nutrición clínica y Dietética Hospitalaria

Artículo Original

Nutr Clín Diet Hosp. 2025; 45(2):110-120
DOI: 10.12873/452khomsan

The impact of nutritional and psychosocial interventions on the development of children with severe acute malnutrition (SAM): a cluster randomized controlled trial

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Recibido: 30/enero/2025. Aceptado: 18/abril/2025.

ABSTRACT

Introduction: Toddlers with Severe Acute Malnutrition (SAM) are at high risk of impaired growth and development. Nutritional intake and lack of adequate stimulation can be the cause. The purpose of this study was to evaluate the effectiveness of the Bregas Nutriroll Ready to Use Therapeutic Food intervention, with and without combination of psychosocial stimulation among SAM toddlers.

Methods: This research was a cluster random controlled experiment, involved 55 children ages 12 to 59 months with SAM which split up into three groups. The control group was given F100, group 1 received an intervention consisting of Bregas Nutriroll, whereas group 2 received both Bregas Nutriroll and psychosocial stimulation. This research conducted on August 2023 to February 2024 in Panite and Kualin villages, South Central Timor Regency, East Nusa Tenggara Province, Indonesia. Data collected included toddler and family characteristics, as well as toddler development, anthropometric data including weight, height, and upper arm circumference.

Results: Kruskal Wallis test showed data antropometric between group were homogen, except for the median age data (p=0.034). One-way ANOVA test showed Weight-for-Age Z-score (WAZ) (p=0.048) and Weight-for-Height Z-score (WHZ) (p<0.001), were significanly different after intervention. The development mean score in toddlers increased in control group (8.4±2.2 to 8.8±1.5), and group 2 (8.4±2.1 to 9.5±1.0), respectively. Friedman test analysis showed there were significant differences in development score between control group and group 2 (p<0.05).

Conclusion: Study showed that a comprehensive approach combining nutritional interventions and psychosocial stimulation could be an effective strategy to improve nutritional status and developmental in SAM toddlers.

KEYWORDS

Malnutrition, Child growth, Therapeutic supplements, Health education, Social impact.

INTRODUCTION

Severe Acute Malnutrition (SAM) in early childhood remains a serious public health issue, especially in developing countries[1]. The two most common forms of child malnutrition in developing countries are 1) wasting, caused by severe acute malnutrition (SAM) or moderate acute malnutrition (MAM), and 2) stunting, which can be seen in more chronic forms of child malnutrition. Each phenotype uniquely affects brain development and behavior[2]. SAM is the most commonly found disease in maternal and child health facilities, with around 60 million children suffering from severe acute malnutrition (SAM) worldwide[3]. Children under the age of five in many developing coun-

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tries mostly die from SAM and need to be hospitalized, with a mortality rate of 25–30%[4]. This condition can negatively impact physical growth and cognitive development. Toddlers with acute malnutrition have poor mental development and tend to have low intelligence levels, which can lead to behavioral problems and achievements in later childhood[5]. Undernutrition at this age will have a lifelong influence on growth, leading to stunted growth and developmental delays, characterized by low brain development capacity[6]. Additionally, infants or toddlers who lack protein and vitamins such as iron and folate may experience problems in language development, learning, memory, and processing, leading to poor school performance. This can continue throughout life, causing difficulties in finding employment and developing other skills[7].

The standard nutritional intervention of F100 contains about 100 kcal per 100 ml, providing a significant calorie intake in a small volume to meet the needs of SAM toddlers. Ready to Use Therapeutic Food is considered effective in addressing severe acute malnutrition furthermore, its provision for children with SAM is a widely accepted strategy in many countries[8] and provided as a comprehensive intervention to improve the quality of life for these children[9]. Bregas nutriroll is a ready to use therapeutic food (BN RUTF) is designed to have a very high energy and nutrient content, this product developed by IPB University using local food ingredients in the form of practical and easy-to-use wafer rolls, which have been tested on SAM toddlers in several regions[10,11]. Bregas nutriroll products are enriched with nutrients designed for children aged 12-59 months with SAM. It has the form of a peanut paste wrapped in a wafer roll, while F100 is a milk formulation that can be consumed directly without cooking and can provide high energy and protein to aid recovery, weight gain, and repair damaged tissues to address malnutrition in SAM toddlers[12]. Bregas nutriroll has a nutritional value comparable to F100 for children with SAM, plus 36 mg of iron per 100g[12]. Although the nutrient-to-energy ratio of both therapeutic diets is equivalent, Bregas nutriroll has an energy density five times higher than F100[13]. Increasing the energy density of Bregas nutriroll by integrating peanut butter into part of the skim milk powder used in the F100 formulation is a pragmatic strategy[11].

