IDENTIFICATION OF MERCURY LEVELS IN COMMUNITY URINE IN TRADITIONAL GOLD PROCESSING LOCATIONS

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Abstract

Gold processing activities carried out in Paya Seumantok Village, Krueng Seabee District, Aceh Jaya Regency still traditionally use amalgamation techniques involving mercury, which can threaten the health of workers and the surrounding community. This study aimed to determine the identification of mercury levels in the urine of the community around the location of the gold processing plant in Paya Seumantok Village. The sample in this study was the urine of the community in the gold processing facility, totaling 91 people. Analysis of mercury levels in urine was carried out using the AAS instrument. Based on the analysis results conducted from 91 urine samples, 16 samples did not detect mercury. In comparison, the other 75 samples identified the presence of mercury, the average mercury level in the urine of the community around the gold processing location was 8,392 g/L with a standard deviation of 6,721 g/ L, the minimum concentration of mercury in people's urine that was detected was 0.19 g/L. In contrast, the maximum or highest concentration was 28.31 g/L. Overall, it can be seen that of the 75 urine samples analyzed, 36 urine samples containing mercury exceeded the predetermined threshold (7 g/L), while 39 urine samples had mercury levels in the blood. below threshold.

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1. Introduction

Global gold mining has caused various health problems in the community. Worldwide there are an estimated 16 million gold miners and have r 380–450 tonnes (t) of gold, representing 17–20% of global gold production [1,2]. One of the impacts of gold mining is river pollution due to mercury disposal [3,4]. Despite its socio-economic importance, mining globally has severe impacts on both the environment and human health through deforestation 5, 6, habitat loss 7, social problems 8, and work-related injuries 9,10. Mercury (Hg) is a toxic material that can harm humans and the environment. Mercury (Hg) is widely used in the gold mining process, purifying precious metals. Gold mining using amalgamation techniques is known to damage the environment and cause human health risks: cardiovascular and neurological disorders. Exposure to mercury at high concentrations in the human body will result in permanent brain damage and kidney damage [11,12,13]. The most toxic compounds in the heavy metal group are mercury, which is released into the atmosphere in mercury vapor, resulting from the amalgamation combustion process [14,15,16]. Mercury can interrupt metabolism and stop enzymes from working in the digestive process [17,18]. The highest levels of toxicity of heavy metals to aquatic biota are mercury (Hg), cadmium (Cd), zinc (Zn), lead (Pb), and nickel (Ni) based on their chemical and physical properties [19]. Mercury poisoning in people living around mining areas is usually chronic. Reported that a person's length of stay in an area contaminated with mercury was seven times more likely to have mercury levels in the hair above the threshold when compared to someone who lived shorter [20,21]. Clinical symptoms of mercury poisoning will appear after 5-10 years, depending on the amount of exposure in the environment. To determine the presence of mercury (Hg) exposure in the body, it can be known by measuring the levels of pollutants in body tissues, such as hair, blood, urine, nails, and breast milk. Mercury can be in the atmosphere for long periods and travel considerable distances by air [22]. Mercury poisoning results from exposure to mercury compounds from various toxic effects depending on the type and chemical form and the route of exposure [23 24].

Many rivers experience mercury pollution, one of which is the Paya Seumantok Village River. Paya Seumantok Village River is one of the rivers in Aceh Jaya Regency. This river has various benefits for the population, and it is even vital for the various needs of the people in the Aceh Jaya Regency. From the preliminary survey results, it is known that gold processing activities carried out in Paya Seumantok Village are still traditional and use amalgamation techniques. The amalgamation process is carried out by mixing gold ore with liquid mercury to form a Hg-Au alloy. One of the efforts to determine mercury exposure to the community is measuring the network.

Measurements of body tissues are known as Biological Markers or Biomarkers, which will assess exposure to a pollutant. One of the biomarkers that can assess mercury exposure to the body is measuring urine samples. In connection with this problem, this study aims to identify and identify mercury levels in the urine of the community in the area where traditional gold processing is located.

