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Effect of iodine status on nutritional status of school-age children in artisanal and small scale gold mining area

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ABSTRACT

Background: Nutritional status of school-age children is influenced by several factors, e.g., nutrition intake, hormone, and underlying disease. Mercury, as a pollutant from artisanal and small scale gold mining (ASGM), inhibits thyroxin production-metabolism regulating hormone. The objective of this study was to evaluate the effect of iodine status and nutritional intake on nutritional status of school-age children in ASGM area.

Methods: Study design was cross sectional. There were two groups; case group was school-age children exposed by mercury from ASGM area from Sekotong subdistrict, and control group was school-age children in Narmada subdistrict. Sixty two children from ASGM were enrolled, and fifty two children from the Narmada subdistrict. Iodine status was assessed by measured urine iodine excretion using acid digestion method; nutrition intake assessed by using recall 24 hours; nutritional status by measured anthropometry. Correlation between nutritional and iodine status was examined by using Spearman' test.

Results: Nutritional status of case group found 45.1% were stunted and 27.4% were underweight. Control group found 13.4% stunted and 9.6% underweight. Iodine status of case group: 3.9% deficient and 68.6% at risk of iodine-induced hyperthyroidism, the control group was found that 3.8% inadequate and 72.8% at risk of iodine-induced hyperthyroidism. Iodine intake both groups were under RDA value that of the case group was 8.3 µg/day, and the control group was 11.5 µg/day. All nutrition supporting growth did not meet the RDA value. Spearman's test result was p=0.56.

Conclusion: Iodine status did not correlate with the nutritional status of children in ASGM area.

Keywords: Iodine status, nutritional status, school-age children, nutrient intake, ASGM

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INTRODUCTION

Iodine deficiency remains a public health problem worldwide. Iodine intake is predicted by assessing iodine excreted in the urine. Iodine deficiency was found in 36.4% of children worldwide. In Southeast Asia region was found 39.8% of school-age children have an iodine deficiency.[1] West Nusa Tenggara is a province with low consumption of iodised salt throughout Indonesia. In 2010 the coverage of iodised salt consumption in West Nusa Tenggara was expected to be 65%, while Indonesia reaches 90%. This condition certainly has an adverse impact on public health in West Nusa Tenggara. Kartono's study, in 2009 found that public consumption in the sufficient iodine category was only 27.9% and 42.4% did not consume iodised salt.[2]

Iodine is a nutrient that is needed at all stages of life and as an essential nutrient which is required for all metabolisms in the human body. Iodine requirement increases in a period of growth and development such as during pregnancy and children. Iodine deficiency during the developmental period not only cause growth disorders but also affect mental disorders. The impact of iodine deficiency on pregnant women is even more severe, including the risk of miscarriage, stillbirth, and the offspring will experience physical and mental disorders.[3,4] These abnormalities will be persistent until adulthood, thereby reducing the quality of future generations.

Small-scale gold mining in West Nusa Tenggara province, especially in ASGM area Sekotong subdistrict has been conducting gold mining and gold processing since 2008, and Krisnayanti *et al.* (2012) found that rice as foodstuff contains mercury above allowance level.[5] Krisnayanti (2015) also found that mercury level in urine of miners and their family was above average level.[6] Mercury exposure was not only from gold processing but also from food. Mercury affected almost the entire organ in the human body, including thyroid.[7]

The effect of chronically low or excess of iodine levels in the community, especially in vulnerable population namely pregnant women and children has not been studied in West Nusa Tenggara province so that research on the epidemiology of iodine deficiency and its effects on the community becomes necessary. Urine iodine levels in school-age children determined urine iodine levels in the community.[8] The objective of this study was to find out the prevalence of iodine deficiency and iodine excess in school-aged children in ASGM area and to analyse the relationship between urine iodine level and nutritional status of school-aged children.

MATERIALS AND METHODS

Research design

The design of this study is a cross-sectional design; that were anthropometric measurements of children, spot urine sampling and 24-hour food recall conducted entirely in the same time. This study conducted in end of 2018 to early 2019. Those data collected from both group; case group was group exposed to mercury in ASGM area, Sekotong sub-district and control group was school-aged children from upstream area that was not exposed to mercury from ASGM areas, and this group was taken from elementary schools in Narmada sub-district. Both areas were in west Lombok district. The case group was located at coastal area, while the control group was located in upstream highland.

