Health Risks Analysis of Lead due to the Consumption of Shellfish (Anadara. Sp) among the Coastal Communities in Makassar City

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Abstract- Lead is a highly toxic metal and has a very strong poison. The aim of the study is to determine the health risk of the lead exposure in *Anadara* sp to the coastal society of Makassar City. The method of the research is an observational study with a draft analysis of environmental health risks. The research was conducted from November 20, 2102 to May 28, 2013 in the coastal area of Makassar City. Shellfish samples taken in five districts, then lead content were measured with AAS (*atomic absorption spectrophotometer*) meanwhile body weight, intake rate, and frequency of exposure are quantitatively measured through questionnaires application interview. The analysis indicated that the highest lead concentration in Tallo was 275,97 µg/kg and the lowest concentration in Biringkanaya was 30.56 µg/kg. The results also revealed that for the Lead RQ (risk quotient) carcinogens was 42,20 % had an average of RQ < 1 and 57,80 % of respondents had RQ > 1. For Non-Carcinogenic RQ 8,90 % of respondents had an average of < 1 and 91,10 % had RQ value >1.

Index Terms- Health risk analysis, Lead, *Anadara* sp

I. INTRODUCTION

Lead is a highly toxic metal and a very strong poison. Lead is commonly found in the environment, especially near roads, mining areas, industrial sites, near power plants, incinerators, landfills, and hazardous waste disposal site. People who live near hazardous waste sites may be exposed to chemicals that contain lead through air, drinking water, eating food, and swallowing dust or dirt that contains lead (ATSDR, 2007).

Lead accumulation is the result of anthropogenic activity that has been concentrated the lead throughout the environment. Because lead is so widely spread throughout the environment, it can be found in everyone 's body today. The magnitude of lead levels found today in most of people are greater than those of ancient times (Flegal, 1995). These levels are within an order of magnitude of levels that have resulted in adverse health effects (Budd et al. 1998).

Since lead is a neuro toxic accumulative, in young children lead can cause a decrease in the ability of the brain, whereas in adults exposure of lead can generate disorders of high blood pressure, as well as poisoning the other tissue. Some evidence of lead study since 1991 suggested that children's intellectual ability is adversely affected at blood lead concentrations < 10 mg / dL (Bellinger and Needleman 2003; Canfield et al., 2003a, 2004; Chiodo et al. , 2004; Lanphear et al., 2000, 2005; Schnaas et al., 2006; Schwartz 1994; Surkan et al., 2007; Tellez - Rojo et al., 2006). Any increase in blood lead concentrations of 10 ug / dl potentially led to a decrease in IQ of 2.5 points, or 0.975 IQ scores (Widowati et al., 2008)

II. MATERIAL AND METHODS

2.1 Study area and Research design

This study was conducted at the coastal areas of Makassar. Site selection was done in five coastal districts such as districts of Tamalate, Mariso, Ujung Tanah, Tallo and Biringkanaya. These districts represent nine coastal districts in the city of Makassar which indicated exposure to heavy metals lead, Figure 1. We applied an observational study using an environmental health risks design analysis. This study was conducted in November 2012 - May 2013.

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Figure 1. Map of sampling location

2.2 Population and sample

All Shellfish (*Anadara*.sp) were collected from three stations in each sub district with three replication whereas elementary school children from five districts at those Makassar coastal areas were interviewed. All sampling process in this study was done in non-random sampling with large sampling using purposive sampling, with a set criteria as follow:

1. Children living and settled in the selected five districts of coastal region of Makassar
2. Children who frequently consume shellfish of *Anadara* sp.
3. Those children agreed to be interviewed. The approval was based on the recommendations of Ethics committee of the Faculty of Medicine, University of Hasanuddin

2.3 Lead Analysis

Shellfish samples taken by hand picking sampling where the locations have been determined using the Global Positioning System (GPS), three stations with three repetitions in five districts. Shellfish samples in sterile plastic insert into the 10-15 tails . Then further examined the levels of lead using AAS method in laboratory BPTP Maros.

