DOI Number: 10.5958/0973-5674.2018.00104.1

Relationships between Lead Contaminated Seafood Consumption and Blood Pressure among Fisherman Communities at the Makassar Coastal Areas, Indonesia

Anwar Mallongi[1], Agus Bintara Birawida[1], Apollo[2], Abdul Muhith[3], Jastal[4]

[1]Environmental Health Department, Faculty of Public Health, Hasanuddin University, Makassar South Sulawesi, Indonesia, [2]Politeknik Negeri Ujung Pandang, Sulawesi Selatan, [3]Associate Professor in Nursing Department of STIKes Majapahit, [4]Health Research and Development Unit, Banjarnegara, Indonesia

ABSTRACT

Background: Lead contaminated coastal areas have been widely studied in many cities both in high-income countries and in some developing countries. However, the related health disturbance outcomes due to the lead seafood consumption have not been well documented particularly in low and middle income countries such as in Indonesia particularly in Makassar city where no data available. This research aimed to investigate the relationships between lead seafood consumption, blood lead level (BLL), and blood pressure (BP) and the hypertension in the community-based study site of coastal areas Makassar city, Indonesia.

Method: The number of respondents within this study was 35 adults male that randomly selected, and voluntary base. All respondent sign an inform consent without any force before involved in the research. Information of education, family income, lifestyle, occupational, dietary, smoking habit was gathered by administered household questionnaire interview. Then, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured as well as the BLL were measured by inductively coupled plasma mass spectrometry technique. In order to assess the relationships between BLL with SBP and DBP, with the hypertension possibility, multiple linier and logistic regressions were applied.

Results: Pb levels in blood averaging of 27.6 µgr/dL with standard deviation 17,56 whereas the minimum value 2 and maximum value 89. In addition, the mean of systolic blood pressure 144.6, standard deviation was 17,56, minimum value was 89 mmHg and value maximum 123 mmHg, mean diastolic blood pressure 84.2, standard deviation 12.37, and the minimum value 54 mmHg and a maximum value of 154 mmHg. Chi square test resulted that there is a relationship between blood pressure and the level of lead in the blood, with p value was 0.01 significant.

Conclusion: The Blood lead level was positively associated with diastolic blood pressure and with the odds for hypertension in adults aged 40 or older. It is necessary to have a monitoring of lead exposure among the fishery communities along the Makassar coastal area.

Keywords: *Contaminated coastal, seafood consumption, blood pressure, systolic blood pressure, diastolic and blood pressure*

INTRODUCTION

Lead contaminated coastal areas have been widely studied in many cities both in high-income countries and in some developing countries. However, the related health disturbance outcomes due to the lead seafood consumption have not been well documented particularly in low- and middle-income countries such as in Indonesia particularly in Makassar city. Specifically, data relate to the Blood Lead Level (BLL) is scarcely available for those people who are living along the coastal area of the city. Lead exposure from air, water and soil among adult both women and man are occurred daily and potentially generate hypertension as a results of the increase of blood pressure which may generated from the frequently lead exposure. This research aimed to investigate the

relationships between lead seafood consumption, BLL, and blood pressure (BP) and the hypertension in the community-based study site of coastal areas Makassar city, Indonesia.

A long period of lead exposure and accumulation in the body may generate to effect of serious health. The effects such as; the increased blood pressure, which is associated with the cardiovascular diseases which has been linked to lead exposure [1,2]. Then hypertensive effects of lead have been widely reported in workers exposed to high levels of the metal and by experimental studies in which animals were exposed to long-term high doses of lead. Under occupational conditions, the development of hypertension has been implicated as a possible consequence of the nephropathy caused by lead exposure. Studies have concluded that lead exposure is a risk factor for raised blood pressure and hypertension even in the general population[1-4].

