

Article

The Impact of the Educational Program on the Processing of Moringa Leaves and Mackerel Tuna for Stunting Prevention in Tongali Village

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Abstract

Background: Stunting prevention can be accomplished by augmenting maternal knowledge through education that employs locally accessible nutrient-rich foods to facilitate children's growth and development. This entails converting moringa leaves into moringa cake and mackerel tuna into chips as nutritional snack alternatives and flavor enhancers to substitute MSG, thereby supporting the Free Nutritious Meal Program (MBG). **Objectives:** This study aimed to determine the impact of the educational program on the processing of moringa cake, tuna-based flavor enhancers, and mackerel tuna chips for stunting prevention toward the knowledge of the Family Welfare Movements (PKK) mothers in Tongali Village. **Methods:** The study used a quasi-experimental design. The sampling method used was accidental sampling, comprising a sample size of 40 respondents. Bivariate analysis was performed utilizing the One Group Pretest-Posttest Design with the Wilcoxon Signed Rank test, facilitated by STATA 13 software. **Results:** Bivariate analysis demonstrated that the educational program significantly influenced the knowledge of PKK mothers before and after their implementation ($\text{Prob} > |z| = 0.0000 < 0.05$). **Conclusions:** This study aimed to enhance the engagement of PKK mothers in the utilization of moringa leaves and mackerel tuna for the preparation of nutritious foods, diminish the reliance on MSG to mitigate stunting, and bolster the local economy.

Keywords: stunting, moringa, mackerel tuna

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1. Introduction

Stunting is a critical worldwide nutrition challenge necessitating urgent intervention, highlighted by the second Sustainable Development Goals (SDGs), which seeks to eradicate hunger and malnutrition, attain food security, and enhance nutritional standards¹. President Joko Widodo promulgated Presidential Regulation No. 2 of 2021 to

expedite the mitigation of stunting in Indonesia. President Prabowo Subianto sustained this constant effort by initiating the Free Nutritious Meal Program (MBG) as an effective catalyst for expediting the decrease of stunting in Indonesia².

Children with stunting suffer from growth and developmental disorders resulting from chronic malnutrition and repeated infections, defined by height or weight falling below the standards established by the Ministry of Health³. Chronic malnutrition in stunted children may result from poverty and inadequate childcare practices, resulting in compromised cognitive development, heightened vulnerability to sickness, and diminished competitiveness, thereby perpetuating a cycle of poverty⁴. Children are classified as stunted if their anthropometric measurements—height-for-age (HAZ) or length-for-age (LAZ)—fall within a z-score between < -3 SD and < -2 SD^{5,6,7}. According to the World Health Organization, stunting becomes a chronic public health issue when its prevalence exceeds 20%⁸.

In 2022, the global prevalence of stunting among children under five years of age was over 20%, namely 22.3%, whereas in Southeast Asian countries, it reached 26.5%⁹. According to data from the SSGI (2023) and SKI (2023), the decline in stunting cases among children aged 0–59 months in Indonesia has not met the target established in the RPJMN 2020–2024, with the prevalence persisting over 14%, currently at 21.6%. In 2022, the prevalence of stunting in Southeast Sulawesi was 20.6%, with South Buton reporting the second highest rate at 37.1%, behind Buton Regency^{10,11}.

Stunting cases in South Buton, specifically in Siompu District and Tongali Village, necessitate intervention, as Tongali Village is a coastal region abundant in natural resources, particularly fish or marine products. Nutritional adequacy from foodstuffs with various nutritional content from marine products for coastal communities is a source to improve health status, including for children¹². Consumption of fish, such as mackerel tuna, offers vital minerals, protein, and micronutrients required for children's growth and development¹³.

Mackerel tuna can be paired with vegetables such as moringa, serving as a local food source that can be transformed into nutrient-dense foods to mitigate stunting. Mackerel tuna possesses elevated levels of omega-3, DHA, EPA, and calcium compared to freshwater fish¹⁴. Moringa has been identified in multiple studies as possessing significant nutritional value, presenting a potential remedy for stunting and serving as a supplementary food source to fulfill children's nutritional requirements during the first 1000 Days of Life, in both wet and dried forms^{15,16}.