2. Materials and Methods

2.1. Urine Sample.

Urine samples in this study were taken from the people of Paya Seu many o k village, Krueng Sabee sub-district, with a total population of 928 people, of which the sample was calculated using the loving formula with a result of 90. Community urine sampling followed the Regulation of the Minister of Health Number 43 of 2013.

2.2. Sampling Method

The urine samples to be taken are the urine of workers and the urine of the community. For the urine sample of 10 workers, using the total sampling method, while the urine sample for the community was calculated using the Slovin formula, this calculation resulted in 90 samples from a total population of 928 people. Community urine samples will be taken using the purposive sampling method. A sampling of worker urine and community urine follows the Regulation of the Minister of Health Number 43 of 2013, the following is the procedure for taking urine samples:

a. in women

In taking the middle portion of the urine specimen, which the patient himself carries out, the following explanation must be given beforehand:

- Patients should wash their hands with soap and then dry with a towel;
- Take off underwear, spread the labia with one hand;
- Clean the labia and vulva using sterile gauze from front to back;
- Rinse with warm water and dry with another sterile gauze;
- During this process, excrete urine, the first stream of urine is discarded. The urine stream is then accommodated in a container that has been provided;
- Avoid urine hitting the rim of the container;
- Urine collection is complete before the urine stream is exhausted; and
- The container is tightly closed and immediately sent to the laboratory.

b. in men

- Patients must wash their hands with soap;
- If not circumcised, pull the foreskin back, expel the urine, the first stream to come out is discarded, the following stream of urine is collected in the container provided. Avoid urine hitting the rim of the container. Urine collection is

complete before the urine stream is exhausted; and
- The container is tightly closed and immediately sent to the laboratory.

c. In infants and children
- Respondents were previously given a drink to facilitate urination;
- Clean the genitals as described above;
- Urine collection is done by:
  - The child sits on the nurse's lap;
  - sterile plastic container or bag; and
  - The baby has a urine collection bag attached to the genitals.

Then we put the sample bottle into the box where the urine sample is stored not to contaminate other metals.

2.3. Sample Storage

The urine sample before the measurement process is carried out using a cold vapor Atomic Absorption Spectrophotometer or Mercury Analyzer must first be preserved according to the Indonesian National Standard (SNI) with the following specifications:
- Containers: Plastic bottles (polyethylene) or glass bottles that have been rinsed with HNO 3 1:1;
- Preservative: Acidify with HNO 3 to pH 2;
- Storage Time: Plastic bottle 14 days or glass bottle 30 days; and
- Storage Conditions: 4 °C ± two °C.

2.4. Mercury Measurement in Urine Calibration Curve Creation

The calibration curve was made using blank, and mercury solutions in several concentrations; the standard mercury concentrations used were 0 (blank) 4 ppb, eight ppb, and 12 ppb. If the linearity of the calibration curve (r) is less than 0.995, then the measurement test step is repeated for making the calibration curve until the value of r is greater than or equal to 0.995.

2.5. Urine Test Sample Measurement

The urine sample that has been prepared previously will be measured for mercury levels. The sample is tested concerning SNI 6989.78-2011 on the method of testing for mercury (Hg) by Atomic Absorption Spectrophotometry (AAS)-steam-cold. The test method is as follows:
- Entered 100 mL of sample or sample that has been diluted and is within the measurement range into a 250 mL Erlenmeyer;
- 100 mL blanks and three standard working solutions were added to each 250 mL Erlenmeyer;
- 5 mL of concentrated H2SO4 and 2.5 mL of concentrated HNO3 into each Erlenmeyer;
- Add 15 mL of KMnO 4 solution and wait for 15 minutes (if the purple color disappears, add KMnO 4 again until the purple color does not disappear);
- Added 8 mL of K 2 S 2 O8 and heated in a water bath for 2 hours at a temperature of 95°C;
- Cool to room temperature;

- Added enough hydroxylamine-NaCl solution to reduce excess KMnO 4 ;
- Added 5 mL of SnCl 2 and immediately measured the absorption using a cold vapor atomic absorption spectrophotometer optimized according to the instrument's instructions.

3.1. Overview of Research Locations

This research was conducted in the village of Paya Seumantok, Krueng Seabee district, Aceh Jaya district; Paya Seumantok village is one of the villages where one of the livelihoods of the community works in gold mining. The gold processing process carried out in This village has been doing for several decades.