Specifically, data relate to the blood lead level (BLL) is scarcely available for those people who are living along the coastal area of the Makassar city. The raised of blood pressure prevalence among adults aged average of 25 years or older was about 35% in 2010.[5] Lead exposure from air, water, oil and sediment among adult both women and man are occurred daily and potentially generate hypertension as a results of the increase of blood pressure which may generated from the daily lead exposure. Having those described data, this study aimed to examine the relationship of aquatic food consumption with the blood pressure among communities along the Makassar coastal area who are living for more than 25 years on the site.[6]

MATERIALS AND METHOD

The population included adults aged of 40 years or older residents and children in an urban coastal Barombong area of South Sulawesi, Indonesia. For the characteristics respondents, the information on sex, age (years), education level, income class, working period and working duration was obtained from each respondent by the orally administered household interviews[7]. All participants were randomly selected and took part in a household interview. In addition, anthropometric measurement, blood pressure measurements and laboratory tests were conducted individually. Data of 35 interviewed respondents who had performed blood tests and had blood pressure measurements were taken for the analysis purpose to the laboratory. Furthermore, the body mass index (BMI) was obtained from the physical examination and calculated as weight in kilograms (kg) divided by the square of height in meter. Weight was measured with an electronic scale, with a precision of 0.1 kg and maximum capacity of 150 kg, and height was measured with a portable stadiometer with a precision of 0.1m, respectively

STATISTICAL ANALYSIS

In order to calculate the data, Stata[8] software was applied to perform descriptive and inferential statistical tests. Means, percentages and standard errors were estimated to describe the sample characteristics and the association between variables. Data research was analyzed by using two proportion test chi Square (X^2), however, if one expected value in the cell less than 5 (>20%) then fisher exact test was applied in accordingly.

Further, blood lead levels were left skewed and log transformed for analysis. Outcome variables, systolic and diastolic blood pressures were determined, respectively, inverse and log transformed to follow normal distribution. Multiple linear regression models were performed to examine relationships of blood lead with systolic and diastolic blood pressures comparing those participants in quartiles 2 to 4 of blood lead levels with those in quartile 1. Multiple logistic regression analysis was used to evaluate the risk of hypertension also by categorizing blood lead in quartiles. This study also performed Pearson correlation analysis to verify the correlations between systolic and diastolic blood pressure with blood lead levels.

Regression models were constructed based on a priori knowledge and biologic association with blood pressure (age, sex, anti hypertensive medication use and blood lead log transformed). Other covariates were added to the model in two separated blocks: Model 1 – sex, age, race, income, education, antihypertensive medication and blood lead level; Statistical tests with *p* value < .05 were considered statistically significant.

RESULTS

The number of the selected sample was 35 fisherman who have been living and working in the

Makassar coastal areas. The characteristics of those respondents is presented in the table 1.

Table 1. Characteristics of respondent in the Makassar coastal area

Characteristics	Mean	Standard deviation	Minimum	Maximum
Age (years) Sex (% male) Working period (y) Working duration(y) Education (y) IMT	47.3 24.2 22.3 18.2 5.2 11.2	8.82 3.32 4.51 8.56 9.78 4.71	21 8.5 1,2 11,9 9.20 10.0	45 18.5 11,2 26,9 17.3 32.0

The mean of age, sex, working period, working duration, education and IMT of the respondents were 47.3, 24.2, 22.3, 18.2, 5.2, and 11.2, respectively. The longest deviation standard was education with 9.78 whereas the shortest deviation standard was sex with 3.32. in addition the minimum SD was working period whereas the maximum was IMT with 32.0. Further, of the 35 respondents who had taken the blood sample and had blood measurement, the level of lead and hypertension information is described in the table 2.

Table 2. Result of respondents blood pressure measurement

Blood pressure status	Number	Percentage
Normal (140/90 mmHg) Not normal (≥140/90 mmHg)	8 person 27 person	22.9 77.1
Number	35 Person	100

Hypertension defined as systolic blood pressure≥140 mmHg or diastolic blood pressure ≥90 mmHg or antihypertensive medication use.