2.4 Data collection

Primary data collection done by taking a sample from a field sample of *Anadara* sp mussels, then anthropometric data were collected by direct measurement and questionnaire application for gathering data of respondents characteristics. frequency of exposure, duration of exposure and the rate of consumption, while the secondary data are taken from the related agency area covers research sites. The method of analysis was environmental and health risk analysis, with univariate analysis by Kolmogorov-Smirnov test and SPSS in calculating the potential health risks.

2.5 Data analysis

The health risk analysis has a formulation of data analysis, the environmental health risk analysis was conducted to determine the level of exposure of respondents (Intake) and the respondents' level of risk (Risk Quotient/RQ), (Rahman,2007). The calculation of the level of exposure (intake) (ATSDR, 2005):

$$Ink = \frac{C \times R \times f_{\mathrm{E}} \times D_{\mathrm{t}}}{W_{\mathrm{b}} \times t_{\mathrm{avg}}}$$

where

Ink : intake, the amount of risk that is acceptable by individual agent per body weight per day (mg/kg / day), C : risk agent concentrations (mg/kg) or (mg/L), R : rate of intake (g / day) or (L/day), FE : annual exposure frequency (days / year), Dt : exposure duration (years), Wb : body weight (kg), Tavg : the average period of time (70 years x 365 days / year) for carcinogenic effects.

To determine the level of health risk that would occur from each individual, thus the calculation is done according to the following RQ equation (ATSDR, 2005):

$$RQ = \frac{\mathrm{Ink}}{\mathrm{RfD}} \qquad (2)$$

RQ calculation results can indicate the level of public health risk due to consuming of *Anadara* sp containing Lead. If RQ ≤ 1 indicates exposure remained below normal limits and people who consume *Anadara* sp is still within safe limits of the risk of suffering from the disease throughout his life. Meanwhile, when RQ > 1 indicates exposure above the normal limits and people who consume the mussels *Anadara* sp risk of developing the disease throughout his life.

2.6 Analysis of risk reduction management

This analysis is useful to assess the management of health risks from exposure reduction of Lead in mussels *Anadara* sp on society. Management of risk reduction that can be used is to lower the concentration, reduce the rate of consumption, and limiting the duration of exposure (Rahman, 2007).

III. RESULT AND DISCUSSION

3.1 Risk Analysis

After measurement of lead concentration in *anadara* sp. and intake rate for those respondent who consumed the shellfish, results indicated that respondent No. 31 has a value of RQ > 1 (1.29) for the risk of exposure of carcinogens and RQ of 3.03 for non- carcinogenic risk. It can be concluded that the respondent included in the risk group to the effects of carcinogens and non-carcinogens disease. RQ value calculation Lead in shellfish for carcinogen risk (exposure 70 years) and non-carcinogenic risk (exposure 30 years). While the RQ distribution of Lead in shellfish for carcinogen risk (exposure 70 years) and non-carcinogenic risk (exposure 30 years) on respondents can be seen in Figure 2.