3. RESULTS AND DISCUSSION

Respondent Demographics Overview

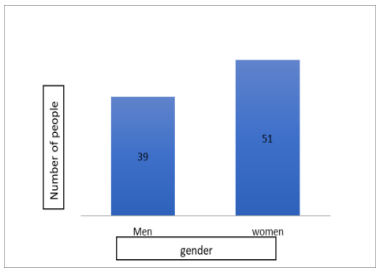

Fig 1 :gender

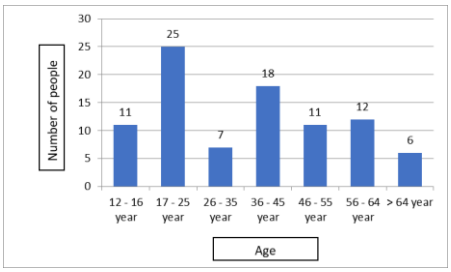

Fig 2:Age

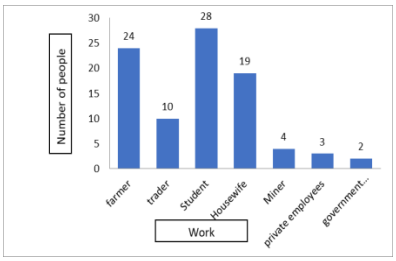

Fig 3:work

Figure 1 shows that the respondents in this study are more dominant women with 51 people or 56.6%, while men as many as 39 people or 43.3%. Figure 2 below shows the distribution of respondents by age. The 17-25 year age group was the largest compared to other age groups with 28%, followed by the 36-45 year age group with 20%, then the 56-64 year age group with 13%, the 46-55 year age group with 13% 12%, the age group of 26-35 years is 8%, and the lowest percentage is the age group above 64 years as much as 7%. Most respondents work as students with 28 people, followed by farmers as many as 24 people, and the least profession is working as civil servants with two people.

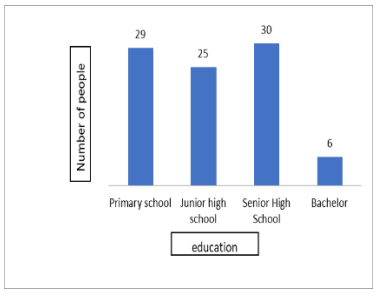

Fig 4:Education

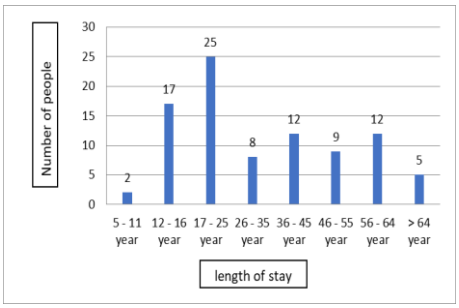

Fig 5:length of stay

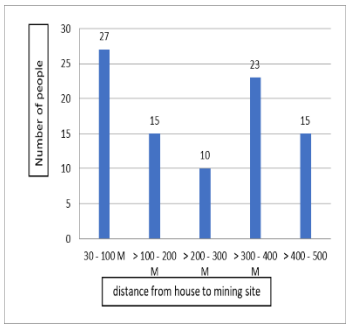

Fig 6:distance from house mining

The average respondents with low education are elementary and junior high schools with as many as 29 and 25 people, during high school education as many as 30 people, and six people with higher education. Respondents with a 17-25 years residence period were the most dominant. All respondents are indigenous people who were born and raised in Paya Seumantok Village, Krueng Seabee District, Aceh Jaya Regency. as many as 27 respondents live at a distance of 30-100 meters from the gold processing location, where the number is the largest among the number of respondents at other distances. From the picture, it is also known that as many as ten respondents' houses are located at a distance of 200-300 meters.

3.2. Mercury Levels in People's Urine

The identification of mercury levels in the urine of the community around the gold processing location was carried out using the AAS instrument. The analysis was carried out at the Environmental Quality Analyst Laboratory, Department of Chemical Engineering, Faculty of Engineering, Syiah Kuala University, Banda Aceh. Before measuring the urine test sample, measurements were made to make a calibration curve. The following figure shows the calibration curve of the mercury standard measurement results.