Table 2 revealed that of the 35 respondents, there were 8 respondents who have a normal blood pressure and 27 have not normal blood pressure during the measurement. After the calculation, the lead (Pb) concentration in the blood with the incidence of hypertension can be found in the following table 3.

Table 3. Lead levels in the blood with the incidence of Hypertension both in pressure systolic and diastolic blood

Variables	Mean µgr/dL	Standard deviation	Minimum mmHg	Maximum mmHg
Lead in blood Systolic blood pressure Diastolic blood pressure	27.6 144.6 84.2	17.56 13.32 12.37	2 98 54	89 123 154

Table 3 indicated Pb levels in blood averaging 27.6µgr/dL with standard deviation 17,56 whereas the minimum value 2 and maximum value 89. In addition, the mean of systolic blood pressure 144.6µgr/dL, standard deviation was 13,32, minimum value was 98 mmHg and maximum value 123mmHg, mean diastolic blood pressure 84.2µgr/dL, standard deviation 12.37, and the minimum value 54mmHg where maximum value of 154mmHg.

DISCUSSION

This study indicated that there is a significant association between blood lead levels and the elevations in systolic and diastolic blood pressures. Result of

statistical test describe that there is a correlation between blood lead concentrations with hypertension incidence as well. The result showed that 27 respondents (77.1%) have high blood level, of those, there were 11 respondents ssuffer from hypertension, p = 0,028 smaller than α = 0,05, it can be concluded there is significant correlation between Pb level in blood with hypertension incidence.

A study result also revealed that the average Pb of the water is about 22.00 µg/dl although the levels are lower when compared to the safe level of Pb levels in the blood by WHO[9] around 10-25 µg / dl. However, these values indicate that the average respondent has experienced lead poisoning in the blood because the levels have exceeded the poisoning limit of 5 µg / dl. Respondents who had high blood levels of Pb had greater risk of hypertension than those who had low blood levels of Pb. This result is consistent with Lippmann's assertion that the effect on blood pressure occurs at blood levels of Pb between 5-35 µg/dl. The study of Riyadina et al.[10], which states that high blood levels of Pb have a relationship with the incidence of hypertension. Other studies suggested that there is sufficient evidence to infer a causal relationship of exposure to lead with hypertension, besides the modest strength observed in these associations[11,12].. In addition, studies with general population also support that found positive associations between blood lead concentrations and elevation on both systolic and diastolic blood pressure[13,14.] According to WHO[9], Pb concentration in blood range between 10-30µg/dl for adults will lead to blood pressure systolic problem and eritrosit protoporphyrin. Lead in blood may generate some disturbance including hypertension.

It is differently to what has been investigated on the lead effects of hypertensive in studies involving workers exposed to high levels of lead, environmental factors exposure is often asymptomatic and as other toxic effects of lead. The magnitude of raised blood pressure depends on the magnitude of the exposure duration and frequency, the longer of exposure duration and frequency the higher magnitude of blood pressure[15,16]. Another perspective on the health effects of lead-associated increases in blood pressure is to consider the effect of a unit increase in median BLL on the overall distribution of blood pressure values in a population and the effect on number of persons with blood pressure elevations associated with stroke and other endpoints. This was calculated by Schwartz[17], who reported that a 1 µg/dL increase in mean population blood lead in US white males aged 40–59, distributed over the range of blood pressure values in this population, would increase the numbers of persons at risk for myocardial infarction by 3200 per year, of strokes by 1300 per year, as well as an overall increase in clinical hypertension of 635,000.