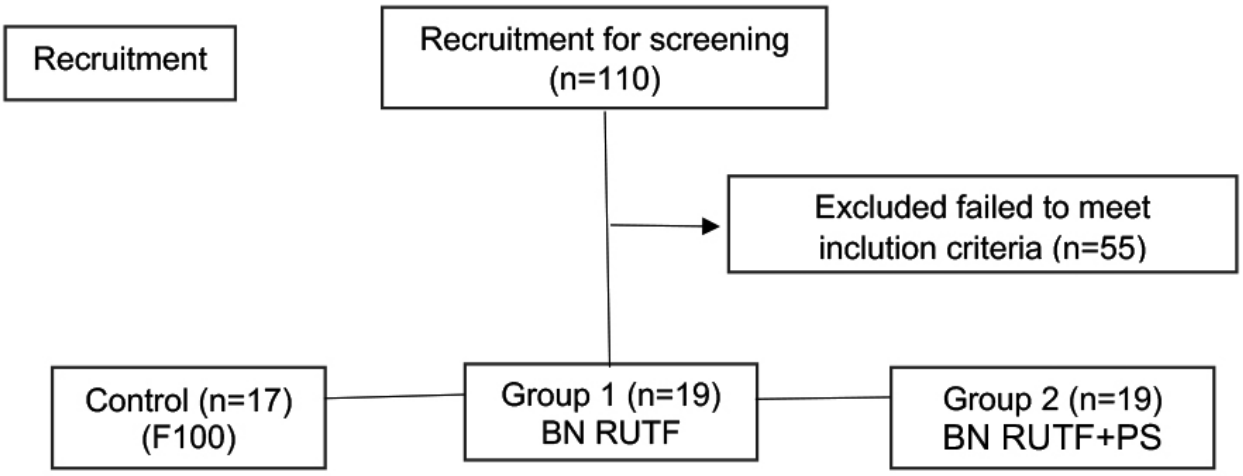
Previous studies have shown that interventions combining nutrition and cognitive stimulation can significantly improve children's mental abilities[14]. The results of the study by Grantham (2016), which conducted home visits with food supplementation and psychosocial stimulation for 2 years, yielded sustained benefits for malnourished children[15]. Additionally, Hamadani (2006) stated that a 1-year psychosocial stimulation intervention in rural Bangladesh was also beneficial for the development of children with moderate to severe underweight[16]. This study evaluated the effectiveness of F100, Bregas nutriroll intervention without and with a combination of psychosocial stimulation on the development of SAM toddlers. The intervention was given for 2 months. Research data were taken at the pre, post of the intervention and 4 months after the intervention.

RESEARCH METHOD

This study uses a cluster randomized control trial/Cluster RCT design. This study focuses on children aged 12-59 months with uncomplicated SAM living in the working areas of Community Health Center Panite and Kualin, South Central Timor Regency, East Nusa Tenggara Province, Indonesia. The inclusion criteria for the subjects are (a) children aged 12-59 months, (b) nutritional status of children meeting the WHO criteria for SAM with cut of point are weight-for-height (WFH) <-3SD or MUAC <11.5 cm [13], (c) children in clinically healthy condition, (d) children with adequate appetite, (e) willingness to follow all research procedures and sign informed consent. The exclusion criteria are (a) toddlers detected with SAM with medical complications such as high fever, weakness, lethargy, continuous vomiting, apathy, difficulty breathing, severe edema, unconsciousness, seizures referred to stabilization centers/ Therapeutic Feeding Center (TFC) for treatment, (b) toddlers with congenital abnormalities/defects, (c) toddlers detected with SAM with complications requiring hospitalization, (d) toddlers detected with SAM with allergies to wheat, nuts, and other raw materials. The flow chart of the study population can be seen at Figure 1.

