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EXPLORING THE EFFECTIVENESS AND IMPLEMENTATION OF LOCAL SUPPLEMENTARY FEEDING PROGRAMS FOR UNDERNOURISHED TODDLERS

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Abstract
Background: Undernutrition among toddlers remains a critical public health challenge in Indonesia, significantly impacting cognitive and motor development during the first 1,000 days of life. This study aims to analyze the effectiveness of a 56-day local food-based Supplementary Feeding (PMT) program at the Bara-Baraya Community Health Center in Makassar City. **Methods:** This research employed a mixed-methods approach with a sequential explanatory design, involving 16 undernourished toddlers. The intervention consisted of a 56-day local food-based PMT, such as moringa fish nuggets and meatball bites, utilizing a 7-day menu cycle. Quantitative data were analyzed using the Wilcoxon Signed-Rank Test, while qualitative data were gathered through in-depth interviews with nutrition officers and cadres. **Results:** The study found a significant increase in anthropometric indicators, with average weight rising from 9.1 kg to 10.06 kg and average body length from 82.3 cm to 83.6 cm. Remarkably, 100% of the respondents (16 children) successfully transitioned from undernourished to good nutritional status (p=0.000). Qualitative findings indicated that the program's success was driven by systematic management, centralized food processing, and a rigorous monitoring strategy by cadres to ensure complete consumption. **Conclusions:** Local food-based PMT interventions utilizing nutrient-dense ingredients like Moringa and fish are highly effective in improving the nutritional status of toddlers during their critical growth period.

Introduction

Undernutrition among toddlers remains a serious public health challenge in Indonesia, which exerts a significant impact on maternal and child health. Globally, malnutrition represents an urgent challenge that contributes substantially to morbidity and mortality rates, particularly in children under five years of age (1). The World Health Organization

(WHO) reports that Indonesia ranks among the top three Southeast Asian countries with the highest prevalence of stunting and ranks fifth globally. National data indicate that the problem of protein-energy malnutrition remains persistent, with South Sulawesi itself ranking fourth among the provinces with high stunting potential in Indonesia. The primary impact of undernutrition, particularly stunting, is the impairment of a child's cognitive and motor development, which potentially leads to long-term socio-economic consequences. Stunted children demonstrate a decline in cognitive abilities compared to non-stunted children; furthermore, even undernourished children without stunting exhibit below-average abilities across various developmental domains (2). From a biological perspective, undernutrition during early life reflects the brain's requirement for adequate nutrients to establish optimal cognitive structure and function. The first 1,000 days of life represent a critical period wherein adequate nutrition plays a vital role in the growth of neurons, neural pathways, and neurochemical mechanisms that support a child's learning capacity.

To address this urgency, nutritional interventions through supplementary feeding programs have served as a pivotal strategy. However, conventional PMT programs often encounter specific field-level bottlenecks, such as poor acceptability among toddlers and logistical hurdles, which limit their overall impact. These constraints justify and drive the crucial transition toward local food-based alternatives. A promising strategy is the utilization of nutrient-rich local foods to combat hunger and malnutrition. Food commodities such as mackerel (*ikan kembung*) represent a source of high-quality protein and omega-3 fatty acids (EPA and DHA), which are essential for neurodevelopment (3). Recent studies evaluating local culinary interventions demonstrate that formulations incorporating mackerel exhibit an exceptionally high protein density; in fact, a single serving can fulfill up to 140.25% of the Recommended Dietary Allowance (RDA) for the daily protein needs of toddlers aged 1–3 years (4)**.** To maximize these nutritional benefits, fish can be combined with other nutrient-dense local ingredients, such as *Moringa oleifera*. Moringa is rich in essential minerals and bioactive compounds (5), and when integrated into modern processed forms like nuggets or meatballs, it significantly enhances both the nutritional value and acceptability among toddlers. Furthermore, the success of such physical interventions heavily relies on systematic management and direct monitoring by community health workers to ensure complete consumption and compliance by the targeted children.

Conducting this study is highly necessary due to recent policy shifts that place a stronger emphasis on utilizing local resources to achieve food self-sufficiency and ensure the sustainability of nutritional programs. The urgency of this research is grounded in the pressing need to establish an intervention model that is not only biologically effective for toddlers but also culturally acceptable and economically sustainable for the local community. Without a thorough evaluation, the implementation of local supplementary feeding risks becoming a merely ceremonial initiative lacking any tangible health impact.

