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Risk management of cadmium (Cd) due to *Leiognathus sp*, *Portunus Pelagicus*, *Anadara sp* and *Penaeus sp* consumption among community in Tallo Subdistric, Makassar, Indonesia

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Abstract- This study aimed to investigate the risk management of Cadmium (Cd) for people who consumed *Leiognathus sp., Portunus pelagicus, Anadara sp.* and *Penaeus sp.,* from Tallo River in Tallo Village of Makassar City, Indonesia. Observational study was used by appliying environmental health risk assessment approach. The Cadmium levels in *Leiognathus sp., Portunus pelagicus, Anadara sp.* and *Penaeus sp,* were measured with the Atomic Absorption Spectrometry "Perkin type 210 Germany". Ninety six (96) respondent's body weight, consumption rate and exposure time duration were analyzed quantitatively to calculate the risk quotient (RQ). Result implied that the risk quotient value due to *Leiognathus sp.* consumption was 0.1655 (for a level of 0.00048 mg/gram). The risk quotient value for consuming *Portunus pelagicus was* 0.126 (for a level of 0.00021 mg/gram), while the risk quotient value for consuming *Anadara sp.* was 0.036 (for a level of 0.00106 mg/gram). Furthermore, the risk quotient value for consuming *Penaeus sp.* was 0.0055 (for a level of 0.00021 mg/gram), respectively. Risk management done by reducing the levels of cadmium, controlling the consumption rate and decreasing the exposure time. This study suggested that the most effective risk management is to control the consumption rate for *Leiognathus sp., Portunus pelagicus, Anadara sp.* and *Penaeus sp. from Tallo River.*

Index Terms- *risk management, cadmium (Cd), Leiognathus sp., Portunus pelagicus, Anadara sp., Penaeus sp., Tallo River.*

I. Introduction

Industrial growth in Makassar considerable potential lead to pollutions in the environment. The number of industries operating in the city of Makassar area are about 4,288 units comprising of 4,099 small industrial units and 199 large industrial units (Environmental Impact Department of South Sulawesi, Indonesia, 2004). A total of 21 industries are the sources of pollutants into Tallo River as water bodies which receiving industrial wastewater disposal (Department of Environmental Management and the cleanliness of Makassar, 2008). Tallo River crosses the 10 districts in the city of Makassar such as the Panaikang Distric, Lakkang Distric, Tallo Distric, Rappokalling Distric, Daya Distric, Bira Distric, Tamalanrea Distric, Tallo Baru Distric, Antang Distric and Rappojawan Distric and long the river there are also industrial activity, namely Makassar Industrial Estate (KIMA).

Aziz (2004) in his study found that levels of heavy metals (Cd) in sediment of Tallo River by an average of 8.92 mg/kg. Likewise, study by Ibrahim (2009) found the average of Cd in water column in Tallo River was 0.0578 mg/l. Akili (2010) found Cd levels in shellfish *Anadara granosa* exceeds the standards set by the WHO range between 0.085 mg/kg to 0.774 mg/kg.

The results of the studies above show that Tallo River has been polluted by chemicals such as Cadmium (Cd) for the water, sediment and biota. This situation will certainly endanger the health and lives of inhabitants in the area and vicinity region, especially when people consume biota come from this river. Residents who live around Tallo River are currently at risk of health problems due to consumption *Leiognathus sp, Portunus pelagicus, Anadara sp.* and *Penaeus sp.* from Tallo River. Then the control efforts of the factors that could potentially be a threat to the health of the population is necessary and should be done immediately.

2. MATERIALS AND METODHS

This observational study commenced by using an approach of environmental health risk analysis where risk factors were measured at the same time to predict health risk due to the amount of cadmium metal in *Leiognathus sp, Portunus pelagicus, Anadara sp.* and *Penaeus sp*. The research was conducted in two phases; analysis of risk assessment to identify the risk quotient (RQ) and risk management to prevent health risks.

