Evaluation of dietary iodine intake of school-age

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Evaluation of dietary antioxidant intake of school-age children in gold mining area Sekotong, West Lombok, Indonesia

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Abstract. Inorganic mercury from artisanal small-scale gold mining had the potency to be free radicals in the human body. Cellular antioxidants e.g. SOD, glutathione, and other antioxidants had an important role in scavenging these free radicals. Dietary antioxidants provided cellular antioxidants. The objective of this study was to identify the dietary antioxidant intake of school-age children in the ASGM area. This study design was cross-sectional and was conducted in the ASGM area of Sekotong subdistrict. Dietary intake of antioxidants was revealed by using 24-hours food recall. The subjects were school-age children in the ASGM area which fulfilled inclusion criteria, namely resided in Sekotong for more than six months, children did not conduct certain diet such as vegetarian. 71s children were enrolled and were inhabitants in 3 villages in Sekotong. 24-hours food recall analyzed using software nutrisurvey and compared to recommended daily allowance. The mean age of the subjects was 9.7 years old, and 60.6 % was female. Mean intake of dietary antioxidants for vitamin A was 566.86 μg, vitamin E was 0.99 mg, vitamin C was 29.81 mg, Zinc 2.42 mg, Copper 0.94 mg, Mangan 1.57 mg, cysteine 0.385 g, and also dietary fiber 3.19 g. All dietary antioxidants did not meet the Recommended Daily Allowance.

1. Introduction

Mercury is a heavy metal that could enter the human body in form of organic and inorganic. Mercury pollution could be from Artisanal small-scale gold mining (ASGM) which the predominant mercury contamination source in West Nusa Tenggara province (WNT) and also from other sources such as soil containing cinnabar ore, volcanoes, the use of cosmetics, equipment used such as the battery, lamp, etc. and consumption of fish [1][2].

ASGM activities in the province of West Nusa Tenggara (WNT) has started in 2009 and released mercury into the ecosystem in several ways [3]. ASGM has conducted simple technology that applied hazardous chemicals including mercury (amalgamation method) and cyanide (cyanidation method) [4]. Amalgamation is the most common method that is used to recapture gold, because of the availability of mercury, and it is considered to be efficient and effective [3]. Amalgamation promoted mercury emissions into the environment. Mercury was spilled onto the ground or agricultural land. Atmospheric transport and deposition at normal temperature is another common way for Hg to enter many water systems. Besides, Hg is often discharged together with other wastes into inadequate tailings ponds, or directly disposed into rivers and water systems [5]. Cyanidation also contributed to mercury pollution since this method proceeds sludge from amalgamation, and it formed more soluble mercury species-mercuric cyanide.

Mercury and its conjugate chemicals will be absorbed by the body and cause intoxication at certain levels [1]. Once mercury enters the body, it will be distributed to almost entirely organ, the most potent affinity with neuron cell at the central nervous system and kidney [6]. Many studies have demonstrated that mercury emissions affect human health [7,8,9,10,11]**.** Organ disorder depends on several factors, such as dose, route, duration of exposure, development phase (age), species of mercury, and organ section [1,12]. Once mercury penetrated the human body, it had the potency to be free radicals. Cellular antioxidants e.g. catalase, peroxidase, superoxide dismutase, glutathione, and other antioxidants had an important role in scavenging these free radicals [13]. Dietary antioxidants provided cellular antioxidants so that it is important to identify the number of antioxidants from the dietary intake of the population in the ASGM area to predicted mercury body burden dan ability of the human body to diminished mercury poisoning.

2. Methodology

This study applied a cross-sectional study design. The research was conducted at Sekotong ASGM, West Lombok Regency, West Nusa Tenggara Province. The subjects were school-age children from three villages: Sekotong Tengah, Taman Sari, and Buwun Mas. Before conducting the study, ethical clearance was obtained from the Ethical Code Board of the Medical Faculty, Mataram University. School-age children who fulfilled inclusion and exclusion criteria were selected as subjects in this study. Inclusion criteria were 6-12-year-old children, inhabit in ASGM area for more than one year, did not apply certain diet such as vegetarian, had permission to participate from parents by signing the informed consent form. While exclusion criteria were the children who had a severe illness and conducting a certain nutritional behavior such as vegetarian. 24-hour food recall was conducted to find dietary antioxidant intake. Subjects were interviewed meal they ate the day before. Nutritional intake was analyzed by software Nutrisurvey and compared to Recommended Daily Allowance.

