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The effect of soybean tempeh nuggets consumption on weight gain among toddlers

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Abstract

Background: Malnutrition in toddlers is a condition in which children experience a lack of essential nutrients that impact physical growth, cognitive development, and overall health. The prevalence of malnutrition in Indonesia is 17.7%. Meanwhile, in Lampung Province, in 2021, the prevalence of malnourished toddlers (wasted) was 7%, increasing to 7.2% in 2022. In Central Lampung Regency, in 2021, the stunting rate (undernutrition) reached 20.8%, which is higher than the average. This condition occurs due to inadequate nutritional intake, both in terms of quality and quantity, as well as health problems that interfere with nutrient absorption and utilization.

Purpose: The purpose of this study was to determine the effectiveness of consuming soybean tempeh nuggets on increasing the weight of toddlers.

Method: The research design used was a quasi-experimental design with a two-group pretest-posttest design. The population consisted of all toddlers suffering from malnutrition in Karang Maritim Village, Panjang District, Bandar Lampung City, with a sample of 37 using purposive sampling. The independent variable in this study was the age at which soybean tempeh nuggets were introduced, and the dependent variable was the weight of the toddlers. Bivariate analysis was conducted using the T-test.

Results: The results of the study showed a significant difference between before and after the intervention with a p-value of 0.000 (<0.05). The intervention group experienced an increase in weight, with an average increase from 11.10 to 11.42, a difference of 0.32, while the control group experienced an increase in weight, with an average increase from 11.19 to 11.34, a difference of 0.15.

Conclusion: Consumption of soy tempeh nuggets is effective in increasing the weight of malnourished toddler.

Keywords: Soybean tempeh nuggets; Toddler weight.

INTRODUCTION

The problem of undernutrition in toddlers remains a serious challenge in many countries, including Indonesia. Undernutrition in toddlers is a condition in which children experience a deficiency of essential nutrients, impacting their physical growth, cognitive development, and overall health. This condition occurs due to inadequate nutritional intake in terms of both quality and quantity, as well as health issues that interfere with the absorption and utilization of nutrients (World Health Organization, 2023). Toddlers who experience undernutrition are not only at risk of growth faltering but are also more vulnerable to infectious diseases and have a greater potential for experiencing mental and physical developmental disorders later in life (UNICEF, 2023).

Globally, undernutrition in toddlers remains a primary concern for the World Health Organization. According to a report by WHO (2023), approximately 144 million children under five years of age suffered from undernutrition in 2022. The same report also indicates that the highest prevalence of undernutrition was found in Africa and Southeast Asia. In Southeast Asia, around 22% of toddlers suffer from undernutrition, while in Africa, this figure reaches 32%. This condition illustrates a significant nutritional gap between developing and developed countries and underscores the importance of more intensive intervention efforts in the most affected regions (World Health Organization, 2023).

Based on data from the Indonesian Basic Health Research in 2022, the prevalence of undernutrition in Indonesia was 17.7%. In 2023, the Ministry of Health announced the results of the Indonesian Nutritional Status Survey at the National Population and Family Planning Board, showing that the prevalence of stunting in Indonesia decreased from 24.4% in 2021 to 21.6% in 2022. Meanwhile, in Lampung Province, in 2021, the prevalence of undernourished (wasted) toddlers was 7%, which increased to 7.2% in 2022. In Central Lampung Regency, in 2021, the stunting (undernutrition) rate reached 20.8%, which was higher than the average for Lampung Province (Lampung Provincial Health Office, 2023).

The causes of undernutrition in toddlers are complex and involve various factors from both individual and environmental aspects. One of the main causes is the lack of nutritious food intake, whether due to poverty, parents' lack of knowledge regarding nutrition, or limited food availability (Nurhayani et al., 2024). Undernutrition in toddlers under three years is caused by two main factors: direct and indirect factors. Direct factors consist of infectious diseases and nutrient intake, whereas indirect factors include economic status, parenting practices, and maternal knowledge. Parenting practices and maternal knowledge in child rearing play a crucial role in terms of child feeding, awareness of appropriate food types according to age and needs, health practices, and providing affection (Puspa & Rahmawati, 2020).

The impacts of unaddressed undernutrition can be fatal for toddlers. Children with undernutrition are at risk of failure to thrive, meaning they do not achieve their expected growth potential. In addition, undernutrition increases susceptibility to infectious diseases such as pneumonia and diarrhea, which are the leading causes of under-five mortality in Indonesia. In the long term, toddlers experiencing undernutrition are at risk of developing chronic health problems such as obesity, diabetes, and heart disease in adulthood (Rahmawati et al., 2024).