Furthermore, a significant research gap exists in the lack of empirical evidence integrating clinical effectiveness (improvement in nutritional status) with implementation aspects (how the program is executed at the community level). Most previous studies tend to focus on only one of these dimensions. This study attempts to fill that gap by simultaneously exploring both dimensions, particularly regarding the utilization of local food ingredients, which have often been perceived as less standardized compared to manufactured products.

Although the potential of local food has been widely discussed, the actual evaluation of local Supplementary Feeding program implementations at the community health center (Puskesmas) level still needs to be strengthened with field-based evidence. Within the working area of the Bara-Baraya Community Health Center in Makassar City, records indicate that cases of undernourished toddlers still persist, requiring integrated management. Therefore, this study aims to analyze the effectiveness of a 56 day local food based PMT administration on changes in the nutritional status of toddlers. Additionally, as this research utilizes a mixed-methods approach, it explicitly aims to analyze the qualitative implementation process by evaluating the program management aspects encompassing inputs, processes, and outputs at the community level, in order to provide comprehensive policy recommendations for nutritional recovery programs rooted in available local resources.

Materials and Methods

This study utilizes a mixed-methods approach with a sequential explanatory design, which sequentially combines quantitative and qualitative analyses to obtain an in-depth understanding of the program's effectiveness. The study was conducted in the working area of the Bara-Baraya Community Health Center in Makassar City in June 2025. The population in this study comprised all undernourished toddlers in the area, totaling 30 children. Due to program budget availability constraints, a targeted sample of 16 toddlers was purposefully selected from the very beginning to undergo the full 56-day local PMT intervention, ensuring no survivorship bias was introduced by dropouts. In addition to the toddler respondents, this study involved two nutrition officers as main informants and five Posyandu cadres as supporting informants for qualitative data collection.

The administered intervention consisted of a 7-day menu cycle of diverse local food-based supplementary feeding designed to prevent menu fatigue. The menus featured combinations of animal protein (fish/*mackerel* and chicken), plant based protein (tofu and legumes), and local vegetables (*Moringa oleifera* leaves). To ensure the 'Implementation' aspect was truly community-based, the local PMT was not outsourced to manufacturers; instead, the entire food processing operation was centralized in the community health center's central kitchen and independently produced by trained local cooks to guarantee hygiene and nutritional quality. The processing methods involved applying specific

techniques, such as blanching the moringa leaves or adding them at the final stage of cooking, to prevent the thermal degradation of essential nutrients. The exact proportions of ingredients were carefully formulated for instance, utilizing adequate portions of mackerel (up to 100 grams per serving) alongside balanced carbohydrates and vegetables to ensure it met the daily energy and protein requirements for toddlers. These ingredients were formulated into child-friendly shapes such as moringa fish nuggets, meatball bites, and modified local snacks including Chicken Martabak, Cilukba Fried Rice, and Crispy Tofu Otak-otak. Furthermore, to guarantee the validity of the program's effectiveness results, PMT consumption was monitored directly at the household level through direct observation. Posyandu cadres conducted daily visits and waited until the toddlers completely finished their served supplementary food portions.

Quantitative data were obtained through secondary data from reports on toddlers' nutritional status monitoring before and after the local PMT intervention. Instead of utilizing Z-score values, this study used absolute measurements of body weight (kg) and body length (cm), which were subsequently categorized into nutritional statuses (from undernourished to good nutrition) based on applicable reference standards such as the Ministry of Health or WHO guidelines. Quantitative data analysis was performed statistically using the Wilcoxon Signed-Rank Test to evaluate changes in the toddlers' anthropometric indicators. This specific non-parametric test was chosen due to the small sample size of the study (n=16) and the paired nature of the data, where the significance level used was less than 0.05. Meanwhile, qualitative data collected from in-depth interviews were analyzed using content analysis techniques by organizing data into information units to draw systematic conclusions. In accordance with the sequential explanatory design, these qualitative interviews were explicitly conducted after the quantitative anthropometric analysis to deeply explore the management factors and implementation processes that led to the program's outcomes.

Results

Based on the data collection conducted involving a total of 16 respondents, an overview of the respondent demographic characteristics based on sex and age was obtained. These characteristic data are presented in detail in Table 1 below.

Table 1. Characteristics of Respondent

Characteristics	n	%
Sex		
Male	10	62.5
Female	6	37.5
Age		
< 1 Year	4	25

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1 – 2 Year	4	25
> 2 Year	8	50
Total	16	100

The majority of respondents in this study were male (62.5%), with half of the total sample falling within the age range above 2 years (50%). This baseline data provides the fundamental context for understanding the target group before evaluating the execution of the intervention program. The clinical impact of the PMT program was meticulously evaluated through routine body weight and length measurements. The weekly monitoring reveals a continuous growth trend among the respondents, as shown in Table 2.

