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Demographic Profile and Illness Symptoms of Artisanal Gold Miners in Ujung Padang Rasian Health Center Area, South Aceh

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ABSTRACT

This study aims to analyze the relationship between demographic characteristics and clinical symptoms experienced by artisanal gold mine workers due to mercury exposure at the UPTD Rasian Ujung Padang Community Health Center Work Area, South Aceh District, Aceh Province. A quantitative descriptive design with a cross-sectional survey approach was employed. The results showed that the most commonly reported chronic toxicity symptoms were headaches (34 respondents), coughing and pain during urination (24 respondents), pelvic pain (23 respondents), and nausea (22 respondents). Regarding acute toxicity symptoms, the majority of respondents experienced muscle cramps (17 respondents), headaches (16 respondents), irritability (3 respondents), and insomnia (2 respondents). Correlation tests indicated that gender was not significantly associated with disease symptoms (p-value = 0.66 > 0.05), while age (p-value = 0.00 < 0.05), education level (p-value = 0.00 < 0.05), and length of employment (p-value = 0.01 < 0.05) showed significant associations. In conclusion, age, education level, and length of employment were significantly associated with the clinical symptoms experienced by artisanal gold mine workers.

Keywords: Workers, Gold Processing, Amalgamation, Toxicity

INTRODUCTION

Artisanal and Small-Scale Gold Mining (ASGM) employs approximately 10 to 15 million people across more than 70 countries, including Indonesia. However, it is also the largest source of global mercury emissions that accounts for roughly 37% of the annual total, which exceeds 2,000 tons (Geyman et al., 2024). Mercury exposure from ASGM activities poses not only environmental threats but also severe public health risks, contributing to an estimated global IQ decline of 580,000 points and approximately 1,430 deaths annually, with associated economic losses exceeding USD 7.1 billion per year (Pang et al., 2022). In Indonesia, mercury use in traditional gold mining is estimated at 195 tons annually, positioning the country among the highest emitters of mercury worldwide (Meutia et al., 2022). This underscores that ASGM is not merely an environmental concern but a pressing public health crisis.

The sector remains a significant contributor to health issues in Indonesia, primarily due to the unregulated use of mercury, which has profound implications for both human health and the environment. Recent studies reveal alarming levels of mercury exposure in Indonesian ASGM sites, posing high risks to local communities (Meutia et al., 2023).

Mercury exerts toxic effects particularly on the nervous and respiratory systems. Evidence from Colombia shows that ASGM workers exhibit blood mercury concentrations far exceeding safe thresholds, with potential neurological and respiratory consequences (Vergara-Murillo et al., 2022). Similar findings have been reported in Indonesia, where ambient mercury levels around mining areas surpass national safety standards, heightening health risks for nearby populations (Nakazawa et al., 2021).

Mercury exposure occurs through inhalation, skin contact, and consumption of contaminated fish or aquatic products. (Makahenggang et al., 2022) Organic mercury compounds, capable of crossing cellular membranes, bioaccumulate in freshwater fish at highly toxic levels (Hertika & Putra, 2019). This poses a significant risk in the food chain, as heavy metals, including mercury, inevitably reach humans via dietary intake. In contaminated industrial or mining areas, individuals may inhale mercury

vapor, which is absorbed through the lungs into the bloodstream and distributed to organs like the kidneys, liver, and brain. Direct skin contact with mercury or its compounds also facilitates absorption, although less effectively than inhalation or ingestion (Indah & Norsita Agustina, 2020). Excessive mercury exposure beyond tolerable limits can lead to poisoning (Lensoni, Nurdin, 2023).

Prolonged mercury exposure can lead to various health issues, including neurological disorders, immune system problems, kidney damage, and risks to fetal development during pregnancy (Nuraini et al., 2023). Neurological disorders are categorized into acute and chronic conditions. Acute symptoms include headaches, hearing loss, and loss of smell, somatosensory disturbances, dysarthria, and occasional emotional instability. Chronic conditions involve tremors, cerebral ataxia, numbness in the lips, hands, and fingers, memory loss, somatosensory disturbances, visual impairments, and insomnia (Kamil & Karma, 2022). Mercury exposure can also result in brain damage, cerebral palsy, motor nerve disorders, and mental retardation. Gold miners and workers in mineral processing industries frequently encounter mercury exposure, adversely affecting their health. In children, mercury exposure can lead to behavioral and cognitive disorders. (Nuraini et al., 2023) In men, particularly with exposure to inorganic mercury, it can cause impotence and reduced libido, while in women, it may disrupt menstrual cycles (Hidayat, 2020).

