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Research Article

Formula F-100 Based Complementary Feeding and Locally Made Flour to Underweight Toddlers

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Abstract

Background and Objective: The prevalence of under nutrition is relatively higher than malnutrition. Under nutrition is a combination between inadequate nutrition intakes and infectious diseases. Problems of under nutrition could overcome through the provision of a proper diet to increase weight. WHO has recommended F-100 formula as complementary feeding for a quick weight gain in toddlers suffering from acute malnutrition. The aim of this study was to know the influence of consumption F-100 that be applied by adding carbohydrate food from local ingredient modifications as complementary feeding for underweight toddlers.

Materials and Methods: This research adopt quasi experimental pre-post test with control group design. It was conducted in 3 districts in South Tangerang Regency, Banten, Indonesia. They were divided into 2 groups having 40 toddlers as a treatment/experimental group and 33 toddlers as a control group. Data processing and data analysis were carried out using paired t-test and changes in treatment and control groups were tested using t-test independent. **Results:** The results showed that they were different with weight changes ($p=0.00$), height changes ($p=0.00$) and Z-score index W/A ($p=0.15$), W/H ($p=0.01$) and H/A ($p=0.02$) between the treatment group and the control group. **Conclusion:** F-100 (liquid) or modified F-100 with locally made flour used as a complementary feeding for solving the acute malnutrition in children.

Key words: Underweight toddlers, consumption F-100, complementary feeding, locally made flour, Z-score index

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Problems of undernutrition in Indonesia haven't shown significant improvement. According to Basic Health Research 2013 showed there were considerable increases in the prevalence of underweight toddlers from 17.9% in 2010 to 19.6% in 2013, while prevalence of stunted toddlers mounted up from 35.6-37.2% in the same period¹. Problems of undernutrition, either underweight or stunted toddlers could be used as an indirect measurement quality of life from its society as well as a basic planning and policy development of the country's welfare program. Furthermore, the prevalence of stunted and underweight toddlers is a key indicator of future food security information system on national and international level². Underweight toddlers have a high risk of health degradation status, considering that they need adequate nutrition during their stages of growth and development. Inadequate nutrition lead to vulnerability to infectious diseases that would interfere nutrient absorption and reduce appetite. Therefore, it could be stated that the nutritional status of the underweight toddlers is a sensitive indicator for their life qualities because it possesses transgenerational effect just like an endless spiral^{3,4}.

The prevalence of undernutrition is relatively higher than malnutrition. Undernutrition occurs due to a substantial imbalance between energy needs and energy as well as nutrients consumptions, causing cumulative macro and micro nutrient deficiency that negatively affects growth, development and other health aspects. In other hands, undernutrition was a combination between inadequate nutrition intakes and infectious diseases. Undernutrition was determined by a Z-score. Extremely underweight if the Z-score is less than -3, underweight if Z-score is higher than or equal to -3 and less than or equal to -2, normal if Z-score is higher than -2 and less than or equal to 2 and overweight if Z-score is higher than 2 above the median standard of the World Health Organization (WHO) for children aged 6-59 months⁵.

Several studies in other countries reported that mortality happened frequently in children under-five suffering undernutrition compared to those with normal weight⁶. The main factor that caused under nutrition among children under 2 years of which is the inadequate intake of complementary feeding/weaning in terms of both quantity and quality. The WHO and United Nations Children's Fund (UNICEF) have committed to improve the quality of feeding behavior to toddlers in order to achieve optimal growth, development and health⁷. Moreover, freedom from hunger is a fundamental

right of all human beings, including children⁸. Problems of undernutrition can be overcome through the provision of a proper diet to increase weight.

A relatively inexpensive, practical, safe and high nutrient food administration is among strategies to improve catch-up growth on stunted toddler. WHO has recommended F-100 formula as complementary feeding for a quick weight gain in toddlers suffering from acute malnutrition⁹. Each 100 cc F-100 formula contains 100 calories, 3.8 g protein, 7 mg zinc, 7.5 mg magnesium, 60 mg potassium and 0.9 mg copper. Unfortunately, the disadvantage is its liquidity, whereas, the thickened one could generate more energy as well as not only useful as a meal for malnourished children in the transition phase but also works interchangeably as a main dietary meal at the age of 6-8 months and as a complementary feeding for children above 8 months.