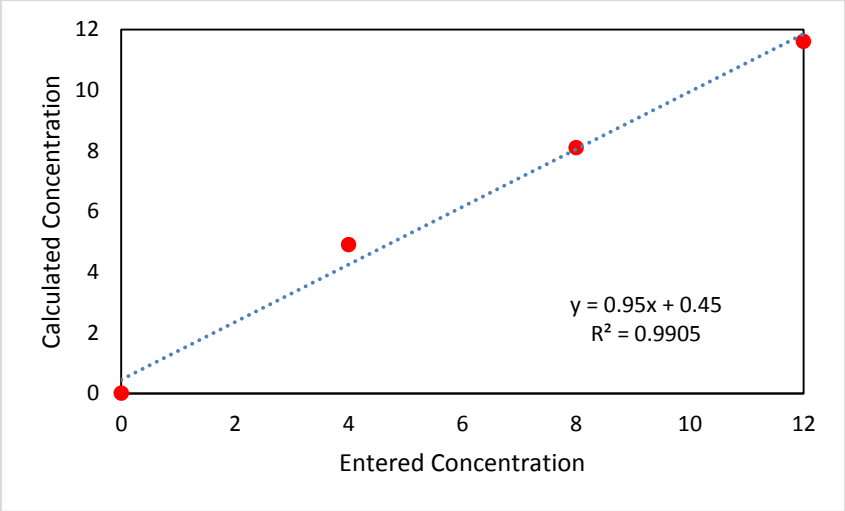

Fig 7 . Calibration Curve

Based on Figure 7, it can be seen that the value of r is 0.9905; this shows that the curve formed is quite linear, so that it shows that the tool can work well. A total of 90 urine samples were collected; figure 8 shows the results of the analysis of mercury levels in people's urine.

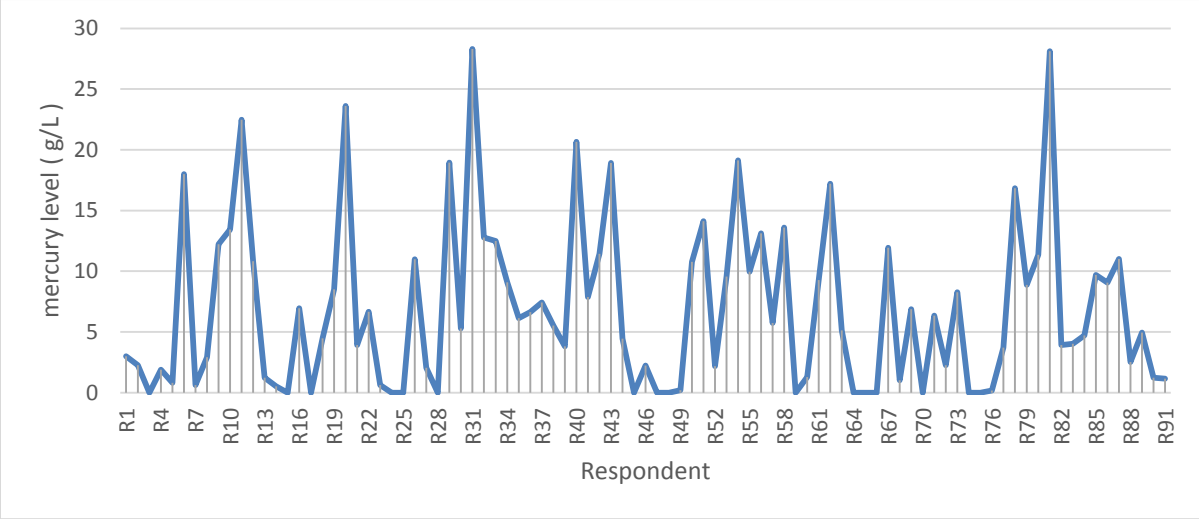

Fig 8. The results of the identification of mercury levels in people's urine (N=91)

Table 1 shows the number of detected and undetected community urine samples of mercury (Hg).

