Family Empowerment Using Moringa Leaf Nuggets to Improve Dietary Adequacy Among Stunted Children: A Quasi-Experimental Study

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Abstract

Family empowerment through the utilization of local food resources is a strategic approach to improving dietary adequacy among children with stunting. Moringa leaves are nutrient-dense local foods that remain underutilized. This study aimed to examine the effect of family empowerment through the use of moringa leaf nuggets on energy intake adequacy among stunted children. This study employed a quasi-experimental pretest–posttest design with a control group. A total of 40 stunted children were assigned to an intervention group (n = 20) and a control group (n = 20). The intervention was conducted over three months and consisted of four empowerment stages (knowledge enhancement, self-efficacy strengthening, training, and evaluation), along with one month of moringa leaf nugget supplementation. The primary outcome was energy intake (kcal), assessed using food records and analyzed with dependent and independent t-tests. showed a significant increase in energy intake within the intervention group, from 886.13 ± 336.49 kcal at baseline to 1063.99 ± 208.04 kcal post-intervention (Δ = +177.86 kcal; p = 0.012). No significant change was observed in the control group (1117.69 ± 647.86 kcal to 1028.43 ± 251.53 kcal; p = 0.289). However, post-test comparison between the intervention and control groups revealed no statistically significant difference (1063.99 ± 208.04 vs. 1028.43 ± 251.53 kcal; p=0.324). Secondary outcomes demonstrated significant improvements in maternal knowledge and psychomotor skills, but not in attitudes. Family empowerment through moringa leaf nugget utilization significantly improved energy intake within the intervention group. However, the absence of a significant between-group difference suggests that the intervention's effectiveness relative to the control remains inconclusive and warrants further investigation using larger samples and more rigorous designs.

Keywords: Family Empowerment, Moringa Oleifera, Dietary Intake, Nutrient Adequacy, Child Stunting, Quasi-Experimental Study.

INTRODUCTION

Stunting remains a significant global public health issue and continues to affect many developing countries, including Indonesia. Stunting is defined as impaired growth and development in children resulting from chronic undernutrition, characterized by a height-for-age z-score below -2 standard deviations according to the WHO Child Growth Standards (Kementerian Kesehatan Republik Indonesia, 2018; World Health Organization, 2018). This condition predominantly occurs during the first 1,000 days of life and is associated with impaired physical growth, suboptimal cognitive development, and an increased risk of chronic diseases later in life (Kementerian Perencanaan dan Pembangunan Nasional/Badan Perencanaan dan Pembangunan Nasional, 2018). The 2018 Basic Health Research reported a

national stunting prevalence of 30.8% in Indonesia (Kementerian Perencanaan dan Pembangunan Nasional/Bappenas, 2018). According to the Directorate General of Regional Development (2022), stunting prevalence varies across provinces, including the Special Region of Yogyakarta, where cases remain evident in several districts, including Gunungkidul. These regional disparities indicate that stunting remains a contextual challenge that requires locally tailored interventions.

Stunting is a multidimensional problem influenced by socioeconomic factors, parental education, access to nutritious food, caregiving practices, and health services (Huriah & Nurjannah, 2020; Khoiriyah & Ismarwati, 2023; United Nations, 2020). Families with limited economic resources and lower educational attainment tend to have reduced access to quality food and health information, thereby increasing the risk of childhood undernutrition (Huriah & Nurjannah, 2020). Therefore, household-based interventions are essential, particularly those that optimize locally available and sustainable food resources (Saleh et al., 2021).

Indonesia has abundant local food resources, including Moringa oleifera. This plant is widely available in various regions, including Gunungkidul Regency; however, its utilization as a nutritious food source remains suboptimal (Budiyono et al., 2022). Moringa leaves are rich in protein, iron, calcium, and essential micronutrients, making them a promising dietary supplement to support children's nutritional adequacy (Katmawanti et al., 2021). Several studies have developed moringa-based fortified foods, such as instant porridge, biscuits, and nuggets, to enhance children's nutrient intake (Hiden et al., 2022; Musa et al., 2022; Nurdin et al., 2022; Vidayanana et al., 2020; Z. Suhaemi et al., 2021). Nevertheless, challenges remain due to the bitter taste and distinctive aroma caused by saponin content, which may affect children's acceptance of moringa-based products (Indanah et al., 2022).