Formula F-100 provision is very excessive at times. It would be better to utilize it, for example by thicken it up. In addition to produce more energy, its consumption also tends to be flexible either as a meal for malnourished children in the transition phase, main dietary meals for infants aged about 6-8 months or complementary feeding for children above 8 months. Energy augmentation through F-100 formula administration could be applied by adding carbohydrate food, particularly those derived from local ingredients. Among the local foodstuffs that could be used as a source of energy are corn, sweet potato and cassava. A selection of these foodstuffs is constituted by their abilities to grow in all types of land, including on a dry land. However, consumption of F-100 or its modification as a complementary feeding for undernourished toddlers still needs to be further analyzed, making it easier for health professionals/health care practitioners to find prevention and solution alternatives for undernutrition problems.

The study aimed to assess the effects of consumption F-100 that be applied by adding carbohydrate food from local ingredient modifications as complementary feeding for underweight toddlers.

MATERIALS AND METHODS

Research subject: This research adopt quasi experimental pre-post test with control group design. It was conducted in 3 districts in South Tangerang Regency, Banten, Indonesia, namely Pamulang, Serpong and North Serpong districts. Basis for sample selection was undernourished children who had met inclusion criteria, which were undernutrition status (underweight and extremely underweight) based on weight to height parameter, possess no prior complication diseases,

both infectious and non-infectious diseases registered and participated in weighing at Posyandu (Integrated Service Post), lactose tolerant, non-allergic to cow's milk and willing to sign the informed consent. Exclusion criteria were uncooperative parents and ill children.

Sample size calculation: Error analysis refers to research of Lamid *et al.*¹⁰ by referring to 5% α ($Z \alpha = 1,960$), 90% β ($Z \beta = 1.282$), standard deviation of Z-score (1.30) and desired average changes in Z-score was 0.6, thus obtained the minimum number of samples for each group was 25 people. This amount was summed up with drop out estimation as much as 20% or equals to 5 people. Hence, the minimum total sample for each group was 30 people.

Data collection: Collected data were anthropometric data consisted of W/H, W/A and H/A, consumption data, other supporting data such as characteristics of children and parents, social and economic data, respondent's past medical history, breast feeding history and data of first weaning food administered to toddlers. Height data were obtained using infantometer with 0.1 cm precision and weight data acquired using foot tap digital scale with a precision of 0.1 kg.

Research implementation: Research was conducted from August-October, 2015. Selection of the sample was assisted by official and 4 enumerators from D4 Nutrition Department who graduates of Polytechnic of Health Jakarta II. Prior to be specified as selected samples, all prospective samples that met the criteria were gathered to be clearly informed about potential interventions, duration and types of measurement, then were asked to sign the informed consent stating their willingness as well as awareness to potential risks.

Intervention and monitoring: Experimental materials were formula F-100-based instant complementary feeding and enriched with locally made flour. F-100 were purchased from PT. Bogor and complementary feeding were formulated by researcher and produced by Laesso catering located in Pamulang. F-100 base contains skim milk, vegetable oil, granulated sugar and complex minerals comprised of potassium chloride, potassium citrate, magnesium chloride, zinc acetate and copper sulphate. While instant pulverized foods were thick paste made from milk powder, sugar and oil diluted into the water, then boiled and added with locally made flour products (corn starch, cassava starch and sweet potato starch).

Table 1: Nutritional values of treatment and control groups (F-100)

Nutrients	Treatment group	Control group (F-100)
Energy (kcal)	324.00	200
Protein (g)	4.50	6
Fat (g)	18.30	12
Carbohydrate (g)	42.90	16
Fiber (g)	0.80	0.6
Calcium (mg)	138.65	360
Phosphorus (mg)	144.82	206
Iron (mg)	0.80	0.2
Potassium (mg)	283.23	34
Total carotene (μ g)	108.30	0.02
Zinc (mg)	8.00	3.3

There are 2 groups in this research, namely a treatment/experimental group and a control group. Treatment group acquired 2 cups of F-100-based instant complementary feeding that was thickened using either corn starch, cassava starch or sweet potato starch containing 324 energy calories, 6 g proteins and vitamins, whilst control group was provided with 2 sachets of F-100 containing 200 kcal, 6 g protein and minerals. Complementary feeding interventions were expected to contribute up to 20-25% of toddler's needs towards energy fulfilment. Composition of F-100-based complementary feeding and locally made flour for treatment group and F-100 for control group could be seen in Table 1.