This research has been approved by the Advanced Study Research Council of Kupang Health Polytechnic (reference number: LB.02.03/1/0147/2023). Written consent has been obtained from the parents or guardians of the participating children. The first data collection is data about the subject's characteristics and includes name, gender, date of birth, IMD history, which child, the first drink given at birth, anthropometric data (weight, height, Upper Arm Circumference/ MUAC), energy, protein, fat, and carbohydrate intake, micronutrient intake (vitamin A, C, calcium, iron, and zinc), and nutritional adequacy. Data were obtained through interviews using a 24-hour recall form. Family characteristic data includes parents names, ages, occupations, and income. Data was obtained through interviews using questionnaires.

Children under five years old who met the inclusion criteria were given an intervention for eight weeks. The control group was given F100, where each package consisted of milk, sugar, oil, and a mineral mix, in measured doses according to the toddlers' needs. The F100 intervention package is given once a week, consisting of 7 packages for the preparation of the following week. One package for one day's serving, in accordance with the protocol for managing malnutrition in toddlers in an outpatient setting[17]. The provision of the F100 package to the control group is adjusted according to the toddlers' weight, taking into account their daily consumption deficit. Toddlers weighing 5-6.9 kg are given F100 at a dose of 500 ml/day. If their body weight ranges from 7 to 9 kg, they are given 500 to 750 ml each day. The nutritional composition of F100 and Bregas Nutriroll RUTF can be seen in Table 1.



F100: Standar therapy Formula 100. BN RUTF: Bregas Nutriroll Ready to Use Therapeutic.
BN RUTF + PS: Bregas Nutriroll Ready to Use Therapeutic with Psychosocial Stimulation.

Figure 1. Flow chart of the study population

Table 1. Nutritional composition of F100 and Bregas Nutriroll

Parameter	Unit	F100	Bregas Nutriroll	Standard Unit (min - max)
Dietary fiber	%	-	5.52	<5
Carbohydrates	%	-	49.01	-
Total Calories	kkal	101.17	534.47	520.00 – 550.00
Total fat	g	5.97	31.59	26.72 – 35.63
Protein	g	3.09	13.53	13.36 – 16.03
Vitamin A (retinol)	mg	-	0.57	0.8 – 1.1
Selenium	mcg	-	11.83	20 - 40
Copper	mg	-	0.68	1.4 – 1.8
Zinc	mg	4.12	7.51	11 – 14
Iron	mg	0.085	6.14	10 – 14
Magnesium	mg	8.74	36.32	80 – 140
Phosphorus	mg	-	218.28	300 – 600
Calcium	mg	-	179.61	300 – 600
Potassium	mg	-	599.93	1100 – 1400
Iodine	mcg	-	40.63	70 – 140
Omega 3	kkal	-	6.63	3 – 10
Omega 6	kkal	-	0.45	0.3 – 2.5

The intervention group1 received Bregas Nutriroll, produced by P.T. Java Indo Sejahtera Mandiri in Depok, West Java, Indonesia, which complies with WHO guidelines (Table 1). The administration of Bregas Nutriroll to SAM toddlers weighing 5-6.9 kg was given two packages (each package containing seven sachets @±14g), while children weighing between 7-9.9 kg received three packages, and toddlers received 100g[12]. Parents of toddlers were given an explanation about the importance of providing appropriate nutritional interventions. They were asked to provide F100 packages and Bregas nutriroll to their children according to the instructions for 8 weeks.

Nutritional status is assessed through anthropometric measurements, height for toddlers over 2 years old using a microtoice, while for children under 2 years old, a Length Board is used, conducted by trained personnel. Upper arm circumference is measured using the UNICEF - Ministry of Health of the Republic of Indonesia Upper arm circumference tape. The determination of nutritional status for children under five years old is calculated based on weight in kilograms compared to height in square meters. Data collection is checked regularly once a week, including calibration. Developmental data were collected using the prescreening questionnaire adjusted to the age at which the developmental data were taken. Meanwhile, the environment that influences toddler development is measured using the Home Observation for Measurement of the Environment (HOME Inventory).

Nutritional intervention group 2 through the provision of Bregas Nutriroll, while psychosocial intervention through "Early Childhood Family Development" education for mothers/caregivers of SAM toddlers, with participants gathered at the village office, given once a week for 8 weeks/2 months. The material was delivered by a Nutrition Health officer who has received education training certificate and works at the Timor Tengah Selatan District Health Office, East Nusa Tenggara Province. That materials provided include understanding positive self-concept, the role of parents in caregiving, children's health and nutrition fulfillment, stimulation of gross and fine motor development in children, stimulation of active, passive, and intelligence communication, introduction to body parts, and proper caregiving[18,19]. Next, respondent development data will be collected three times: at the pre, post of the intervention, and follow-up 4 months after the intervention.

