

The Correlation Between Zinc Source Dietary Intake dan Hair's Zinc Level on Stunting Incidence at Primary School Students of Malang Regency

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Abstract. Based on the result of Basic Health Research in 2013, the prevalence of stunting reached the percentage of 37.2%. Based on the data of the Health Office of Malang Regency in 2012, the prevalence of malnutrition of toddlers in Bululawang Sub-district was 5.49% and that of stunting was 25.9%. Zinc deficiency may lead to linear growth disorders, and when Zinc levels of the students are not fulfilled, the prevalence of stunting episode is predicted to increase. The objective of this research is to analyze the correlation between zinc source dietary intake and hair's zinc level on stunting incidence at primary school students of Malang regency. This research used observational analytical method with the cross-sectional design. Its population was 807 students in Grades I and II of Primary Schools/Islamic Primary Schools in Bululawang Subdistrict, Malang Regency. They consisted of 90 students suffering from malnutrition in Bululawang Subdistrict. The samples were divided into two groups, namely: 46 children in the group of malnourished stunting students, and the rest in the group of malnourished non-stunting students. The nutrition status was measured using the formula of Weight/Age and Height/Age according to the WHO Anthropometry 2007. The examination of the hair Zinc level was conducted at Center for Health Laboratory of Surabaya. The correlation between zinc source dietary intake and hair's zinc level on stunting incidence at primary school students of Malang regency was investigated by using the Chi Square test and Odds Ratio aided with the computer program of SPSS 22. There was a significant correlation of consumption level and eating pattern of Zinc food resources ($p=0,037$) with malnutrition episodes in Primary School students with stunting and non-stunting. In addition, there was a significant correlation between hair Zinc level ($p=0,000$) and malnutrition episodes in Primary School students with stunting and non-stunting. Hair with deficient Zinc level had 116.286 times more risk to experience stunting than hair with normal Zinc level. Hair Zinc level have a significant correlation with malnutrition episodes in Primary School students with stunting and non-stunting in Bululawang Subdistrict, Malang Regency.

Key words: *Stunting, Zinc Source Dietary Intake, Hair's Zinc level*

1. Introduction

Based on Health Research in 2013, the national prevalence of underweight by weight-for-age (W/A) in children under five years old in 2013 showed that 5.7% of children suffered from malnutrition and 13.9% of them were under nutrition. The prevalence of under nutrition in East Java in 2013 was 15.5%.

The prevalence of short height in children aged 5-12 years in East Java is very short (18%) and short (11%). Low birth weight and birth length less than 48 cm are related to the problem of stunting in children [1]. Stunting occurs because of lack of nutrients in a long term from the fetal period up to the first two years of children's lives [2].

Micronutrients (iron, zinc, iodine, selenium, etc.) are nutrients that affect growth and development in addition to macro-nutrients (carbohydrates, protein, and fat). Zinc deficiency can cause linear growth disorders and decreased appetite [3]. Based on Recommended Dietary Allowances (RDA) in 2014, zinc need per day in children aged 7-9 years was 11.2 mg/day. If children suffer from zinc deficiency, the prevalence of stunting is set to increase [4].

Based on the data from Malang Regency Health Office in 2012, the prevalence of malnutrition among children under five years was 6.3% and the prevalence of stunting was 16.1% [5]. Bululawang sub-district had the prevalence of malnutrition by 5.49% and 25.9% for stunting. Looking at the importance of zinc intake on the growth and development of children and the high prevalence of stunting in Malang, it is necessary to analyze the correlation between zinc source dietary intake and hair's zinc level on stunting incidence at primary school students of Malang regency.

2. Research Method

This study is analytical observational study with cross sectional design. The subject is elementary school children aged between 6-8 years who suffer from malnutrition with stunting and non stunting and have

met the inclusion criteria, namely living in Bululawang sub-district Malang regency, not suffering from any infectious or chronic disease during the research, and staying with parents. The number of samples was 90 children consisting of 46 malnourished children with stunting and 44 malnourished children non stunting. The independent variables are, Zinc source dietary intake and hair Zinc level while the dependent variables are malnutrition and stunting.

The study is conducted in elementary schools and Islamic elementary schools in Bululawang subdistrict Malang regency. Data on the characteristics of children and parents are obtained from interview. Data on food intake and children's eating pattern are obtained by interview using food recall and food frequency questionnaire. Data of weight and height are acquired by anthropometric measurements. Meanwhile, the hair samples are obtained from children's hair cutting by as many as 3 grams after the interview, and then it is examined at the Center for Health Laboratory of Surabaya. The data obtained are analyzed using SPSS 22, namely the Chi Square analysis (X^2) and Odds Ratio (OR) [6].

3. Results

3.1 Children's Level of Consumption

The result of statistical test on the level of consumption of malnourished primary school children with stunting and non stunting can be seen in Table 1.