Analysis level of risk carried out by counting the number of cadmium intake (I) through *Leiognathus sp*, *Portunus pelagicus, Anadara sp*. and *Penaeus sp* consumption. Data and information that are required to calculate the rate of intake, R (mg /day), the concentration of risk agent, C (mg/kg), exposure time (tE) (hours/day), frequency of exposure, f_E (days /year) and duration of exposure, Dt (year). The formulations from (EPA 2006) below were used to calculate the intake rate and the risks quotient.

$$I = \frac{C \times R \times f_E \times D_t}{W_b \times t_{avg}} \qquad (1)$$

$$RQ = \frac{I}{RfD} \quad (2)$$

Level of risk (Risk Quotient) is the quotient of the intake (I) and Reference Dose (RfD). According to U.S. EPA *RfD* for Cadmium is equal to 0.001 mg/kg/day. It means that intake of cadmium in excess of 0.001 mg/kg/day has exceeded the safety standard for cadmium intake and risk for the occurrence of impaired renal disfungis (proteinuria). Risk exists and needs to be controlled if RQ > 1. However, if RQ ≤ 1, the risk does not need to be controlled, but all existing conditions at the time of this research should be maintained. Risk management can be done with the three approaches using the following formulas:

$$C = \frac{RfD \times W_B \times t_{avg}}{\mathrm{R} \times f_E \times \mathrm{D_t}} \quad (3)$$

$$R = \frac{RfD \times \mathrm{W_B} \times \mathrm{t_{avg}}}{\mathrm{C} \times f_E \times \mathrm{D_t}} \quad (4)$$

$$D_{\mathrm{t}} = \frac{RfD \times \mathrm{W_B} \times \mathrm{t_{avg}}}{\mathrm{C} \times R \times f_E} \quad (5)$$

3. RESULTS

The magnitude concentrations of Cd in *Leiognathus sp.* were ranged from 0.021 to 0.048 mg/kg. The content of cadmium in *Portunus pelagicus* was equal to 0.021 mg/kg. Then, the level content of Cd in *Anadara sp* were ranged from 0.077 mg/kg to 0.106 mg/kg. The concentration of Cd in *Penaeus sp*. is equal to 0.021 mg/kg. Based on SNI standards (2009) levels of Cd in biota is still meet the standard because they ≤ 0.1 mg/kg, except on shellfish samples, one that did not meet the standards set by SNI.

The average exposure frequency of respondents who consumed *Leiognathus sp* was 110.08 days/year, with the highest exposure frequency of 365 days/year whereas the lowest was 12 days/year. The average exposure frequency of respondents who consumed *Portunus pelagicus* was 24 days/year. The highest exposure frequency of 365 days / year and the lowest was 12 days/year. In addition, the average exposure frequency of respondents who consume *Anadara sp*. was 12 days/year, where the highest exposure frequency of 162 days/year and the lowest one of 12 days/year. Lastly, the average exposure frequency of respondents who consume *Penaeus sp. was* 12 days/year, with the highest exposure frequency of 365 days / year and the lowest one was 12 days / year.

Intake rate or the amount (grams) of *Leiognathus sp, Portunus pelagicus, Anadara sp.* and *Penaeus sp.* that were consumed by a person each day. Tallo urban population had an average rate of *Leiognathus sp* intake by 80 grams/day. The highest intake rate of 450 grams / day and the lowest of 20 grams / day. The average rate intake of *Portunus pelagicus* was 426.4 grams/day, where the highest intake of daily consumption of 1918.8 grams/day and the lowest of 213.20 grams/day. in addition, the average rate of *Anadara sp.* intake is 45 grams / day. *Penaeus sp.* was 30 grams / day, respectively.