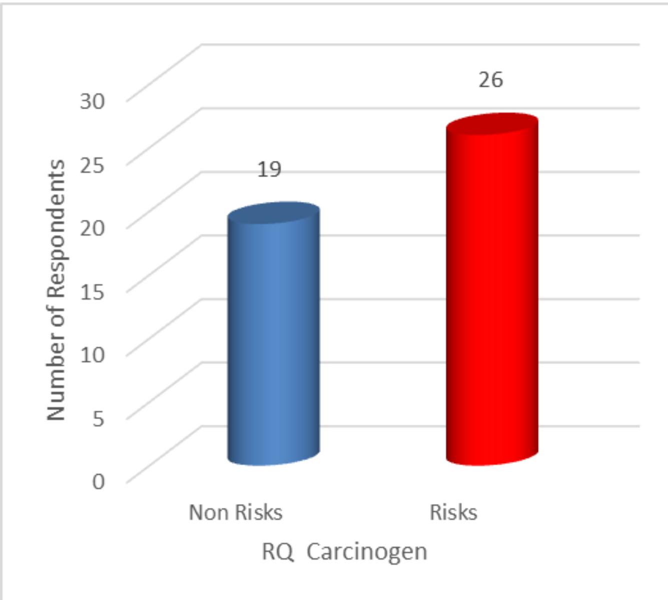

Figure 2 Distribution of Exposure RQ Lead for carcinogens disease risk in five respondents in the Coastal District of the city of Makassar in 2013

Figure 2 shows that the highest RQ respondents carcinogens to carcinogens disease were 20 respondents in RQ from 1.10 to 2.0 and the lowest RQ as much as 6% of respondents in RQ> 2. From Figure 2, with the health problems experienced last three months include headache, cough, and nervous system disorders. Group with RQ values ≤ 1 categorized as a safe group, while the group with RQ values > 1 are called risk groups to the effects of carcinogens.

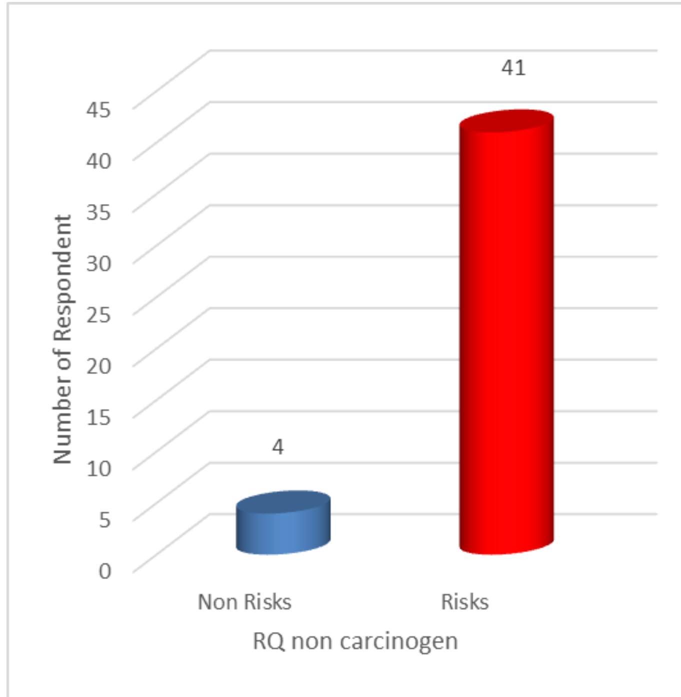

Figure 3. Distribution of exposure lead RQ for non-carcinogenic risk in five respondents in the Coastal District of the city of Makassar in 2013.

Figure 3 shows that the highest RQ values respondents for non-carcinogens disease were 23 respondents in RQ > 3 while the lowest RQ were 4 respondents at 0.00 to 1.00. Group with RQ values ≤ 1, categorized as a safe group, whereas the group with RQ > 1 is called a group at risk for non- carcinogenic effects of the disease.

3.2 Risk Management

Based on the characterization of risk, the result can be formulated use risk management options to minimize the RQ values that equal or smaller than 1, by manipulating or changing the value of the exposure factors included in equation (1) such that the intake values (Ink) become smaller or equal in value to the reference dose (RfD) toxicity. There are three options how to equalize the value of Ink with RFD agent that lowers the risk of concentration (C), reducing the amount of consumption (R) or reduce the exposure duration (Dt). This means that only the variables in equation (1) such that could be changed or adjusted value (Rahman, 2007).