Treatment group acquired 2 cups every day within 30 days, which were directly sent to the respondent's house. Whereas, control group was provided with 12 sachets at once/week. To monitor respondent's compliance, they were visited once a week to gather information regarding their compliance as well as asked about toddlers' current health conditions e.g., diarrhea, frequency of bowel movements, etc. Additionally, anthropometric measurements that includes weighing, height measurement and nutritional status measurement (underweight, wasting and stunting) were also conducted. By the time mother received food formula, she should return the cups and report her compliance, also noted on the form of compliance. Form of compliance was filled out every week and submitted at the time research assistant performed anthropometric measurement.

Statistical analysis: Data processing and data analysis were carried out using computer program. Nutritional status based on W/H and W/A Z-scores were calculated using the WHO Antro 2005 software. Meanwhile, data of formulation and food intakes were analyzed using nutri-survey 2005 program. Data were analyzed using descriptive statistics to observe illustration of characteristic, energy intake and nutrients as

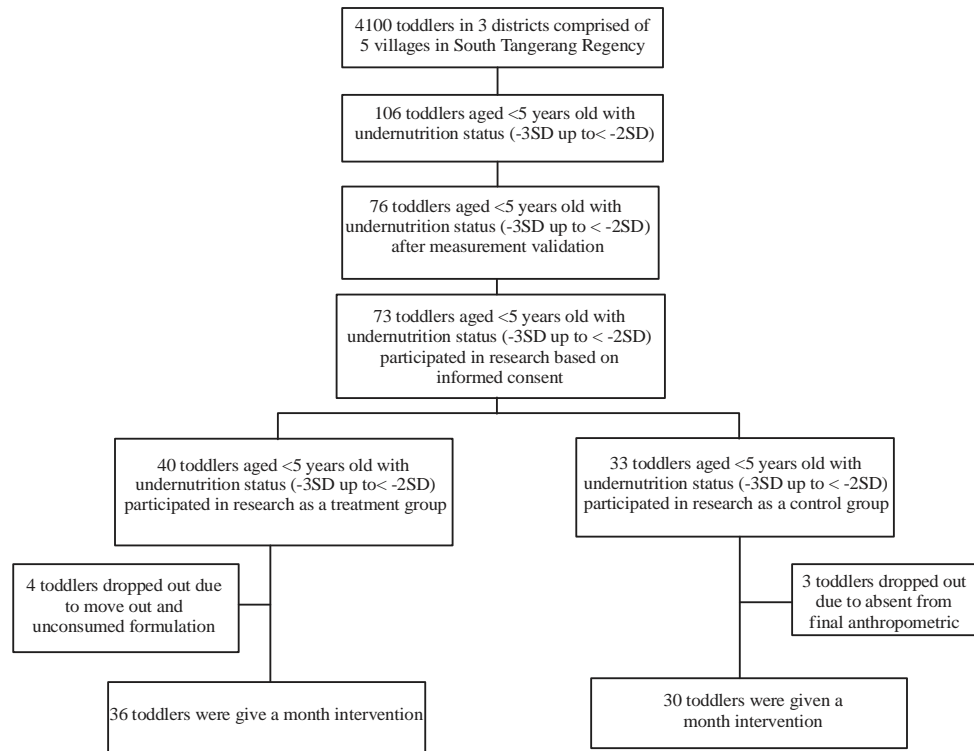


Fig. 1: Flow diagram of identified subject

well as contribution of complementary feeding and nutritional status. The Z-score difference before and after the test was calculated using paired t-test and changes in treatment and control groups were tested using t-test independent with probability level 5%.

RESULTS

Initially, 4100 children under 5 years old (toddlers) of Posyandu (Integrated Service Post) participants from 3 districts Pamulang, Serpong and North Serpong were chosen. Following a screening process based on undernutrition status using W/H parameter with Z-score > -2 SD, 106 toddlers with undernutrition cases were found. Screening was conducted based on age limit under 5 years old until October, 2015 and undernutrition status. Out of 106 undernourished toddlers reported by officials, only 76 children were actually fit into the category (undernutrition status) after re-weighing. Mothers and child's caretakers were then gathered and given an explanation about potential intervention as well as asked their willingness to follow the nutrition improvement program. Only 73 respondents agreed to do so. This number was then divided into 2 groups, which were 40 as a treatment/experimental group and 33 as a

control group. During a month treatment turned out there were 4 people from the treatment group and 3 people from the control group resigned due to migrating parents and due to absent from the last anthropometric measurement. Further details could be seen in Fig. 1.