Various efforts have been made to address the issue of undernutrition in toddlers, ranging from Supplementary Feeding programs, increasing access to healthcare services, to nutrition education for parents (Ministry of Health of the Republic of Indonesia, 2022). One type of PMT that meets these requirements is the provision of processed soybean tempeh. To ensure maximum consumption of processed soybean tempeh, it can be modified into the form of nuggets. With an alternative presentation, toddlers are expected to be interested and willing to consume it (Mariyam et al., 2017).

Soybean tempeh nuggets, an innovation from this traditional food, are easily accepted by children due to their crispy texture and pleasant taste. Tempeh nuggets can serve as an alternative source of high-quality plant protein that is easy to prepare. Several studies show that children who regularly consume tempeh have a lower risk of malnutrition and gastrointestinal infections, owing to the natural probiotics produced during the tempeh fermentation process (Astuti et al., 2000). The high protein content in tempeh nuggets which is easily digestible and readily accessible makes tempeh one of the excellent protein sources to help improve children's nutritional status (Mariyam et al., 2017).

RESEARCH METHOD

This study is an experimental research aimed at determining the effectiveness of soybean tempeh nugget consumption on weight gain in undernourished toddlers. The study was conducted in Karang Maritim Urban Village, Panjang District, Bandar Lampung City, over a 1-month period from June 15 to July 15, 2025.

The research design utilized a quasi-experiment with a two-group pretest-posttest design, comprising two groups: an experimental group receiving the intervention (soybean tempeh nuggets) and a control group receiving no intervention. Both groups had their body weight measured before the intervention (pretest) and after the intervention (posttest). The population in this study consisted of all undernourished toddlers in Karang Maritim Urban Village, totaling 60 toddlers. The sample size was calculated using the Lemeshow formula, yielding a minimum of 37 toddlers; however, this study utilized 30 toddlers selected via purposive sampling, consisting of 15 toddlers in the experimental group and 15 toddlers in the control group.

The research variables included the independent variable, which was the provision of soybean tempeh nuggets, and the dependent variable, which was the toddlers' body weight. The operational definition of the independent variable was the administration of 50 grams of soybean tempeh nuggets per day for 1

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month, whereas the dependent variable was measured using a digital scale before and after the intervention. The research instruments consisted of an observation sheet monitoring the implementation of tempeh nugget administration and a digital scale to measure the toddlers' body weight. Data collected comprised primary data (direct toddler body weight measurement results) and secondary data (records of undernourished toddlers at the Integrated Healthcare Center.

Data processing was carried out through the stages of editing, coding, entry, and tabulation. Data analysis included univariate analysis to describe respondent characteristics as well as toddler weight changes before and after the intervention, and bivariate analysis using a Paired T-test (for normally distributed data) or a Wilcoxon test (for non-normally distributed data). The normality test used was the Shapiro-Wilk test, given that the number of respondents was fewer than 50.

With this design, the study is expected to provide an overview of the effectiveness of soybean tempeh nugget consumption as a nutritional intervention effort for underweight toddlers. This study has obtained ethical clearance from the Health Research Ethics Committee of Malahayati University under reference number: 5047/EC/KEP-UNMAL/VIII/2025.

RESEARCH RESULTS

Table 1. Characteristics of Respondents (N=30)

Variable	Intervention Group	Kontrol Group
Age (Mean±SD) (Years) (Range)		
3	8/53.3	6/40.0
4	4/26.7	5/33.3
5	5/26.7	4/26.7
Gender (n/%)		
Male	8/53.3	9/60.0
Female	7/46.7	6/40.0

Based on Table 1. the majority of respondents in both groups were male, with 8 children (53.3%) in the intervention group and 9 children (60.0%) in the control group. Meanwhile, based on age, the majority of toddlers in both groups were 3 years old, comprising 8 children (53.3%) in the intervention group and 6 children (40.0%) in the control group.

