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EVALUATION OF BLOOD MERCURY LEVELS AND CREATININ LEVELS IN INDONESIAN TRADITIONAL GOLD MINERS IN CENTRAL JAVA

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ABSTRACT
Based on the world gold council data in 2024, Indonesia is the eighth largest gold producing country in the world. More than 200 gold mining locations spread throughout Indonesia, but gold mining processes in Indonesia especially in Central Java are still carried out traditionally. The importance of this research is that traditional gold mining can lead to health issues such as mercury poisoning and impaired kidney function wich is characterized by the increased of creatinine levels Purpose : to evaluate the blood mercury levels and creatinine levels in Indonesian traditional gold miners in Central Java. Methods : This research uses a cross-sectional analitycal method. The number of samples in this research was 20 gold miners as respondents using a quota sampling technique. Data on blood mercury level results were obtained by examining blood mercury levels with a mercury analyzer and creatinine levels were obtained by examining serum creatinine with a photometer. The spearman's rho test is used to test the correlation between blood mercury and creatinine levels. Results : As many as 19 out of 20 respondents had mercury levels of more than 20 µg/L, exceeding the threshold set by NCBI but they all had creatinine levels that were still within normal limits according to the NCBI limits wich is less than 1,2 mg/dL. The results of the Pearson correlation test obtained a sig. value (2 tailed) 0,962 where it can be concluded that there is no correlation between blood mercury levels and creatinine levels in.

Keywords: blood mercury; creatinine; gold miners

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INTRODUCTION

Gold mining in Indonesia has started sice the 19th Century. There are more than 2000 gold mines spread throughout Indonesia. Most of small scale gold miners still use traditional methods. One of the small scale gold mines that still uses traditional methods is gold mining in Central Java, Indonesia. Gold miners in this village still use the amalgamation process to purify gold ore. Currently, the amalgamation process has been banned by the government because the mercury waste produced is dangerous for gold miners and the environment. This prohibition is outlined in the Minamata Convention on October 10th 2013 and enforced on August 16th 2017.(Diaz et al., 2020). The main purpose of this convention is to reduce the use of mercury in various industries and processes, and to manage mercury waste in a safer way, but the reality is that there are still many who use the amalgamation process. The use of ion exchange resins such as thiosulfate, thiourea and glicyne is actually more recommended because they have a low level of toxicity (Li et al., 2023). These leaching reagents still have many weaknesses, such as unit consumption is still high, gold recovery is still low, and the

gold recovery process from leaching reagents is still difficult. Therefore, the amalgamation process is still the main choice for gold miners in the gold leaching refining process.

There are four stages of the gold ore free milling process including crushing, milling leaching and recovery. After the gold ore is crushed, gold particles are liberated by milling with a ball mill and sag mill, in general the gold ore is crushed to P80 700 mesh or 74 µm. After that, gold mud will form and this is when the amalgamation process takes place, the gold mud will be mixed with mercury and water as a medium. or this process can be carried out using a flotation process or a chemical process such as cyanidation (this also a very toxic reagent). In this process, mining workers squeeze the gold and mercury amalgam mud using a cloth filter directly by hand to separate some of the mercury from the amalgam. In this process, mercury is directly exposed to mining workers. To purify gold, amalgam is burned at temperatures up to 800 ºC in order to evaporate the mercury. The boiling point of gold is around 2.856 ºC (Santos-Munguía et al., 2019) while mercury has a much lower boiling point than gold, the boiling point of mercury is around 356,7 ºC.(Handschuh-Wang et al., 2022) This allows mercury to evaporate before gold. This mercury vapor is very dangerous when inhaled by gold miners.

Mercury is found in nature in various forms: organic, inorganic and elemental. The level of health effect posed by mercury is determined by its form.(Ye et al., 2016). The respiratory tract is the main route for mercury in organic form, most of which can enter and be adsorbed through the respiratory system. Mercury can also be adsorbed in small portions (3-4%) through the skin or absorbed via the oral route and also absorbed by 2-10%. Meanwhile, mercury in inorganic form, when it enters the body, cannot penetrate the blood-brain barrier but it will accumulate in the kidneys. Organic mercury in the form of Methylmercury, which in nature is very easily found in the form of monomethyl mercury and dimethylmercury, is easily absorbed by the human body. Approximately 80 to 95% of this organic form of methyl mercury is absorbed through the digestive and respiratory tract, causing very bad toxic effects on the human body. When methylmercury enters the body, 90% will be excreted in the feces through bile, and no more than 10 % excreted in urine. Once mercury is in the human body, it will circulate throughout the body in only approximately 30 hours.