Because there are no national-level indicators for psychosocial stimulation, poverty is used as a proxy to identify the estimated number of children worldwide who have cognitive and language development test scores far below the expected level. The number of these children is estimated to reach 200 million, or 39% of the total[20]. The Indonesian government has a national program aimed at reaching all toddlers, namely "Early Child Development Stimulation, Detection, and Intervention" program. Implementation of this program use a Screening Kit. This kit is a set of tools used to monitor and assess children's growth and development comprehensively, containing educational game tools to stimulate children's motor, cognitive, and social development, as well as development screening forms or guidebooks (for example, red wool thread, raisins or beads, a drum with a handle, red, yellow, purple, and blue cubes with 8-10 colors, small bells, a small bottle, a tennis ball, small bells, blank paper, a table and chair, and the manual book). During the testing session, each child was given instructions to perform motor functions that the child could achieve[21].

Child development status is analyzed based on pre-development screening questionnaire score, where the measurements assess fine motor skills, gross motor skills, speech, language, socialization, and independence which is an early detection instrument in the development of children aged 0 to 6 years, whether their development is normal or there are deviations. The assessment is based on how many instructions the toddler can follow to measure development, where all ten commands must be carried out by the SAM toddler respondents according to their age level, which is 12, 15, 18, 21, 24, 30, 36, 42, 48, 54, and 60 months. For the interpretation, the number of "Yes" answers is counted. Number of "Yes" answers = 9 or 10, the child's development is in accordance with the developmental Appropriate (A). Number of "Yes" answers = 7 or 8, child's development is Questionable (Q), number of "Yes" answers = 6 or less, there may be Deviations (D).

The quality that affects the growth and development of toddlers was collected using HOME Inventory questionnaire. This instrument is for infants/children aged 0-3 years and 3-6 years, consisting of 55 items that describe the quality of the child's environment, with each question scored 1 (if the question applies) and 0 (if the question does not apply). Parenting is categorized as low if the total score is 0-25, moderate 26-36, and good 37-45. Child development data were collected at the beginning, end of the intervention, and follow-up 4 months after the intervention. This questionnaire is a more accurate way to measure psychosocial stimulation[22]. Mothers with higher scores show more positive and engaging reactions when they talk to their children about pictures[23]. The mental development of children is also highly correlated with those scores. The HOME Inventory can be used as a blueprint for stimulation interventions and as a manipulation check to determine whether the intervention has changed the way parenting is conducted.

Data on respondent characteristics were analyzed descriptively and presented in n (%). To determine the comparison of respondent characteristics (age, gender, birth weight, birth length and order of children) between 3 unpaired groups, the Kruskal Wallis test with the post hoc Mann Whitney test with Bonferroni correction was used. This analysis is used because the data is not normally distributed. To determine the difference in nutritional status between the 3 groups using Oneway

Anova, the significance value is set at p<0.05. Data on the differences in intervention effects between paired groups were analyzed using the Friedman test with post hoc Wilcoxon, and significance was determined at p<0.05.

RESULT

Characteristics of respondents

This study involved 55 SAM toddler respondents who met the inclusion criteria. The number of respondents in the control group (n=17), intervention group I (n=19), and intervention group II (n=19). Data characteristics between groups showed no significant or homogeneous differences in gender, birth weight, birth length, and birth order. However, there is a substantial difference in the median across all age groups (p=0.034). The age proportion of respondents in the control and intervention groups were mostly ≤23 months and above (58.1%), and those aged ≥24 months (41.9%). In the control group, only five respondents (29.4%) were aged ≤23 months, while those aged ≥24 months numbered 12 respondents (70.6%). Meanwhile, the intervention groups 1 and 2 did not differ significantly, both groups were mostly aged ≤ 23 months. Child characteristic data are presented in Table 2.