Mercury Level	Number of Respondents	%
Not detected	16	17.58
Detected	75	82.42
Amount	91	100

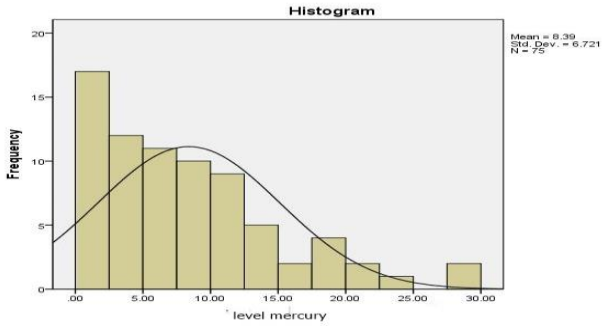

Fig 9 Distribution of mercury concentration in people's urine (N=91)

Figure 9 shows mercury levels in the urine of the dominant community at concentrations <10 g/L. Table 2 below shows a description of mercury levels in people's urine based on the analysis results with AAS.

Table 1. Description of the results Analysis of mercury levels in people's urine (n=75)

No	Description		Amount (µg/L)
1	mean		8.3928
2	median		6.8675
3	Std deviation		6.7210
4	Minimum rate		0.19

5	Maximum Level		28.31
6	percentile	25%	:2.94
		50%	:6.86
		75%	:11.82

Table 2 shows that the average level of mercury found in the urine of the community around the gold processing location is 8,392 g/L with a standard deviation of 6,721 g/L, the minimum concentration of mercury in the urine of the community that was successfully detected was 0.19 g/L. In comparison, the maximum concentration or the highest was 28.31 g/L. Figure 10 shows the distribution of mercury levels in the respondents' urine based on gender characteristics and distance from home.

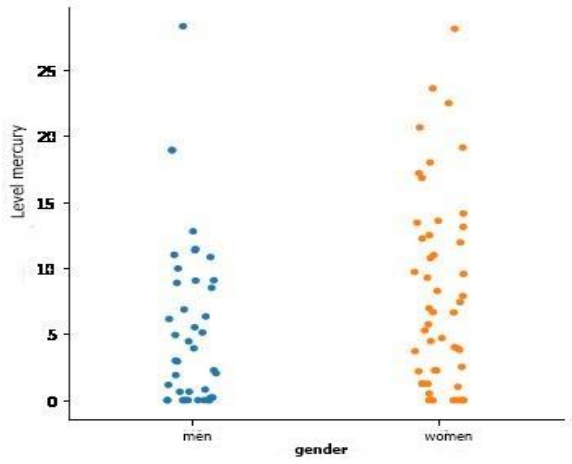

Fig 10

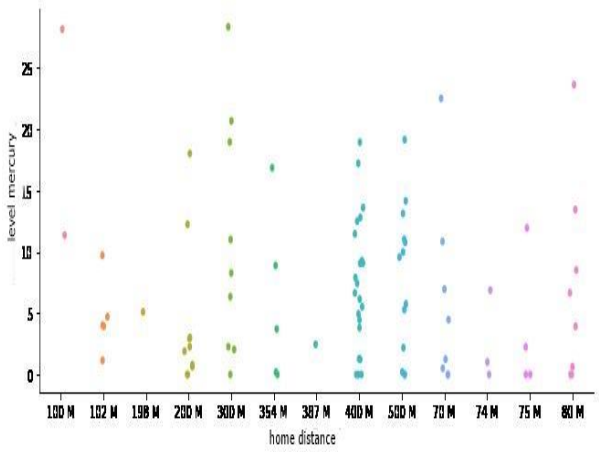

Fig 11

Based on gender, it is known that the mercury level in the urine of female respondents is higher than that of male respondents. The distance between the house and the location of the gold processing collection did not affect the mercury level in the respondent's urine. It can be seen that the majority of people's urine that contains mercury are respondents who have a house distance of more than 300 m. The risk of mercury levels due to the distance of residence, if not influenced by other factors, is 5.76 times higher at a distance of 261 meters from the river flow when compared to those who live >261 meters in the study location. Rivers that become tailings for mercury disposal in mining activities will contain a large concentration of mercury in river bodies; the natural process of mercury in water bodies will release ions and elements containing mercury into the air around the river so that the concentration of mercury in the air around the river increases. Therefore, having a place to live close to mercury-contaminated air quality can increase mercury levels in hair in the long term.

