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Hair Mercury Exposure and Hypertension among Community Artisanal and Small Scale Gold Mining in Banten, Indonesia

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Abstract

Background: Mercury was a heavy metal that persistent in the environment and harmful to human health and still used by Artisanal Small Scale Gold Mining (ASGM), especially in Indonesia. Cimanggu was one of ASGM in Banten province who still active using mercury and had found high levels of mercury that exceed the threshold in wastewater and human hair. Mercury exposure can affect human health, such as hypertension. This research aimed to determine the levels of hair mercury, hypertension, and individual characteristics such as age, sex, and smoking habits. And also determine the association between hair mercury with hypertension among communities in ASGM.

Material and Method: Design studies in this research using cross-sectional design. The data from BBTKLPP Jakarta datasheet "Analysis of Potential Impact of Risk Factors Environment Based for Disease Outbreaks on Interest Mining Society". Retrieved data was hair mercury that analyzed in the laboratory BBTKLPP Jakarta using Mercury Analyzer (MA) 3000 with cold pavor method and blood pressure were measured directly two times using sphygmomanometer merk ABN and individual characteristics taken through a questionnaire. Totaling 100 samples analyzed were taken by quota sampling. Findings: Univariate test showed that most of the respondents had abnormally hair mercury levels (55%), hypertension 29%, woman 78%, smoking 23%, and > 40 years 46%. Chi-square test showed no significant association between hair mercury levels and hypertension (P value=1, OR= 1.01, 95% CI = 0.42-2.40).

Conclusion: Respondents who had normal or abnormally hair mercury levels had the same odds to have hypertension risk. Further research is needed by using a larger sample with high-intensity process mercury use to clarify the association of hair mercury levels with hypertension.

Keywords: *Mercury; hypertension; Artisanal and Small Scale Gold Mining (ASGM).*

Introduction

Mercury emissions in the environment can from human activities such as fossil fuels burning, solid waste burning, and Artisanal Small Scale Gold Mining (ASGM)[(1)]. In the ASGM, mercury used to extract gold from the seeds by forming an amalgam. The widespread of mercury use in ASGM because simple to use, can be done individually, and relatively quick to separate the gold. Globally around 15 million people, including 3 million women and children participate in ASGM in 70 countries[(2)]. Based on the survey results consisting of 800 ASGM in Indonesia with estimated 250,000 miners and 1 million, whereas women and children[(3)]. ASGM had an increase in Indonesia. It's in line with many studies have shown that mercury pollution has occurred the sea, sediments, water wells, fishes, plants, and communities have an impact on public health[(4–6)]. Such as Hartono research which found mercury exposure in fish in Buyat Bay and Teluk Ratotok which has improved health for people who consume air from the Ratotok River Estuary,

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Buyat River Hulu, and clean water/drinking water storage PT. Newmont Minahasa Raya[7]. The results of a study conducted in ASGM Gorontalo showed that the concentration of hair mercury respondents had exceeded the established standard of 2 with an average concentration of hair mercury in 5.0480 ppm[8].

ASGM donate 37% of mercury emissions in air and water. Mercury vapor present in the air around ASGM always high and the mercury pollution in water almost exceeds the quality standards by WHO. Continuously exposure can affect the central nervous system, the reproductive system and the cardiovascular system[2].

The last few years, the impact of mercury on the cardiovascular system, especially hypertension has become a concern. Hypertension has been proved as a major risk factor for cardiovascular disease triggers. The incidence of hypertension has increased for the last three decades. Besides food consumption which high salt intake and obesity, exposure to mercury in the environment also one important factor driving the incidence of hypertension. Epidemiological and experimental studies showed association between mercury exposure and increased blood pressure. Chronic mercury exposure levels in humans can be determined by examining the hair biomarker are considered most suitable for chronic exposure, easy to collected, and non-invasive[9]. Several studies in the world showed an association between mercury exposure to increased blood pressure among the gold miners who use mercury were found significant increased sistolee blood pressure ($P < 0.01$) correlated with lipid peroxidation and oxidative stress ($P < 0.01$)[10]. A case-control study showed the incidence of gold miners who have hypertension 46% greater than the control group. Other studies showed that a significant correlation between hair mercury levels with hypertension[11].A study of 251 people in the Brazilian Amazon showed that blood pressure was associated with higher levels of total mercury in the hair where an increased in blood pressure sistolee along with the increased amount of mercury in the hair of <10 lg/g[12]. In Indonesia research about association between hair mercury exposure with hypertension is still not received attention by researchers.

This research aims to determine the levels of hair mercury, blood pressure as well as individual factor characteristics (age, sex, and smoking habits) and determine the association between hair mercury with hypertension in communities around ASGM Cimanggu, Pandeglang, Banten Province. Cimanggu was an area of the ASGM who around a residential area that still used mercury to gold processing and has operated for approximately eight years. Balai Besar Teknik Kesehatan Lingkungandan Pengendalian Penyakit (BBTKLPP) Jakarta in 2017 had found mercury in wastewater in the processing of gold and mercury hair on people living around ASGM above the predetermined quality standards[13]. If it continuously happened could have a negative impact on human health one of hypertension disorders due to exposure to mercury.

Material and Method

This study was conducted using a quantitative method with cross-sectional study design and use secondary data derived from datasheet "Analysist of Potential Impact of Risk Factors Environment Based for Disease Outbreaks on Interest Mining Society" conducted by BBTKLPP Jakarta. This research will describe mercury levels in the hair and it's association with hypertension in community living around ASGM, Cimanggu, Pandeglang, Banten.