In addition, family empowerment approaches in stunting prevention have been widely explored. Family empowerment models have been shown to enhance families' capacity to care for children and utilize available resources effectively (Arief et al., 2018; Januarti et al., 2020; Indanah et al., 2022). Family-based educational interventions can improve parental knowledge and skills related to stunting prevention. However, most previous studies have focused either on stunting education or on the development of moringa-based food products separately.

The research gap lies in the limited evidence integrating a structured family empowerment model with moringa-based food utilization, accompanied by consumption monitoring and evaluation of dietary adequacy outcomes among stunted children within a specific village context. Previous studies have primarily assessed product acceptability or weight gain outcomes, with limited examination of the adequacy of Recommended Dietary

Allowances (RDAs) as an indicator of daily nutritional fulfillment among stunted children. Furthermore, systematic empowerment approaches involving staged knowledge enhancement, self-efficacy strengthening, practical training, and evaluation have rarely been comprehensively examined in the context of local food utilization.

The urgency of this research is underscored by the Global Nutrition Targets 2025, which aim to reduce stunting by 40%, and the Sustainable Development Goals (SDGs), which seek to end all forms of malnutrition by 2030 (United Nations, 2020; World Health Organization, 2018). Indonesia's National Medium-Term Development Plan 2020–2024 also prioritizes the acceleration of stunting reduction (Kementerian Perencanaan dan Pembangunan Nasional/ Badan Perencanaan dan Pembangunan Nasional, 2018). In this context, family empowerment interventions that leverage local food resources offer a sustainable and contextually appropriate strategy.

This study aims to analyze the effect of family empowerment through the use of moringa leaf nuggets on the adequacy of the Recommended Dietary Allowances (RDAs) among stunted children. The study focuses on improving dietary adequacy as a critical step in supporting nutritional improvement and reducing the long-term risks associated with stunting, without making direct claims regarding short-term recovery in linear growth.

METHODS

This study employed a quasi-experimental pre-test–post-test design with a control group and was conducted in Pilangrejo Village, Nglipar District, Gunungkidul Regency, Indonesia, from November 2023 to January 2024. A total of 40 stunted children (height-for-age z-score < -2 SD according to WHO standards) and their mothers were recruited using purposive sampling. Twenty mother–child dyads were allocated to the intervention group and twenty to the control group. Sample size was calculated based on the comparison of mean differences, with statistical power considered. The sample size in this study was determined based on feasibility considerations and the total number of eligible stunted children available in the study area during the research period. A total of 40 mother–child pairs were included, with 20 participants in the intervention group and 20 in the control group.

Given the relatively small sample size, this study may have limited statistical power to detect small or moderate between-group differences. Therefore, the findings should be interpreted with caution, and future studies with larger samples are recommended to confirm these results.

The primary unit of analysis was the child (dietary intake and adequacy outcomes), while the secondary unit of analysis was the mother (knowledge, attitude, and psychomotor outcomes related to stunting prevention).

Inclusion criteria comprised stunted children aged 7–59 months and mothers who were primary caregivers, literate, able to communicate effectively, and willing to participate throughout the study. Exclusion criteria included children with autism spectrum disorder, a history of infection within the previous three months, psychiatric disorders, caregivers with severe illness or communication difficulties, and participants who withdrew during the study. The family empowerment program was delivered over 12 weeks in four stages: knowledge enhancement (education on stunting and utilization of local foods), self-efficacy strengthening (guided problem-solving discussions), skills training (early detection of stunting and preparation of moringa leaf nuggets), and monitoring and evaluation. During Weeks 7–10, children in the intervention group received moringa leaf nuggets (60 g per serving) three times daily (total 180 g/day) for 30 consecutive days as supplementary food. Mothers were instructed not to replace main meals with the nuggets. Adherence was monitored through daily consumption logs and weekly visits. The control group received routine health services without empowerment sessions or supplementation.