Table 1. The result of statistical test on children's level of consumption of malnourished primary school children with *stunting* and non *stunting*

Information	Category	<i>Stunting</i> (n=46)	Non <i>stunting</i> (n=44)	Chi Square	P	Odds Ratio
Level of zinc consumption	<70% AKG RDA	44	36	4,358	0,037	4,889
	≥100% RDA	2	8			

Source : Primary data analysis, 2015

Table 1 show children's level of consumption of malnourished primary school children with *stunting* and non *stunting*. Based on chi square analysis on the level of Zinc consumption of malnourished primary school children with stunting and non stunting, the result shows the value of $p = 0.037$ which is smaller than alpha 0.05. It means that the level of Zinc consumption has a significant relationship with the incidence of malnourished primary school children with stunting and non stunting. Furthermore, from the result of odds ratio analysis, it is obtained that $OR = 4.889$. It means that children with a deficit in the level of Zinc consumption are 4,889 times more likely to suffer from stunting, compared to those with adequate Zinc consumption.

3.2 Children's Eating Pattern

Statistical test result on children's eating pattern in the case of malnourished elementary school children with stunting and non stunting can be seen in Table 2.

Table 2. The result of statistical test on the eating pattern of malnourished primary school children with *stunting* and non *stunting*

Information	Category	<i>Stunting</i> (n=46)	Non <i>stunting</i> (n=44)	Chi Square	P	Odds Ratio
Diet of Zinc	Imbalanced	44	36	4,358	0,037	4,889
	Balanced	2	8			

Source : Primary data analysis, 2015

Table 2 show eating pattern of malnourished primary school children with *stunting* and non *stunting*. Based on chi square analysis on the diet of zinc sources in the case of malnourished elementary school children with stunting and non stunting, the result shows the value of $p = 0,037$ which is smaller than alpha 0.05. It means that diet of zinc sources has a significant relationship with the incidence of malnourished primary school children that the value of $OR = 4.889$. It means that children with imbalanced diet of zinc source are 4,889 times

more likely to experience the incidence of malnourishment with stunting, compared to those having balanced diet of zinc source.

3.5 Hair Zinc Levels of Children

Table 3. The result of laboratory examination on hair zinc level of malnourished primary school children with *stunting* and non *stunting*

Category of Zinc	Malnutrition with <i>stunting</i>		Malnutrition non <i>stunting</i>		Total		Chi Square	p	Odds Ratio
	n	%	n	%	n	%			
<150 µg/kg	44	48,9	7	7,8	51	56,7	58,238	0,000	111,286
>150 µg/kg	2	2,2	37	41,1	39	43,3			
Total	46	51,1	44	48,9	90	100			

Source : Primary data analysis, 2015.

Analysis of hair zinc level in the case of malnourished children with stunting and non stunting can be seen in Table 3.

Table 3 shows hair zinc levels of malnourished primary school children with stunting and non stunting in which from 90 children, 51 children (56.7%) are under the category of zinc levels <150 mg/kg (deficit) and 39 children (43.3%) fall into the category of zinc levels > 150 mg/kg (normal). Based on the chi square analysis on hair Zinc levels of malnourished primary school children with stunting and non stunting, the result shows the value of $p = 0.000$ which is smaller than $\alpha 0.05$. It means that zinc level in hair has a significant relationship with the incidence of malnourished primary school children with stunting and non stunting. From the result odds ratio analysis the value of $OR = 116.286$ is obtained. It means that children with deficient zinc level in hair are 116.286 times more likely to experience the incidence of malnourishment with stunting, compared to those having normal zinc level in hair.

4. Discussion

4.1 Children's Rate of Consumption

To determine the intake of food in this study food recall is carried out three times (3x). The levels of Zinc consumption in malnourished primary school children with stunting and non stunting mostly belong to the category of <70% RDA (deficit). Low intake of nutrients in the case of malnourished elementary school children with stunting and non stunting is caused by food intake which is less than the recommended daily allowance (RDA). If it continues over time, deficit in food intake (<70% RDA) will lead to malnutrition which will continue into adolescence and adulthood [7]. Selection of sources of Zinc in malnourished elementary school children with stunting tends to be less than their daily need than in non stunting children. Research conducted [8] concludes that there is a significant relationship between consumption of milk, meat, and liver with serum zinc levels. Research conducted [9] concludes that the low height-for-age (H/A) is due to the low intake of energy and protein, and the low consumption of sources of iodine and zinc.

Consumption of zinc sources for school children in developing countries is relatively low which can be seen from the low consumption of animal source foods (ASF) and high consumption of Phytate contained in plant-derived foods which can inhibit the absorption of Zinc [10]. Zinc bioavailability in animal products is more easily absorbed (35-55%) compared to vegetable products (<15%). Foods high in zinc include: oyster, red meat, lamb liver, milk and other dairy products [11].