absorbed is distributed throughout the tissues within 30 hours. Mercury in the human body has a fairly long half-life, ranging from 45 days to 75 days. This causes metal and organic mercury to have sufficient time to enter the blood-brain barrier. For mothers who are pregnant, mercury can enter the fetus's body through the placenta, while for mothers who are breastfeeding, mercury can enter the baby's body through breast milk. According to the National Centers of Biotechnology Information (NCBI), a person is said to have been poisoned by mercury if a mercury level of more than 20µg/L is found in their blood.(Ye et al., 2016). Various symptoms of mercury poisoning can arise depending on the intensity, duration of exposure and also the form of mercury (organic, inorganic or elemental mercury) that is the source of the toxicant. Mercury poisoning can cause proteinuria (excess protein in the urine) (Andita & Wimpy, 2023). This proteinuria will lead to chronic kidney disease (Jalili et al., 2021). Apart from that, mercury poisoning can damage the nervous system, impaired muscle coordination, impaired balance, seizures, speech and hearing problems.(Ganguly et al., 2022). In the respiratory system, mercury causes coughing, shortness of breath, and chest pain. When mercury enters the digestive tract, it causes problems with symptoms of vomiting, nausea, stomach pain and decreased appetite. Exposure to these toxicants in the skin can cause the skin to become red and hyperpigmented (Wimpy et al., 2023).The ignorance of community members, especially traditional gold miners, regarding the dangers of exposure to mercury

has resulted in very high cases of mercury poisoning in metal processing. This is the main reason researchers conducted this research, to evaluate to evaluate the blood mercury levels and creatinine levels in Indonesian traditional gold miners in Central Java.

METHOD

Cross sectional is the analytical research method used in this research. Quota sampling is the sampling method used and is in accordance with the needs and conditions of the research. A total of 20 gold miner were selected as respondents. After agreeing to informed consent, the respondents' blood was taken for laboratory examination. Blood mercury examination is carried out using a mercury analyzer using the principle of atomic absorption spectrophotometry. Examination of mercury levels begins with a blood sample destruction process where 5 mL of blood sample is placed in a test tube and then added with 5 mL of HNO3 (conc.) as an organic compound destructor which is then assisted by heating using a water bath. This process is carried out until the yellow vapor disappears. The next step is to add 3 mL of H2O2 (conc.) as an oxidizer to remove residual organic compounds. Then heating is continued until the sample solution becomes clear. The next process is making a mercury stock solution with a concentration of 1000 µg/dL which is then diluted to 100 µg/dL. From the mother liquor, a series of standard solutions, namely 1, 10, 30, 50, 70, 100 and 120 µg/dL, were made. Then the standard solution was put into a test tube and added 0,1 mL KMn04; 0,1 mL hydroxyl-aminehydrochloride; 0.5 mL SnCl2O was mixed. Then read the absorbance of the solution using a mercury laboratory analyzer LA254 series at 257,3 nm. Sample from the previous destruction was put into a test tube and added 0,1 mL KMn04; 0,1 mL hydroxyl-aminehydrochloride; 0.5 mL SnCl2O was mixed. Then the mercury levels are measured using a mercury laboratory analyzer LA254 series at 257,3 nm. The results of mercury levels in the blood are measured in µg/dL. According to National Centers for Biotechnology Information (NCBI), adult men's blood mercury levels are less than 20 µg/L(Ye et al., 2016). Serum creatinine levels were checked with a photometer using the Jaffe reaction. The principle of this instrument is that creatinine will react with a picrate solution in an alkaline environment to form a yellow-orange complex. This color complex was measured with a photometer microlab 300 at a wavelength of 510 nm. The results of serum creatinine levels are measured in mg/dL. According to NCBI, creatinine levels in adult male serum are in the range of 0,6 to 1,2 mg/dL (Walker et al., 1990).

RESULTS

The following are the results of examining blood mercury levels using a LA254 mercury laboratory analyzer and creatinine levels using a Microlab 300 photometer from a total of 20 respondents.

From the data in table 1, it is known that 19 out of 20 respondents had blood mercury levels that exceeded 20 µg/L, where these levels exceed the threshold according to the National Center for Biotechnology Information (NCBI) (Ye et al., 2016). All respondents had creatinine levels that were still within normal limits according to NCBI. All This data was then analyzed descriptively using the SPSS program. The following analysis results are presented in table 2.