Table 2. Summary of Weekly Monitoring of Changes in Body Weight and Length

Monitoring Period	Average Weight Difference (kg)	Average Difference in Body Length (cm)
Week 1 - week 2	0.15	0.11
Week 2 - week 3	0.15	0.66
Week 3 - week 4	0.13	0.06
Week 4 - week 5	0.19	0.11
Week 5 - week 6	0.11	0.05
Week 6 - week 7	0.11	0.11
Week 7 - week 8	0.12	0.20

Rather than indicating stagnant development, the weekly monitoring demonstrates a positive yet fluctuating growth trend over the eight-week period. The respondents experienced continuous physical growth, with body length accelerating most notably in the early weeks of the intervention (peaking between the second and third weeks), followed by the highest acceleration in weight gain during the middle weeks. This consistent progression highlights the physical adaptation and biological utilization of the provided local foods. Beyond weekly monitoring, the overall effectiveness of the intervention was measured by comparing the pre-intervention and post-intervention data, as shown in Table 3.

Table 3. Analysis of the Effectiveness of Local PMT Interventions on Anthropometry and Nutritional Status

Indicator	Pre-Intervention	Post-Intervention	p value
Weight	9.1	10.06	-
Body length	82.3	83.6	-
Nutritional status			
malnutrition	16	0	0.000
good nutrition	0	16	

The intervention resulted in a positive increase in the respondents' overall anthropometric indicators. Most notably, all sixteen children who initially suffered from undernutrition successfully transitioned to a good nutritional status by the end of the program. The statistical analysis yielded a significance value of zero, which is well below the standard statistical significance level of 0.05. This result firmly establishes that the local PMT intervention was highly effective in improving nutritional status and supporting the children's physical growth. Program Management To understand how these targeted respondents received the intervention, it is essential to evaluate the program's implementation process. Qualitative analysis results indicate that the success of the local Supplementary Feeding program at the Bara-Baraya Community Health Center was supported by systematic program management across the input, process, and output components.

At the input stage, target determination was accurately conducted by integrating data from the Electronic PKGMB reporting system in accordance with the Ministry of Health's technical guidelines. Human resource readiness was strengthened through a two-day training session for cadres to align perceptions regarding intervention procedures and anthropometric measurement techniques. Furthermore, the entire food processing operation was centralized in the community health center's central kitchen by trained cooks to guarantee nutritional quality, hygiene, and the suitability of the menus to be distributed.

"The target group for PMT is 16 toddlers who are malnourished, which we have selected according to the budget. "Nutrition Officer"

In the process component, program implementation included cross-sector coordination and daily food distribution conducted in a disciplined manner every day at 10:00 AM local time. The primary strategy in this process was direct consumption monitoring, wherein cadres waited until the toddlers finished their supplementary food portions to ensure nutritional intake compliance. The served menus followed a varied 7-day cycle consisting of daily snacks and a complete meal serving every Friday to prevent menu fatigue in toddlers as illustrated in Figure 1.

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Figure 1. 7-day menu cycle: a) Moringa Leaf Fish Nuggets, b) Chicken Martabak, c) Cilukba Fried Rice, d) Meat Balls, e) Complete Menu, f) Crispy Tofu Otak-otak

So, the PMT (Food Management Program) program is implemented by each team, where the team tasked with delivering food consists of six cadres from each sub-district, and there are cadres tasked with managing the food supply from around the health center, which is provided directly by the responsible officer. "Nutrition Officer"

In the output component, this structured and highly monitored implementation paved the way for significant clinical impacts on the toddlers' nutritional status without any significant obstacles in the field.

DISCUSSION

The results of this study indicate that the local Supplementary Feeding intervention demonstrates strong potential to significantly improve the nutritional status of toddlers, provided that consumption compliance and basal dietary factors are adequately controlled. The successful transformation of the respondents to a good nutritional status category suggests that the provided nutritional intake effectively met the energy and protein requirements necessary for physical catch-up growth. Furthermore, the subjects experienced an average increase of 0.96 kg in body weight and 1.3 cm in body length. Rather than merely reiterating the statistical significance, it is crucial to understand the biological mechanisms driving this outcome. This rapid physical adaptation is likely driven by the continuous supply of high-quality amino acids from mackerel combined with the high bioavailability of micronutrients from Moringa. Synergistically, these nutrients accelerate cellular regeneration, osteogenesis, and the maturation of cognitive centers in the brain during the children's golden age (9). Integrated nutritional interventions through local supplementary feeding tailored to the nutritional needs of toddlers are effective in

significantly improving nutritional status, reflecting the fulfillment of energy and protein needs required for optimal growth during this critical period of child development (6).