Moringa leaves and mackerel tuna can also function as alternative food sources for children in the MBG regimen. There is a necessity to augment public awareness regarding the advantages of moringa and mackerel tuna in stunting prevention through educational initiatives focused on the processing of these ingredients into local foods, such as moringa cake, mackerel tuna chips, and mackerel tuna-based flavor enhancers. This is essential for diversifying food sources and represents a key part of the national strategy to expedite the reduction of stunting in Indonesia, which encompasses national campaigns, behavior change communication, and nutrition and food security³. Initiatives to improve community awareness through the educational program on the processing of moringa cake, mackerel tuna chips, and mackerel tuna-based flavor enhancers are deemed essential as preventive strategies to expedite the reduction of stunting in Tongali Village, Siompu Sub-district, South Buton Regency.

2. Materials and Methods

2.1 Study and Setting

This study used a quasi-experimental design to assess the impact of the educational program on the knowledge level of PKK mothers. The study was conducted at Tongali Village, Siompu Sub-district, South Buton Regency, Southeast Sulawesi. The study was undertaken from October to November 2024. The educational program was conducted using demonstration and lecture methods, supported by leaflets.

2.2 Population and Sampling

The sampling method used was accidental sampling, resulting in the inclusion of all PKK mothers present during the educational program, amounting to a total of 41 respondents. One respondent failed to complete the questionnaire, yielding a total of 40 respondents.

2.3 Data Collection

The study collected data using a pre-test and post-test questionnaire. We gave the questionnaire to respondents before and after the implementation of the educational program.

2.4 Variables and Operational Definitions

The independent variable of this study is the educational program. While the dependent variable is the knowledge level of respondents. The following is the operational definition used:

Knowledge Level	Good	If the correct answer score greater than 6 points
	Sufficient	If the correct answer score between 3 and 6 points
	Less	If the correct answer score less than 3 points

2.5 Data Analysis

Data analysis was conducted using univariate and bivariate methods. Univariate analysis utilized descriptive statistical techniques, displaying data in tables and graphs, and was conducted using MS Excel software. The bivariate analysis used the One Group Pretest-Posttest Design methodology. The normality of the data was assessed before. The Shapiro-Wilk test was used to assess normality due to the sample size being fewer than 50 responses. Data that followed a normal distribution were analyzed using the Paired t-test, while data that did not conform to a normal distribution were assessed using the Wilcoxon Signed-Rank test. Data analysis was performed utilizing STATA 13 software.

2.6 Ethical Considerations

This study uses the Code of Ethics permit which was studied and considered by the Ethics Review Team of the Faculty of Public Health, Nusa Cendana University with the administration number: 001041/KEPK FKM UNDANA/2024.

3. Results

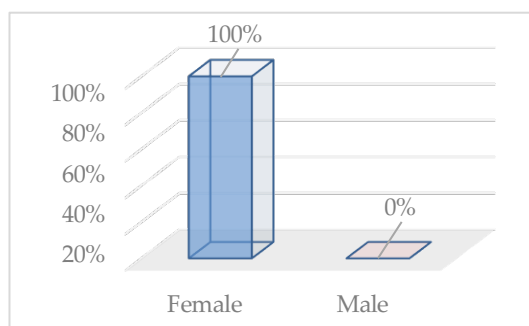
3.1 The Characteristics of Respondents

The characteristics of respondents categorized by gender, age, and educational attainment are presented in the subsequent table and graph.

Table 1. Demographic Characteristics of Respondents by Gender

Gender	n	%
Female	40	100
Male	0	0
Total	40	100

Source: Primary Data, 2024



Graph 1. Demographic Characteristics of Respondents by Gender

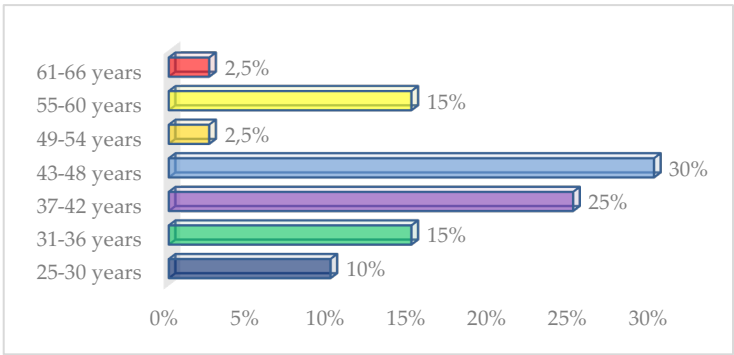
Source: Primary Data, 2024

According to Graph 1, among 40 respondents, the predominant demographic was female, comprising 100% of the respondents, all of whom were PKK mothers from Tongali Village. The Characteristics of respondents categorized by age are presented in the subsequent table and graph.

