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Immune Response and Nutritional Status of Infants' Birth after Supplementation with *Dadih* and Zinc during Pregnancy: A Prospective Intervention Study

Helmizar Helmizar[1]*, Sri Rahma Sari[1], Utami Ariyasra[1], Andani Eka Putra[2]

[1]*Department of Nutrition, Faculty of Public Health, Universitas Andalas, Padang, Indonesia;* [2]*Department of Microbiolgy, Faculty of Medicine, Universitas Andalas, Padang, Indonesia*

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***Correspondence:** Helmizar Helmizar, Department of Nutrition, Faculty of Public Health, Universitas Andalas, Padang, Indonesia. E-mail: helmizar@ph.unand.ac.id
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Abstract

BACKGROUND: Dadih is an Indonesian traditional fermented buffalo milk produced and consumed by the secretory immunoglobulin A (sIgA) level and nutritional status of infants aged 4–10 months.

AIM: This study aims to assess the effect of dadih and zinc supplementation given to pregnant mothers for 6 months on fecal.

MATERIALS AND METHODS: A prospective randomized controlled trial was conducted in two districts on 138 pregnant mothers for 6 months, randomly assigned into three groups, namely, control, *dadih*, combination of *dadih* and zinc groups. Then, the combination of groups was supplemented to expecting mothers, respectively, 6 times a week during 6 months. Anthropometric measurement and fecal sIgA of infants were assessed.

RESULTS: The prevalence of nutritional status of infants who mothers were supplemented during pregnancy with *dadih*, *dadih* and zinc, and, normal diet, respectively, are 10% stunting, 5.0% underweight, and 5.0% wasting infants; and 22.5% stunted, 20.0% underweight, and 5.0% wasting infants were found in expecting mothers supplemented with it and without any supplementation (control group). The percentage of stunting in 8 months and older infants tended to reduce: 28.57%, 31.25%, and 11.76%. Their mothers were supplemented with all groups.

CONCLUSION: *Dadih* and zinc are potential for improving nutritional status of the newborn. In addition, the two types of supplementation are recommended to pregnant mothers, to reduce the prevalence of stunting. Potential probiotic contained in Dadih which consumed in adequate amounts can help the absorption of nutrients and increase immunity of mothers and infants amounts confer a health benefit. Acceleration and growth of infants to achieve optimal growth and development should be carried out before they are under two years old.

Introduction

Malnutrition experienced by infants is a manifestation of stunting, wasting, intrauterine growth retardation, low body mass index (BMI), and various micronutrient deficiencies [1], [2], [3]. The results of research conducted on infants under 2 years old in West Sumatra Province, in 2013, show a prevalence of stunting by 21% and infants with zinc deficiency of 63%.[4], [5], [6].

The proportion of stunting infants 2 years of age increases due to the low intake of primary nutrients based on the recommended nutrition adequacy rate (NAR), where the average percentage of infants' energy intake is 42.8% NAR, and the average protein intake is 53.38% NAR. The combining intervention of nutritional supplementation and psychosocial stimulation of *manjujai* results in them increase of nutrient intake of infants, the average energy intake increased by 155.30 calories (+256.74 SD), and the average protein intake increased by 8.96 (+12, 15 SD). Psychosocial stimulation itself can improve infants' nutritional intake at the end of the intervention due to close interaction between the child and mother or caregiver so that the child's appetite is also better [4], [7], [8], [9].

Insufficient nutrition and infection are direct causes of malnutrition in infants and children [4], [10], [11], [12]. The lack of macro nutrient intake is always followed by a lack of micronutrients with a very strong influence on the growth and development of infants. According to the World Bank, nutritional intervention efforts need to be made since early childhood. It will have an impact on the decline in physical growth, brain development, intelligence, and productivity in the future, where this effect is largely irreversible [13], [14], [15]. Providing food supplementation for infants is very important, especially to optimize the physiological functions of the body including the immune system. Food supplementation can improve the body's immune function of vulnerable types such as infants, toddlers, and people with immune disorders. Safe guarding the impact on

this group can improve the quality of health in the future [10], [13], [16], [17].

Dadih is a typical Minangkabau dairy product that is produced through the application of natural fermentation methods with buffalo milk in bamboo tubes with conditions that tend to be facultative anaerobic and use banana leaves as a cover. *Dadih* is traditionally produced in several regions of West Sumatra Province. In general, *Dadih* is served as side dishes, snack, complementary traditional ceremonies, and traditional medicine [18], [19], [20].