Table 1.
Blood mercury and creatinine serum froom 20 respondents

Sampel Code	Blood mercury levels (µg/L)	Creatinine Levels (mg/dL)
C1	3,129	0,89
C2	69,2475*	0,75
C3	17,3355*	0,64
C4	24,024*	0,56
C5	17,3775*	0,64
C6	25,1265*	0,67
C7	32,7285*	0,76
C8	53,844*	0,75
C9	21,0525*	0,92
C10	50,925*	0,73
C11	20,244*	0,79
C12	30,366*	1,08
C13	20,8635*	0,95
C14	61,6665*	0,73
C15	87,423*	0,66
C16	42,042*	1,14
C17	81,2595*	0,71
C18	67,9875*	1,02
C19	83,496*	0,71
C20	105,357*	0,85

***** blood mercury levels exceed the threshold according to NCBI

Table 2.
Descriptive data table

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Blood_mercury	20	3,13	105,36	45,7331	6,48598	29,00617
Creatinine	20	,56	1,14	,7975	,03509	,15691
Valid N (listwise)	20					

Table 2 it can be seen that the standard error (6,48598) has a value smaller than the standard deviation (29,00617), this means that the sample estimate is close to the population parameter. So it can be concluded that this research data is suitable for use as primary data. Standard error is used as a parameter to measure the accuracy of the sample in representing the population so that a smaller standard error means that the level of accuracy of the research data is getting better. Standard deviation describes the extent to which individual respondent data deviates from the sample or population average (Wan et al., 2014). The standard deviation value (29,00617) is smaller than the mean (45,7331), it can be concluded that the variable data in this study is homogeneous. After that, the data was tested to find out whether the sample came from a normally distributed population or not. The Shapiro Wilk test is used to determine this as presented in table 3.

Table 3.
Normality test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Blood_mercury	,173	20	,119	,928	20	,143
Creatinine	,194	20	,046	,930	20	,156
a. Lilliefors Significance Correction						

Table 3 it is known that the significance value is more than 0,05, which indicates that the sample comes from a normally distributed population. Because the two variables, wich are blood mercury levels as independent variable and creatinine as dependent variable are numerical data and are supported by normal data distribution, the Pearson correlation test was chosen as a parametric test to determine the correlation between the two variables The results of the Pearson correlation test are presented in table 4.

Table 4.
Pearson Correlations

		Blood_mercury	Creatinine
Blood_mercury	Pearson Correlation	1	-,068
	Sig. (2-tailed)		,775
	N	20	20
Creatinine	Pearson Correlation	-,068	1
	Sig. (2-tailed)	,775	
	N	20	20

Table 4, the sig value is obtained. 2 tailed 0,775. This value is more than 0,05 which means that there is no significant correlation between mercury levels in the blood and creatinine levels of gold mining workers. From this table, a negative correlation value (-0,068) is also obtained, which means that creatinine levels are lower when blood mercury levels are higher.

DISCUSSION

Many factors caused high levels of mercury in the 19 respondents. None of the 19 respondents used proportional personal protective equipment. Mercury exposure occurs when gold miners squeeze amalgam mud using filter cloth. This process is carried out with bare hands without using hand protection. This process is considered cheaper and does not require sophisticated and expensive equipment(Surya & Qurthuby, 2022). Apart from that, gold miners are also exposed to mercury through the process of heating amalgam to purify gold. This mercury vapor is inhaled by gold miners who do not wear masks. Mercury vapor is cololess dan odorless, so without realizing it, the mercury vapor accumulates in the human body . Apart from that, the mercury waste that comes from washing the amalgam does not go through a waste processing process. This mercury will accumulate in nature and pollute the environment (Mus et al., 2024). Most residents definitely have traditional gold mining in their backyard. This mining location is very close to a pump well which is used for bathing, washing and toilet purposes. Mercury contamination will also seep into groundwater, it will be consumed by local residents.

Lack of awareness among traditional gold miners can pose various health risks. One of them is impaired kidney function. mercury in the body will induce HEK-293 T cell toxicity which disrupts mitochondrial function which is responsible for energy production. Apart from that, HEK-293 T cell toxicity can also trigger oxidative stress which produces reactive oxygen species (ROS) in cells. ROS are highly reactive molecules and can damage the structure of kidney cells (Han et al., 2022). The results of serum creatinine examination in 20 respondents were still within the normal range, although there were results that were close to the threshold, namely sample codes C12, C16 and C18. Normal results are because the impact of mercury exposure is accumulative and depends on the size of the exposure dose. Even though the respondents were examined, they did not show significant health problems, but it is important to remember that mercury that accumulates in the body for years will definitely cause health impacts.(Beckers & Rinklebe, 2017) Traditional gold miners are expected to be able to anticipate this by reducing the risk of exposure to mercury by using personal protective equipment such as masks, gloves, boots and aprons. Personal and public hygiene also needs to be improved and maintained consistently. It would also be better if mercury waste was not

thrown directly into nature, because it can pollute the environment and ecosystem (Singh & Singh, 2017). This research requires further study regarding the long-term health impacts of mercury poisoning on gold miners.

CONCLUSION

The conclusion that can be drawn from this study is that 19 of the total 20 respondents with sample codes C2 to C20 were in a condition of mercury poisoning where the blood mercury level was more than 20 µg/dL. A total of 20 respondents had normal creatinine levels, namely less than 1,2 mg/dL. From the results of the correlation test with the Pearson test, unsignificant correlation was found between blood mercury levels and gold miners' creatinine levels.

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