4.2 Children's Eating Habit

Diet is children's habit in the consumption of everyday foods that can be measured by using food frequency questionnaire (FFQ) [12]. In this study the dietary sources of Zinc have a significant relationship with the case of malnourished elementary school children with stunting and non stunting ($p = 0.037$). Children's poor diet can be caused by imbalanced diet consumed each day. Mostly consumed staple food is rice which is eaten 2-3 times a day with an average serving of 100 grams/meal. Mostly consumed animal proteins are chicken eggs,

chicken, and beef by as many as 3-4 times per week with an average serving of 50 grams/meal, while fish and shrimp are rarely consumed. Mostly consumed plant-derived foods are tempeh and tofu by as many as 3-4 times per day with an average serving of 50-100 grams in one meal. Vegetables which are frequently consumed are carrots, green beans, spinach, and water spinach by as many as 1-2 times per week with an average share of 50 grams/meal.

Frequently consumed fruits are bananas, papaya, mango, apples, and watermelon eaten once a week with an average share of 75-100 grams/meal. Mostly consumed drinks are tea and milk as many as 1-2 times per week (for milk) and 5-6 times per week (for tea) with an average share of 1 cup (200-250 ml) in one drink. Mostly consumed snacks are *chiki*, meatballs, and fried foods by as many as 5-6 times per week. Frying is the most preferred method of processing food whether for animal source foods or plant source foods, and it is done almost every day. To meet the daily nutritional needs of children aged 6-8 years, it is expected that they are given an appropriate portion so that the balance of the diet is met (\geq RDA). In this research, there are some children with high diet of zinc due to the selection of foods high in zinc as found in meat, milk and dairy products. In average, children who consume these foods have fulfilled zinc requirement in addition to consuming a variety of other foodstuffs.

Research conducted by Padmiari has proven that PAUD students in Denpasar city with less Zinc consumption have 3 times greater risk of stunting than children with adequate zinc consumption [13]. In accordance with 13 General Guidelines for Balanced Nutrition [14], it is stated in the first and the second message to eat a variety of food and eat to meet your energy need. If children's diet is not balanced and does not correspond with recommended dietary allowance (RDA) and this continues over time, the issues of nutrition and illness will increase [15].

4.3 Hair Zinc levels

Zinc is an essential trace element that functions in synthesis, secretion, and growth hormone activity. Zinc deficiency is related to the cessation of hair growth or alopecia [3]. In addition, some children experiencing Zinc deficiency will have brownish and thin hair [4]. Zinc examination through AAS method performed at the Center for Health Laboratory of Surabaya shows that malnourished primary school children with stunting tends to have lower levels of zinc in their hair than non stunting children. Therefore, one of the factors of the incidence of stunting in this study is the lack of zinc in body. Low level of zinc in children's hair is because of consumption of food sources that have low Zinc level. From the result of odd ratio analysis, it is obtained that OR value = 116.286, which means children with deficient hair zinc levels are 116.286 times more likely to experience the incidence of malnourishment with stunting, compared to those having adequate hair Zinc levels.

Research conducted by Budiastutik, et al [16] shows the value of $p = 0.031$, which means giving biscuit as complementary feeding and Zinc supplementation has a significant influence on the level of zinc in toddler's hair, whereas the control group shows no difference before and after treatment ($p > 0.05$). Research conducted by Rahmawati [17] shows that children who have high height-for-Age Z-score (HAZ) high will have high levels of Zinc in hair. Zinc content in hair reflects the amount of zinc available for hair follicles at the time of growth. Assuming a normal rate of hair growth, the concentration of zinc in the proximal 1-2 cm of hair reflects the uptake of zinc by follicles in 4-8 weeks. Therefore, the positive correlation between the concentration of Zinc in hair and other biochemical indices can be observed in chronic zinc deficiency [4].

5. Conclusion

Incidence of malnutrition which causes stunting is due to inadequate levels of zinc consumption and imbalanced diet on daily food menu.

Zinc intake has a relationship with the incidence of stunting in the case of malnourished elementary school children in Bululawang subdistrict Malang regency. Insufficient level of zinc consumption and imbalanced diet contribute to 4,889 times the risk of stunting compared to children with sufficient level of zinc consumption and a balanced diet.

Hair zinc level is related with the incidence of stunting in the case of malnourished elementary school children in Bululawang subdistrict Malang regency. Children with a deficit in zinc levels of hair are 116.286 times more likely to suffer from malnutrition with stunting compared to those with normal zinc levels of hair.

6. Suggestion

For endemic areas where zinc deficit is found, examination of zinc levels in the hair of primary school children needs to be performed periodically by School Medical Unit with the fund from the local government/Regency Health Office.

Malnourished children with stunting should be given special PMT high in zinc in the form of fortified zinc biscuit.

Education about nutrition and balanced diet and PMT high in Zinc are needed, especially in food consumption for elementary school children.

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7. Conflict of Interest

None

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