Subject

The subjects of this study were school-age children in grades 3, 4, and 5 in elementary school who were in the Sekotong sub-district as a representation of the region with the consumption of food containing lots of iodine and which was affected by mercury from ASGM pollution. For the representation of areas with low iodine intake, upstream areas not affected by ASGM, Narmada subdistrict was selected. The subject should met the inclusion criteria.

Inclusion criteria:

1. Students are registered at the school where the research is conducted and are in grades 3, 4 and 5
2. Age 6-12 years old
3. Inhabited in ASGM area for at least six months
4. Agree to participate

Exclusion Criteria:

1. In the period of therapy of substance-related to thyroid hormone (PTU, thyroxine)
2. Had an experience of thyroid gland abnormalities
3. Suffered from serious illness

Sample Collection and Analysis

Anthropometric measurement

Anthropometric data consist of height and weight measurement. These data were needed to calculate BMI.

BMI is an indicator of measurement of body fat content obtained through the division of height in meters by weight in kilograms, and it was stated as kilograms squared (kg/m^2). BMI/age is considered normal if it was located between the 5th and 98th percentile.

Iodine Urine

Median iodine urine is the mean value of urinary iodine levels in the population of school-age children. 5 ml of spot urine samples were collected in a plastic container. Collected samples were stored at -20°C until assessed. Iodine urine excretion (UIE) examined by using the Acid Digestion Method at GAKY Laboratory, Magelang. The results of the study will be presented in median urine iodine and μg/L.

24-hour food recall

24-hour food recall conducted to find out iodine intake and other nutritional intake related to growth. Subjects were interviewed meal they ate the day before. Nutritional intake was analysed by software Nutrisurvey and compared to Recommended Daily Allowance.

Data Analysis

Data iodine urine level between two groups was compared by using Mann-Whitney test in 95% of confident interval. Correlation between iodine status and nutritional status were analysed using Spearman's rank test.

RESULTS

Subject characteristics were described in Table 1.

Table 1 described that all participant was in a range of inclusion criteria for age; between 6-12 year old. In the control group, male and female almost the same number, but in the case of group female was twice as many as male. Table 2 presented that case group had a higher level of iodine urine (412.12±322.09 μg/L) than the control group (319.19±229.12 μg/L), but this value was not significantly different.

Table 3 indicated that in the case of group, 3.9% of subjects were deficient, 27.5% had adequate intake group, and 68.6% had excessive intake. In the control group, 3.8% of subjects were deficient, 23.07% had adequate intake group, and 72.96% had excessive intake.

Case group had a higher number of norm weight (n=43, 86%) than the control group (57.7%), Case group also had a higher number of thin and severe thin status (10%) compared to control group (5.7%). Prevalence of stunting for the control group

Table1 Subject Characteristics

Characteristics	Percentage (%), frequency (n)
Age	
Control Group	
Mean	10.5 year old
<10 year old	0 (n=0)
10 year old	50 (n=21)
11 year old	50 (n=21)
12 year old	0 (n=0)
>12 years old	0 (n=0)
Case group	
Mean	9.7 year old
<10 year old	50.7 (n=36)
10 year old	23.9 (n=17)
11 year old	15.5 (n=11)
12 year old	7.0 (n= 5)
>12 year old	2.8 (n=2)
Gender	
Control Group	
Male	51.9 (n=27)
Female	48.1 (n=25)
Case Group	
Male	39.4 (n=28)
Female	60.6 (n=43)

Table 2 Iodine Urine Level

Group	Iodine urine level (μg/L)
Control	
Mean±SD	319.19±229.12
Median	291
Minimum	85
Maximum	1480
Case	
Mean±SD	412.12±322.09
Median	389
Minimum	58
Maximum	1762

Mann-Whitney test (p=0.15)

was 9.6%, and the case group was 27.4%. Statistical analysis by Spearman's rank test to the examined correlation between iodine status and nutritional status at confident interval 95% had p-value 0.557.

Case group had lower dietary intakes than the control group; the control group had 1590.6 kcal energy intake while case group had 979.5 kcal; protein intake for the control group was 54.3 g, while case group 33.3 g; sodium intake for control group 11.5 μg, but case group 8.3 μg.