3. Result and Discussion

From questioner and also from 24-hour food recall we found characteristic of subjects and identified their nutritional intakes.

Table1. Subject characteristics.

Characteristics	**Percentage (%), frequency (n)**	
	Male	**Female**
Total participant	29.6 (n=21)	70.4 (n=50)
Mean age	9.5 year old	9.7 year old
Age group		
4-6 year old	4.8 (n=1)	0 (n=0)
7-9 year old	33.3 (n=7)	56.0 (n=28)
10-12 year old	61.9 (n=13)	42.0 (n=21)
13-15 year old	0 (n=0)	2.0 (n= 1)
Parent occupation		
Government officer	5.6 (n=4)	
Entrepreneur	1.4 (n=1)	
Farmer	28.2 (n=20)	
Construction worker	8.5 (n=6)	
Miner	56.3 (n=40)	

Table 1 demonstrated that female subjects (70.4 %) were more than male (29.6 %). Mean age for male was 9.5 year old and 9.7 year old for female. Modes for age female was 7-9 year old and 10-12 year old for male. The highest percentage for parent occupation was miner (56.3 %)

Subjects in this research were directly exposed to mercury because they have been living in contaminated air, water, foodstuff, and soil as a consequence of mining activities. A study of Krisnayanti demonstrated that soil and rice in Sekotong have higher mercury levels than threshold level [5]. Gold mining was started in 2009 in Sekotong so that the subjects were exposed to mercury since they were in uter The fetal period was more susceptible than another period of lifecycle [14,15].

Some study subjects were children that had direct contact with mercury from mercury panning after school and standing close to burning processes. This type of child activity has also been reported in other gold mining areas [7]. The duration of exposure to mercury contaminants was an average of 9.03 years. This period was much shorter than the 14.8 years needed to show specific clinical manifestations in previous reports [9]. Ekawanti, et al (2015) found that miners and their families need a shorter period (5.4 years) to had manifestations including proteinuria and anemia [5]. These manifestations are affected by the type and dose of mercury, the age or developmental stage, duration of exposure, and route of exposure [1]. As long as they were exposed to mercury, they were exposed to free radicals [13,16].

The socio-economic factor is a risk factor in nutritional intake. This study identified that 56.3 % of parents were miners with low educational status, although Sausenthaler et al (2007) demonstrated that education and occupation inequal with nutritional intake [17].

Table 2. Antioxidant dietary intake.

Age group	**Dietary intake**						
Age	**Fiber (g)**	**Vitamin A (RE)**	**Vitamin E (mcg)**	**Vitamin C (mg)**	**Zinc (mg)**	**Copper (mcg)**	**Mangan (mg)**
Male							
4-6 year old	4.1	1090.3	4.1	9.6	2	0.2	0.9
7-9 year old	4.25	350.44	1.86	65.69	1.46	0.2	0.96
10-12 year old	3.138	533.88	1.17	61.85	2.19	3.87	2.25
13-15 year old	NA	NA	NA	NA	NA	NA	NA
Female							
4-6 year old	NA	NA	NA	NA	NA	NA	NA
7-9 year old	1.81	508.76	1.47	6.33	2.35	0.24	1.1
10-12 year old	4.39	683.75	2.14	27.08	2.9	0.37	1.87
13-15 year old	4.9	808.9	1.8	31.6	2.9	0.4	3.2

Table 2 showed that the highest fiber intake was in a group of 13-15-year-old female, the highest intake for vitamin A was in male group 4-6 year old, vitamin E the highest intake was in male group 4-6 year old, vitamin C the highest intake was in male group 7-9 year old, Zinc intake the highest was in female group 10-12 year old, Copper the highest intake was in male group 10-12 year old, and Mangan the highest intake was in male group 10-12 year old.

Several studies showed that antioxidant plays important role in quenching mercury-induced free radicals and reducing mercury toxicity [18, 19, 20, 21, 22, 23, 24, 25]. Dietary and natural product sources of antioxidants provided sufficient cellular antioxidant [18, 19, 26, 22]. This study was focused on children as subjects because they were in the developmental stage, they were susceptible to lacking essential nutrients and they still have a dependent eating behavior. In this study, the researcher found that All nutritional antioxidants did not meet the RDA of the Indonesia Ministry of Health [27], except for vitamin A in several groups. Vitamin E has potency in reducing inorganic mercury toxicity [21, 26], ascorbic acid also has a role in reducing malondialdehyde (MDA) as a consequence of mercury toxicity [20, 21, 25]. A study from Durak showed that vitamin E and vitamin C has a protective effect on erythrocyte oxidative stress after mercury exposure in rat [16].