Meanwhile, since *dadih* is a type of a milk product fermented by lactic acid bacteria, the benefit of *dadih* is more than just a food. Lactic acid bacteria which have been successfully isolated amounted to 36 strains, some of which are probiotic. Lactic Acid Bacteria found in *dadih* are 108 CFU with various therapeutic functions, such as to improve microbial balance in the digestive system, and can improve the immune system [21], [22], [23].

The results of the previous research on 160 pregnant mothers in Bukittinggi City and Agam Regency in West Sumatra Province showed that there were 30 people or 18.7% pregnant mothers with zinc deficiency (serum zinc <8.6 mg/L) where the condition is malnourished. If this condition is not followed up, there will be a major impact on increasing maternal morbidity and child development [24], [25], [26], [27]. One of the right solutions and the sustainability of interventions provided with the use of local food ingredients are giving *dadih* and zinc to pregnant women to have a sustainable effect on the child's immunity and the child's growth and development. In addition, as a potential of local wisdom in Minangkabau, *dadih* is also used as traditional medicine. The next research is conducted to determine the sustainability of the effects of *dadih* and zinc supplementation during pregnancy on immune response and nutritional status of infants' birth in West Sumatra Province.

Materials and Methods

Design of study

This study is an observational design with a prospective cohort study which a continuation and prior intervention study with experimental quasi design to see the follow-up effect of intervention *dadih* and zinc supplementation during pregnancy on immunity and nutritional status of infants.' The population of this study were mothers and infants born during the study period from Bukittinggi City and Agam Regency in West Sumatra Province, while the samples were all infants. From the results of the previous study, as many as 138 infants were selected purposively with the criteria that mothers and infants were the inhibitants of the study area, and the willingness of parents to participate in the study by signing the forms which had been prepared. The exclusive criteria were those infants who were sick at the time of initial data collection, or with other congenital defects. This study was conducted in Agam District and Bukittinggi City, West Sumatra in 2018–2019.

Variable

The study variables consisted of independent and dependent variables included *dadih* supplementation intervention group, the combination of *dadih* and zinc supplementation intervention groups and the control group; variables between nutrition intake and parenting practices. Dependent variables included immunity status, growth, and development of infants, while confounding variables (Covariate) are characteristics of infants and mothers.

Statistical analysis

The data collection was done by cleaning, editing, coding, and analyzing. Those were computerized. Correlation and chi-square analysis were used to see the trend of child growth and development relationship to each group, while multilevel analysis was used to analyze the effects of interventions with various

Table 1: Frequency distribution of mother's characteristics

Variable	Intervention			Total (n = 126), n (%)	p
	Dadih (n = 46), n (%)	Dadih + zinc (n = 40), n (%)	Control (n = 40), n (%)		
Age of pregnant mothers (years)					
<20	1 (2.2)	0	0	1 (0.8)	0.39
20–35	36 (78.3)	32 (80)	27 (67.5)	95 (75.4)	
>35	9 (19.6)	8 (20)	13 (32.5)	30 (23.8)	
BMI of pregnant mothers					
<23.5	20 (43.5)	13 (34.2)	22 (57.9)	55 (45.1)	0.18
23.5–25	8 (17.4)	4 (10.5)	3 (7.9)	15 (12.3)	
>25	18 (39.1)	21 (55.3)	13 (34.2)	52 (42.6)	
Total of infants					
Do not have infants	13 (28.3)	9 (22.5)	9 (22.5)	31 (24.6)	0.89
1–2 infants	25 (54.3)	21 (52.5)	23 (57.5)	69 (54.8)	
>3 infants	8 (17.4)	10 (25)	8 (20)	26 (20.6)	
Family income					
<2,000,000/month	35 (76.1)	24 (60)	23 (57.5)	82 (65.1)	0.14
≥2,000,000/month	11 (23.9)	16 (40)	17 (42.5)	44 (34.9)	

BMI: Body mass index.