Table 2. Demographic Characteristics of Respondents by Age

Age Group	n	%
25-30 years	4	10
31-36 years	6	15
37-42 years	10	25
43-48 years	12	30
49-54 years	1	2.5
55-60 years	6	15
61-66 years	1	2.5
Total	40	100

Source: Primary Data, 2024



Graph 2. Demographic Characteristics of Respondents by Age

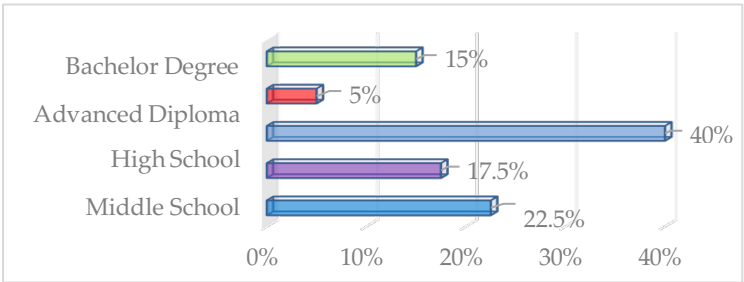
Source: Primary Data, 2024

According to Graph 2, among 40 respondents, the predominant age group was 43–48 years, with 12 individuals (30%), whereas the least represented age groups were 49–54 years and 61–66 years, each with 1 individual (2.5%). The characteristics of respondents based on educational attainment are illustrated in the table and graph below.

Table 3. Characteristics of Respondents Based on Educational Attainment

Educational Attainment	n	%
Elementary school	9	22.5
Middle school	7	17.5
High school	16	40
Advanced Diploma	2	5
Bachelor Degree	6	15
Total	40	100

Source: Primary Data, 2024



Graph 3. Characteristics of Respondents Based on Educational Attainment

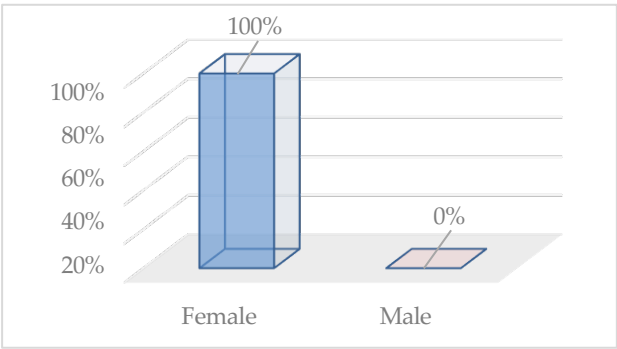
Source: Primary Data, 2024

According to Graph 3, among 40 respondents, the predominant educational attainment was high school/vocational school, represented by 16 respondents (40%), and the least common was D-III education, with just 2 respondents (5%). The characteristics of respondents based on their utilization of flavor enhancers are illustrated in the table and graph below.

Table 4. Characteristics of Respondents Based on Flavor Enhancers Utilization

Flavor Enhancers Utilization	n	%
Yes	40	100
No	0	0
Total	40	100

Source: Primary Data, 2024



Graph 4. Characteristics of Respondents Based on Flavor Enhancers Utilization

Source: Primary Data, 2024

According to Graph 4, all respondents (100%) incorporate flavor enhancers in their everyday culinary preparations. The knowledge levels of PKK mothers in Tongali Village, before and after the educational program are examined in the following section.

3.1. Knowledge Proficiency of PKK mothers in Tongali Village Preceding and Following the Educational Program

The knowledge level of PKK mothers was classified into three categories: low, adequate, and good, determined by the mean and standard deviation of the pretest and posttest data as follows.

