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Nutritional Intake, Biochemical Status and Anthropometric Values of Stunting Children after Added Zinc on Vitamin A Supplementation

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Abstract

One form of nutritional services for individuals is nutritional supplementation. Zinc supplementation is recommended to overcome growth problems in children. Giving of high-doses vitamin A should also be followed by zinc supplementation because both of them have relation in the absorption process. Vitamin A deficiency can decreases zinc-binding proteins and can lead to impaired absorption of zinc. Zinc plays a role in metabolism and transport of vitamin A as well as in the synthesis of protein transport retinol (PTR), such as hepatic cell PTR (cPTR) which is an intracellular protein transport retinol in the liver cells and holo PTR that brings retinol from the liver into the blood stream and other tissues. Purpose of this study was to determine the effect of zinc supplementation in stunting children after giving of high-dosage vitamin A.

This study used pre- and post- control study design. The study was conducted for a month, with supplementation 10 mg/day of zinc syrup in stunting children aged 2 to 4 years, after giving of high-dosage vitamin A. Sample size was 45 children that was divided into 3 groups: zinc group, vitamin A group and zinc + vitamin A group. Indicators under measurements were nutritional intake, biochemical status and anthropometric.

Zinc supplementation followed by high-dosage vitamin A in stunting children was effective to improve biochemical status while the same treatment was not effective to improve nutritional intake and anthropometry.

Keywords: Zinc supplementation; High-dosage Vitamin A; Stunting; Nutritional intake; Biochemical

Introduction

Increasing physical size or anthropometrics such as weight, height and other body size are representation of balance between food intake and nutritional needs in children [1]. Proper balance between the two results in good nutritional status. One of nutritional problem in Indonesia that affected many children was stunting. Stunting is condition of individual height that is shorter than the lower limit value (z-scores less than -2.0 SD) in accordance to height-for-age. Basic Health Research in 2013 showed the prevalence of stunting reached 37.6%. Indonesian Medium Development Plan aimed to reduce number of stunting in children under five years to 32% in 2015 [2].

Nutritional interventions aimed at providing services for nutritional improvement, while nutritional supplementation is one many kinds of nutritional services for children. Giving of high- dosage vitamin A was conducted in several programs to address nutritional problems in children that included stunting [3]. The program had not been completely successful to overcome the problem, proven by still-high prevalence of stunting in Indonesia compared to other Southeast Asian countries [4].

Zinc supplementation is a proper supplementation to address growth issues in children. From the result of double-blind study conducted in Vietnam by providing 10 mg zinc per days to 146 children aged 4 to 36 months for 5 months, it showed that zinc supplementation increases body weight (+ 0.5 ± 0.1 Kg: $p < 0.001$) and height (+1.5 ± 0.2 cm; $p < 0.001$) [5]. A randomized double-blind study with placebo-controlled conducted to 85 children in Guatemala with giving of 10 mg zinc per days showed changes of activities pattern that more positives [6].

Giving of vitamin A in high dosage should also be followed by zinc supplementation. The two are related, with vitamin A deficiency leads to decrease of zinc-binding protein (ZBP) while vitamin A deficiency leads to impaired absorption of zinc. The role of zinc as micro mineral is to mediate vitamin A transport through Retinol Binding Protein (RBP). Zinc deficiency also leads to decrease of RBP synthesis in the liver which results to decrease of RBP concentrations in plasma. Thus the absence of zinc results to less optimized functions and mechanism of vitamin A [7,8].

Children with stunting will experience the same problems as of those of children with malnutrition such as decreasing biochemical statuses i.e. zinc, albumin, total protein and hemoglobin. The decline in biochemical status is often associated with low nutritional intake while loss of appetite is one of the causes [9]. Zinc supplementation in children can help increase their appetite thereby can improving nutritional intake of children [10].

Based on the relationship between zinc and vitamin A and their roles in growth and the existence of government programs with supplementation of vitamin A in high dosage, it was necessary to conduct a study concerning to zinc supplementation in stunting children after the giving of high-dosage vitamin A with nutritional intake, biochemical and anthropometric status as the indicators.

Methods

Study design and population

This study was an experimental study with pre-test and post-

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test control group design. Double blind methods were chosen as an approach during treatments. The study conducted from March to June 2013. The sample size in this study were 45 children aged 2 to 4 years that passed screening criteria based on stunting nutritional status with height-for-age -2 SD up to -3 SD, and was not in a state illness for then taken up randomly. The samples were divided into three groups: high-dosage vitamin A group, zinc group and high-dosage vitamin A + zinc group, with each group consisted of 15 children. The sample size in this study was determined by formula used by Lemeshow et al. [11].

