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**Submission date:** 03-Feb-2022 10:45AM (UTC+0800)

**Submission ID:** 1753858170

**File name:** ARTIKEL\_C-19.pdf (1.06M)

**Word count:** 3116

**Character count:** 16720

# MERCURY EXPOSURE FROM FISH IN THE KENJERAN BEACH AREA, SURABAYA: RESEARCH PROTOCOL

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## ABSTRACT

**Background:** One of the abundant food sources of high protein is fish. Fish can be an alternative source of protein. However, recent developments in industrialization and human activities (agriculture, plantations) that lead to degradation of environmental quality followed by ecological imbalances have created major public health problems related to the safety of fish consumed in mining areas and industrialization has occurred.

**Methods:** This study was conducted by analyzing mercury levels in raw fish (freshwater and saltwater fish) originating from the waters of the city of Surabaya. The samples used were the total population of 8 traditional markets at Kenjeran Beach in Surabaya. Fish seller recruitment was carried out using a simple random sampling technique. Seven sellers were randomly selected from each market. From each seller, one freshwater fish, and one saltwater fish was taken for laboratory analysis of mercury contamination. The fish seller's knowledge was assessed through an interview with a structured questionnaire.

**Discussion:** The purpose of this study was to measure and identify mercury contamination in fish (freshwater and saltwater fish) and to see the level of knowledge of fish sellers regarding mercury contamination in fish. Due to the different levels of knowledge for each seller. Potentially, this research can provide information and education to sellers regarding mercury contamination and obtain a map of the distribution of mercury pollution in the waters of the Kenjeran area of Surabaya.

**Keywords:** contamination; fish; heavy metal; coastal-industrial area

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## INTRODUCTION

One of the abundant high protein food sources in Indonesia is fish. However, recent developments in industrialization and human activities (agriculture, plantations) that lead to degradation of environmental quality followed by ecological imbalances have created major public health problems related to the safety of fish consumed in areas where mining and industrialization are taking place.

Food safety issues are in the spotlight because they occur more frequently and can have both short- and long-term health impacts and place a significant health burden on the population. One example is heavy metal contamination between fish (freshwater fish and saltwater fish). Consumption of contaminated fish can cause health problems in various age groups(1). A study(10) China found that fish consumption was significantly associated with blood mercury levels. Blood mercury levels were also found to correlate with anthropometric characteristics in children (2). Another study showed that maternal fish consumption during pregnancy has a protective effect(14) on metabolic disorders of the child, but that increased levels of mercury in the mother's blood during pregnancy are associated with an increased risk of metabolic syndrome in the child(3). Therefore, it is important to explore the types of fish and the content of mercury contamination in fish in an area so that fish consumption can have a positive effect, by minimizing the negative effects of environmental pollution.

This research is useful to rank the level of mercury contamination among several types of food that are mostly consumed by the public and to see the level of knowledge of fish sellers regarding mercury pollution in fish. At the end of this research, establish a sufficiently safe limit from fish consumption for the community and is useful for

preventing the impact of health problems caused by exposure to food from mercury as well as providing information and education to sellers regarding mercury contamination and obtaining maps of the distribution of mercury pollution in water areas.

There is an abundance of studies to provide solid evidence of the detrimental health effects of industrial contaminants. Coastal areas are one of the areas that receive the greatest impact of pollution compared to other areas. As an industrial city located in a coastal area, the city of Surabaya has a great opportunity to experience mercury contamination.

Heavy metal contamination can cause health harm through many channels such as bioaccumulation and biomagnification in the food chain (consumption of contaminated fish), consumption of contaminated water, and daily use of surface water for washing and bathing. Consumption of fish and seafood from polluted seas is the main entry point for exposure to heavy metals in humans. Heavy metal contamination in humans has long been studied for its associated health consequences. Mercury contamination is indicated as a causative agent for several disorders including immunological, neurological, reproductive, motor, nephrological, and cardiac. Several genetic disorders such as Alzheimer's, Parkinson's, Autism, Lupus, and Amyotrophic lateral sclerosis have also been found to be mediated by exposure to heavy metals (4). Gustin et al (2017) examined the effects of methyl mercury in children at age 10 which resulted in a significant association with poor behavior of developmental neurotoxicity (5). Gump et al (2012) reported a significant association of blood mercury with systemic inflammation in children aged 9-11 years (6).

