethylene moulding materials using Anderson-Darling statistics and top-down uncertainty estimates. In: 2015 3rd International Conference on Advances in Energy and Environmental Science, Atlantis Press.

Chuan, M.C., Shu, G.Y. and Liu, J.C. 1996. Solubility of heavy metals in a contaminated soil: Effects of redox potential and pH. Water, Air and Soil Pollution, 90(3-4): 543-556.

Colvile, R.N., Hutchinson, E.J., Mindell, J.S. and Warren, R.F. 2001. The transport sector as a source of air pollution. Atmospheric environment, 35(9): 1537-1565.

De la Fuente, D., Castano, J.G. and Morcillo, M. 2007. Long-term atmospheric corrosion of zinc. Corrosion Science, 49(3): 1420-1436.

Edwards, M., Triantafyllidou, S. and Best, D. 2009. Elevated blood lead in young children due to lead-contaminated drinking water: Washington, DC, 2001-2004. Environmental Science & Technology, 43(5): 1618-1623.

Harrison, M.E., Page, S.E. and Limin, S.H. 2009. The global impact of Indonesian forest fires. Biologist, 56(3): 156-163.

Hedberg, Y., Herting, G. and Wallinder, I.O. 2011. Risks of using membrane filtration for trace metal analysis and assessing the dissolved metal fraction of aqueous media-a study on zinc, copper and nickel. Environmental pollution, 159(5): 1144-1150.

Islam, R., Al Foisal, J., Rahman, M., Lisa, L.A. and Paul, D.K. 2016. Pollution assessment and heavy metal determination by AAS in waste water collected from Kushtia industrial zone in Bangladesh. African Journal of Environmental Science and Technology, 10(1): 9-17.

Khayan, K., Husodo, H., Sudarmadji, S. and Sugandawaty, S. 2017. Usage of filter tube to reduce Pb, turbidity and increase pH of rain water flowing through zinc rooftop house. KEMAS: Jurnal Kesehatan Masyarakat, 13(1): 41-49.

Khotijah, K., Sjarifah, I., Mahendra, P.G.O., Widyaningsih, V. and Setyawan, H. 2017. The effects of lead (Pb) exposure to blood Pb concentration and haemoglobin levels in book sellers and street vendors of Surakarta. KEMAS: Jurnal Kesehatan Masyarakat, 13(2): 286-290.

Kido, M., Syawal, M.S., Hosokawa, T., Tanaka, S., Saito, T., Iwakuma, T. and Kurasaki, M. 2009. Comparison of general water quality of rivers in Indonesia and Japan. Environmental Monitoring and Assessment, 156(1-4): 317.

Knotkova, D. and Bartoň, K. 1992. Effects of acid deposition on corrosion of metals. Atmospheric Environment. Part A. General Topics, 26(17): 3169-3177.

Liu, C., Huo, X., Lin, P., Zhang, Y., Li, W. and Xu, X. 2015. Association between blood erythrocyte lead concentrations and haemoglobin levels in preschool children. Environmental Science and Pollution Research, 22(12): 9233-9240.

Meera, V. and Ahammed, M.M. 2006. Water quality of rooftop rainwater harvesting systems: A review. Journal of Water Supply: Research and Technology-AQUA, 55(4): 257-268.

Peniwati, K. and Brenner, W. 2008. Multi-decisions rating model: Establishing rescue policies for regional drinking water companies (PDAMs) in Indonesia. European Journal of Operational Research, 186(3): 1127-1136.

Resosudarmo, B.P. 2003. River water pollution in Indonesia: An input-output analysis. International Journal of Environment and Sustainable Development, 2(1): 62-77.

Ryan, P.B., Huet, N. and MacIntosh, D.L. 2000. Longitudinal investigation of exposure to arsenic, cadmium, and lead in drinking water. Environmental health perspectives, 108(8): 731-735.

Sastry, N. 2002. Forest fires, air pollution, and mortality in Southeast Asia. Demography, 39(1): 1-23.

Sun, Y., Zhuang, G., Wang, Y., Han, L., Guo, J., Dan, M., Zhang, W., Wang, Z. and Hao, Z. 2004. The air-borne particulate pollution in Beijing-concentration, composition, distribution and sources. Atmospheric Environment, 38(35): 5991-6004.

Tacconi, L., Moore, P.F. and Kaimowitz, D. 2007. Fires in tropical forests–what is really the problem? Lessons from Indonesia. Mitigation and Adaptation Strategies for Global Change, 12(1): 55-66.

Wani, A.L., Ara, A. and Usmani, J.A. 2015. Lead toxicity: A review. Interdisciplinary Toxicology, 8(2): 55-64.

Wilopo, W., Resili, R. and Putra, D.P.E. 2013. Effect of traditional gold mining to surface water quality in Murung Raya District, Central Kalimantan Province. Journal of Degraded and Mining Lands Management, 1(1): 33.

Wondyfraw, M. 2014. Mechanisms and effects of acid rain on environment. Journal of Earth Science & Climatic Change, 5(6): 1.

Zhang, R., Wilson, V.L., Hou, A. and Meng, G. 2015. Source of lead pollution, its influence on public health and the countermeasures. International Journal of Health, Animal Science and Food Safety, 2(1): 18-31.

Plumbum (Pb) in Rainwater

ORIGINALITY REPORT

13%	7%	9%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Khayan Khayan, Adi Heru Husodo, Indwiani Astuti, Sudarmadji Sudarmadji, Tjut Sugandawaty Djohan. "Rainwater as a Source of Drinking Water: Health Impacts and Rainwater Treatment", Journal of Environmental and Public Health, 2019 Publication	8%
2	Submitted to Lincoln University Student Paper	1%
3	neptjournal.com Internet Source	1%
4	ijecm.co.uk Internet Source	1%
5	link.springer.com Internet Source	1%
6	www.science.gov Internet Source	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		