Table 5. Mean and Standard Deviation of Pretest and Posttest Data

Variable	Obs	Mean	Standard Deviation	Min	Max
Pretest and Posttest	40	4.5	1.5	0	9

Source: Primary Data, 2024

The categorization of knowledge levels, as indicated in Table 5 above, was established according to the following criteria.

- Less : If $X < (\text{Mean} - \text{SD})$
- Sufficient : If $(\text{Mean} - \text{SD}) \leq X \leq (\text{Mean} + \text{SD})$
- Good : If $X > (\text{Mean} + \text{SD})$

The knowledge level categories, based on the aforementioned criteria, were established as follows.

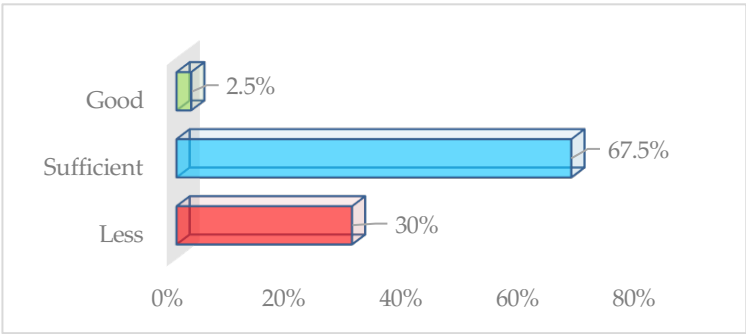
- Less : If $X < 3$
- Sufficient : If $3 \leq X \leq 6$
- Good : If $X > 6$

The outcomes of these categories demonstrate the respondents' knowledge levels before and after the educational program, as illustrated in the following table.

Table 6. The Knowledge Level of Respondents Before the Educational Program

Knowledge Level	n	%
Good	1	2.5
Sufficient	27	67.5
Less	12	30
Total	40	100

Source: Primary Data, 2024



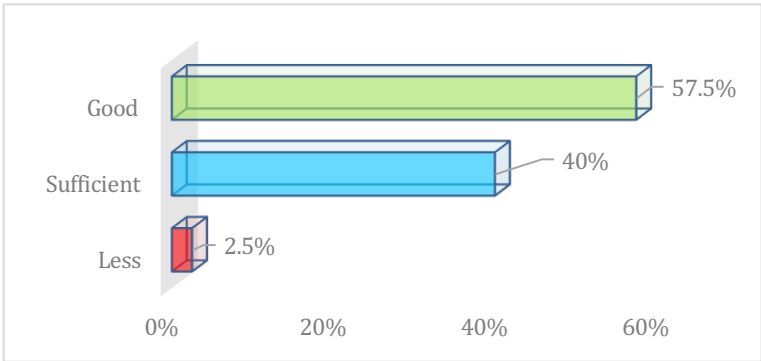
Graph 5. The Knowledge Level of Respondents Before the Educational Program
Source: Primary Data, 2024

According to Graph 5, before the educational program, among 40 respondents, the predominant knowledge level was sufficient, represented by 27 respondents (67.5%), while the least common was good knowledge, indicated by 1 respondent (2.5%). The respondents' knowledge level after the educational program is illustrated in the ensuing table and graph.

Table 7. The Knowledge Level of Respondents After the Educational Program

Knowledge Level	n	%
Good	23	57.5
Sufficient	16	40
Less	1	2.5
Total	40	100

Source: Primary Data, 2024



Graph 6. The Knowledge Level of Respondents After the Educational Program
Source: Primary Data, 2024

According to Graph 6, following the educational program, among 40 respondents, the majority exhibited a good knowledge level (23 respondents, 57.5%), while the minority demonstrated a less knowledge level (1 respondent, 2.5%). The subsequent discussion elaborates on the influence of the educational program on the knowledge level of PKK mothers in Tongali Village.

3.2. The Impact of the Educational Program toward the Knowledge Level of PKK mothers in Tongali Village

Bivariate analysis was used to assess the impact of schooling on respondents' knowledge levels, commencing with a normality test of the pretest and posttest data. The normality test used the Shapiro-Wilk test, given that the sample size was fewer than 50 responses, adhering to the specified conditions.