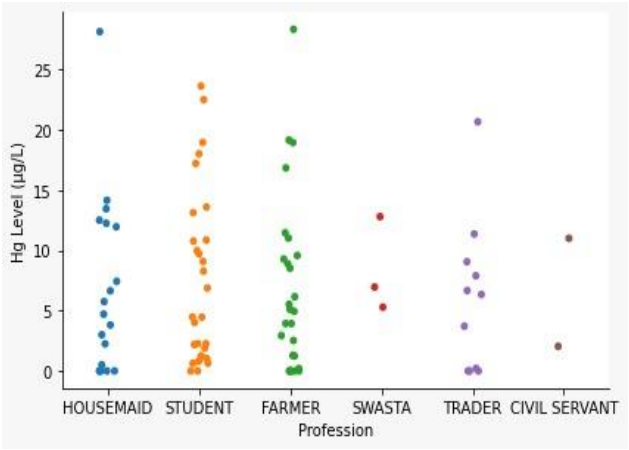

Fig 12

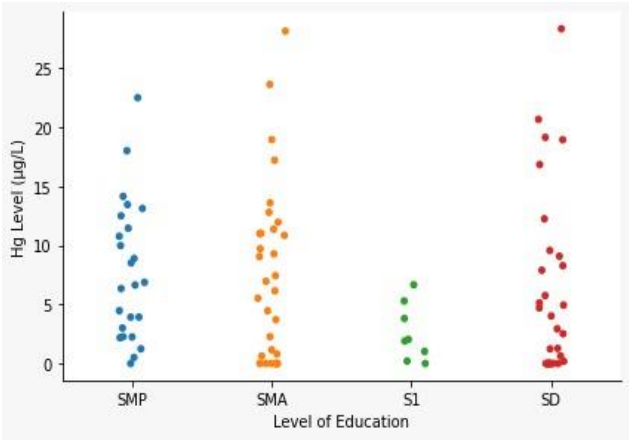

Fig 13

More mercury levels are contained in respondents who have jobs as household workers, students, and farmers. Based on the results of previous studies, there was no effect of work on symptoms of illness in the community around the gold processing location; it was obtained that there was no effect of the type of work on symptoms of the disease [25,26]. The level of distribution of mercury in respondents' mercury based on education level shows that respondents with elementary education level tend to have higher mercury levels; it can be seen that there are respondents who have mercury levels in their urine above 15 g/L. Figure 14 shows the distribution of mercury levels in the urine based on the length of stay of respondents in Paya Seumantok Village.