Informed consent and ethical clearance

Informed consent was obtained from the parent or guardian of the children before supplementation. Ethical clearance was given by the ethical committee of the Public Health Faculty of Airlangga University.

Supplement

Zinc supplementation was given 10 mg/day for 30 times or a month, while high-dosage vitamin A followed a standard used by government program which is 200,000 IU and was carried out on February 2013.

Anthropometric assessment

Anthropometric measurements included height using microtoise with 0.1 cm accuracy and weight using SECA with 0.1 kg accuracy. Nutritional status categories were according to WHO Antro.

Dietetic assessment

Primary data collected were macro nutrient intake (which was measured with food recall 3 x 24 hours with ≥ 90% RDA classified into good category).

Biochemistry assessment

Measurement of biochemical status that included zinc using spectrophotometry method, albumin and total protein using the biuret method or spectrophotometry and hemoglobin using cyanmethemoglobin [12].

Statistical analysis

Paired samples test in SPSS was used to measure effectiveness of the treatments at each group, while t-test used to determine which had the most effectiveness [13].

Result

Anthropometric

This study measured the intake, biochemical status and anthropometric of stunting children before and after intervention. The number of samples was 45 children (25 male and 20 female) were divided into three groups. Each group consisted of 15 children. Anthropometric results to be seen in Table 1.

Anthropometric	Before		After		p-value
	n	%	n	%	
According to weight-for-age					
Poor	1	4	0	0	
Low	16	36	16	36	0.184
Normal	28	60	29	64	
High	0	0	0	0	
According to height-for-age					
Stunting	14	30	14	30	0.325
Shortness	31	70	31	70	
According to weight-for-height					
Severe thinness	0	0	0	0	
Thinness	0	0	0	0	
Normal	45	100	45	100	

Table 1: Distribution of anthropometric status of samples before and after intervention.

Table 1 showed stunting in children according to height-for-age had a diverse nutritional status. When viewed from the index weight-for-age and weight-for-height, majority respondents tend to normal. Judging from the numbers, there is just a change from poor to normal categories in index weight-for-age. The results of Paired samples test showed that there was no difference of anthropometric values in respondents between before and after intervention.

Nutritional intake

The results of nutritional intake measurements using food recall 3x24 hours compared to Nutritional Adequacy Score in 2012 shown at Table 2.

Nutritional Intake	Before		After		p-value
	n	%	n	%	
Energy intake					
Low	19	43	19	43	
Sufficient	26	57	26	57	0.325
High	0	0	0	0	
Carbohydrates intake					
Low	21	46	21	46	
Sufficient	13	30	13	30	0.16
High	11	24	11	24	
Protein intake					
Low	20	45	20	45	
Sufficient	25	55	25	55	0.24
High	0	0	0	0	
Fat intake					
Low	24	52	24	52	
Sufficient	19	42	19	42	0.325
High	2	6	2	6	

Table 2: Distribution of nutritional intake before and after interventions.

From Table 2, it can be seen that there is no change in nutrient intake before and after interventions. Paired test results also show that the treatment in all groups did not have any impact on the changes in intake of energy and other macro-nutrients such as carbohydrates, proteins and fats.

Biochemical status

For biochemical status as measured from each group is shown in Table 3.

Table 3 shows that there were changes in the average of biochemical status in each group. Zinc and albumin of respondents in all group tended to increase to normal status after intervention. In vitamin A group, there are differences of zinc ($p < 0.03$), protein total ($p < 0.01$) and hemoglobin ($p < 0.01$) before and after intervention. Same with vitamin A, in zinc group there are differences of zinc ($p < 0.04$), protein total ($p < 0.01$) and hemoglobin ($p < 0.03$) before and after intervention. In vitamin A + zinc group there are differences of zinc ($p < 0.01$), albumin ($p < 0.03$) and protein total ($p < 0.01$).