Nutritional Status

The nutritional status of respondents under five years old is an important indicator in determining the health status of the community, especially during the critical period of growth and development in early childhood. Good nutritional status during the toddler period determines the quality of children's lives in the future, affecting their physical, cognitive, and immune development. This study uses four anthropometric indicators (WAZ, HAZ, WHZ, and MUAC) to assess the nutritional status of children under five years old. The analysis

Table 2. Characteristics of respondents

Characteristics	Control		Group 1		Group 2		P-value
	n	(%)	n	(%)	n	(%)	
Age (month)							
≤23 months	5	(29.4)	15	(78.9)	12	(63.2)	
24-36 months	5	(29.4)	3	(15.8)	4	(21.1)	
>36 months	7	(41.2)	1	(5.3)	3	(15.8)	
Median (IQR) (month)	29.8	(25)	18.7	(7.4)	20.9	(15.2)	0.034*
Gender							
Male	10	(58.8)	7	(36.8)	10	(52.6)	0.397
Female	7	(41.2)	12	(63.2)	9	(47.4)	
Birth weight							
< 2500 g	5	(29.4)	2	(10.5)	6	(31.6)	0.255
≥ 2500 g	12	(70.6)	17	(89.5)	13	(68.4)	
Birth length							
< 48 cm	7	(41.2)	13	(68.4)	11	(57.9)	0.261
≥ 48 cm	10	(58.8)	6	(31.6)	8	(42.1)	
Child order							
< 3	8	(47.1)	6	(31.6)	12	(63.2)	0.155
≥ 3	9	(52.9)	13	(68.4)	7	(36.8)	

Analyzed using: Kruskal Wallis test. Post hoc: Mann Whitney test with Bonferroni correction. *Statistically significant at p<0.05.

results show a statistically significant difference ($p < 0.05$) in the WAZ and WHZ indicators between groups. The nutritional status is presented in Table 3.

WAZ analysis showed a significant difference (p=0.048), the control group showed that 100% of the children experienced severe underweight, while the intervention groups 1 and 2 showed lower proportions, namely 78.9% and 68.4%. This difference indicates that the interventions provided to groups 1 and 2 may have a positive impact in reducing the prevalence of severe underweight. On the WHZ indicator, there is a very significant difference ($p < 0.001$) between groups. The control group and intervention group 1 showed that 100% and 94.7% of the children experienced severe acute malnutrition, while intervention group 2 showed a much lower proportion, namely 15.8%. On the other hand, group 2 showed that 84.4% of the children experienced moderate acute malnutrition, whereas the control group and group 1 had almost none. This indicates that the intervention in group 2 successfully reduced the proportion of severe acute malnutrition, but the proportion of moderate acute malnutrition remains high.

The HAZ and MUAC indicators did not show significant statistical differences between groups (p=0.112) and (p=0.204). However, there are still variations in the proportion of children with different nutritional statuses in each group. For example, in the MUAC indicator, the intervention group 1 showed a higher proportion of children with severe wasting compared to the control group and intervention group 2. This is consistent with research showing that adequate nutritional intake during infancy and early childhood correlates with improved growth trajectories[24].

Table 3. Nutritional Status of Children [n (%)]

Nutritional Status	Control	Group 1	Group 2	P-value
	n (%)	n (%)	n (%)	
WAZ				
Severely underweight (Z-score<-3 SD)	17 (100)	15 (78.9)	13 (68.4)	0.048*
Moderately underweight(-3SD≤Z-score<-2 SD)	0 (0)	4 (21.1)	6 (31.6)	
Normal (-2 SD≤Z-score≤ 2 SD)	0 (0)	0 (0)	0 (0)	
Overweight (Z score>2 SD)	0 (0)	0 (0)	0 (0)	
HAZ				
Stunting (Z-score<-3 SD)	8 (47.1)	6 (31.6)	10 (52.6)	0.112
Moderately stunted (-3≤Z-score<-2 SD)	7 (41.2)	5 (26.3)	7 (36.8)	
Normal (Z-score≥ 2 SD)	2 (11.8)	8 (42.1)	2 (10.5)	
WHZ				
Severe Acute Malnutrition (Z-score<-3 SD)	17 (100)	18 (94.7)	3 (15.8)	<0.001*
Moderate Acute Malnutrition (-3 SD ≤Z-score≤-2 SD)	0 (0)	1 (5.3)	16 (84.4)	
Normal (-2 SD ≤Z-score≤2 SD)	0 (0)	0 (0)	0 (0)	
Overweight (Z-skor>2 SD and≤3 SD)	0 (0)	0 (0)	0 (0)	
MUAC				
Severally wasted (<11.5cm)	2 (11.8)	6 (31.6)	3 (15.8)	0.204
Moderatelly wasted (11.5-12.4cm)	7 (41.2)	8 (42.1)	7 (36.8)	
Normal (≥12.5cm)	8 (47.1)	5 (26.3)	9 (47.4)	

Analyzed using: a one-way ANOVA test shows that there is a significant difference. *Statistically significant at p<0.05.