The average body weight of the population consumed *Leiognathus sp* was 60 kg, the lowest weight of 35.5 kg and the highest was 103 kg. The average body weight of the population consuming *Portunus pelagicus* was 58 kg, with the lowest weight of 35.5 kg and the highest was 103 kg. The average weight of the population consumed *Anadara sp.* Was at 59.5 kg, with the lowest body weight of 39 kg and the highest of 94 kg. The average weight of the population consumed *Penaeus sp.* Was at 61 067 kg, the lowest weight was 58 kg and the highest was 103 kg. Population who consumed *Leiognathus sp.* with cadmium levels of 0.00021 mg/gram (the lowest levels) are at risk quotient (RQ) by an average of 0.0725 while for consumption *Leiognathus sp.* with cadmium levels 0.00048 mg/g (the highest levels) are at risk quotient (RQ) by an average of 0.1655. People who consume *Portunus pelagicus* with cadmium levels 0.00021 mg/g obtained the risk quotient (RQ) by an average of 0.126.

Respondents who consumed *Anadara sp.* with cadmium levels of 0.00077 mg/gram (the lowest levels) are at risk quotient (RQ) by an average of 0.026. Then, consumption of *Anadara sp.* with levels of 0.00106 mg/g (the highest levels) obtained an average risk level of 0.036. Likewise, the consumption of *Penaeus sp.* with levels of cadmium 0.00021 mg/g had RQ by an average of 0.0055. There are three people who have risk population due to consumption *Leiognathus sp.* contained cadmium of 0.00048 mg/g (Figure 1). Level of risk per individual due to consumption of *Portunus pelagicus* with cadmium levels 0.00021 mg/g was found four people at risk (Figure 2). There was no people at risks due to consumption of *Anadara sp*. with cadmium level 0.00106 mg/g and *Penaeus sp.* with cadmium level of 0.00021 mg/gram (Figure 3 and Figure 4).

4. DISCUSSION

4.1 Risk Analysis of Cadmium

Risk analysis could be developed with two approaches, disease oriented approach and agent-oriented. Methods of risk analysis with disease-oriented approach to assess risk based on the effect that has arisen or appears that the environmental health epidemiology studies. While the agent-oriented approach does not take into account the effects that have occurred, but the risk analysis can be done simply by the existence of an agent that exposes humans either through inhalation, oral or dermal to predict the effects that may occur in the future. This research is a study of risk analysis using agent oriented approach. Agent in question in this research is cadmium which exposes residents of the Tallo Subdistric through consumption *Leiognathus sp, Portunus pelagicus, Anadara sp.* and *Penaeus sp.* from Tallo River.

In an experiment carried out to follow the transfer of cadmium from a terrestrial to a local aquatic ecosystem, it was found that the number (94-96 %) of cadmium in the soil left behind. Cadmium accumulation had a faster process in the sediment than in living organisms. Twenty percent of cadmium in water was found in suspended particles (Anonim, 2009). A study conducted in areas of high runoff indicates the fact that a large amount of cadmium decreases after passing through sedimentation ponds and wane after going through an arrest in wet areas (Irwin, 1997). Some forms of dissolved cadmium in water and Cadmium bound strongly to soil particles. Fish, plants, and animals can be contaminated with cadmium from the environment (ATSDR, 2008a).

Cadmium can undergo a process of accumulation in fish, mussels and algae, especially species living in an area that is very close to the sediment that has been contaminated by cadmium (IPCS, 1972; 2004; 2009; Irwin, 1997). US.EPA. (1985) in Drinking Water Criteria Document on Cadmium mention that the cadmium concentration of 200 µg/gram wet tissue of human kidney is the highest level that does not cause the occurrence of proteinuria. A model toksikokinetik to determine the level of chronic oral exposure in humans (NOAEL) in which the levels of cadmium contained 200 ug/g wet tissue of human kidney, the model assumes that the daily load cadmium 0.01% experienced a reduction in body (US. EPA, 1985).

With this basis forecasts NOAEL (No Observed Adverse Effect Level) of 0.005 mg cadmium/kg/day for source water intake with UF value (Uncertainty Factor) of 10 while through food by 0.001 mg/kg/day (US-EPA, 1985; IRIS, 2007; 2010).