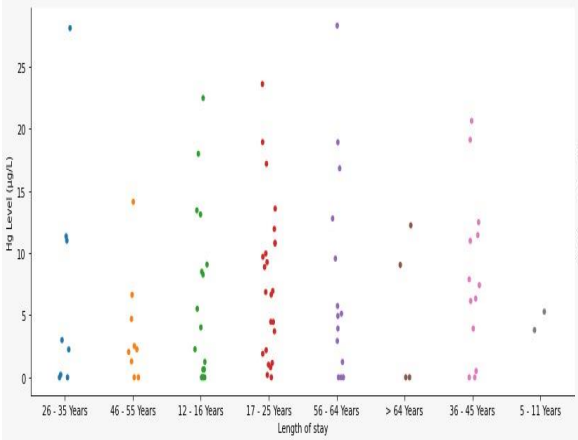

Fig 14

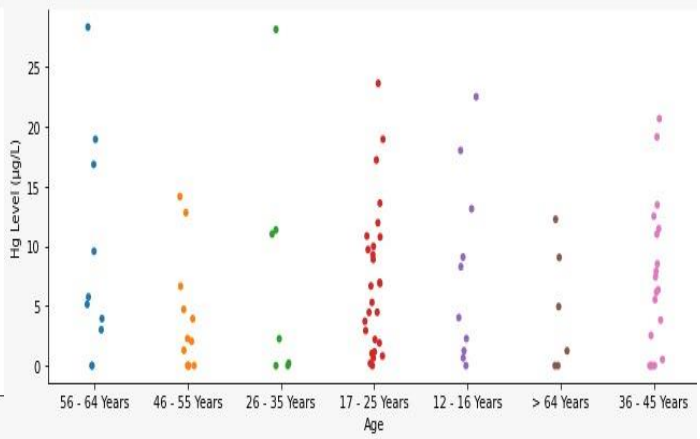

Fig 15

Based on the picture above, the distribution of mercury concentration in the urine of the people of Paya Seumantok village is based on the length of stay. Based on this information, it can be seen that the level of mercury in the urine is not affected by the length of stay of the respondent in the village. The age factor did not affect the level of mercury in the urine, where the distribution pattern of mercury concentration for each age criterion showed the same pattern.

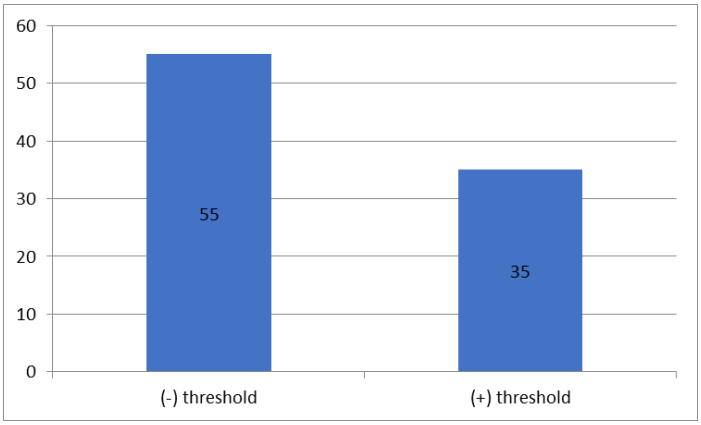

Figure 16 Mercury levels in people's urine that exceeds the threshold (7 g/L)

Based on the figure above, it can be seen that from the 91 urine samples analyzed, 36 urine samples containing mercury exceeded the predetermined threshold (7 g/L), while 55 urine samples contained mercury levels below the threshold. Based on previous research that measured the level of disease symptoms in the community around the gold processing location in Paya Seumantok Village, Krueng Seabee District, Aceh Jaya Regency, the results obtained were a description of the clinical symptoms of acute toxicity commonly experienced by the community such as headache (48.6%), cough (39.6%). %) Abdominal Pain (37.8%), Diarrhea (29.7%), Hip Pain (25.2%), and easy tooth loss (21.6%). Meanwhile, chronic clinical symptoms commonly experienced by people around gold processing are headaches (47.7%), irritability (27.9%), insomnia (26.1%), muscle cramps (23.4%), decreased body weight (20.7%), and restlessness (17.1%) [27]. As several previous studies stated that symptoms of illness caused by mercury exposure to communities around the Amazon river, namely experiencing vision problems, had the highest prevalence (43.3%) among health problems and symptoms of Hg poisoning, followed by complaints/symptoms of memory loss (42, 9%), weakness (35.1%), fatigue (34.3%), mood swings (28.7%) and difficulty. in the most reported concentration (27.2%) [28]. The clinical symptoms experienced by the community around the gold processing site are almost the same as those experienced by gold processing workers, as previously reported by previous studies that people's gold milling operations impact workers' health. Nearly half of the workers reported experiencing acute symptoms such as fatigue (41.7%), headaches (39.6%), and numbness of the mouth (39.6%)[29]. Mercury exposure in the long term results in health problems for humans, especially those exposed to mercury-contaminated environmental conditions [30,31]. Mercury poisoning in people living around mining areas is usually chronic. The toxic effects of mercury depend on mercury, the route it enters the body, and the length of time it develops.

4. Conclusion

Identification results show that most of the Urine of the Community In the Traditional Gold Processing Location contains Mercury.

of the 75 urine samples analyzed, there were 36 urine samples containing mercury that exceeded the predetermined threshold (7 g/L), while 39 urine samples contained mercury levels below the threshold.

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