Characteristic of research subject: The data in Table 2 showed the characteristics of treatment group and control group. Most samples ($> 50\%$) of both the treatment group and the control group were female, 25-29 months old and normal birth. Characteristics that appear different from the 2 groups were a treatment group have a habit of drinking milk, complete immunization and regularly went to Posyandu better than control groups which was 43.3, 100 and 100%, respectively, while the treatment group was 22.2, 80.6 and 80.6%. Nutritional status before the intervention did not differ significantly between the intervention and the control group, i.e., the proportion of H/A was 16.3 vs. 3.3%, W/A was 100 vs. 100% and W/H was 52.8 vs. 73.3%. For more details can be seen in Table 2.

Intervention efficiency of formula F-100-based complementary feeding and locally made flour to underweight children: This result after intervention showed

Table 2: Toddlers' basic characteristic data of treatment and control groups

Socio-demography	Characteristics		
	Treatment group (n = 36) (%)	Control group (n = 30) (%)	p-value (Chi-square test)
Age (months)			
6-12	11.1	3.3	0.10
13-24	25.0	36.7	
25-29	63.8	60.0	
Sex			
Female	52.8	51.4	0.13
Male	47.2	29.7	
At term birth			
9 months	83.3	93.3	0.01
≥ 9 months or ≤9 months	16.7	6.7	
Birth weight			
Thin (< 2500 g)	16.7	3.3	0.11
Normal (2500-3500 g)	75.0	96.7	
Heavy (> 3500 g)	8.3	0	
Birth order			
1st child	47.2	53.4	0.125
2nd child	38.9	43.3	
3rd child	13.9	3.3	
Breastfed children	22.2	43.3	0.01
Weaning food administration (%)			
<1 month	2.8	0	
≥1 -<6 months	44.4	20.0	
≥6 months -1 year	52.8	60.0	
Complete immunization	80.6	100	0.00
Children with Posyandu routine	80.6	100	0.00
Children with sickness in the last 3 months	69.4	26.7	0.49
Children nutritional status			
Weight (kg) (Mean±SD)	9.40±1.92	9.45±1.68	0.53
Height (Mean±SD)	84.70±9.71	85.1±8.30	0.51
Stunting on first visit (%)	167	3.3	0.19
Wasting on first visit (%)	100	100	0.16
Underweight on first visit (%)	52.8	73.3	0.61

that weight had changed in treatment group and control group which were 0.477+0.53 and 0.453+0.122 kg. There were no height changes for both of the groups. The change about the nutritional status was seen to be significant, especially on indicators W/H which increased Z-score of 0.283+0.510 and 0.397+0.183. While in other indicators W/A and H/A Z-score didn't increase significantly.

The values in Fig. 2 and 3 significantly showed an improvement in nutritional status for the given treatment as seen from the value of Z-score on W/H. While no scores were shown on W/A as well as H/A indicators. When seen in depth, changes occurred differently between solid formula and liquid formula. Where liquid formula shows effective improvement in Z-score after the 2nd week of treatment. While solid formula showed a more consistent pattern of change in improvement ever since the 1st week of treatment delivery.

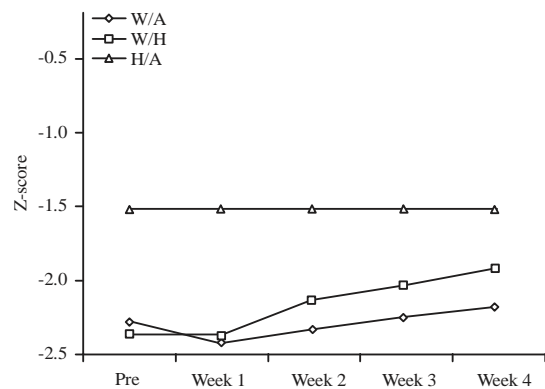


Fig. 2: Z-score changes during intervention on control group

DISCUSSION

The findings showed that modifications formula can improve nutritional status. The core research aimed to assess