Table 2: Frequency distribution of characteristics and nutritional status of infants

Variable	Intervention			Total (n = 126), n (%)	p
	Dadih (n = 46), n (%)	Dadih + zinc (n = 40), n (%)	Control (n = 40), n (%)		
Age (months)					
<8	30 (65.2)	23 (57.5)	19 (47.5)	72 (57.1)	0.25
≥8	16 (34.8)	17 (42.5)	21 (52.5)	54 (4.9)	
Gender					
Male	24 (52.2)	17 (42.5)	22 (55.0)	63 (50.0)	0.50
Female	22 (47.8)	23 (57.5)	18 (450)	63 (50.0)	
Nutritional status					
WHZ Z-score WHO					
Wasting	0	2 (5.0)	2 (5.0)	4 (3.2)	0.31
Normal	46 (100.0)	38 (95.0)	38 (95.0)	122 (96.8)	
HAZ Z-score WHO					
Stunting	7 (15.2)	4 (10.0)	9 (22.5)	20 (15.9)	0.31
Normal	39 (84.8)	36 (9.0)	31 (77.5)	106 (84.1)	
WAZ Z-score WHO					
Underweight	3 (6.5)	2 (5.0)	8 (20.0)	13 (10.3)	0.05
Normal	43 (93.5)	38 (95.0)	32 (80.0)	113 (89.7)	

WHO: World Health Organization, WHZ: Weight-for-height Z-score, HAZ: Height-for-age Z score, WAZ: weight-for-age Z score.

impact indicators, such as the results of anthropometric measurements, the infants' immunity status based on the characteristics of the sample, and region. The data analysis was performed using SPSS Version 20.00 for windows with a significant level $p < 0.05$.

Results

Mothers' and infants' characteristics

Maternal characteristics are illustrated by education, occupation, maternal age, BMI, number of infants, and family income, as shown in Table 1. One hundred and twenty-six infants in the sample who were successful in the follow-up of 138 mothers had received the intervention during pregnancy, as shown in Table 2.

Table above shows the overall subjects that the educational characteristics of mothers are mostly graduated from high school and college amounts to 65.9% and the remaining to 34.1% graduated from junior high school. The characteristics of the mothers' occupation were mostly housewives amounts to 66.7%. Besides, most of mothers were >20 years old which amount to 98.2%. The total of 46.2% of mothers are with BMI >25. This condition shows that some mothers are more nutritional status. About 54.8% of mothers have 1–2 children and most mothers 65.1% of mothers are with low socioeconomic status. Statistically, there were no significant differences in maternal characteristics according to each intervention group ($p > 0.05$).

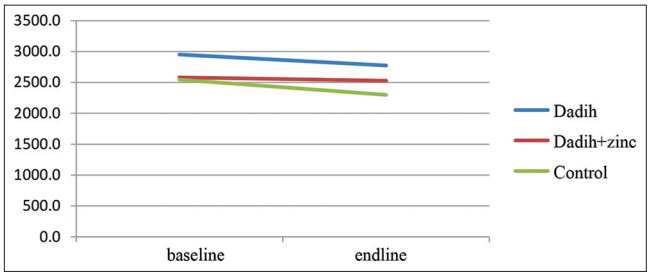

Figure 1: Changing of SIgA infants' level after 6 months of intervention

Table 3: Differences in infant's weight gain

Variable	Dadih (n = 46), n (%)	Dadih + zinc (n = 40), n (%)	Control (n = 40), n (%)	Total (n = 126), n (%)	p
Weight gain					
Decrease	4 (8.7)	7 (17.5)	7 (17.5)	18 (14.3)	0.49
Stable	2 (4.3)	2 (5)	4 (10)	8 (6.3)	
Increase	40 (87.0)	31 (77.5)	29 (72.5)	100 (79.4)	

Follow-up of infants' growth

Table 3 above shows that the growth of infants with the highest weight gain (87.0%) is in the *dadih* group and in *Dadih* + Zinc group (77.5%). Meanwhile, the lowest proportion was in the control group (72.5%). Statistically, it also shows that there is no significant difference in the growth of infants' weight in each intervention group ($p < 0.05$).

The total morbidity of infants in the *Dadih* + Zinc group is 8.9%. They were exposed to three types of diseases (fever, diarrhea, and cough/flu) for 6 months of follow-up. The highest proportion of infants who had no disease during 6 months of follow-up was found in the *Dadih* + Zinc group which amounts to 28.9%.

