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Conference Paper

Glomerulus Filtration Rate (GFR) Estimation Value Using Cockcroft and Gault Equation Against Community Exposure to Mercury at Artisanal and Small Scale Gold Mining (ASGM) Area in Lebaksitu Village, District of Lebak, Banten

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Abstract

The usage of mercury in Artisanal and Small Scale Gold Mining (ASGM) is quite troublesome because, within the process, ASGM produces mercury within its waste to the environment that might become pollution. Exposure of mercury to the body in long period could threaten the body's health such as kidney as excretion organ that exerts toxic materials from the body. Glomerulus filtration rate (GFR) is one parameter to evaluate the work of the kidney and the stadium of the kidney disease. This research aimed to understand the relation between mercury level in hair and GFR and used cross-sectional design with measured variables including mercury level in hair, respondent characteristic, and GFR. The respondents included 58 people. The output showed that 51.7% of respondents had mercury level above the guideline (> 2 ppm) in their hair and 43.1% of respondents had experienced a decrease in GFR (abnormality in kidney function). The decrease in GFR was caused by age and mercury level in hair. This decrease can be prevented by consuming more water, reducing medicine consumption, and conducting promotion about health service and the impact of mercury on public health.

Keywords: *glomerulus filtration rate* (GFR), mercury level in hair, Artisanal and Small Scale Gold Mining (ASGM)

1. Introduction

Mercury (Hg) is an element found naturally in the environment. As a toxic substance, mercury enters the human body and flows into blood circulation. They would go the absorption, distribution, metabolism, and excretion process. The kidney is one of excretion organ that excretes toxic materials from the body [1]. The exposure of toxic to the kidney is quite intense as the kidney is the excretion organ that would excrete any liquid waste. The kidney is very sensitive to metal elements because they would form

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complexes with an organic ligand, for example, is mercury that would create a complex with sulphydryl [2]

Glomerulus filtration rate (GFR) is one of the parameters to determine the function of the kidney. GFR describes the function of the kidney and is generally measured by the level of blood creatinine. Besides assessing the function of the kidney, GFR is the most proper test to measure kidney diseases [3].

Gold mining in many countries including Indonesia uses a bunch of mercury. ASGM in Lebak District, Banten, is one of the currently active gold mining. According to several types of research in this area, it is known that the concentration of mercury in the water, soil, and fishes took from the ASGM are around 0.000392 mg/dl, 0.5709 mg/dl, and 0.05175 mg/dl. The result of this measurement shows that the mercury concentration exceeds the guideline [4].

The research conducted by Lubis (2016) and Fauzia (2016) showed that the average of mercury concentration in Lebaksitu was 0.01109 mg/dl with the minimum concentration of 0.0043 mg/dl and the maximum concentration of 0.691 mg/dl. This concentration exceeded the normal limit standardized by US EPA (2006) which was > 0.00058 mg/dl. Nasution (2016) stated that around 31 people of Lebaksitu (51.7%) had mercury level in their hair at > 0.2 mg/dl (> 2ppm) and based on the analysis result, there was a significant relationship between mercury poisoning and fish consumption [6], showing that Lebaksitu civilians had been contaminated by mercury and would result in several health problems caused by the gold mining in the area.

2. Methods

This research used cross-sectional design which had been conducted in ASGM in Lebaksitu, Lebak District, Banten, on April – July 2017. The population of this research was the civilians of ASGM area in Lebaksitu, exactly in Sampay and Lebakpari Village, Lebaksitu, which has been the closest civilization to the gold mining area.

This research used 43 secondary samples, while the whole sample was 58. The mercury level in hair used secondary data (Nasution, 2016) meanwhile the primary data was the GFR values and the individual characteristics. The data gathering of creatinin serum to measure GFR was done by using laboratory analysis meanwhile the individual characteristic data was gathered from the interview by using questionnaire. The calculation of GFR was using the *Cockcroft and Gault* by the formula; $GFR\frac{ml}{min} = \frac{(140-age)\ x\ weight\ \ (Kg)}{72\ x\ Scr\left(\frac{mg}{dl}\right)}$; If the research subjects were female, the calculation result was multiplied by 0.85.