Highlighting the aspect of local wisdom, the utilization of nutrient-dense local food ingredients specifically *Moringa oleifera* and fish in culturally familiar processed forms like nuggets and meatball bites represents a superior strategy compared to conventional manufactured PMT. Moringa is widely recognized as a rich source of protein, minerals (such as potassium, magnesium, phosphorus, zinc, and manganese), and bioactive compounds that possess antioxidant activity (7,8). The animal protein content from fish combined with moringa micronutrients fulfills the basic energy and essential micronutrient requirements for the formation of brain cognitive structures, particularly during the golden age a period with the highest nutritional demands for central nervous system growth and development. The advantage of presenting these ingredients in the form of nuggets and meatballs is the increase in acceptability among toddlers, which is crucial to ensure adequate and sustainable consumption (9). This approach is highly strategic for catching up on toddler growth and development while ensuring an adequate supply of organic substrates for the formation and maturation of cognitive centers in the brain (10).

Qualitatively, the effectiveness of this program was highly influenced by the rigorous monitoring system implemented by the Posyandu cadres. Interview findings revealed that the strategy of “waiting until the targets finished their food” became a key factor ensuring complete dietary compliance. This direct supervision effectively prevented intra-household food sharing a common bottleneck in supplementary feeding programs where the targeted toddler shares the food with siblings or other family members thereby ensuring the nutritional intervention was completely ingested by the target subjects. While preliminary reports suggested there were no significant obstacles in the field, this claim requires critical evaluation. The program effectively managed to bypass typical logistical hurdles such as inconsistent food distribution or poor food quality by centralizing the cooking process in the community health center's kitchen, thereby ensuring daily quality control. Nevertheless, it is plausible that minor field-level constraints, such as occasional parental reluctance, minor daily compliance fluctuations, or logistical delays, were simply underreported by the cadres, indicating a potential minor reporting bias. Despite this potential bias, the two-day cadre training prior to the program's commencement ensured that anthropometric measurement procedures and food distribution were conducted in a standardized manner. This standardization became the primary factor in maintaining data validity and the effectiveness of the nutritional fulfillment intervention (11). Furthermore, collaboration among Posyandu cadres, the community health center (Puskesmas), village maternity posts (Polindes), as well as support from the community, strengthened the implementation. A well-executed multisectoral approach can optimize existing resources and enhance the overall quality of Posyandu services (11,12).

Despite the highly positive outcomes, this study has several limitations that must be acknowledged to provide an honest perspective on the generalizability of these findings. First, the small sample size (n=16) and the relatively short intervention duration (56 days) imply that this local PMT program should be viewed as a highly promising model rather than a definitive, absolute solution to regional malnutrition. Second, this study did not incorporate precise, detailed tracking of the toddlers' daily nutritional intake (e.g., exact calculations of total daily calories and protein consumed at home outside of the PMT). Without this detailed intake data, it is difficult to definitively claim that the significant weight gain is purely due to the PMT without considering other confounding variables, such as variations in the basal household diet or maternal feeding practices. Future research must address these limitations by incorporating comprehensive dietary recall methods and larger sample sizes.

Conclusion

This study demonstrates the high effectiveness of the 56-day local food-based Supplementary Feeding program, as evidenced by a 100% success rate in transitioning toddlers from an undernourished state to a good nutritional status category. Beyond mere statistical improvements, these findings hold significant practical implications for stunting and malnutrition management policies at the local level. The use of nutrient-dense local ingredients, specifically Moringa and fish, provides the essential protein and micronutrients required for physical and cognitive development during the "golden age." Crucially, the quantitative success of this intervention was heavily dependent on the disciplined qualitative implementation process. The rigorous direct monitoring by Posyandu cadres, who waited until the children finished their meals, effectively prevented intra-household food sharing ensuring that the nutritional intervention was entirely ingested by the targeted subjects. Therefore, as a concrete policy recommendation, District Health Offices and Primary Health Centers (Puskesmas) should institutionalize this centralized, local food-based PMT model. Policy guidelines must firmly mandate direct consumption supervision by trained cadres as a standard operational procedure to ensure the sustainability, accountability, and tangible health impacts of future nutritional recovery programs.

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