The inclusion of confounding factors in regression models has been considered very important to control for residuals in such analysis, especially when examining small effects as the influence of lead in blood pressure[18]. The inclusion of inappropriate covariates in regression models can attenuate associations between lead levels and the studied outcomes. Still, the absence of certain variables in the analysis may overestimate the strength of the association[19]. In this study, we included in the analysis risk factors for cardiovascular disease such as smoking, alcohol consumption, sex, age, socioeconomic and demographic variables and BMI to account for covariates that are known to be associated with blood pressure outcomes. Even so, some unmeasured variables not included in the analysis may influence the association of lead and blood pressure as, for example, pre-existing diseases, genetic aspects and renal function.

Furthermore, lead-induced oxidative stress reduces the availability of NO, which is an endogenous catalyst of several biochemical processes with an important role in cardiovascular system regulation, leading to endothelial dysfunction. Barbosa Jr et al.[20] reported that lead exposure exerted a significant inhibitory effect on NO production, as shown by analyses of nitrite concentrations in adults living in the Southeast region of Brazil, suggesting that this biological mechanism is possibly related to the increased cardiovascular risk associated with lead exposure.[20-23]

This study also included the measurement of multiple anthropometric and socioeconomic characteristics and the standardization of blood pressure measurements. However, some limitations of this study are the cross-sectional design that does not allow causal inferences about the association of blood lead and blood pressure; and the fact that we may not have measured all the potential confounders of the relationship between hypertension and lead exposure.

Differences observed among the results of other studies may be associated to the methodological design, such as study of bone lead measurement as a marker of lead exposure compared with blood lead and to stratified

statistical analysis which have shown that distinct risk factors for lead exposure exist among populations in Americans. Although family income and education level have been considered significant predictors of blood lead levels, the historically difference observed among income level in fact has been decreasing. Furthermore, some Pb-related outcomes, including blood pressure outcomes, may vary by race/ethnicity, providing some evidence that certain groups of people may be at higher risk of generating some various diseases at the end[24-26].

CONCLUSIONS

There is a positive association between blood lead and diastolic blood pressure, and a significant association and hypertension in communities in the coastal area of Makassar aged 40 years or older. This results add knowledge about the health risks associated with current environmental exposures to lead in Makassar, and encourage efforts to prevent lead exposure in the general population.

Acknowledgement: We thanks to the Ministry of Education, the Republic of Indonesia for giving a fund for this research. Also to the Health laboratory staffs who have analyzed the accordingly

Conflict of Interests : We declare that there is no any potential conflict financial interests within this study and from the funding institution including the publication.

Ethics approval : All participants who participated on this research were asked to sign a consent form after the presentation of the research objectives in front of them. Every participant consented to the publication of data. At any interview, two copies of the consent form were issued, one being given to the participant another one kept by researcher.

REFERENCES

1. Toxicological profile for lead. [http://www.atsdr.cdc.gov/toxprofiles/tp13.pdf]. Accessed 12 July 2016.
2. U.S. Environmental Protection Agency. Air Quality Criteria for Lead. [https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=158823]. Accessed 12 July 2016.
3. Navas-Acien A, Guallar E, Silbergeld EK, Rothenberg SJ. Lead exposure and cardiovascular disease--a systematic review. Environ Health Perspect. 2007;115(3):472–82.
4. Schwartz BS, Hu H. Adult lead exposure: time for change. Environ Health Perspect. 2007;115(3):451–4.
5. WHO. Global status report on noncomunicable diseases 2010. Burden: mortality, morbidity and risk factors. 2010:9–31.
6. Paoliello MM, De Capitani EM. Environmental contamination and human exposure to lead in Brazil. Rev Environ Contam Toxicol. 2005;184:59–96.
7. Mallongi, A., P. Parkpian, P. Pataranawat, S. Chinwetkitvanich, 2015, Mercury distribution and its potential environmental and health risks in aquatic habitat at artisanal buladu gold mine in Gorontalo Province, Indonesia. Pak. J. Nutr. 14: 1010-1025.
8. STATACORP. Stata Statistical Software: Release 14. StataCorp LP. 2015.
9. World Health Organization (WHO), 1997. Deteksi Dini Penyakit Akibat Kerja, Buku Kedokteran, Jakarta
10. Riyadina, W., M. Notosiswoyo, Anna M. Sirait, L. Tana, 2002, "Hubungan Antara Plumbum (Pb) dalam darah dengan hipertensi pada operator pompa bensin (SPBU)", Buletin Penelitian Kesehatan, 30 (2): 82-88.2006
11. Navas-Acien A, Guallar E, Silbergeld EK, Rothenberg SJ. Lead exposure and cardiovascular disease--a systematic review. Environ Health Perspect. 2007;115(3):472–82.
12. Glenn BS, Stewart WF, Links JM, Todd AC, Schwartz BS. The longitudinal association of lead with blood pressure. Epidemiology. 2003;14(1):30–6.
13. Bushnik T, Levallois P, D'Amour M, Anderson TJ, McAlister FA. Association between blood lead and blood pressure: Results from the Canadian Health Measures Survey (2007 to 2011). Health Rep. 2014;25(7):12–22.
14. Martin D, Glass TA, Bandeen-Roche K, Todd AC, Shi W, Schwartz BS. Association of blood lead and tibia lead with blood pressure and hypertension in a community sample of older adults. Am J Epidemiol. 2006;163(5):467–78.
15. Agency for Toxic Substances and Disease Registry.