Overall, the results of this analysis indicate differences in nutritional status between groups, particularly in the WAZ and WHZ indicators. The intervention provided to intervention groups 1 and 2 seems to have different impacts on different indicators. Group 2 intervention showed significant improvement in the WHZ indicator, but group 1 intervention showed improvement in the WAZ indicator. These findings indicate that although interventions can address acute malnutrition, the path to optimal dietary status is complex. Research has shown that early childhood malnutrition can have devastating consequences, including stunted growth and a weakened immune system[25].

Anthropometric findings have important implications for long-term health outcomes. Nutrition during childhood is crucial for building a strong immune system, supporting brain development, and promoting healthy organ function (21). Children who receive balanced nutrition during their formative years typically show healthier body mass indices and lower chances of developing obesity-related diseases in adulthood.

Child Development Status

Toddler development is an important foundation for shaping their behavior, attitudes, and abilities in the future. Table 4 shows how interventions can affect the developmental status of toddlers in three different groups, as measured by the Pre-Screening Developmental Questionnaire. Some important aspects related to toddler development that were observed include behavior, attitudes, and parenting knowledge (such as health, hygiene, and feeding care); stimulation (such as talking, singing, and playing); responsiveness (such as early bonding, secure attachment, trust, and sensitive communication); and safety (such as routines and protection from hazards). The home environment and close child care, often provided by mothers, fathers, and other family members, as well as child care services, are two of the strongest environments for supportive parenting[26].

Table 4 shows the effectiveness of various interventions on toddler development. Statistical analysis shows significant differences between groups, where the control group (F100) and the intervention group 2 show substantial differences (p=0.021) (p=0.009). On the other hand, the group 1 did not show a significant difference, possibly due to non-compliance in its consumption. This emphasizes the importance of targeted interventions in promoting the significance of early childhood development for their long-term lives. The development of these children is evaluated at pre, post, and follow-up, with three categories of development: Deviant (D), Questionable (Q), and Appropriate (A).

This study shows that nutrition intervention alone can improve nutritional status but does not always have a more significant impact on child development compared to when combined with psychosocial stimulation. The results for the intervention group 2 show that this combination is very influential and highlights the importance of holistic interventions in child development. This is consistent with the research by Grantham et al. (2013), which states that nutritional intervention and psychosocial stimulation benefit children's cognitive development, especially in economically disadvantaged countries[25]. Another study on integrated child development, by Dulal et al. (2021), states that interventions combining nutrition and stimulation are effective in improving child development outcomes, especially in low- and middle-income countries (LMICs)[27].

Early intervention significantly affects child development, especially during the crucial developmental window. Early intervention is more likely to be successful in the first three years of life because research has revealed that brain circuits are at their highest level of flexibility[25]. Improvements in motor, linguistic, and cognitive development outcomes can be achieved by applying focused care during this critical stage. The success of early intervention programs is closely related

Table 4. Effect of Intervention on Toddler Development [n%]

Group	Developmental		
	Deviation (P)	Questionable (Q)	Appropriate (A)
Control (F100)			
Pre	3 (17.6)	3 (17.6)	11 (64.7)
Post	2 (11.8)	8 (47.1)	7 (41.2)
Follow up	1 (5.9)	4 (23.5)	12 (70.6)
p-value		0.021*	
Group1			
Pre	3 (15.8)	3 (15.8)	13 (68.4)
Post	0 (0)	3 (15.8)	16 (84.2)
Follow up	3 (15.8)	3 (15.8)	13 (68.4)
p-value		0.072	
Group 2			
Pre	4 (21.1)	3 (15.8)	12 (63.2)
Post	2 (10.5)	1 (5.3)	16 (84.2)
Follow up	1 (5.3)	1 (5.3)	17 (89.5)
p-value		0.009*	

Analyzed using Friedman test, with post hoc Willcoxon. *Statistically significant at p<0.05.

to family involvement and support. Family-centered services and training help parents develop skills to effectively engage and support their child's development[28]. This approach strengthens family relationships and contributes to better developmental outcomes.