The results of statistical tests using paired samples test, all groups

Biochemical status	Before				After				p-value
	Normal		Deficiency		Normal		Deficiency		
	n	%	n	%	n	%	n	%	
Vitamin A group									
Zinc	3	20	12	80	7	46.7	8	53.3	0.03
Albumin	4	26.7	11	73.3	8	53.3	7	46.7	0.34
Protein Total	8	53.3	7	46.7	9	60	6	40	0.01
Hemoglobin	9	60	6	40	8	53.3	7	46.7	0.01
Zinc group									
Zinc	3	20	12	80	8	53.3	7	46.7	0.04
Albumin	4	26.7	11	73.3	11	73.3	4	26.7	0.24
Protein Total	6	40	9	60	12	80	3	20	0.01
Hemoglobin	9	60	6	40	10	66.7	5	33.3	0.03
Vitamin A + Zinc group									
Zinc	3	20	12	80	9	60	6	40	0.01
Albumin	4	26.7	11	73.3	9	60	6	40	0.03
Protein Total	6	40	9	60	10	66.7	5	33.3	0.01
Hemoglobin	7	46.7	8	53.3	9	60	6	40	0.1

Table 3: Distribution of biochemical status before and after interventions.

had significant value to the status of zinc (0.001), albumin (0.001) and total protein (0.001), while it was insignificant for hemoglobin (0.590). Thus it can be inferred that the all treatments were effective for total zinc, albumin and protein statuses. T-test was used to determine the most effective treatment. As the result, vitamin A + zinc were effective in increasing the total protein (0.04). This means that the treatment with vitamin A is more effective in increasing the total protein content compared the zinc alone.

On another comparison between vitamin A and vitamin A + zinc, it was known that both were effective to all biochemical status. Thus there was no difference between the two groups mentioned. Similar results were also obtained when comparing between zinc and vitamin A + zinc.

Discussion

The result was obtained through comparing intake of energy before and after intervention. t-test was used with $p < 0.325$ to distinguish between the intake before and after intervention. This showed that there was no difference on energy intake before and after intervention on all groups. These situations were similar to the characteristics of children with stunting, that they often followed wrong diets due to poverty in the long term. Stunting is the best indicator to reflect cumulative effects of long-term inadequate diet or recurrent disease [1].

The result of t-test showed that macro-nutrient intake that included carbohydrate, protein and fat had no significant difference before and after intervention for all groups. This was due to that nutritional status of an individual with stunting is directly affected by food intake and the incidence of disease. Inadequate food intake and poor health status are the most significance direct causes in the incidence of malnutrition including stunting [14].

Interrelated causes included low dietary intake that increases susceptibility to illness while state of illness reduces food intake. Stunting follows with decreases of food intake in long-term, thus lead to both macro and micro nutrients deficiency [14]. Zinc is one of the micronutrients that its deficiency can decrease tasting abilities thus the appetite, that leading to low intake as well [10,15]. Giving of zinc with 10 mg/day for one month is insufficient to increase the intake in stunting children.

The results of anthropometric measurements that included weight and height and served as indicators of nutritional status, namely weight-for-age, height-for-age and weight-for-height. T-test showed no difference nutritional status in all groups before and after intervention. Any changes in anthropometric measurements, particularly linear growth as reported by Supariasa [16] that the growth can be differentiated into two kinds; linear growth and tissues mass growth. Linear growth is associated with nutritional status at the past and tissues mass growth is associated with the nutritional status at the present time or at the time of measurement [16].

Linear growth of children is related to the length, such as body length, chest circumference and head circumference. Small linear size commonly indicates a state of poor nutritional status due to lack of energy and protein suffered in the past. Type of linear size that used the most is height and body length. This growth requires a long time span, thus one month zinc supplementation as a form of intervention will not show any changes in anthropometry. Meta-analysis of relationship between zinc supplementation and linear growth need at least in 3 consecutive months [9].

Biochemical status is basically the fastest status that can be measured to determine the change as the impact of a nutrient supplementation. Biochemical status under study was that of zinc, albumin, total protein and hemoglobin. From the result of study, it can be interpreted that zinc supplementation after giving of high-doses Vitamin A is effective to improve zinc status, albumin, total protein and less effective for hemoglobin repair.

This study proves that the biochemical status is the first one to change before any changes in anthropometry.

Conclusion

Intervention through zinc supplementation for children with stunting after giving of vitamin A in high-dosage is effective to overcome the problems in biochemical status. This study showed significant differences in each groups by comparing before and after intervention. This study could not determine the most effective intervention among zinc, vitamin A or zinc + vitamin A since statistical tests showed the same effectiveness as well as the changes in all biochemical status.

Intervention in this study was performed for 30 times or a month-long treatment. This short- time intervention could not prove significant relationship for energy and macro-nutrients intakes such as carbohydrate, protein and fat. Similarly, changes in anthropometric indices weight-for-age, height- for-age and weight/-for-height for one month the treatment did not show different things.

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