DISCUSSION

Prevalence of stunting in the case group (27.4%) in this study was lower than found by Priyambodo et al. (2015) and also compared to national prevalence 30.8%.[9,10] Iodine status of children in case group 3.9% were deficient less than national deficiency rate[11] and 68.6% were at risk of iodine-induced hyperthyroidism, and this rate was higher than found by Sartini (2012).[11,12] An iodine status of school-age children assessment is one of the determining indicators of iodine status in the population. In this study, the median value of iodine urine for ASGM children in coastal was 412 μg/L and control group in the highlands obtained median urine 319 μg/L, from the results of the mean difference test, also found no significant difference in the 95% confidence level between groups. This means that the impact of mercury from ASGM pollution has not yet affected thyroid hormone function in school-age children. Both groups were at risk of thyroid induced disorders due to iodine, particularly at iodine urine levels above 500 μg/L. Urinary iodine status of both groups was higher than the national median, which is 229 μg/L. If compared to Sartini (2012) the median urine iodine in the case group was higher than that of elementary school children in Brebes, Central Java with a median urine iodine of 346 μg/L, so that the children in the case and control group with high iodine level were at risk of thyroid disease related to autoimmune. The distribution of urine iodine in the control group was for UIE 50-99 μg/L was 3.8%; 100-200 μg/L was 23.07%; 201-300 μg/L was 23.07% and >300 μg/L was 49.8%. In the case group, iodine deficiency was obtained 3.9%; 100-200 μg/L was 27.5%; 201-300 μg/L was 13.7%; and >300 μg/L was 54.9%. The percentage of mild deficiency in mountainous area was lower than the national prevalence and likewise in the coastal areas a level of deficiency is found lower than the national level, compared to Indonesia's UIE distribution with a distribution of 50-99 μg/L was 5.2%, 100-299 μg/L was 28%, >300 μg/L at 26.2%.[11] Optimum levels of iodine intake in coastal areas are higher than the national percentage, as well as in mountainous areas.

Thyroxine hormone affects the overall metabolism of our body and affects the physical and mental development of children. In this study, nutritional status was evaluated by using BMI/Age and also height/age. Chronic iodine deficiency affects

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Table 3 Distribution of Median Urine Iodine

Median urine iodine (µg/L)	Percentage (%)
Control group	
<20	0
20-49	0
50-99	3.8 (n=2)
100-200	23.07 (n=12)
201-299	23.07 (n=12)
>300	49.8 (n=24)
Case group	
<20	0 (n=0)
20-49	0 (n=0)
50-99	3.9 (n=2)
100-200	27.5 (n=14)
201-299	13.7 (n=7)
>300	54.9 (n=26)

Table 4 Nutritional Status

Nutritional status	Percentage (%)
Control group	
Obese	17.3 (n=9)
Overweight	19.2 (n=10)
Normoweight	57.7 (n=30)
Thin	3.8 (n=2)
Severe thin	1.9 (n=1)
Case group	
Obese	2 (n=1)
Overweight	2 (n=1)
Normoweight	86 (n=43)
Thin	4 (n=2)
Severe thin	6 (n=3)

Table 5 Nutritional Intake of Children

	Nutrient				
Group	Energy (kcal)	Protein (g)	Lipid (g)	Carbohydrate (g)	Iodine µg
Control group	1590.6	54.3	67.2	195.2	11.5
Case group	979.5	33.3	34.6	133.0	8.3

children's height. In this study, the proportion of stunted children in the coastal area was 27.4% and in the mountainous area was 9.6%, this proportion was higher than that obtained by Pardede *et al.*, which was 48%.[13]

Iodine intake of both groups was below recommended daily allowance that of case group was 8.3 µg/day and control group was 11.5 µg/day while iodine recommended daily allowance for school-age children is 120 µg/day.[13,14] Other nutritional intake found that all nutrition supporting growth did not met recommended daily allowance. Correlation between Iodium intake and UIE using Spearman's test result was p=0.557 the same as found by Kunarti (2016).[15] Nutritional status was affected by several factors such as biological (nutritional intake, hormone, genetic), economic and socio-cultural factors.[16,17] This study explored only nutritional factors so that it is very important to find out the contribution to another factor in this area.

CONCLUSION

This study concluded that iodine status did not correlate with the nutritional status of school-age children in ASGM area. This study also revealed that nutritional intakes related to optimal growth (calorie, protein and iodine) did not met recommended daily allowance.

ETHICAL CLEARANCE

This study was approved by Medical Research Ethical Commission of Universitas Mataram with the number: 166/UN18.8/ETIK/2018.

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DISCLOSURE

There was no conflict of interest in regarding this publication and also from the source of funding.

AUTHOR CONTRIBUTION

All authors contributed to this study.

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