The primary outcome was average daily energy intake (kcal/day), measured using 24-hour food records collected over three consecutive days at baseline (Week 0) and post-intervention (Week 12), analyzed using Nutrition Survey Software. Energy adequacy was also expressed as a percentage of the recommended dietary allowance (%RDA). Secondary outcomes (maternal knowledge, attitude, and psychomotor skills) were measured using the validated *Stunting Prevention Module Questionnaire* (Huriah, 2022), with scores categorized as poor, moderate, or good.

Data were analyzed using paired and independent tests as appropriate. To address baseline imbalances, change scores (Δ post–pre) were compared between groups and, when necessary, adjusted using ANCOVA. Statistical significance was set at $p < 0.05$. The participants in this study have already received an explanation about the research and have provided informed consent. The author submitted the ethics research to the Health Research Commission of Muhammadiyah University of Yogyakarta under reference number 310/EC-KEPK FKIK UMY/XII/2023.

Study the instrument using the "Stunting Prevention Module" by Ns. Imam Akbar, S. Kep., and Dr. Titih.

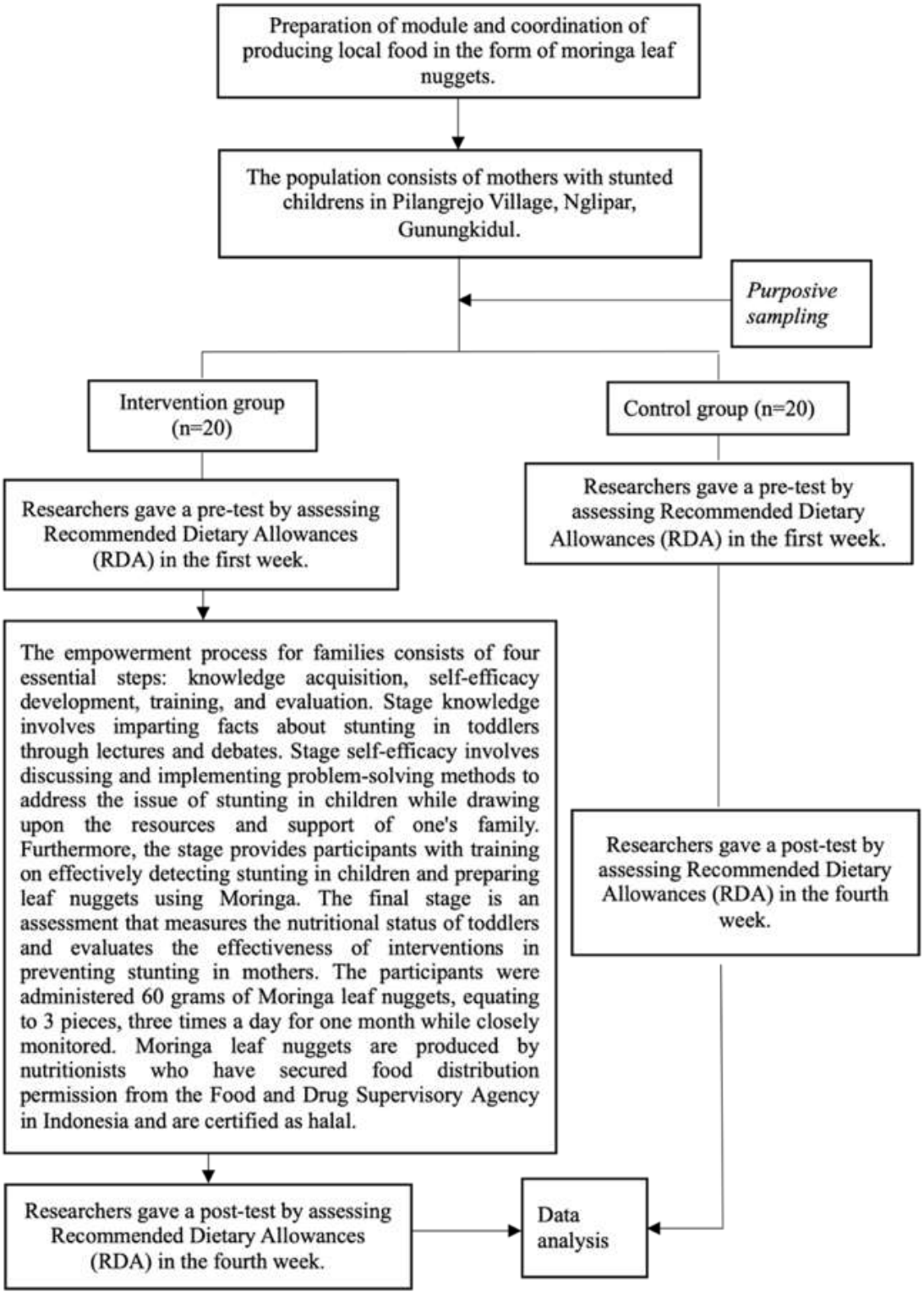

Figure 1. Research Flow

Huriah. The research instruments to measure knowledge, attitude, and psychomotor skills used the questionnaire developed by Huriah (2022).

RESULTS

Table 1. The respondents' description is based on the mother's age, the children's age, the child's order, and the number of children (n=40)

Characteristics Respondent	Group Control (n=20)		Group Intervention (n=20)		P*
	Min-Max	Mean±SD	Min-Max	Mean±SD	
Age of Mother (years)	24-49	33.60 ± 7.54	23-44	30.50 ± 7.13	0.095
Age of child (months)	13-58	35.95 ± 14.29	7-53	33.15 ± 13.87	0.267
Child order	1-4	2.20 ± 1.06	1-4	1.65 ± 0.87	0.04*
The number of children	0-4	1.25 ± 1.12	0-4	0.70 ± 0.92	0.049*