Toxicological Profile for Lead. [http://www.atsdr.cdc.gov/toxprofiles/tp13.pdf]. Accessed 12 July 2016.

16. U. S. (Environmental Protection Agency). Integrated Science Assessment for Lead. [http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=255721-Download]. Accessed 14 Oct 2015.
17. Schwartz J. Lead, blood pressure and cardiovascular disease in men. Arch Environ Health. 1995;50(1):31–7.
18. Nash D, Magder L, Lustberg M, Sherwin RW, Rubin RJ, Kaufmann RB, Silbergeld EK. Blood lead, blood pressure, and hypertension in perimenopausal and postmenopausal women. Jama. 2003;289(12):1523–32
19. Martin D, Glass TA, Bandeen-Roche K, Todd AC, Shi W, Schwartz BS. Association of blood lead and tibia lead with blood pressure and hypertension in a community sample of older adults. Am J Epidemiol. 2006;163(5):467–78.
20. Barbosa Jr F, Sertorio JT, Gerlach RF, Tanus-Santos JE. Clinical evidence for lead-induced inhibition of nitric oxide formation. Arch Toxicol. 2006;80(12):811–6.
21. Rantetampang, A.L. and A. Mallongi, Risks Assessment Of Cadmium Through Aquatic Biota Consumption From Sentani Lake In Papua, Indonesia International Journal of Engineering Research & Technology (IJERT), 2013. 2(6): p. 2493-2500. 2013.
22. Mallongi, A., Herawaty, 2015, Assessment of mercury accumulation in dry deposition, surface soil and rice grain in Luwuk gold mine, Central Sulawesi Research Journal of Applied Sciences, 10 (1) : 22-24, 2015
23. Yi, Y., Z. Yang, and S. Zhang, Ecological risk assessment of heavy metals in sediment and human health risk assessment of heavy metals in fishes in the middle and lower reaches of the Yangtze River basin. Environmental Pollution, 2011. 159(10): p. 2575-2585. 2011.
24. U. S. (Environmental Protection Agency). Integrated Science Assessment for Lead. [http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=255721-Download]. Accessed 14 Oct 2015.
25. Scinicariello F, Yesupriya A, Chang MH, Fowler BA. Modification by ALAD of the association between blood lead and blood pressure in the U.S. population: results from the Third National Health and Nutrition Examination Survey. Environ Health Perspect. 2010;118(2):259–64.
26. Yang, Y., Comprehensive assessment of heavy metal contamination in sediment of the Pearl River Estuary and adjacent shelf. Marine Pollution Bulletin, 2012. 64(9): p. 1947-1955. 2012.