3. Results

Univariate analysis showed that half of the respondents had mercury level in their hair exceeding the guideline (>2 ppm), for about 53.4% (31 people). Number of respondents with abnormal GFR (GFR <90 mL/minute per body surface 1.73 m^2) was quite high, about 43.1% (25 people); and respondents with normal GFR (GFR ≥90) were 56% (33 people).

TABLE 1: The Relations between Mercury and GFR.

Variable	Estimated GFR				n	OR (95% CI)	p
	< 90		≥ 90				
	n	%	n	%			
Mercury level in hair							
> 2 ppm	9	29	22	71	27	0.281	**0.04***
≤ 2 ppm	16	59.3	11	40.7	31	(0.094 −0.838)	
Chi-Square test							

The result showed that 39,7% respondents with abnormal GFR (GFR <90) had suffered from kidney dysfunction and 1,7% respondents had suffered from chronic kidney disease (CKD, *Penyakit Ginjal Kronik or PGK*) ranged from low to higher stadium.

Respondents in this research consisted of 58 adults, aged between 22 to 70 years old with 43.84 years old on average. Majority of the respondents in this research was female (72.4%) with low education level, about 37.9% had never get formal education and 34.5% of them only passed formal education in elementary level. The number of respondents with recorded smoking habit was fewer (25.9%) than the rest (74.1%). Most respondents (about 70.7%) were categorized as frequent medicine consumers. Based on water intakes variable, the majority of respondents consumed drinking water less than 2 liters/day (up to 72.4%).

The analysis result shows that there was a significant relationship between age and GFR with p=0.001. The average age of respondents with abnormal GFR (GFR <90 mL/minute per 1.53 m^2 body surface) was 48.36 years old (25 people) and the average age of respondents with normal GFR (GFR ≥90 mL/minute per 1.53m^2 body surface) was 40.42 years old (33 people).

The result of bivariate analysis of mercury level in hair, individual characteristics, and habits towards GFR is presented below (see table 1 & 2).

3.1. Analysis

3.1.1. Mercury concentration in hair

The majority of respondents had a mercury level in their hair above the standardized guideline. The high mercury concentration in their hair was caused by high exposure of this substance in a long period.

This research is different from the one that had been conducted by Roels et al. (1982) which studied two groups of workers that had been exposed to elemental mercury with the median of mercury concentration in urine higher than 71 ug/g creatinin. There were no kidney dysfunction characteristics from the conducted observation within 62 workers from the chloralkali industry, where average mercury concentration in urine was 56 mg/g creatinin. However, the observation found characteristics of tubular dysfunction in respondents with average mercury concentration more than 30 ug/g creatinin.

TABLE 2: The Relations between Individual Characteristics and GFR.

Variable	Estimated GFR				n	OR (95% CI)	p
	< 90		≥ 90				
	n	%	n	%			
Occupation						3.667 (0.898-14.97)	0.072
Gold processing	3	21.4	11	76.6	14		
Non-Gold Processing	22	50	22	50	44		
Smoking status						1.739 (0.509-5.947)	0.559
Smokers	5	33.3	10	66.7	15		
Non-smokers	20	46.5	23	53.3	43		
Medicines Consumptions						1.255 0.402-3.913	0.920
Frequent	17	41.5	24	58.6	41		
Rare	8	47.1	9	52.9	17		
Water intake						2.00 (0.591-6.763)	0.407
< 2 litre/day	20	47.6	22	52.4	42		
≥ 2 liter/day	5	31.2	11	68.8	16		

Likewise, the research that had been conducted by Bangun (2014) [7] about mercury concentration in urine affected kidney function of 30 people who were traditional gold miners in South Aceh region where the known ureum and creatinin concentration in urine are still normal (average mercury concentration in urine 2.85 µg/l ± standard deviation 0.58 µg/l, average ureum concentration in urine 26.6 mg/dl ± standard deviation 10.59 mg/dl, and average creatinine concentration in urine 0.84 mg/dl ± standard deviation 0.13 mg/dl in urine of gold miners in Panton Luas village) and not affecting the kidney function.