*Note: *P < 0.05 based on independent t-test, primary data (2024)*

Based on Table 1 of respondent characteristics, the age of mothers in the control group ranged from 24 to 49 years, with a mean of 33.60 ± 7.54 years, while in the intervention group, it ranged from 23 to 44 years, with a mean of 30.50 ± 7.13 years. The statistical test showed a p-value of 0.095 (>0.05), indicating no significant difference between the control and intervention groups in maternal age. Regarding children's age, the control group ranged from 13–58 months, with a mean of 35.95 ± 14.29 months, whereas the intervention group ranged from 7–53 months, with a mean of 33.15 ± 13.87 months. The analysis showed a p-value of 0.267 (>0.05), indicating no significant difference in children's age between the two groups. For the birth order variable, the control group ranged from 1 to 4 with a mean of 2.20 ± 1.06, while the intervention group had the same range (1–4) with a mean of 1.65 ± 0.87. The p-value of 0.04 (<0.05) indicates a significant difference between the control and intervention groups in birth order. Similarly, for the number of children, the control group ranged from 0 to 4 with a mean of 1.25 ± 1.12, whereas the intervention group ranged from 0 to 4 with a mean of 0.70 ± 0.92. The statistical test showed a p-value of 0.049 (< 0.05), indicating a significant difference between the two groups in the number of children. Overall, the respondent characteristics indicate that maternal and child age were relatively homogeneous across the control and intervention groups, whereas birth order and the number of children showed significant differences between the two groups.

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Table 2. Characteristics of respondents in the intervention and control groups based on parental occupation, parental education, exclusive breastfeeding status, immunization history, primary caregiver, and child's gender (n = 40)