Parenting Environment and Toddler Development

This study evaluates the home environment and toddler development variables in three different groups at pre-intervention, post-intervention, and 4-month follow-up after the intervention. Home environment as a predictor of cognitive development explores the relationship between aspects of the home environment and the cognitive, emotional, and social development of children. The advantage as a predictor of cognitive development is its strong correlation with cognitive measures. This is strong evidence that the device can measure the elements of the home that promote thinking and learning. It is a common finding that the correlation between very early HOME Inventory scores at 6 or 12 months and cognitive assessments conducted during infancy and childhood is less significant compared to obtained after the age of two. The data of nurturing environment and toddler development tables are presented in Table 5.

HOME Inventory has been used to describe changes in the environment over time, particularly the impact of interventions. However, several studies on interventions aimed at improving deficiencies in the environments of high-risk children have been unable to detect differences in parenting environment between the intervention and control groups[29]. In this study, the initial data between the intervention and control groups also showed no difference. This is shown by the results of the ANOVA test, where the significance value (p=0.07).

Table 5. Parenting Environment and Toddler Development

Variable	Control	Intervention group		P-value
		Group 1	Group 2	
Parenting Environment				
Pre	17.8 ± 7.8^{a}	22.8 ± 5.5^{b}	20.1 ± 5.5^{ab}	0.070[1]
Post	23.3 ± 5.9^{ab}	21.2 ± 5.7^{a}	26.3 ± 4.5^{b}	0.020[1*]
Follow-up	22.3 ± 3.9^{a}	22.5 ± 4.3^{a}	25.7 ± 3.6^{b}	0.018[1*]
P value	0.010*	0.141	0.000*	
PostPre Difference	2.53 ± 6.42	-2.00 ± -1.58	5.76 ± 4.87	
FU_Pre Difference	4.5 ± 6.8	1.00 ± -3	5.6 ± 4.6	
FU_Post Difference	-1.0 ± 2.5	-3 ± 1.3	-6 ± 1.7	
Toddler Development				
Pre	8.4 ± 2.2	8.5 ± 2.1^{a}	8.4 ± 2.1^{a}	0.986[2]
Post	8.0 ± 1.3	8.4 ± 2.1^{a}	8.9 ± 1.5^{a}	0.253[2]
Follow-up	8.8 ± 1.5^{a}	9.2 ± 1.1^{a}	9.5 ± 1.0^{a}	0.180[2]
P value	0.002[3*]	0.152[3]	0.005[3*]	
PostPre Difference	-35 ± 1.77	-0.5 ± 1.99	0.53 ± 1.71	
FU_Pre Difference	0.41 ± 1.66	0.68 ± 2.03	1.11 ± 1.59	
FU_Post Difference	0.76 ± 0.75	0.74 ± 1.52	0.58 ± 0.77	

1 Analyzed using Anova test, Post hoc test (Duncan ab).
2 Analyzed using the Kruskal Wallis test.
3 Analyzed using Friedman test; Different letters indicate that $p < 0.05$.

This intervention study investigates the effectiveness of Ready to Use Therapeutic Food-based interventions on the care environment and child development outcomes. In the control group, child development outcomes experienced a slight decrease from before to after the intervention but increased again at follow-up, with a p-value of 0.0023. Meanwhile, the intervention group showed a significant increase from pre- to post-intervention (p-value 0.0053), and this increase continued until the follow-up. This indicates a more substantial positive effect from the combination of Bregas nutriroll with psychosocial stimulation. In Table 5, the control group and the intervention group 2 show significant p-values (p<5%). This proves that the quality of the care environment is related to children's developmental achievements in various aspects. If the results of the parenting environment are supportive, the results of toddler development will usually show good development.

The results of the analysis in Table 5 show significant differences in the toddler parenting environment and child development among the three groups. The parenting environment of the control group experienced an increase from the pre-intervention value (17.8 ± 7.8) to (23.3 ± 5.9) at post-intervention with a significance value (p= 0.010), indicating a positive effect of the intervention. However, at the follow-up, there was a slight decrease. Similarly, the intervention group 2 showed a more consistent and significant increase from pre (20.1 ± 5.5) to post-intervention (26.3 ± 4.5) with a significance value (p= 0.000), without any decrease during the follow-up.