Such a thing could happen because the decrease of kidney function was affected by many factors that made it hard to find the source or the major causing factor. There was an assumption that mercury affected the decrease in GRF estimated value but not the main risk factor. This research involved community from gold mining area so they might have a lower risk of mercury concentration than the workers.

3.2. Age

The analysis result stated that the age of respondents who have the GFR of <90 (mL/minute per 1.73 m^2 body surface) or those who suffered from degrading kidney function was 48 years old. This was by several theories and existing researches which stated that the aging would impact the kidney's physiology.

Smeltzer and Bare (2002) mentioned that age was the factor that could affect someone's health. Further explanation said that the higher the age was, the function of the kidney would experience the decreasing of its longevity as a result of neuron loss resulting in the decreasing of GFR [8].

The decreasing of GFR (as a result of glomeruli dysfunction) will cause the increasing of creatinin klirens and the increasing of creatinine serum. This will lead to kidney failure progressively [9]. Usually, the degrading kidney function occurs at the age above 40 years old (Sidharta, 2008).

On the other side, the kidney is experiencing structure changing particularly on the number of glomeruli within it [10]. This happens because, at the age above 40 years old, the kidney will have less front. This can be interpreted that at the age of 40, there will be little damage, with GFR 60-89 mL.minute/1.73 m^2. In other words, there is 10% degrading on kidney function.

According to Ginting (2008), at Adam Malik Medan Center Hospital, the sufferers of chronic kidney diseases are at the age of 45-59 years old (43.1%) [11]. Whereas, based on the research by Widyantara (2016) at Tugurejo Semarang District Hospital, about 89.7% of the respondents suffering from chronic kidney diseases are at the age of $\geq$ 45 years old.

3.3. Occupation

Warsono (2000) wrote that occupation is one of the factors that affected mercury concentration inside the human's body [12]. This depended on which environment a person is working. Rockman's research (2013) in Malasari Village, Bogor, also obtained the same result which had given us information that average mercury concentration in respondents occupied as non-gold miners were 0.0509 ppm, meanwhile 0.824 ppm was the average of gold miners.

The research that had been conducted by Inswiasri and Kusnoputranto [13] about mercury exposure in traditional gold miners in Kabupaten Gunung Mas showed a significant relationship between occupation and mercury level in hair with value p = 0.001. Another research also found that gold processing workers had 5,02 higher risk than non-gold processing workers (Andi, dkk, 2011).

In Lebaksitu village, the locals mostly work as gold processing workers. Based on the field observation, almost 100% of locals that work as gold processing workers are male. Also, most of the workers have a side job as farmers.

3.4. Smoking habit

There is no significant relation between smoking habit and the decrease of GRF. However, if the OR value (1.739) become one of the basic references, it can be concluded that respondents who smoke have the chance to suffer from decreasing GFR compared to nonsmokers.

Hidayat's research result (2008) [14] shows that passive smokers can suffer from chronic kidney diseases three times higher than nonsmokers. Meanwhile, based on research that has been conducted by Retnakaran (2006), active smokers might suffer from chronic kidney diseases seven times higher than nonsmokers. Ahyar (2009) found that heavy smokers have a higher risk to suffer from kidney diseases. Heavy smokers

can suffer from terminal kidney failure than nonsmokers. The smoke and chemical substances that contained in cigarettes can increase oxidative stress causing blood vessels burning.

Nicotine concentration in 2 pieces of cigarettes could trigger blood tension up to 20 ml/hg. Oxidative stress is tissue disruption caused by the higher level of oxidant that exceeds antioxidant level inside the body. Gradually, those smokers will suffer from hypertension. If hypertension happens regularly, oxidative stress becomes more dangerous. If hypertension is mistreated, it will lead to terminal kidney failure (Ahyar, 2009).

3.5. Medicine consumption

The statistical result showed an insignificant correlation between medicine consumption frequency and the decrease in GFR, yet the OR value was 1.255. Even though it's small, this OR value could represent the risk of this variable.