Effect of dadih and zinc on secretory immunoglobulin A (SIgA) level

This study shows that sIgA level at the beginning of the study is 2951 ± 960 ng/mL for the *dadih* group, 2578 ± 960 ng/mL for *Dadih* + Zinc group, and 2544±1044 ng/mL for the control group (Figure 1). Statistical analysis does not show the difference in the gastrointestinal sIgA level among three groups ($p > 0.05$). After the treatment, there is a decrease in sIgA level among three groups. In the *dadih* group, the sIgA level decreases to 2773 ± 1401 (the decrease is 178 ng/mL). In the *Dadih* + Zinc group, it decreases to 2528 ± 1015 (the decrease is 50 ng/mL), whereas in the control group, it decreases to 2299 ± 927 ng/mL (the decrease is 245 ng/mL). Statistical analysis shows that the magnitude of the decline among three groups is not different ($p > 0.05$).

Discussion

Analysis of the relation of infants' sIgA level to zinc shows a relating pattern that is directly proportional, where the higher the zinc level, the higher the sIgA level. Statistically, there is no relationship between the two variables ($p = 0.197$, $r = 0.227$).

The total sIgA examination shows the defense system in the gastrointestinal mucosa. IgA is found in many parts of the body's secretions (saliva, mucus, tears, colostrum, and milk). The contribution of a constant fragment of sIgA with the mucus component bond allows microbial binding. sIgA is the body's most widely produced antibody through the mucosal system, especially in mucosal-associated lymphoid tissues. It is estimated that there are about 3–5 g of sIgA secreted into the intestinal lumen every day.

This study compares the sIgA level in the group that receives *dadih* to the group that receives and *dadih* combined with zinc. The results shows a decrease in sIgA level in the three groups, where the largest decrease is found in the control group and the smaller decrease is found in the combination of *dadih*-zinc. These results show that the *dadih* with the components of lactic acid bacteria in it is not considered as strange (non-self) components by the body so that no immunological response occurs. However, this data do not show the development of sIgA at the initial stage. Greater decrease in sIgA level in the control group shows that *dadih* and zinc have a strong influence on maintaining total digestion in the gastrointestinal system for a longer period of time [18], [20], [28].

Zinc is a very important trace element for the body's immune system that has a benefit as a non-specific immune system, such as neutrophils and natural killer cells [21], [29], [30], [31]. Zinc does not only affect natural killer cells but also affects the cytolytic activity of T-cells [24], [32], [33], [34]. Zinc is related to the immune system because zinc can accelerate the translocation of nuclear factor kappa-beta. This protein is a transcription regulator that regulates the production of cytokines, inflammation, etc. Th1 cell activity keeps the length of sIgA levels high in the digestive tract. This cell activity is affected by the presence of zinc in the circulation.

From the results of the study, it can be said that *Dadih* + Zinc supplementation has an effect on increasing the immunity response of infants by one-third without pain during the 6 months of follow-up found in the zinc *dadih* group compared to the *dadih* group and control group. Nearly one-third of infants have suffered from one type of disease or more than one type of disease. The effect of giving the *dadih* and zinc to the mother during this pregnancy can decrease the level of pain experienced by the baby after birth also has an impact on the infant's nutritional status which is also better than the control group, although it is not statistically significant ($p > 0.05$).

The results of this follow-up study find out that there were still infants suffering from stunting, which amounts to 15.9% found in three intervention groups. This stunting condition was 2 times higher in the control group. In stunting, the child's height does not meet normal height standard according to their ages [6], [35], [36], [37]. Short infants are closely related to conditions that occur in a long time, such as poverty, poor hygiene and healthy behavior, poor environmental health, poor parenting, and low levels of education [7], [38], [39], [40]. Therefore, further subscriptions are needed to improve the stunting condition suffered by infants at that time. There are solutions for these problems, such as feeding complementary with breast milk and zinc-fortified local foods to infants that might be carried out in the next phase of research.

Conclusion

Dadih supplementation and Dadih + Zinc supplementation has a positive effect in pregnancy outcome which can lower the proportion of stunting in infants. Acceleration and growth of infants to achieve optimal growth and development should be carried out before they are under 2 years old. The level of technology preparedness in the form of development of *dadih* products as a supplementary food of local products in West Sumatra that is high nutritional value needs to be developed as a form of further intervention to improve infants' development.

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