A person's daily intake of cadmium levels exceeding 0.001 mg/kg/ day generated the increase of excretion of cadmium in urine that has a significant relationship with changes in renal function. Then it might be accompanied by a low molecular weight proteins, intracellular tubular enzymes, amino acids, proteins with a molecular weight high, metalotionin and electrolysis. A comprehensive study found a significant relationship between the dose response to cadmium in urine (or cumulative cadmium intake) and the prevalence of abnormal levels of the biomarker of renal dysfunction.

Exposure to cadmium in a long period in humans will lead to the accumulation of chemicals in the human body, in a certain period of time will lead to the emergence of adverse health effects. Chronic Cadmium poisoning caused by toxins carried by the metal cadmium, occurred in long intervals, then at some point the body can no longer tolerate the toxicity brought by Cd (ATSDR, 2008a). Toxic effects of metals are closely linked to the level and duration of exposure. Generally, the higher levels of the metal and the longer the exposure, the toxic effect of a metal will be greater. For example, cadmium in single dose, large dose can induce gastrointestinal disorders. While the intake of Cd in small amounts but can repeatedly cause malfunctioning of kidney. (Lu, 1995)

The main health effects due to long-term exposure to cadmium were including kidney dysfunction, lung cancer, and prostate cancer. Cd can lead to a local irritation to the skin and eyes, and the effects can occur from inhalation or ingestion. (OSHA, 2004). Weight loss is a simple index of toxic effects but is sensitive to the presence of toxic substances in the body. Gastrointestinal absorption of cadmium is influenced by diet and nutritional status, with iron status has an important position. An average of 5% of the total oral intake of cadmium can absorbed, but individual values ranged from less than 1% to more than 20% (Lu, 1995).

Takenaka et al (1983) on exposure to rodents by inhalation of cadmium in the form of cadmium chloride at concentrations of 12.5, 25 and 50 ug/cu.m for 18 months, with an additional period of observation for 13 months, obtained significant results in increased lung tumors (IRIS, 2010). Cadmium is known to accumulate in the human kidney for a relatively long time, from 20 to 30 years, and, at high doses, is also known to cause health effects on the respiratory system and are associated with bone disease. Epidemiological information related to support this as the worker or the Japanese people living in areas contaminated with high levels of cadmium (US.EPA, 1985).

Dose-response assessment is the process of characterizing the relationship between the dose of an agent that has been recorded or obtained by the case of a health effect in exposed populations and estimating the incidence as a function of human exposure to an agent (NRC, 1983). Toxicant can be eliminated from the body through several routes. Kidney is a vital organ to remove toxins. Some xenobiotics material is first converted into a water-soluble materials before disposal. Kidney is an organ that is very efficient in eliminating toxicant from the body. Toxic compounds excreted in urine by the same mechanism as when the kidneys remove metabolites result from the body (Mukono, 2005; Lu, 1995). This suggests that the continuous intake of cadmium will eventually lead to a reduction in the kidney's ability to make efforts neutralization cadmium, which eventually led to the occurrence of renal dysfunction.

Chemicals that have undergone cycles in the environment will go into the human body through the three channels of exposure is through the digestive tract (ingestion), breathing (inhalation) and skin contact (dermal) (WHO, 2000; Mukono; 2005; Soemirat, 2009). However, specifically with human engineering alone, toxicant can also enter the body by way of intravenous, intraperitoneal, subcutaneous and intramuscular (Mukono, 2005; 2000). In addition to the entry of toxicant in the body can also be through parental (Soemirat, 2009). Even the entry of chemicals into the human body through three routes of exposure to the same time (WHO, 2000).