Population awareness, including seller awareness, is one approach that can be taken to reduce the circulation of the

food chain from contaminated food. The increased risk of contamination from food can be caused by low awareness of the public and vendors.(7).

The purpose of this study was to measure and identify mercury contamination in fish (freshwater and saltwater fish) and to see the level of knowledge of fish sellers regarding mercury contamination in fish, to identify the potential for mercury contamination that occurs due to consumption of fishery products. The results of this study are expected to be able to reduce the risk of mercury contamination through dietary modification and nutritional behavior and can provide information and education to sellers regarding mercury contamination and obtain a map of the distribution of mercury pollution in the waters of the Kenjeran area of Surabaya.

#### Methods and Design

This study used 2 groups, namely the treatment group and the control group. Saltwater fish has considered the treatment group and freshwater fish are the control group. From the two groups, the mercury levels will be determined. After conducting the survey, there were 8 traditional markets in the Kenjeran beach area of Surabaya which would be the population and samples in this study. From the 8 markets, 7 raw fish sellers were randomly selected. From each seller, 2 fishes were taken. A saltwater fish as the treatment group and a freshwater fish as the control group. Not only looking at mercury levels in fish, but research was also carried out on the knowledge of fish sellers about mercury contamination in the fish being sold.

#### Objectives and hypothesis

The objective of this study is to measure and identify mercury contamination in fish (freshwater and saltwater fish) and to see the level of knowledge of fish sellers about mercury pollution in fish.

#### Primary hypothesis

The hypothesis of this study is that there is mercury contamination in fish sold in the Kenjeran Beach area market.

#### Secondary hypothesis

1. The presence of mercury contamination in saltwater and freshwater fish.
2. Lack of knowledge of fish sellers about mercury contamination in fish.

#### Setting

This study has conducted in the waters of Surabaya, precisely in the Kenjeran Beach area. Kenjeran sub-district has an area of 14.42 km<sup>2</sup> with population of 9144 people / km<sup>2</sup>(8), kenjeran district is the largest of the waters and fisheries areas in Surabaya. In the coastal area of Kenjeran there are many populations of shellfish and fish that sold and consumed by residents of the surrounding area. Kenjeran coastal waters have an important role in the cycle of handling heavy metal pollution in fish because they are the center of waters and fisheries in the city of Surabaya. Research in three coastal areas in East Java shows that sea water in Surabaya area has the highest heavy metal content compared to other coastal areas. The content of metallothionein (MT) which is a biomarker of heavy metal accumulation in aquatic animals is also found mostly in aquatic species originating from the Kenjeran sea (9). In addition, research done by Suryono *et al.* (2019)

found higher bioaccumulation of mercury in various species of shellfish caught off the Kenjeran coast, compared to other areas (10). Apart from water quality in the sea area, groundwater quality in the Surabaya area is also vulnerable to contamination. A study in the Surabaya and Sidoarjo regions found that groundwater in these two regions contained various levels of arsenic and magnesium contamination(11). This indicates that the fish raised in fresh water in Surabaya area also has a risk of being contaminated with heavy metals.

#### Target Population

The population of this research is 8 traditional markets in the Kenjeran beach area. The entire market will be sampled. From each market, 7 fish sellers who sell freshwater and saltwater fish will be selected, so that 112 fish will be tested for mercury content. In addition, sellers will be respondents who will be interviewed using a questionnaire to determine the seller's level of knowledge about mercury pollution and contamination in fish.

#### Inclusion and exclusion criteria

The inclusion criteria of this study are a market in the waters of Kenjeran District, Surabaya, and the seller is a seller of raw fish sold in the Kenjeran District, Surabaya.

#### Outcome

Outcomes of this study are map of distribution of the mercury pollution in the waters of Kenjeran area, Surabaya along with level of knowledge of fish sellers about mercury pollution in fish, especially the ones they sell. Map of distribution will be acquired after fish samples and processed fish products samples are being tested for mercury in Sucofindo Laboratory, Indonesia. The results of this study would be the base of qualitative study in the second- and third years regarding control and countermeasures of mercury contamination.

#### Discussion

This study measure and identify mercury contamination in fish (freshwater and saltwater fish) and processed fish products and also to see the level of knowledge of fish sellers regarding mercury contamination in fish. Entry of Mercury to the body's majority comes from food, because almost majority 90% of heavy metal or toxic comes from food. Based on the research Nakoe *et al.* (2014), the average mercury contains in Nila Fish from Limboto Lake (one of the Lake in Gorontalo Province) was 0.007 mg/kg – 0.089 mg/kg that according to the SNI standard, Mercury concentration in the Nila Fish still under limitation standard  $\leq 0.5$  mg/kg(12).