Observations in the Rasian Ujung Padang Community Health Center area, South Aceh, suggest that artisanal gold mining practices likely involve the use of mercury without adequate control measures. However, data on the demographic profiles and disease symptoms experienced by miners in this region remain limited. This gap highlights the need for focused attention to identify the miners' demographic characteristics and the health symptoms they exhibit, as a basis for formulating occupational and environmental health interventions.

In light of this context, the present study aims to: (1) identify the demographic profile of artisanal gold miners in the Rasian Ujung Padang area; (2) analyze the disease symptoms reported by miners; and (3) assess the potential association between mercury exposure and the observed health symptoms among artisanal miners.

METHODS

Research design

This study employed a quantitative method with a survey approach to identify and describe the demographic profile and disease symptoms experienced by artisanal gold miners. The study protocol received ethical approval from the Research Ethics Commission of Sari Mulia University, Banjarmasin, under letter No. 076/KEP-UNISM/IX/2023, dated September 9, 2023.

Location and Time

The research was conducted in the working area of the Rasian Ujung Padang Community Health Center, South Aceh Regency, a region known for its active Artisanal and Small-Scale Gold Mining (ASGM) activities. The data collection took place from October to December 2023.

Population and Sample

The study population included all artisanal gold miners operating within the Rasian Ujung Padang Community Health Center's working area. Due to the relatively small and accessible population size, total sampling was employed, resulting in 39 respondents. Inclusion criteria for participants were: (1) actively working as miners during the study period, (2) able to communicate effectively, and (3) willing to participate by signing an informed consent form.

Research instruments

The structured questionnaire used in this study was adopted from Sofia & Sugiharto, (2016) and has received direct approval from the author. All respondents were given informed consent before being interviewed. Information collected in the questionnaire includes personal identity, type of work, length of work, and symptoms of acute and chronic toxicity. Symptoms of the disease in this study are grouped into symptoms of acute toxicity and symptoms of chronic toxicity (Sofia & Sugiharto, 2016).

Data Analysis

The relationship between demographic profile and toxicity symptoms, calculated by Chi-Square test. Significance was set at α = 0,05. The analysis was done using SPSS 25.

RESULTS AND DISCUSSION

Respondents' Characteristics

Respondents' characteristics are categorized based on gender, age, education, and length of work.

Table 1.
Respondents' Characteristics

No	Criteria		f
1	Gender		
	1	Male	36
	2	Female	3
2	Age		
	1	12-16	1
	2	17-25	5
	3	26-35	9
	4	36-45	9
	5	46-55	9
	6	56-65	3
	7	>65	3
3	Education Level		
	1	Elementary School	16
	2	Junior High School	11
	3	Senior High School	10
	4		2
4	Years of Service		
	1	< 5 years	26
	2	5-10 years	9
	3	11-15 years	4

Table 1 illustrates the gender distribution of the respondents, with 36 participants (92.3%) being male and 3 participants (7.7%) being female. The age distribution

indicates that 9 respondents (23.1%) fell within each of the age categories of 26-35 years, 36-45 years, and 46-55 years. Five respondents (12.8%) were aged 17-25 years, while 3 respondents (7.7%) each were in the age groups of 56-65 years and above 65 years. Additionally, 1 respondent (2.6%) was aged 12-16 years. The educational background of the respondents shows that 16 participants (41%) had completed elementary school, 11 participants (28.2%) had a junior high school education, and 10 participants (25.6%) had finished senior high school. Only 2 participants (5.1%) had attained a bachelor's degree. Regarding work duration, 26 respondents (66.7%) had been employed for less than 5 years, while 9 respondents (23.1%) reported a work history of 5-10 years. Four respondents (10.3%) had worked for 11-15 years.

Description of Disease Symptoms Among Miners

In this study, disease symptoms experienced by workers at the traditional gold processing site were identified, including both acute and chronic medical symptoms. The results of the identification of acute disease symptoms experienced by the workers are shown in Figure 1.