4.2 Risk Management

Risk management aims to control the risk factors that may lead to health problems due to consume of *Leiognathus sp, Portunus pelagicus, Anadara sp.* and *Penaeus sp.* containing cadmium. In a study of risk analysis with agent-oriented approach there are some variables that were measured to determine the amount of risk, the level (concentration) of the chemical in the environment, body weight, duration of exposure, the rate of intake, and frequency of exposure. So in some risk management these variables can be controlled to avoid occurrence of risk due to exposure to a disease agent in the environment. Efforts to control risk can be done in several ways: lower levels of cadmium *in Leiognathus sp, Portunus pelagicus, Anadara sp.* and *Penaeus sp.*, controlling the rate of intake and reduce the duration of exposure. Control of risk approaches by reducing cadmium levels in *Leiognathus sp, Portunus pelagicus, Anadara sp.* and *Penaeus sp.* can be done by calculating safe levels of cadmium in

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the biota if taken every day for a certain period. Where the determination of safe levels of cadmium can vary among individuals depending on contact time (duration of exposure) and the person's weight.

Table 1. Exposure Duration of Cadmium due to comsumption of *Leiognathus sp*, *Portunus pelagicus*, *Anadara sp.* and *Penaeus sp*., base on the varied body weight

Body Weight (kg)	Duration of Exposure (year)											
	Leiognathus sp. [a)]						*Portunus pelagicus* [b)]					
	5	10	15	20	25	30	5	10	15	20	25	30
35	0.00274	0.00137	0.00091	0.00068	0.00055	0.00046	0.0005	0.00026	0.00017	0.00013	0.0001	0.000085
40	0.00313	0.00156	0.00104	0.00078	0.00063	0.00052	0.0006	0.00029	0.0002	0.00015	0.00012	0.000098
45	0.00352	0.00176	0.00117	0.00088	0.0007	0.00059	0.0007	0.00033	0.00022	0.00017	0.00013	0.00011
50	0.00391	0.00196	0.0013	0.00098	0.00078	0.00065	0.0007	0.00037	0.00024	0.00018	0.00015	0.000122
55	0.0043	0.00215	0.00143	0.00108	0.00086	0.00072	0.0008	0.0004	0.00027	0.0002	0.00016	0.000134
60	0.00469	0.00235	0.00156	0.00117	0.00094	0.00078	0.0009	0.00044	0.00029	0.00022	0.00018	0.000146
65	0.00508	0.00254	0.00169	0.00127	0.00102	0.00085	0.001	0.00048	0.00032	0.00024	0.00019	0.000158

Body Weight (kg)	Duration of Exposure (year)											
	Anadara sp. [c)]						*Penaeus sp.* [d)]					
	5	**10**	**15**	**20**	**25**	**30**	**5**	**10**	**15**	**20**	**25**	**30**
35	0.0049	0.0024	0.0016	0.0012	0.001	0.0008	0.0073	0.0037	0.0024	0.0018	0.0015	0.0012
40	0.0056	0.0028	0.0019	0.0014	0.0011	0.0009	0.0083	0.0042	0.0028	0.0021	0.0017	0.0014
45	0.0063	0.0031	0.0021	0.0016	0.0013	0.001	0.0094	0.0047	0.0031	0.0023	0.0019	0.0016
50	0.007	0.0035	0.0023	0.0017	0.0014	0.0012	0.0104	0.0052	0.0035	0.0026	0.0021	0.0017
55	0.0076	0.0038	0.0025	0.0019	0.0015	0.0013	0.0115	0.0057	0.0038	0.0029	0.0023	0.0019
60	0.0083	0.0042	0.0028	0.0021	0.0017	0.0014	0.0125	0.0063	0.0042	0.0031	0.0025	0.0021
65	0.009	0.0045	0.003	0.0023	0.0018	0.0015	0.0136	0.0068	0.0045	0.0034	0.0027	0.0023

[a)] *Safe levels of Cd (mg/g) according to the duration of exposure and the weight on the residential / population that consumes Leiognathus sp for 350 days/year with the rate of intake of 80 grams/day for 30 years.*

[b)] *Safe levels of Cd (mg/g) according to the duration of exposure and the weight on the residential / population that consumes Portunus pelagicus for 350 days/year with intake rate of 426.4 g/day for 30 years.*

[c)] *Safe levels of Cd (mg/g) according to the duration of exposure and the weight on the residential / population that consumes Anadara sp. for 350 days/year with the rate of intake of 45 grams/day for 30 years.*