The parenting environment of the three groups before the intervention did not differ significantly (p=0.070), but intervention group 2 had the highest average score and its changes were very significant at each pre-post and follow-up stage (p=0.000), as well as the control group (p=0.010). Meanwhile, the children's development scores did not show significant differences between groups at all stages, although there was an increase in score patterns. Within-group analysis showed substantial changes in the control group (p=0.002) and intervention group 2 (p=0.005), reaching the highest scores at follow-up. It can be said that the combination intervention of group 2 has proven to be the most effective in improving parenting environment scores and child development sustainably.

DISCUSSION

Acute malnutrition in children under five years old is one of the main causes of developmental delays, which negatively impacts lifelong health[30]. It has been previously observed that malnutrition during childhood increases the likelihood of experiencing developmental delays that indicate serious physical or psychosocial problems[31]. This is also one of the causes of low economic productivity in adulthood[32]. Malnourished children are lazy and apathetic, making it difficult for them to understand information and less interested in their environment compared to well-nourished children. This causes delays in social interaction. Good personal and social development in childhood is key to good mental health and performance in adulthood[33].

Acute nutritional deficiencies can disrupt a child's cognitive profile and auditory system, causing difficulties in both spoken and written language. Furthermore, previous research found a significant correlation between weight loss in children and delays in the development of their motor and language skills[34]. Child development occurs through gradual and multifaceted interactions between parental education levels, caregiving environments, living conditions, social circumstances, availability of healthcare facilities, and work. Non-constructive social or external environments during the early years of life are usually associated with hindered development.

The intervention outcomes, whether through nutritional supplementation or psychosocial stimulation, had a significant impact on children's development. The percentage of developmentally appropriate children in the control group increased from 64.7% at baseline to 70.6% at follow-up, although it decreased at post intervention. This control group showed a significant change in development, as indicated by (p=0.021). Meanwhile, intervention group 1, had a developmentally appropriate increase from 68.4% to 84.2% at the final stage of intervention. However, this decreased again to 68.4% at follow up, with a value of (p=0.072) indicating no significant change. Intervention group 2 showed the most favorable results, where appropriate child development increased from 63.2% to 89.5% at follow-up with a value of (p=0.009), indicating a significant change. This suggests that nutritional interventions accompanied by psychosocial stimulation can improve the development of SAM children under five years old. This proves that mental stimulation is an important aspect of an effective intervention to reduce the impact of malnutrition on child development. This study is in line with Harland (1979), who highlighted the importance of mental stimulation in restoring cognitive development in malnourished children[35]. In addition, this study showed that children who received additional stimulation experienced better recovery compared to children who did not receive stimulation.

This research shows that nutritional intervention alone can improve nutritional status, but it does not always have a more significant impact on child development compared to when combined with psychosocial stimulation. On the contrary, a less supportive environment can lead to developmental delays in children. Overall, there is a comprehensive relationship between the quality of the caregiving environment and child development. Although child development did not differ significantly across all groups, these results indicate that the group 2 was more effective in consistently improving child development compared to group 1.

Nutritional interventions supplemented with stimulation have a more positive impact on cognitive and language de-

velopment, especially among malnourished children, compared to nutritional interventions alone[27]. This is also supported by research by Hamadani et al. (2006), which found that psychosocial stimulation also proved to enhance the development of malnourished children in rural Bangladesh[16]. Overall, these findings support a comprehensive approach to nutrition and psychosocial stimulation interventions to enhance optimal child development, particularly in reducing the rates of developmental delays and increasing the proportion of children with appropriate development.

CONCLUSION

Children with severe acute malnutrition are at high risk of developmental delays, so proper care is needed to address this. Intervention through the provision of nutrition and psychosocial stimulation is expected to meet the growth and development needs of toddlers. This study evaluates the effectiveness of Bregas Nutriroll with and without a combination of psychosocial stimulation, where the control group was given Formula 100 for SAM toddlers. The results showed a significant improvement in development (p=0.009) in the intervention Bregas Nutriroll combined with psychosocial stimulation compared to the control group (F100) and intervention Bregas Nutriroll only (p=0.072). Nutritional interventions combined with psychosocial stimulation are very important for improving developmental outcomes in malnourished children.

ACKNOWLEDGEMENT

The research was supported by Minister of Health Human Resources Health Indonesia Education Scholarship (SDMK) for the PhD scholarship fund.

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