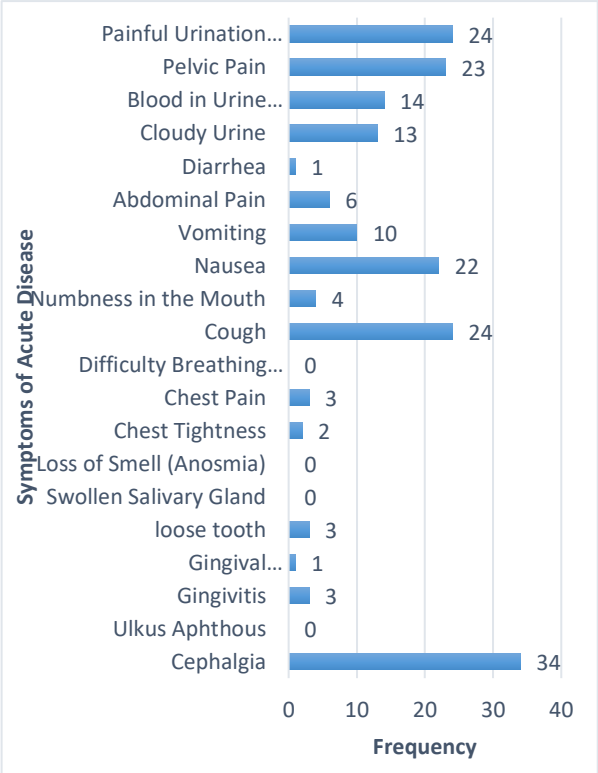

Figure 1. Chronic Toxicity Symptoms

Figure 1 highlights the chronic toxicity symptoms experienced by the workers. The most common symptom reported was headaches, affecting 34 respondents. Other prevalent symptoms included coughing and painful urination, each experienced by 24 respondents, followed by pelvic pain reported by 23 respondents and nausea by 22 respondents.

The findings indicated that the majority of miners experienced symptoms associated with the central nervous, respiratory, and urinary systems. Headaches were among the most frequently reported neurological symptoms, commonly linked to mercury exposure, particularly through inhalation of elemental mercury vapor during the amalgam burning process (Suhelmi et al., 2020). Cough and other respiratory issues were also prevalent, likely resulting from inhalation of mercury vapor, which can irritate the respiratory tract and damage lung tissue (Nakazawa et al., 2021). Pain during urination and pelvic discomfort may signal urinary system disorders, such as nephropathy or kidney damage—well-documented toxic effects of mercury exposure (Ekawanti & Krisnayanti, 2015).

A similar study in Makassar, Indonesia, found that 63% of 44 artisanal gold workers experienced neurological problems, including tremors and abnormal knee reflexes, which correlated with elevated mercury levels in urine (Suhelmi et al., 2020). In Colombia, research involving 238 small-scale gold miners revealed that 55% had mercury levels in their hair exceeding the U.S. EPA threshold, with those directly involved in amalgam burning exhibiting mercury levels 6 to 8 times higher than other workers (Calao-Ramos et al., 2021).

In Indonesia, Nakazawa et al., (2021)'s study across three small-scale mining sites reported airborne mercury concentrations ranging from 100 to 14,000 ng/m³ near milling drums—levels far exceeding safety thresholds and posing serious health risks due to inhalation. These findings align with the results from South Aceh, which demonstrate that mercury exposure in small-scale gold mining activities significantly impacts workers' health.

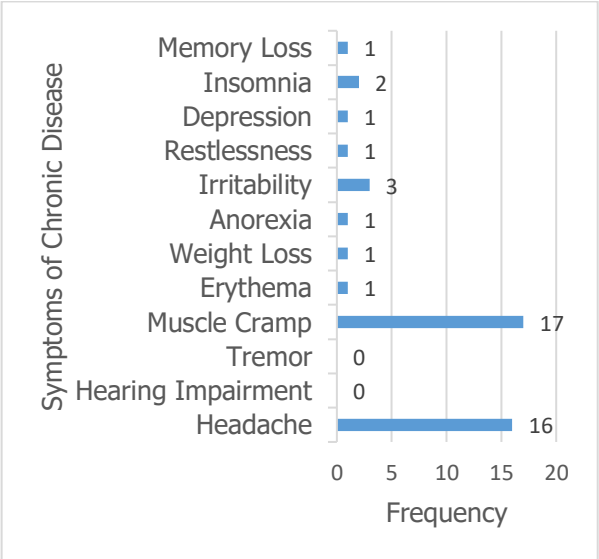

Figure 2. Acute Toxicity Symptoms

Figure 2 illustrates acute toxicity symptoms, including somatosensory disturbances. Muscle cramps were the most frequently reported symptom, affecting 17 respondents. Headaches were reported by 16 respondents, while irritability and difficulty sleeping were experienced by 3 and 2 respondents, respectively. These symptoms suggest impairments in both the central and peripheral nervous systems that may be associated with mercury exposure—particularly from elemental mercury