[d)] *Safe levels of Cd (mg/g) according to the duration of exposure and the weight on the residential population that consumes Penaeus sp. for 350 days / year with the rate of intake of 30 grams / day for 30 / years.*

Someone with a less weight would have a greater risk, so, to control the risk of cadmium levels in *Leiognathus sp*, *Portunus pelagicus*, *Anadara sp.* and *Penaeus sp.* should be lower than someone with greater weight. Similarly, the contact length (duration of exposure), a person who is exposed to a longer period of time, is safer to consume *Leiognathus sp*, *Portunus pelagicus*, *Anadara sp.* and *Penaeus sp*. the cadmium content of less than someone who consumes life with smaller expose duration although the same weight.

Controlling overall levels of cadmium in biota in the river Tallo cannot be done directly through the control of cadmium levels Tallo river waters. Risk management with control intake rate can be developed by reducing the amount of consumption *Leiognathus sp*, *Anadara sp.*, *Portunus pelagicus* and *Penaeus sp.*, While maintaining other factors such as body weight, levels of cadmium, frequency of exposure as the current state of the research was conducted.

Body Weight (kg)	Duration of Exposure (year)											
	Leiognathus sp. a)						*Portunus pelagicus* b)					
	5	10	15	20	25	30	5	10	15	20	25	30
35	456.25	228.125	152.083	114.063	91.25	76.042	1042.857	521.429	347.62	260.71	208.57	173.81
40	521.429	260.714	173.81	130.357	104.286	86.905	1191.837	595.918	397.28	297.96	238.37	198.639
45	586.607	293.304	195.536	146.652	117.321	97.768	1340.816	670.408	446.94	335.2	268.16	223.469
50	651.786	325.893	217.262	162.946	130.357	108.631	1489.796	744.898	496.6	372.45	297.96	248.299
55	716.964	358.482	238.988	179.241	143.393	119.494	1638.776	819.388	546.26	409.69	327.76	273.129
60	782.143	391.071	260.714	195.536	156.429	130.357	1787.755	893.878	595.92	446.94	357.55	297.959
65	847.321	423.661	282.44	211.83	169.464	141.22	1936.735	968.367	645.58	484.18	387.35	322.789

Body Weight (kg)	Duration of Exposure (year)											
	Anadara sp. c)						*Penaeus sp.* d)					
	5	10	15	20	25	30	5	10	15	20	25	30
35	206.604	103.302	68.868	51.651	41.321	34.434	1042.857	521.429	347.619	260.714	208.571	173.81
40	236.119	118.059	78.706	59.03	47.224	39.353	1191.837	595.918	397.2789	297.959	238.367	198.639
45	265.633	132.817	88.544	66.408	53.127	44.272	1340.816	670.408	446.9388	335.204	268.163	223.469
50	295.148	147.574	98.383	73.787	59.03	49.191	1489.796	744.898	496.5986	372.449	297.959	248.299
55	324.663	162.332	108.221	81.166	64.933	54.111	1638.776	819.388	546.2585	409.694	327.755	273.129
60	354.178	177.089	118.059	88.544	70.836	59.03	1787.755	893.878	595.9184	446.939	357.551	297.959
65	383.693	191.846	127.898	95.923	76.739	63.949	1936.735	968.367	645.5782	484.184	387.347	322.789

a) Maximum intake rate (g/day) according to the weight on the residential population consumes Leiognathus sp with cadmium levels 0.00048 mg/g for 350 days / year

b) Maximum intake rate (g/day) according to the weight on the residential population consumes Portunus pelagicus with cadmium levels 0.00021 mg / g for 350 days / year

c) Maximum intake rate (g/day) according to the weight on the residential population consumes Anadara sp. with high levels of cadmium 0.00106 mg / g for 350 days / year