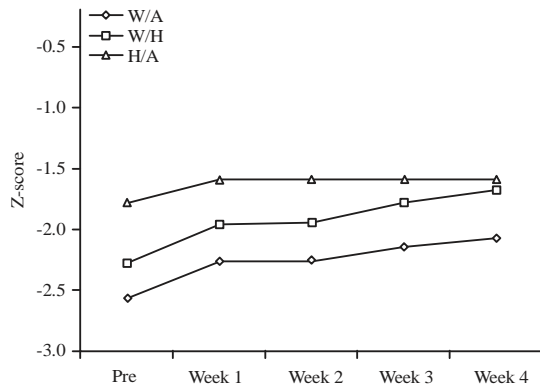


Fig. 3: Z-score changes during intervention on treatment group

whether complementary feeding between main meal time as much as 200-300 liquids (F-100) and solid (modified local foods coupled with milk, sugar and oil) calories could improve nutritional status of children aged 6-35 months of extremely low and low income families. The findings had showed that complementary feeding in liquid and solid forms equally possess weight gain effect and improve children nutritional status. It corresponds to several previous studies pointing that treatment group who was provided with milk, sugar and oil-based liquid food has higher effectiveness in weight gain and nutritional status improvement.

Adequate food compliance was among key factors that prevents morbidity and mortality risks, especially for children under 3 years old¹¹. Children undernutrition do not solely happen due to lack of food consumption but also caused by parenting of mothers, particularly in the course of feeding practices to infants and children, the quality of beside water and sanitation¹². Their ignorance is mostly about children's growing needs in accordance with growing age, therefore it was essential to pay attention to its compliance, both in the aspects of quantity and administration frequency¹³. A study in Malawi administering food intervention as much as 75 kcal kg⁻¹/day for 12 weeks reported that oil-based additional food increase higher weight gain than complementary feeding that was derived from locally made flour¹⁴.

The result of this study was somewhat different to common research. Complementary feeding interlude in liquid form which was formula F-100 with twice administration periods contains only 200 calories and solid food which was solid formula from local ingredients (corn/cassava/sweet potato) with additional milk, sugar and oil with twice

administration periods within a month contains 300 calories found out to be able to increase weight gain and improve nutritional status of the undernourished. However, even though complementary/additional feeding in liquid form which was Formula 100 (F-100) had less effect in increasing weight gain compared to solid food, it could improve undernutrition status relatively higher. It corresponds to some researchers who claimed that instant solid foods had a small chance of bacterial exposure because they did not require any processing prior to consumption. Nevertheless, they had higher viscosity value that caused a longer process in the gastrointestinal tract, slower gastric drainage and causing children to feel full rather long compared to complementary feeding in liquid form^{15,16}. Thus, the administration on feeding in liquid form would not interfere main dietary intake that was close to complementary feeding time. It was in line with an argument that key recovery of malnourished children aren't replacing regular intake but rather enhancing the commonly consumed food intake.

Other studies also reported that recovery success of the undernourished toddlers would be more effective if complementary feeding administration was combined with counselling to child's caretakers and/or parents¹⁷. It was in line with study of Phuka *et al.*, mentioning that complementary feeding administration to undernourished children in rural areas could only improve nutritional status based on W/A and W/H but did not cover nutritional status improvement based on H/A¹⁸. The difference only showed in the age range. Phuka's research observed children aged 6-18 months, while this research observed children with an age range of 6-35 months. Other causes that were suspected to prompt invisible height gain was that possibly due to intervention period, which was only performed for 30 days. Saleem *et al.*, 2014 reported that the height changes were visible and stunting problems were recovered through complementary feeding administration in a longer period (at least 70 days)¹⁹.

CONCLUSION

Modified local foods could improve undernutrition status relatively higher. It is better than instant solid foods that had a small chance of bacterial exposure because they did not require any processing prior to consumption. Nevertheless, they had higher viscosity value that caused a longer process in the gastrointestinal tract, slower gastric drainage and causing children to feel full rather long compared to complementary feeding in liquid form.

SIGNIFICANCE STATEMENTS

This study discovers the complementary feeding in liquid and solid forms equally possess weight gain effect and improve children nutritional status. Formula as complementary feeding can be beneficial for a quick weight gain in toddlers suffering from acute malnutrition. This study will help the researcher to uncover the critical areas of developing food local ingredient modifications as complementary feeding for underweight toddlers. Food local such as corn, cassava and sweet potato are very easy to get around and low price so mothers can prepare food for her children. On the others hand, many researchers explored modification food for severe malnutrition. This study will help the researcher to cover the critical area of undernutrition, that many other researchers used this modification food as a reference.

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