This study setting is in coastal area of Kenjeran, Surabaya, Indonesia. Kenjeran coastal waters was chosen because it is the center of waters and fisheries in the city. With industrial development in Surabaya is growing rapidly, the increase in the number of these industries will always be accompanied by many environmental problems caused by these industrial activities(13). Industrial waste produced will be disposed of into Surabaya's many rivers and eventually ended up in the coastal waters in Surabaya. One of the causes of high mercury is human pollution due to the mining process that causing water pollution in the lake or river(14). Fithriyah, *et al.* (2015) stated that with the bio magnification process that works in the oceans, the levels of mercury that enter will continue to be increased in addition to the continuous addition of factory waste. The mercury that enters is then associated with the food

chain system, so that it enters the body of aquatic biota and is eaten by humans along with food taken from waters contaminated by mercury.

The primary hypothesize of this study is that there is mercury contamination in fish sold in the Kenjeran Beach are market. The secondary hypothesize of this study are that there is presence of mercury contamination in saltwater and freshwater fish and that the fish sellers are not knowledgeable about mercury contamination in fish. Junaidi *et al.* (2019) research, tell that around 10% of fish sample contained very high methylmercury concentrations(14). Research conducted by t2 Environmental Welfare Engineering Center in collaboration with the East Java revealed the average heavy metal content in shellfish and various types of fish in the Kenjeran Beach area for mercury levels were 11.35 ppb, copper level was 1,276.16 ppb, and lead level was 913,369 ppb(15). Based on previous studies on mercury exposure in raw fish, it was found that the concentration of mercury exposure in fish and shellfish in the Kenjeran Beach area of Surabaya was still higher (= 0.898 ppm) than the normal limit allowed by WHO / FAO (= 0.5 - 0.8 ppm)(16). Another study found the average content of mercury (Hg) in eggplant sea cucumbers from Kenjeran beach in Surabaya is 0.099 ppm; at medium size, namely 0.112 ppm; and the large size is 0.106. This value still meets the 2009 SNI standardd, which is 1 ppm(17). In processed fish products such as sea cucumber crackers sold by Kenjeran's fishermen, the Hg concentration obtained in raw sea cucumber crackers was 0.058; 0.0149; 0.108 ppb and in cooked sea cucumber crackers was 0.078; 0.074; 0.061 ppb, still below the Indonesin National Standard's threshold (18). In research conducted in human hair, the level of consumption of marine fish originating from Kenjeran Beach has a significant relationship with Hg levels in hair in research subjects. The more often and the more a person consumes sea fish from the catch of Kenjeran Beach, the higher the Hg content in the person's head hair(19). The Hg level of the exposed group was still far below the threshold value recommended by NRC of 112 ppm and Hg levels in hair have a significant relationship with health complaints in research subjects(19). Hopefully, this research can provide information and education to sellers regarding mercury contamination and obtain a map of the distribution of mercury pollution in the waters of the Kenjeran area of Surabaya.

#### ACKNOWLEDGEMENTS

We thank all the panelists involved in this study. The researchers also extend the gratitude to Direktorat Riset dan Pengabdian Masyarakat, Deputy Bidang Penguatan Riset dan Pengembangan Kementerian Riset dan Teknologi/ Badan Riset dan Inovasi Nasional for funding this study.