Most of the medicinal substances are excreted by the kidney, whereas many of the medicines are toxic, this is why the circumstance is called nefrotoxic (Pagunsan, 2003).

Consuming painkiller medicine daily for a long period (few years) could lead to chronic kidney disease, which is why they need consultation from the specialist doctor to make sure the consumption would not harm the kidney (Laguliga, 2009). Some medicines, including those, can be consumed without a doctor's recipe, could toxicate the kidney when consumed in a long period. Those include antibiotic, Aspirin, acetaminophen, ibuprofen (most dangerous for the kidney), solution (carbon tetrachloride, methanol, ethylene glycol).

There are also medicines other than antibiotics that could also lead to kidney failure, such as analgesic (painkiller). Analgetic medicine is dose-dependent that means the dose would be higher as the consumption more frequent, which might cause damage to kidney tissue. Long period consumption of this medicine daily within a few years could make someone get neuropathy analgetic, a chronical kidney disease caused by medicine that would lead to the last stadium and need permanent treatment such as hemodialysis or kidney transplant [15]. Besides, antiepileptic (for epilepsy and stiff), anti-cancer medicine, and Immune complex inducers (medications for the immune system) could give effect to the kidney.

Based on the interview result on the field, it is known that most people have a high tendency of consuming medicine, for about 70.7% of total respondents. Some medications that are most consumed by the respondents include an analgetic type for painkiller (such as email, oksadon, mixagrib, paramex, bodrex, promag, pil kitam contrex). The others are antibiotic, medicine for hypertension sufferer, gastritis medicine, and medicine for cholesterol.

3.6. Water intake

The research result shows that respondents who consume drinking water less than 2 liters/day will have the possibility to suffer from grading kidney function two times bigger compared to respondents who consume drinking water more than 2 liters/day.

Kidney has functions to maintain water balances and dilute or concentrate urine. If water intake is less than the body needs in hot weather, heavy worker, or heavy dehydration, the kidney will have to work harder to dilute urine and overworked/failure.

Less water intake will lead to kidney failure because of less water supply to the organ. It will cause degrading kidney function. It is suggested to drink water more than 1.5-2 L a day. The body will excrete water more frequent through urine which will lead to excrete dirt and toxic from the kidney (Laguliga, 2009).

The daily needs for water intake are different for individuals, depends on different circumstances, such as physical activity, weather, diet, weight, sex, and health condition. Thirst is the best indicator to know when the body needs water intake immediately. It is suggested to drink water sufficiently, no more than 0.03 liter per kg of weights [16].

This village is located in high Terrance about 690 m from sea surface with average temperature 18°C-29°C. Cold weather in this area contributes to a low level of water intake in its community. This is caused by a tendency to drink less water when the temperature is low. This happens because the low temperature can delay the desire of thirst. Despite, when the temperature is high, the human body will produce sweat and easy to get dehydrated so the urge to drink water will increase.

The increase in the need for water intake is influenced by physical activity, weather, and other factors. Even though the locals have high intensity of activity, cold weather will contribute to their body signals demanding for water intake and drink less water which will lead to dehydration. The locals are suggested to take a good concern and increase water intake to help kidneys perform better in excreting toxic waste from the body and prevent kidneys dysfunction.

4. Conclusion

Most of the locals (53.4%) in PESK area in Lebaksitu village had mercury level in hair exceed the standardized guideline (>2 ppm). Number and presentation of the respondents suffering from degrading kidneys functions with GFR <90 (mL/minute per 1.53 m^2body surface) was as high as 43. 1%. There was significant relations between mercury level in hair and estimated GFR with p=0.040, and there was significant relations between age and estimated GFR with p=0.011. The decrease in GFR was influenced by age, occupation, and mercury level in hair with a value of OR= 0.97.

5. Suggestion

Publics are suggested to increase drinking water consumption to support a high level of activity and reduce dependency on medicines consumption. Respondents who are

indicated suffering from degrading kidney function need to conduct a medical check-up to prevent chronic kidney diseases.

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