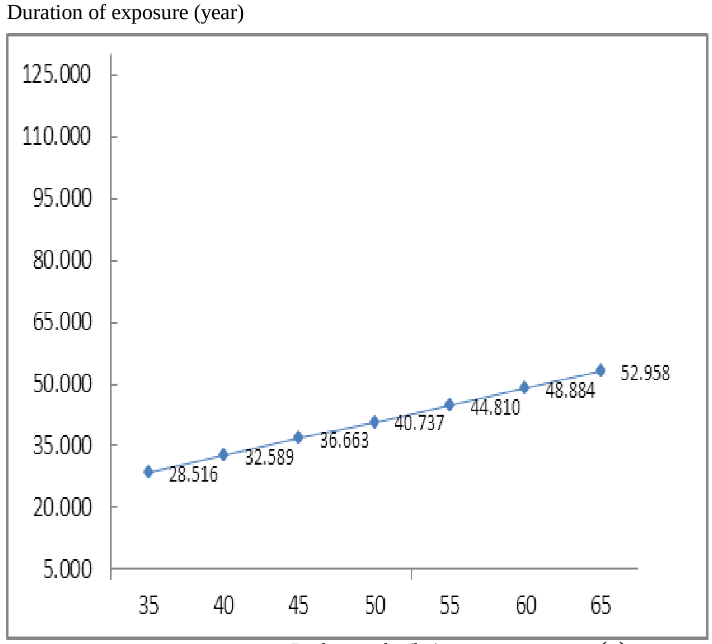
d) Maximum intake rate (g/day) according to the weight on the residential population consumes Penaeus sp. with high levels of cadmium 0.00021 mg / g for 350 days / year.

The rate of intake, frequency of exposure, and weight vary each respondent. This means that safe exposure duration may vary on each respondent. Someone with greater weight, the smaller the rate of intake and frequency of exposure lower daily safe exposure duration has longer than someone who has a smaller weight, greater intake rate and duration of exposure are higher in the same levels of cadmium.

Frequency of exposure and body weight varies each respondent. Someone with greater weight, and frequency of exposure greater daily has safe levels of intake greater rate than someone with a smaller weight, and frequency of exposure which is smaller.

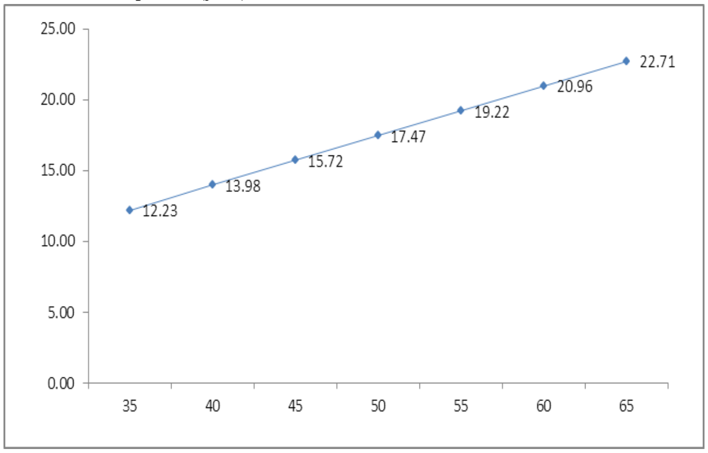
Management of risk with duration of exposure control can be done by reducing the contact time someone with cadmium contained in *Leiognathus sp*, *Anadara sp.*, *Portunus pelagicus* and *Penaeus sp.* while maintaining factors such as body weight, levels of cadmium, frequency of exposure and intake rate remains at the current state of the research was conducted.