#### REFERENCES

- Okpala COR, Sardo G, Vitale S, Bono G, Arukwe A. Hazardous properties and toxicological update of mercury: From fish food to human health safety perspective. *Crit Rev Food Sci Nutr* [Internet]. 2018;58(12):1986-2001. Available from: <https://doi.org/10.1080/10408398.2017.1291491>
- Gao ZY, Li MM, Wang J, Yan J, Zhou CC, Yan CH. Blood mercury concentration, fish consumption and anthropometry in Chinese children: A national study. *Environ Int* [Internet]. 2018;110(June):14-21. Available from: <http://dx.doi.org/10.1016/j.envint.2017.08.016>
- Stratakis N, Conti D V., Borrás E, Sabido E, Roumeliotaki T, Papadopoulou E, *et al.* Association of Fish Consumption and Mercury Exposure During Pregnancy With Metabolic Health and Inflammatory Biomarkers in Children. *JAMA Netw open*. 2020;3(3):e201007.
- Zahir F, Rizwi SJ, Haq SK, Khan RH. Low dose mercury toxicity and human health. *Environ Toxicol Pharmacol*. 2005 Sep;20(2):351-60.
- Gustin K, Tofail F, Mehrin F, Levi M, Vahter M, Kippler M. Methylmercury exposure and cognitive abilities and behavior at 10years of age. *Environ Int*. 2017;102:97-105.
- Gump BB, MacKenzie JA, Dumas AK, Palmer CD, Parsons PJ, Segu ZM, *et al.* Fish consumption, low-level mercury, lipids, and inflammatory markers in children. *Environ Res*. 2012 Jan;112:204-11.
- Kunii N, Fujimura MS, Komasa Y, Kitamura A, Sato H, Takatsuji T, *et al.* The knowledge and awareness for radiocesium food monitoring after the fukushima daiichi nuclear accident in Nihonmatsu city, Fukushima prefecture. *Int J Environ Res Public Health*. 2018;15(10):1-11.
- Pemerintah Kota Surabaya. Kecamatan kenjeran. 2015.
- Hertika AMS, Kusriani K, Indrayani E, Nurdiani R, Putra RBDS. Relationship between levels of the heavy metals lead, cadmium and mercury, and metallothionein in the gills and stomach of crassostrea iredalei and crassostrea glomerata [version 1; referees: 2 approved]. *F1000Research*. 2018;7(0):1-12.
- Suryono CA, Sabdono A, Subagiyo S. Bioakumulasi Arsen (As) dan Merkuri (Hg) pada Bivalvia dari Pesisir Sekitar Demak dan Surabaya Indonesia. *J Kelaut Trop*. 2019;22(2):157.
- Rochaddi B, Atmodjo W, Satriadi A, Suryono CA, Irwani I, Widada S. The Heavy Metal Contamination in Shallow Groundwater at Coastal Areas of Surabaya East Java Indonesia. *J Kelaut Trop*. 2019;22(1):69.
- Nakoe MR, Ardian Y, Ruhardi A, Dwinugroho F, Yudhastuti R, Sulistyorini L, *et al.* Risk Assessment Exposure of Mercury (Hg) at People who Consuming Nila Fish (*Oreochromis niloticus*) from Limboto Lake of Gorontalo Province. In 2014.
- Fithriyah A, Rusmiati, Narwati. Differences in levels of heavy metal mercury (Hg) in mackerel (*Scomberomorus commerson*) sold at Kenjeran Beach, Surabaya in 2015. *Gema Kesehat Lingkungan*. 2016;14(1):16-9.
- Junaidi M, Krisnayanti BD, Juharfa, Anderson C. Risk of mercury exposure from fish consumption at artisanal small-scale gold mining areas in West Nusa Tenggara, Indonesia. *J Heal Pollut*. 2019;9(21).
- Fathurrofiq. Saving Kenjeran's Future. *Kompas* [Internet]. 2009; Available from: <https://nasional.kompas.com/read/2009/07/21/17114617/twitter.com>
- Sjarkawi JA. Effect of Mercury Exposure on Children's Intelligence Level (IQ) in Kenjeran Beach Area, Surabaya [Internet]. Airlangga University; 2002. Available from: <http://repository.unair.ac.id/35764/2/gdlhub-gdl-s2-2006-sjarkawijo-681-tkm190-p.pdf>



17. Lestari WF. Analysis of Metal Mercury (Hg) and Lead (Pb) Levels in Sea Cucumber (*Phyllophorus* sp.) From Kenjeran Beach, Surabaya by Atomic Absorption Spectrophotometry (SSA). Vol. 49, Biomass Chem Eng. Maulana Malik Ibrahim Islamic University; 2015.
18. Wulandari AW, Yuliani D, Adi TK. Mercury (Hg) and Copper (Cu) Analysis of Sea Cucumber *Paracaudina australis* Crackers from Kenjeran Surabaya using Atomic Absorption Spectroscopy. *Alchemy*. 2015;4(1):17-24.
19. Sudarmaji, Sutomo AHh, Suwarni A. Sea Fish Consumption, Defree of Mercury Content in Hair, and Fisherman Health at Surabaya Kenjeran Beach, Indonesia. *Hum Environ*. 2004;11(3):134-42.

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