If the probability value ($\text{Prob} > z$) exceeds 0.05, the data is regularly distributed.

If the probability value ($\text{Prob} > z$) is less than 0.05, the data is not normally distributed.

The subsequent results pertain to the normality test conducted by the Shapiro-Wilk test, utilizing pretest and posttest data.

Table 8. Outcomes of the Shapiro-Wilk Test for Pretest and Posttest Data

Variabel	Obs	W	V	Z	Prob>z
Pretest	40	0.90157	3.891	2.859	0.00213
Posttest	40	0.83311	6.597	3.970	0.00004

According to Table 8, the $\text{Prob} > z$ value for the pretest is 0.00213 and for the posttest is 0.00004, both of which are less than 0.05, indicating that the pretest and posttest data are not normally distributed. Bivariate analysis was subsequently performed to assess the impact of the educational program, utilizing the Wilcoxon Signed-Rank test, given the non-normal distribution of the data. The outcomes of the Wilcoxon Signed-Rank test for pretest and posttest data are presented according to the specified criteria.

If the probability value ($\text{Prob} > |z|$) is less than 0.05, then the alternative hypothesis (H_a) is accepted.

If the probability value ($\text{Prob} > |z|$) exceeds 0.05, then the alternative hypothesis (H_a) is rejected.

The hypotheses are defined as follows:

H_0 : there is no significant impact between the educational program toward the knowledge level of PKK mothers.

H_a : there is a significant impact between the educational program toward the knowledge level of PKK mothers.

The outcomes of the analysis using the Wilcoxon Signed-Rank test on the pretest and posttest data are illustrated in the subsequent figure.

According to Figure 1, the Wilcoxon Signed-Rank test findings for the pretest and posttest data indicate that $\text{Prob} > |z| = 0.0000$, because the significance is < 0.05 then H_0 is rejected and H_a is accepted, which means that there is a significant impact between the educational program toward the knowledge level of PKK mothers. This signifies that the educational program influences the knowledge level of PKK mothers both before and after following the program.

Wilcoxon signed-rank test			
sign	obs	sum ranks	expected
positive	0	0	405
negative	36	810	405
zero	4	10	10
all	40	820	820
unadjusted variance	5535.00		
adjustment for ties	-127.38		
adjustment for zeros	-7.50		
adjusted variance	5400.13		
Ho: Pre = Post			
z =	-5.511		
Prob > z =	0.0000		

Figure 1. Outcomes of the Wilcoxon Signed-Rank Test for Pretest and Posttest Data
Source: Data analyzed utilizing STATA, 2024

4. Discussion

The analysis revealed that there is a significant impact between the educational program toward the knowledge level of PKK mothers. It means that the educational program significantly influenced the knowledge level of PKK mothers in Tongali Village, Siompu Sub-district, Buton Regency, regarding the processing of moringa cake, tuna-based flavor enhancers, and mackerel tuna chips for stunting prevention, before and after the program's implementation. This analysis is substantiated by the Wilcoxon Signed-Rank test of the pretest and posttest data, which indicated a $\text{Prob} > |z|$ value = $0.000 < 0.05$. This suggests that the education offered can enhance the knowledge of PKK mothers.

The findings of this study align with the study conducted by Rachmah et al. which indicated that nutrition education regarding the advantages of fish consumption can enhance mothers' understanding of stunting prevention in children throughout the critical developmental phase¹⁷. Perwitasari et al. documented a 68.75% enhancement in understanding following the education of mothers of infants on the utilization of moringa leaves for stunting prevention, facilitated through demonstrations and lectures employing leaflets¹⁸.

Rosnah et al. asserted that an educational program utilizing leaflets and hands-on food processing activities centered on fish significantly enhanced the awareness of mothers of infants concerning the nutritional advantages of fish in stunting prevention¹⁹. This demonstrates that the educational program can enhance knowledge. Urufia et al. indicated that educational programs on stunting prevention utilizing moringa leaves among students at SD Negeri 2 Nganganaumala considerably improved students' knowledge ($\text{Pr}(|T| > |t|) = 0.0000 < 0.05$)²⁰.