vapor, which is commonly released during the amalgam burning process.

Inhaled elemental mercury can cross the blood–brain barrier, leading to acute neurotoxic effects such as tremors, muscle cramps, and cognitive or emotional disturbances (Park & Zheng, 2012). Muscle cramps and headaches are frequently observed as consequences of peripheral neuronal dysfunction and neurotransmitter imbalances, which are thought to result from oxidative stress triggered by mercury accumulation (Tomicic et al., 2011). Sleep disturbances and irritability may indicate involvement of the limbic system, which regulates emotional responses and sleep patterns, and can be disrupted by the neuropsychological effects of mercury exposure (Murata et al., 2004).

Similar symptoms headaches, tremors, and insomnia were also reported in a previous study on small-scale gold miners, highlighting the short-term neurological consequences of mercury exposure (Abbas et al., (2017)). In the Philippines, research conducted among traditional mining communities found that irritability and sleep disorders were significantly more prevalent among mercury-exposed individuals compared to control groups (Santos-Lima et al., 2020).

The symptoms reported in this study further reinforce the evidence that artisanal gold mining, when conducted without adequate safety controls, poses a heightened risk of acute mercury exposure with direct impacts on neurological health and psychological well-being.

Correlation Test

The correlation test aimed to determine whether there is a significant relationship between respondent characteristics and the toxicity symptoms experienced by workers. Table 2 shows that the chi-square test result was 0.6, with a p-value > 0.05.

Table 2.
Correlation of Gender and Symptoms

Category	Symptoms						Total		*P-Value*
	Low		Moderate		High				
	f	%	f	%	f	%	f	%	
Male	34	94.2	2	5.6	0	0	36	100	
Female	3	100	0	0	0	0	3	100	0.66
Total	37	94.9	2	5.1	0	0	39	100	

Chi-square test results indicate that gender was not significantly associated with the reported symptoms, as evidenced by a p-value greater than 0.05. This suggests that both male and female miners engaged in gold mining activities have a relatively equal likelihood of experiencing toxicity symptoms related to mercury exposure. These findings are consistent with those reported by Tomicic et al., (2011), who noted that the risk of mercury exposure is more strongly influenced by the intensity and duration of exposure rather than by gender.

Table 3.
Correlation between Age and Symptoms

Category	Symptoms						Total		*P-Value*
	Low		Moderate		High				
	f	%	f	%	f	%	f	%	
12-16 years	1	100	0	0	0	0	1	100	
17-25 years	5	100	0	0	0	0	5	100	
26-35 years	9	100	0	0	0	0	9	100	
36-45 years	8	100	0	0	0	0	8	100	
46-55 years	9	88.9	1	11.1	0	0	10	100	0.00
56-65 years	2	66.7	1	33.3	0	0	3	100	
> 65 years	3	100	0	0	0	0	3	100	
Total	37	94.9	2	5.1	0	0	39	100	

Tabel 3 showed the chi-square test for the age variable yield a p-value of 0.00 ($p < 0.05$), indicating a statistically significant association between miners' age and the toxicity symptoms experienced. This suggests that age influences susceptibility to the health impacts of mercury exposure. Older workers were more likely to exhibit a greater number or severity of toxicity symptoms, which may be attributed to age-related declines in the body's detoxification capacity and the cumulative effect of long-term mercury exposure (Park & Zheng, 2012).

A study conducted in Tanzania (Bose-O'Reilly et al., (2016)) similarly found that older artisanal gold miners were more prone to developing neurological symptoms from mercury exposure compared to their younger counterparts. This phenomenon highlights the need for age-sensitive health interventions and regular monitoring of miners with prolonged exposure histories. Accordingly, these findings underscore the importance of incorporating age as a key consideration in health risk mitigation programs for artisanal miners, particularly in the design of occupational health interventions and routine medical examinations.