Table 3. RDA Vitamin Evaluation.

Age group	Vitamin A			Vitamin E			Vitamin C		
Age	Level (RE)	RDA	% RDA	Level (mcg)	RDA	% RDA	Level (mg)	RDA	% RDA
Male									
4-6 year old	1090.3	450	243.33	4.1	7	58.57	9.6	45	21.33
7-9 year old	350.44	500	70.08	1.86	8	23.25	65.69	45	145.98
10-12year old	533.88	600	88.98	1.17	11	0.2	61.85	50	123.7
13-15 year old	NA	600	NA	NA	15	NA	NA	75	NA
Female									
4-6 year old	NA	450	NA	NA	7	NA	NA	45	NA
7-9 year old	508.76	500	101.75	1.47	8	18.37	6.33	45	14.07
10-12 year old	683.75	600	113.95	2.14	15	14.27	27.08	50	54.16
13-15 year old	808.9	600	134.82	1.8	15	12	31.6	65	48.62

Table 3 indicated that vitamin A intake more than RDA was found in all-female groups, but vitamin C intake met RDA in the male group. Vitamin E intake met RDA neither in the male group nor the female group.

Table 4. RDA Mineral Evaluation.

Age group	Zinc			Copper			Mangan		
Age	Level (mg)	RDA	% RDA	Level (mcg)	RDA	% RDA	Level (mg)	RDA	% RDA
Male									
4-6 year old	2	5	40	0.2	440	0.045	0.9	1.5	60
7-9 year old	1.46	5	29.2	0.2	570	0.035	0.96	1.7	56.47
10-12year old	2.19	8	27.37	3.87	700	0.55	2.25	1.9	118.42
13-15 year old	NA	11	NA	NA	795	NA	NA	2.2	NA
Female									
4-6 year old	NA	5	NA	NA	440	NA	NA	1.5	NA
7-9 year old	2.35	5	47	0.24	570	0.042	1.1	1.7	64.70
10-12 year old	2.9	8	36.25	0.37	700	0.053	1.87	1.6	116.87
13-15 year old	2.9	9	32.22	0.4	795	0.050	3.2	1.6	200

Table 4. revealed that only Mangan intake met RDA in group female and also in group male 10-12 year old, but neither zinc nor copper met RDA. The lowest level was the copper intake.

Jan et al, 2015 stated that essential minerals for reducing mercury toxicity were iron, copper, selenium, and zinc. And all micronutrients have to met RDA to run their function in reducing mercury toxicity [13]. From data collected and analyzed in this study that almost all micronutrients did not meet RDA from the Indonesian Ministry of Health. At the low level of these essential nutrients, they will not have the ability to quenching mercury toxicity. This condition needs advanced investigation in identifying in vivo antioxidant capacity. This study failed to identify several minerals including selenium, while selenium has a specific affinity to mercury.

Table 5. Evaluation of Fiber Intake.

Age group	Fiber (g)	RDA	
		RDA	% RDA
Male			
4-6 year old	4.1	20	20.5
7-9 year old	4.25	23	18.48
10-12 year old	3.138	28	11.21
13-15 year old	NA	34	NA
Female			
4-6 year old	NA	20	NA
7-9 year old	1.81	23	7.87
10-12 year old	4.39	27	16.26
13-15 year old	4.9	29	16.90

Table 5 identified that the highest fiber intake was in the male group 4-6 year old and the lowest was in female group 7-9 year old.

Fibers needed to inorganic mercury excretion, mercury pollution in ASGM was inorganic mercury species and one route of inorganic mercury entered human body was by ingestion. Low fiber intake reducing mercury excretion.

4. Conclusion

It concluded that dietary antioxidants of school-age children in gold mining area Sekotong from micronutrient neither vitamins nor minerals did not meet RDA and inequal with mercury exposure. This result needs further investigation to evaluate in vivo antioxidant capacity, signs and symptoms of mercury intoxication, and also the concentration of mercury from the environment.

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