a. Decreasing the concentration of Lead in Shellfish

The decrease in the concentration of Lead is essentially different for each respondent. It is influenced by the pattern of exposure and anthropometric characteristics of each different respondents. Here's an example of the calculation of the concentration decrease of Lead in Shellfish for carcinogen risk (exposure 70 years) consumed by respondents with 30 kg body weight, 11 year exposure duration, exposure frequency of 144 days/year, the rate of consumption of 21 g/day, and the value of RfD = 0.004 mg/kg/day. RFD = Ink, then the formula becomes;

$$Rfd = \frac{C \times R \times f_E \times D_t}{W_b \times t_{avg}}$$

0.004 = (C x 7 gr / hr x 144 hr / yr x 11 years) / (30 kg x 25550)
C = 0.115

Concentrations of lead 0.115 mg/kg is a safe concentration of the carcinogen risk for respondents with a body weight of 30 kg and shellfish consumed 21 g/day for consumption continuously for 11 years with a frequency of 144 days/year. Based on the above calculation, the value of C Lead in the shellfish were safe to consume for non- carcinogenic risk (exposure duration of 30 years) is 0,115 mg/kg. Complete calculation of the reduction of the concentration of risk management lead in mussels can be found in table 1. The description of the concentration of Lead in shellfish were safe to be consumed by the respondent against the risk of carcinogens and non- carcinogens based risk weight group can be seen in Table 1 below.

Table 1. Concentrations of Lead in the shellfish were safe for consumption by the group of respondents with various body weigh to the risks of carcinogens and non- carcinogens in the coastal areas of the city of Makassar 2013.

Body weight (kg)	Lead concentration in shellfish for risks carcinogenic (mg/kg)	Lead concentration in shellfish for risks non -carcinogenic (mg/kg)
20	0.0768	0.0988
25	0.0960	0.1234
30	0.1152	0.1481
35	0.1344	0.1728
40	0.1536	0.1975
45	0.1728	0.2222
50	0.1920	0.2469
55	0.2112	0.2716

Source: Primary data, 2013

Table 1 shows the results of calculation of the concentration of Lead in mussels are safe to take on the risk of carcinogens and non-carcinogens to the frequency of exposure 144 days/year, 11-year exposure duration, and the rate of intake of 21g/day based on body weight groups. From the table above shows that the higher the weight the bigger the concentration of respondents Lead in shellfish were safe to eat respondents to the risk of carcinogens and non-carcinogens disease. In addition, it also shows that the concentration of Lead in shellfish were safe to eat respondents higher in risk than the risk of non-carcinogenic carcinogens.

b. Reduction in the amount of consumption

Other efforts that can be done to reduce or manipulate the value of the intake to match the RFD is reducing the amount of consumption, or in other words, lowering the rate of intake. For example, the calculation of the rate of decrease in the intake of Lead in shellfish for carcinogen risk among respondents with 30 kg body weight, exposure frequency of 144 days / year, 11 years duration of the exposure concentration of Lead in Shellfish 0.157 mg/kg, and the value of RFD = 0.004 mg/kg/day. RFD = Ink, then the formula becomes:

$$Rfd = \frac{C \times R \times f_E \times D_t}{W_b \times t_{avg}}$$

0.004 = (0.157 mg / kg x R x 144 hr / yr x 11 years) / (30 kg x 2550)
R = 15.41 g / day

The rate of intake of 15.41 g / day is a safe amount to carcinogen risk for respondents with a weight of 30 kg, the duration of exposure of 11 years, the frequency of 144 days / year, and the concentration of Lead 0.157 mg / kg. Based on the calculation above, the obtained value of R (the rate of intake) Lead in Shells for non-cancer risk (exposure 30 years) was 6.60 g/day.