Respondents' Characteristics	Category	Control (n=20)		Intervention (n=20)		p-value*
		n	%	n	%	
Mother's Job	Housewife	20	100	15	75	0.057
	Self-employed	0	0	3	15	
	Civil servants/Private	0	0	2	10	
	Laborer	0	0	0	0	
Father's Occupation	Self-employed	2	10	7	35	0.002*
	Civil servants/Private	3	15	9	45	
	Laborer	15	75	4	20	
Mother's Education	College	0	0	4	20	0.061
	Senior High School	13	65	13	65	
	Junior High School	7	35	3	15	
	Elementary School	0	0	0	0	
Father's Education	College	1	5	2	10	0.712
	Senior High School	13	65	14	70	
	Junior High School	3	15	3	15	
	Elementary School	3	15	1	5	
Exclusive Breastfeeding	Exclusive	20	100	15	75	0.017*
	Not	0	0	5	25	
Immunization History	Complete	17	85	16	80	0.677
	Not complete	3	15	4	20	

The respondent characteristics analysis indicated that most variables were relatively comparable between the control and intervention groups. Mothers in both groups were predominantly unemployed or housewives, with no significant difference between the groups ($p = 0.057$). Similarly, the educational levels of both mothers and fathers were mostly at the high school level and did not differ significantly between groups ($p = 0.061$ and $p = 0.712$). No significant differences were also observed in immunization history, primary caregiver, or child's gender ($p > 0.05$). However, significant differences were identified in fathers' occupations ($p = 0.002$), with laborers dominating the control group, while self-employed and civil servant/private employees were more common in the intervention group. A significant difference was also observed in exclusive breastfeeding history ($p = 0.017$). Overall, these

findings suggest that the baseline characteristics of respondents were largely homogeneous, although variations in fathers' occupations and exclusive breastfeeding may potentially influence the study outcomes. Several factors influence toddlers' nutritional adequacy, including individual characteristics and family socioeconomic conditions. The findings revealed differences between the control and intervention groups in birth order, number of siblings, fathers' occupation, and exclusive breastfeeding ($p < 0.05$). The intervention involving family empowerment and the provision of Moringa leaf nugget products was associated with increased intake of the Recommended Dietary Allowance (RDA) in the intervention group, although no significant difference in RDA values was observed between the two groups overall.

Furthermore, the pretest results showed that most participants in the intervention group had moderate levels of knowledge, attitudes, and psychomotor skills. Following the intervention, participants demonstrated improvements in knowledge and psychomotor domains, while attitudes remained moderate. Statistical analysis confirmed significant improvements in knowledge and psychomotor skills but not in attitudes.

Table 3. The disparities in RDA between the intervention and control (n=40)

RDA	Before Intervention (n=20)		After Intervention (n=20)		P*
	Min-Max	Mean±SD	Min-Max	Mean±SD	
RDA in Intervention Group (kcal)	478.18-1895.05	886.130 ± 336.49	581.88-1370.87	1063.99 ± 208.04	0.012
RDA in Control Group (kcal)	432.07-3519.68	1117.69±647.86	598.59-1553.27	1028.43 ± 251.53	0.289

*Note: *P < 0.05 based on dependent t test*

An analysis of changes in energy intake based on the Recommended Dietary Allowance (RDA) was conducted in both the intervention and control groups before and after the study period. In the intervention group (n = 20), the mean energy intake before the intervention was 886.13 ± 336.49 kcal, with a range of 478.18–1895.05 kcal. After the intervention was implemented, the mean energy intake increased to 1063.99 ± 208.04 kcal, with a range of 581.88–1370.87 kcal. Statistical analysis demonstrated a significant difference between the pre- and post-intervention measurements ($p = 0.012$), indicating that the intervention was effective in improving the participants' energy intake. In contrast, in the control group (n = 20), the mean energy intake before the observation period was 1117.69 ± 647.86 kcal, with a range of 432.07–3519.68 kcal. After the observation period, the mean energy intake was 1028.43 ± 251.53 kcal, with a range of 598.59–1553.27 kcal. However, the statistical test indicated no significant difference between the pre- and post-observation measurements in the control group

(p = 0.289). Overall, these findings indicate that a significant improvement in energy intake occurred only in the intervention group, whereas the control group did not show a statistically significant change.