Duration of exposure (year)



Body weight (kg) (a)

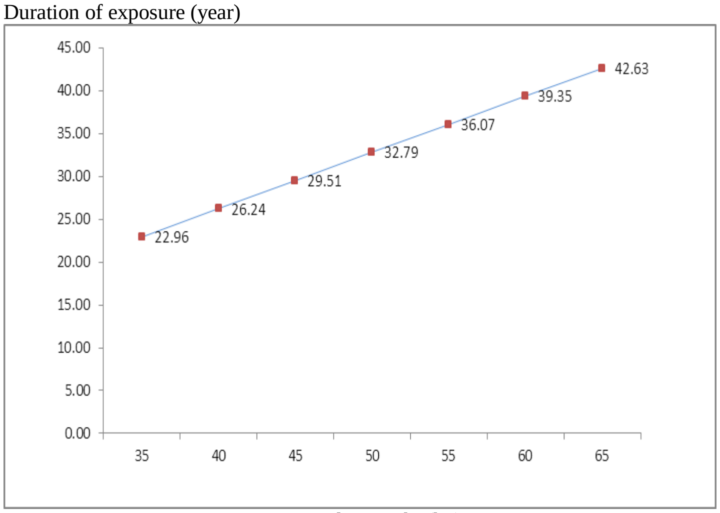
Duration of exposure (year)



Body weight (kg) (b)

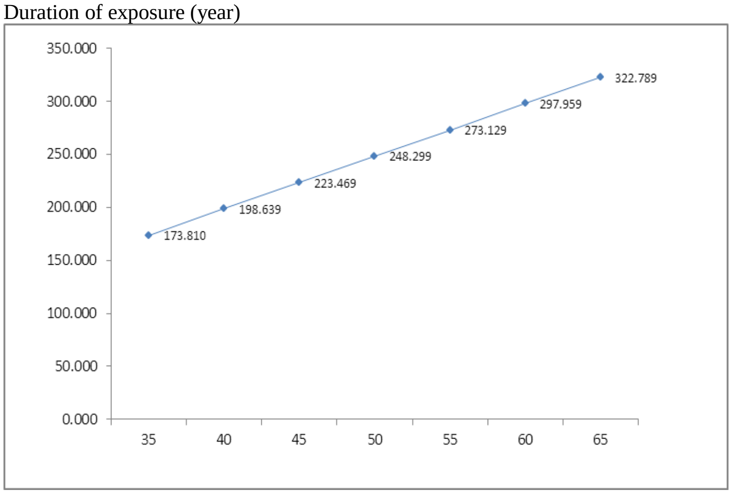
Figure 1. (a) Maximum exposure duration (years) according to the weight on the residential population that consumes *Leiognathus sp* for 350 days/year with the rate of intake of 80 g/day with Cd concentration 0.00048 mg/g. (b) Maximum Exposure Duration (years) according to the weight on the residential population that consumes *Portunus pelagicus* for 350 days/year with intake rate of 426.4 grams/day with a concentration 0.00021 mg/g.

Duration of exposure (year)



Body Weight (kg) (a)

Duration of exposure (year)



Body Weight (kg) (b)

Figure 2. (a) Maximum Exposure Duration (years) according to the weight on the residential population that consumes *Anadara sp* for 350 days/year with the rate of intake of 45 grams/day. With Cd concentration 0.00106 mg/g. (b) Maximum exposure duration (days/year) according to the weight of residential population that consumes *Penaeus sp.* for 350 days/year with the rate of intake of 30 grams/day with cadmium levels 0.00021 mg/g.

The rate of intake, frequency of exposure, and weight vary each respondent. This means that safe exposure duration may vary on each respondent. Someone with greater weight, the smaller the rate of intake and frequency of exposure lower daily safe exposure duration has longer than someone who has a smaller weight, greater intake rate and duration of exposure are higher in the same levels of cadmium. In it`s application, a risk management decision-making process for controlling which will involve and consider many factors such as social, economic, and relevant techniques. So that risk management is achieved by eating better risk management options should be communicated to the parties concerned.

5. CONCLUSION

Leiognathus sp, *Portunus pelagicus*, *Anadara sp.* and *Penaeus sp*. from Tallo River are safe to eat. while maintaining levels of cadmium, weight and frequency of exposure such as when the research was conducted. The most effective risk management in controlling risks due to consumption *Leiognathus sp*, *Portunus pelagicus*, *Anadara sp*. and *Penaeus sp*. is to control the rate of intake.

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