Table 2. The intake rate of Lead in shellfish were safe for consumption by the group of respondents with various body weigh to the risk of carcinogens and non carcinogen in Five Coastal District of the city of Makassar in 2013

Body weight	Intake rate of shellfish for carcinogenic risk (gr/hr)	Intake rate of shellfish for non-carcinogenic risk (gr/hr)
20	10.27	4.40
25	12.84	5.50
30	15.41	6.60
35	17.98	7.71
40	20.55	8.81
45	23.12	9.91
50	25.68	11.01
55	28.25	12.11

Source: Primary data, 2013

Complete calculation of the rate of reduction in the risk management intake Lead in mussels can be found in table 2. The description of the rate of intake of Lead in shellfish were safe to be consumed by the respondent against the risk of carcinogens and non- carcinogens by weight group can be seen in Table 2.
The results of calculation of the intake rate of Lead in mussels are safe to take on the risk of carcinogens and non - carcinogens to the frequency of exposure 144 days/year, 11 year exposure duration, and lead concentration of 0.157 mg / kg based on body weight groups. From the table above shows that the higher the weight the higher the rate of responders safe intake on the risk of carcinogens and non-carcinogens. Table 2 also shows that the rate of intake of Lead in shellfish were safe to eat by respondents higher in carcinogen risk than the non- carcinogenic risk.

c. Reduction of the duration of exposure

Another efforts to reduce or manipulate the value of the intake to match the RFD is reducing the duration of exposure to Lead. For example, a decrease in the duration of the exposure calculation Lead in Shellfish for carcinogen risk among respondents with 30 kg body weight, exposure frequency of 144 days/year, the concentration of lead in shellfish 0.157 mg/kg, and the value of RFD = 0.004 mg/kg/day. RFD = Ink, then the formula becomes:

$$Rfd = \frac{C \times R \times f_E \times D_t}{W_b \times t_{avg}}$$

0.004 = (0.157 mg / kg x 21 g / day x 144 hr / yr x Dt) / (30 kg x 25550)
Dt = 8.1 years

The duration of exposure was 6.8 years was safe exposure to carcinogen risk for respondents with a body weight of 30 kg, the frequency of exposure to 144 days / year, the rate of intake of 21 g / day and the concentration of Lead 0.157 mg / kg. Based on the above calculation, the obtained value of Dt (exposure duration) Lead in shellfish for non- cancer risk (exposure 30 years) was 10.4 years. Complete calculation of the reduction of the duration of exposure to the risk management of Lead in mussels can be found in table 3. The description of the duration of exposure to Lead in clams were safe to be consumed by the respondent against the risk of carcinogens and non- carcinogens based on weight group can be seen in Table 4 below.

Table 4. Duration of Exposure Lead in mussels were safe for consumption by the group of respondents with various body weigh to the risk of carcinogens and non-carcinogen in Five Coastal District of the city of Makassar in 2013

Body weight (kg)	Lead exposure duration in shellfish for carcinogenic risks (Years)	Lead exposure duration in shellfish for non carcinogenic risks (Years)
20	5.4	6.9
25	6.7	8.6
30	8.1	10.4
35	9.4	12.1
40	10.8	13.8
45	12.1	15.6
50	13.5	17.3
55	14.8	19.0

Source: Primary Data 2013

Table 3 shows the results of calculation of the duration of exposure to Lead (Pb) in mussels are safe to take on the risk of carcinogens and non- carcinogens to the frequency of exposure to 144 days / year , the rate of intake of 21 g / day , and the concentration of Lead (Pb) 0.157 mg / kg based on body weight groups. From the table above shows that the higher the weight the longer the duration of the respondents' safe exposure to the risk of carcinogens and non- carcinogens disease . In addition to the table 4.19. The above also shows that the duration of exposure to Lead (Pb) in clams were safe for older respondents in the non- carcinogenic risk than the risk of carcinogens .

IV. CONCLUSION

1.The number of School children who consume shellfish *Anadara* sp were higher at risk (RQ > 1) than those who were not at risk (RQ < 1).

2. Body weight is a factor that may lead to a risks, the more body weight people have the higher potential to a lead exposure risks to have.

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