Table 4. The disparities in RDA post-test scores between the group interventions and the control groups (n=40)

Research variable	Intervention Post-Test (n=20)		Control Post-Test (n=20)		P*
	Min-Max	Mean±SD	Min-Max	Mean±SD	
RDA (kcal)	581.88-1370.87	1063.99 ± 208.04	598.59-1553.27	1028.43 ± 251.53	0.324

Note: *p<0.05 based on independent t test

Table 4 presents the comparison of energy intake based on the Recommended Dietary Allowance (RDA) between the intervention and control groups at the post-test assessment. The intervention group demonstrated a mean energy intake of 1063.99 ± 208.04 kcal, with values ranging from 581.88 to 1370.87 kcal. In comparison, the control group showed a mean energy intake of 1028.43 ± 251.53 kcal, with a range of 598.59 to 1553.27 kcal. Although descriptively the intervention group exhibited a slightly higher mean energy intake than the control group, the statistical analysis indicated that the difference between the two groups was not statistically significant (p = 0.324). This finding suggests that the intervention in this study did not have a significant effect on participants' energy intake compared with the control group at the post-test. The relatively wide range of energy intake observed in both groups reflects considerable inter-individual variability in dietary consumption, which may contribute to the absence of statistically significant differences between groups.

Table 5. Distribution of Maternal Knowledge, Attitude, and Psychomotor Skills Before and After Intervention (n = 20)

Research Variable	Category	Before Intervention (n=20)		After Intervention (n=20)		p-value*
		N	%	n	%	
Knowledge	Poor	1	5	0	0	0.414
	Moderate	9	45	9	45	
	Good	10	50	11	55	
Attitude	Poor	3	15	1	5	0.180
	Moderate	17	85	18	90	
	Good	0	0	1	5	
Psychomotor	Poor	6	30	5	40	0.197
	Moderate	8	40	13	65	
	Good	6	30	1	5	

The results indicate that although descriptive changes were observed in respondents' knowledge, attitudes, and psychomotor abilities following the intervention, these changes were not statistically significant. For the knowledge variable, the proportion of respondents with good knowledge slightly increased from 50% to 55%, while the poor category was no longer

observed after the intervention; however, this change was not statistically significant (p = 0.414). Similarly, the attitude variable showed a modest improvement, with a small proportion of respondents (5%) in the good category and a reduction in poor attitudes from 15% to 5%, yet the difference remained statistically non-significant (p = 0.180). In terms of psychomotor ability, the proportion of respondents in the moderate category increased from 40% to 65%, while the good category decreased substantially to 5%; the overall change was not statistically significant (p = 0.197). Overall, while the descriptive trends suggest slight improvements following the intervention, the statistical findings indicate that the intervention did not significantly influence knowledge, attitudes, or psychomotor outcomes among respondents (p > 0.05).

Table 6. The disparities in knowledge, attitude, and psychomotor skills between the group interventions and the control groups (n=40)

Variable	Category	Intervention (n=20)		Control (n=20)		p-value*
		N	%	n	%	
Knowledge	Poor	0	0	0	0	0.014*
	Moderate	9	45	0	0	
	Good	11	55	20	100	
Attitude	Poor	1	5	5	25	0.201
	Moderate	18	90	15	75	
	Good	1	5	0	0	
Psychomotor	Poor	5	40	0	0	0.001*
	Moderate	13	65	3	15	
	Good	1	5	17	85	

*Note: *p < 0.05 based on the Mann Whitney test.*

Table 6 presents the distribution of knowledge, attitude, and psychomotor variables between the intervention and control groups (n = 20 per group). For the knowledge variable, the intervention group consisted of respondents with moderate (45%) and good (55%) knowledge levels, while all respondents in the control group were categorized as having good knowledge (100%). Statistical analysis indicated a significant difference between groups (p = 0.014).

For the attitude variable, most respondents in both groups were categorized as having a moderate attitude (intervention: 90%; control: 75%). Although the control group had a higher proportion of poor attitudes (25%) compared with the intervention group (5%), the difference was not statistically significant (p = 0.201).

Regarding the psychomotor variable, the majority of respondents in the intervention group were in the moderate category (65%), whereas most respondents in the control group were in the good category (85%). Statistical testing showed a significant difference between

the two groups (p = 0.001). Overall, significant differences were observed in knowledge and psychomotor skills, while attitude showed no significant difference between groups.