The educational initiatives implemented are components of health promotion strategies designed to assist communities in transforming their lives to attain optimal health, transitioning from detrimental behaviors to those that enhance well-being²¹. Health promotion through educational initiatives might enable individuals to make informed health choices while concurrently altering social and environmental factors that may obstruct health improvement efforts²². The increase in PKK mothers' knowledge following their education on moringa cake, tuna-based flavor enhancers, and mackerel tuna chips is anticipated to inspire them to incorporate moringa and fish as local foods to combat stunting and create economic value, thus yielding financial advantages for PKK mothers post-participation in the educational program. Education improves community access to information and services and constitutes part of the support offered to families at risk of stunting, as delineated in the government's national action plan through the family-based strategy for stunting prevention²³.

The instruction on processing moringa cake, mackerel tuna-based flavor enhancers, and mackerel tuna chips serves as assistance for families at risk of stunting and can help bolster the MBG program by supplying food items suitable for inclusion in the MBG menu. *Moringa oleifera*, referred to as moringa, is acknowledged as a 'superfood' ^{23,24}. Moringa leaves can be utilized in both fresh and dried states as complementary foods to avert malnutrition and as supplementary foods to fulfill children's nutritional requirements during the initial 1,000 days of life¹⁵. Moringa leaves possess 6.8 mg of vitamin A per 100 grams, surpassing carrots, which contain 1.8 mg per 100 grams. The calcium concentration is 440 mg per 100 grams, surpassing that of milk at 6.49 mg per 100 grams²⁵, whereas the potassium level in moringa leaves is 259 mg per 100 grams, markedly exceeding that of bananas at 88 mg per 100 grams. It includes 6.7 grams of protein per 100 grams, above yogurt's 3.1 grams per 100 grams, and 220 mg of vitamin C per 100 grams, surpassing oranges' 30 mg per 100 grams²⁶.

Moringa leaf extract ingested during pregnancy can mitigate the occurrence of stunting in neonates²⁷. Preschool children aged 5–6 years exhibited favorable average growth metrics from mothers who ingested moringa leaf extract during gestation²⁸, and there was an enhancement in infant height from 0.476 cm to 0.594 cm following the consumption of complementary foods enriched with moringa powder²⁹. Moringa leaves contain more protein composition compared to yogurt, with 6.7 g/100 g; yet, animal protein sources offer greater quantities of important amino acids in comparison to plant-based proteins. Consequently, the intake of a singular variety of plant-based protein with insufficient amino acid content should be supplemented with animal protein sources³⁰. Consequently, moringa leaves ought to be paired with animal protein, such as mackerel tuna.

Mackerel tuna (*Euthynnus affinis*), contains more protein level compared to other tuna species, varying from 21.6% to 26.3%³¹. High protein intake boosts the secretion of insulin and insulin-like growth factor (IGF-1) as well as IGF-binding protein (IGFBP-1), which are essential for growth. Protein intake in infants and toddlers is associated with increased growth and higher BMI in early childhood³⁰. Mackerel tuna contains elevated concentrations of both essential and non-essential amino acids, including isoleucine, leucine, threonine, arginine, alanine, aspartate, cysteine, glutamate, glycine, histidine, proline, and serine. Reduced concentrations of essential amino acids in the bloodstream are frequently observed in stunted children relative to their healthy counterparts. A shortage in essential amino acids may result in signs of stunting³².

Processing moringa leaves into a widely enjoyed dish, such as moringa cake favored by children, along with converting mackerel tuna into crispy mackerel tuna chips, can stimulate the appetite. Furthermore, mackerel tuna-based flavor enhancer is anticipated to diminish the use of MSG (Monosodium Glutamate). The study on mice demonstrated that high intake of MSG during gestation and lactation may lead to developmental abnormalities in the teeth and bones of neonatal mice³³.

5. Conclusions

Based on the findings, it can be concluded that the educational program on the processing of moringa cake, tuna-based flavor enhancers, and mackerel tuna chips significantly improved the knowledge of PKK mothers in Tongali Village regarding stunting prevention. This study is expected to encourage mothers to create nutritious food using moringa and tuna, reduce MSG consumption, improve the local economy, and promote the inclusion of these ingredients in the MBG program.

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7. Conflicts of Interest

The authors declare no conflict of interest.

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