The population in this study was communities who live around ASGM in Cimanggu with total of 5442 people, the samples in this study were communities who selected based on inclusion criteria among men or women have equal opportunity to participate, length of stay ≥1 year around ASGM, in good health and willing to become respondents signed an informed consent. Calculation of sample size using the formula Lemeshow sought, in order to obtain a maximum sample is 100 sample. Sampling was conducted using quota sampling.

This study will use Univariate analysist to describe Hair mercury level, blood pressure, and individual characterictics respondents, and bivariate analysist used a chi square test to show association between hair mercury with hypertension. Hair mercury analyzed in the laboratory BBTKLPP Jakarta using Mercury Analyzer (MA) 3000 with cold pavor method and blood pressure were measured directly two times using sphygmomanometer merk ABN and individual characteristics taken through a questionnaire.

Findings: Based on Table 1 showed that of the 100 respondents who checked his blood pressure, only 29% who have hypertension, that was systolic≥140 or diastolic pressure ≥90[14]. Respondents who had hair mercury levels above the quality standards that have been established by UNEP (2 ppm) is 55%. Individual

characteristics show that respondents >40 years old only 46%, which was man 22%, and smokers only 23%.

Table 1. Distribution of Hair Mercury, Hypertension, and Individual Characteristics Around ASGM in Cimanggu 2018

Variables	Total	Presentation (%)
Hypertension		
No (<140/90)	71	71
Yes (≥140/90)	29	29
Hair Mercury Levels		
Normal (≤ 2ppm)	45	45
Abnormally (> 2ppm)	55	55
Age		
≤ 40 years	54	54
> 40 years	46	46
Gender		
Woman	78	78
Man	22	22
Smoking Status		
Do Not Smoke	77	77
Smoking	23	23

The association showed There is no association between hair mercury levels and hypertension (P value = 1, OR= 1.01, CI 95% = 0.42-2.40). OR = 1.01 that means respondents with abnormally hair mercury level have equal odds to have hypertension with normally hair mercury with 95% confidence interval hair mercury respondents between 0.42-2.40 ppm. Mercury exposure in society was measured using hair as a biomarker because can explain mercury levels long term in the body, hair mercury also quite persistent even not lost when washing with shampoo and coloring, and hair mercury levels 250 times in blood[15]. Hair will be examined using Mercury Analyzer (MA) 3000 and cold vapor method with the results of measuring parts per million (ppm) with quality standards set by UNEP (2 ppm)[16].

The analysis showed most of the respondents have hair mercury level abnormally. Abnormally hair mercury level in ASGM communities related to their exposure to mercury from combustion processes and the separation of gold which exposes humans through intermediary of water, air, and land for a long time, in additionally the hair shaft grows to combine mercury from the blood[17]. This result same with previous studies conducted around ASGM in Krueng Sabee, Aceh, 90.28% of respondents contains mercury levels above the quality standard value 10 μg/g set by the WHO. Fillion found 67.9% of the population living around the Amazon River containing hair mercury levels ≥ 10 mg/g[12].

Hypertension was defined as increasing systolic blood pressure or diastolic after at least 2 times measurement. Hypertension in this study defined as blood pressure that had systole pressure of 140 mmHg or diastolic pressure of 90 mmHg[14].This study showed just a few respondents with hypertension. This result was lower than research conducted by Valera et al. that showed 53.9% of people living around the mining have hypertension[18]. And about 46% of miners in Europe have hypertension[10]. Many factors can lead to hypertension such as age, sex, smoking, obesity, lack of exercise, excessive salt consumption, and stress[19]. And from this research, we can show that most of the respondent had a low risk of hypertension, because most of the respondents were woman, ≤ 40 years and do not smoke.

In this study showed no significant association between hair mercury levels and hypertension with OR = 2.072. It's not in line with Bautista et al. where people with high levels of hair mercury was four times more at risk for hypertension (p value= 0.02)[17]. The same results also proved by Fillion et al. and Valera who reported a positive association between mercury levels and hypertension[12,20]. In recent years there had increased attention to mercury effects on cardiovascular system like atherosclerosis, cardiac arithema, and renal dysfunction[21,22]. The mechanism of mercury affecting blood pressure cannot be explained with certainty, but the accumulation of mercury can affect endothelial function by inhibiting NO synthesis[23]and increasing oxidative stress, lipid peroxidation, and TNFα and interculin[17,24,25]. Increased oxidative stress from lipid peroxidation and decrease in antioxidants can trigger endothelial and renal dysfunction, which can increase the risk of hypertension and atherosclerosis, and result increase in blood pressure and pulse[22,23,25].

The same result with this study showed by Rajaee who cannot found association between mercury levels with blood pressure around communities ASGM[26]. The lack of association between hair mercury levels with hypertension because there had many factors causing hypertension behind mercury contaminants such as age, smoking, obesity, alcohol consumption, high natrium consumption, and low physical activities[27]. Besides that small sample size and low hair mercury levels can effect significance result study. Therefore need further

verification by using a larger sample with high intensity process mercury use. Although statistically there's no association between hair mercury and blood pressure, mercury exposure continuously for a long time can had a negative impact on health, one of them is hypertension, so monitoring of mercury use in ASGM areas should be monitored and conducted routine health monitoring in the community around ASGM.

Conclusion

The study concluded that most of (55%) respondent had abnormally hair mercury level, but only 29% had hypertension with the characteristics age >40 years old 46%, man 22%, and smoking 23%. There's no significant association between hair mercury and hypertension (p value = 1) with OR = 1.01 means respondents with abnormally hair mercury level have equal odds to have hypertension with normally hair mercury.

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Ethical Clearance: The research protocol was approved by the research and community engagement, the ethical committee of public health faculty of the Universitas Indonesia with number of ethics 95/ UN.2.F10/PPM.00.02/2019.

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