DISCUSSION

This study demonstrated a significant increase in energy intake (RDA) within the intervention group following the family empowerment program, although no significant post-test difference was observed between the intervention and control groups. The improvement within the intervention group suggests that the empowerment component, particularly the psychomotor training, played an important role in modifying household feeding practices rather than the supplementation alone.

The behavioral mechanism underlying this improvement can be interpreted through the Health Belief Model (HBM) and Social Cognitive Theory (SCT). According to HBM, individuals are more likely to adopt health-related behaviors when they perceive a condition as serious and believe that preventive actions provide meaningful benefits. The educational sessions likely increased mothers' awareness of the severity and long-term consequences of stunting, while practical demonstrations reduced perceived barriers to preparing nutritious foods. In parallel, SCT emphasizes the importance of self-efficacy in sustaining behavioral change. The hands-on preparation of moringa leaf nuggets enhanced mothers' confidence in their ability to provide nutrient-dense meals using local resources. The significant improvement in psychomotor skills indicates that participants progressed beyond knowledge acquisition to practical competence, which may explain the observed increase in children's dietary adequacy (Rahmawati et al., 2021; Sarinengsih et al., 2021).

Parental education and occupation were identified as contributing factors to nutritional fulfillment, consistent with previous research (Jasmawati, 2020; Maulina et al., 2021; Ilmani & Fikawati, 2023; Munawaroh et al., 2022). While higher education is generally associated with better nutritional practices, working mothers may experience time constraints that affect childcare and feeding practices (Huriah et al., 2021; Pertiwi et al., 2021; Simamora & Kresnawati, 2021, 2023). These findings reinforce that knowledge alone is insufficient without practical skills and supportive household conditions.

The sustainability of the intervention is an important consideration. Although moringa leaf nuggets were provided during the study, long-term effectiveness depends on whether families continue to prepare and incorporate moringa independently. Because the program emphasized skill development rather than reliance on external supplementation, it has the

potential for sustainability at the community level. However, continued implementation may depend on economic factors, food preferences, and community health support systems.

Regarding duration, the three-month empowerment process and one-month nugget administration were likely adequate to detect short-term improvements in dietary intake but insufficient to observe measurable changes in linear growth. Recovery from stunting requires sustained nutritional adequacy over longer periods; therefore, the findings should be interpreted as improvements in intake rather than definitive growth recovery.

Although knowledge and psychomotor skills improved significantly, attitudes did not change, possibly due to baseline educational characteristics (Ekayanthi & Suryani, 2019). Attitudinal change often requires longer exposure and reinforcement.

Limitations include the small sample size, non-randomized design, and reliance on self-reported dietary records. Future studies with larger samples, longer follow-up periods, and randomized designs are recommended to confirm long-term effectiveness and growth outcomes.

CONCLUSIONS

This study evaluated the effect of family empowerment through the utilization of moringa leaf nuggets on dietary adequacy among stunted children, as well as on maternal knowledge, attitudes, and psychomotor skills. The results showed a significant increase in energy intake within the intervention group; however, no significant difference was observed between groups at post-test, indicating that the comparative effectiveness of the intervention remains uncertain. Improvements were observed in maternal knowledge and psychomotor skills, while attitudes did not change significantly.

These findings suggest that structured family empowerment interventions incorporating practical skill development may support improvements in household dietary practices, particularly when using locally available food resources. The family empowerment module developed in this study has the potential to be integrated into supplementary feeding programs (Program Pemberian Makanan Tambahan/PMT) delivered through primary health services such as community health centers (Puskesmas) and village health posts. Integrating structured education and hands-on training may strengthen caregivers' capacity to prepare nutrient-dense meals and enhance program sustainability. However, given the quasi-experimental design, causal inference remains limited. Future studies with larger sample sizes, longer follow-up periods, and randomized designs are needed to confirm long-term effectiveness and potential impacts on child growth outcomes.

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