In the education category, the p-value was 0.00 ($p < 0.05$), indicating a significant correlation between education level and the symptoms experienced by workers (table 4).

These results indicate that lower educational level is associated with a higher likelihood of experiencing symptoms related to mercury exposure during mining activities. This is likely due to limited knowledge and awareness regarding the dangers of mercury, the use of personal protective equipment (PPE), and the implementation of safe work practices among individuals with lower levels of education (Jensen et al., 2021).

Table 4.
Correlation between Education level and Symptoms

Category	Symptoms						Total		*P-Value*
	Low		Moderate		High				
	f	%	f	%	F	%	f	%	
Elementary School	14	87.5	2	12.5	0	0	16	100	0.00
Junior High School	11	100	0	0	0	0	11	100	
Senior High School	10	100	0	0	0	0	10	100	
Bachelor's degree	2	100	0	0	0	0	2	100	
Total	37	94.9	2	5.1	0	0	39	100	

Workers with higher educational backgrounds tend to have better access to information and a deeper understanding of safe mining practices and the health risks posed by hazardous chemicals. This finding aligns with previous research by Adotey et al., (2025), which demonstrated that education plays a critical role in shaping preventive behaviors among workers exposed to toxic substances in the informal mining sector.

The implications of these findings underscore the role of education as a protective factor in the context of artisanal gold mining. Therefore, occupational health interventions and safety training programs in this region should be tailored to the educational background of the workers and delivered using communication strategies that are accessible and easily understood by those with limited formal education.

In the work duration category, the p-value was 0.01 ($p < 0.05$), indicating a significant correlation between the length of work and the symptoms experienced by workers.

Table 5.
Correlation between years of service and symptoms

Category	Symptoms						Total		*P-Value*
	Low		Moderate		High				
	f	%	f	%	f	%	f	%	
1-5 years	25	96.2	1	3.8	0	0	26	100	0.01
6-10 years	9	100	0	0	0	0	9	100	
11-15 years	3	75	1	25	0	0	4	100	
Total	37	94.9	2	5.1	0	0	39	100	

The test results revealed a significant correlation between the duration of employment and the toxicity symptoms experienced by artisanal gold miners. These findings suggest that the longer an individual is involved in mining activities, the greater the likelihood of developing health issues due to chronic exposure to hazardous substances such as mercury. This aligns with the concept of bioaccumulation, wherein prolonged and continuous mercury exposure can lead to the accumulation of heavy metals in the body, thereby increasing the risk of toxic effects—particularly on the nervous system, kidneys, and respiratory tract (Taux et al., 2022).

Several previous studies support this finding, noting that miners with more than five years of experience are more likely to experience neurological symptoms and kidney disorders (Ijaz et al., 2024). This strengthens the argument that duration of exposure is a critical determinant of health outcomes in mining activities, especially when not accompanied by proper use of personal protective equipment and adherence to safe working procedures (Tubis et al., 2020).

Therefore, occupational health interventions and monitoring efforts should prioritize miners with longer work histories. Regular medical check-ups, continuous education, and comprehensive mercury exposure mitigation efforts are essential to prevent long-term health impacts.

CONCLUSIONS

This study revealed that the majority of artisanal gold miners in the working area of Puskesmas Rasian Ujung Padang, South Aceh, exhibited various toxicity symptoms indicative of both acute and chronic mercury exposure. Predominant symptoms such as headaches, muscle pain, coughing, and urinary disturbances reflect tangible health impacts resulting from mining activities conducted without adherence to occupational safety standards. The findings highlight that being of productive age, having a low level of education, and working in mining for extended periods are significant factors associated with an increased risk of mercury-related toxicity symptoms. The practical implications underscore the urgent need for public health interventions, including education on the dangers of mercury, improved access to personal protective equipment (PPE), and training in safe mining practices. Local governments and health authorities must also conduct routine health monitoring of miners to facilitate early detection and management of health effects. Furthermore, strict regulation of illegal mining practices must be complemented by community-based approaches to ensure that proposed solutions are both contextually relevant and sustainable.

RECOMMENDATION

Further research should be conducted to assess the mercury exposure levels among gold miners.

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