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Table 2. Average Body Weight of Toddlers Before and After Given Soybean Tempeh Nuggets in the Intervention and Control Group

Variable	Mean±SD	Min-Max
Intervention Group		
Prettest	11.10±0.32	9.50 – 12.90
Posttest	11.42±0.32	10.00 – 13.20
Control Group		
Prettest	11.19±0.15	9.20-12.90
Posttest	11.340.15	12.90

Based on Table 2. The average body weight of toddlers in the control group before the observation was 11.19 kg, with a minimum weight of 9.20 kg and a maximum of 12.90 kg. After the observation, the average body weight was 11.34 kg, with a minimum weight of 9.40 kg and a maximum of 12.90 kg. respondents in the intervention group experienced an increase in average body weight from 11.10 kg to 11.42 kg, with a mean increase of 0.32 kg. Meanwhile, respondents in the control group experienced an increase in average body weight from 11.19 kg to 11.34 kg, with a mean increase of 0.15 kg.

Tabel 3. Data Normality Test

Body Weight	P-value	Description
Intervention Control	0.377	Normal
(Pretest)	0.346	Normal
Intervention Control	0.270	Normal
(Posttest)	0.326	Normal

Based on Table 3. the Shapiro-Wilk test results for both pretest and posttest in both groups showed a p-value > 0.05, indicating that the data were normally distributed. Therefore, the bivariate analysis was conducted using the Paired T-test.

DISCUSSION

Based on the body weight measurements of toddlers prior to administering 50 grams of soybean tempeh nuggets daily for 1 month, the baseline average body weight in the intervention group was 11.10 kg (min 9.50 kg; max 12.90 kg). Following the intervention, the average body weight increased to 11.42 kg (min 10.00 kg; max 13.20 kg). These results demonstrate a weight change between pre- and post-intervention.

Another study the normal body weight range for toddlers aged 3–5 years is 11.3–24.9 kg. Underweight is a condition where a child's body weight falls below the average or normal range. Ideally, children are classified as having normal weight when their weight aligns with peers of the same age (World Health Organization, 2024). Conversely, underweight status indicates that a child's body weight is disproportionate to or lower than their age group (Salma et al., 2021).

Underweight status can reflect an inadequate intake of essential nutrients relative to requirements, or excessive nutrient loss compared to intake. Anthropometric measurement is one method used to assess nutritional adequacy. A key anthropometric parameter is the Weight-for-Age (W/A) index, which measures relative body weight compared to age. This index identifies children who are underweight (-3 SD to <-2 SD) or severely underweight (<-3 SD) (National Legal Documentation and Information Network, 2020).

Another study showed that the average weight of undernourished toddlers before consuming soybean tempeh nuggets was 9.99 kg (min 7.87 kg; max 13.01 kg) (Mariyam et al., 2017). Similarly, demonstrated that the baseline average weight of the experimental

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group prior to receiving high-nutrition food made from tempeh and cauliflower was 9.04 kg, compared to 9.81 kg in the control group, both falling into the underweight category (Salma et al., 2021).

Toddler body weight is influenced by direct factors (dietary intake and infectious diseases) as well as indirect factors (household food security, parenting practices, healthcare access, and environmental sanitation). To reduce the prevalence of undernourishment, fulfilling dietary needs through nutrient-dense supplementary feeding is essential (Supardi et al., 2023).

Findings from this study revealed that most toddlers were 3 years old with a baseline average weight of 11.10 kg, reflecting an age-inappropriate body weight indicative of undernutrition. Age serves as an indicator of growth during toddlerhood and reflects nutritional adequacy. Unmet nutritional requirements during this stage impair physical growth and development, thereby hindering weight gain (Sulistianingsih, 2018).

Therefore, the researcher assumes that the low baseline weight observed in most respondents resulted from insufficient intake of key nutrients, particularly calories and protein, in their daily diet. However, following 1 month of tempeh nugget supplementation, a significant weight increase occurred. This improvement is attributed to tempeh nuggets providing a rich source of plant protein and energy that helps satisfy daily nutritional demands, thereby supporting growth and nutritional recovery.

The results showed that the average weight of toddlers in the control group prior to observation was 11.19 kg (min 9.20 kg; max 12.90 kg) and changed to 11.34 kg (min 9.40 kg; max 12.90 kg) post-observation. This minor weight gain was not statistically significant, indicating that the body weight of toddlers in the control group remained in the underweight category. Suboptimal weight reflects insufficient nutritional intake to keep pace with age-appropriate growth demands (Salma et al., 2021).

Toddler weight gain relies heavily on adequate energy and protein intake, even though growth progresses gradually. WHO (2019) asserts that healthy weight velocity in toddlers should average approximately 20–30 grams per day (Hatala (2021). As a source of plant protein, energy, and essential micronutrients, tempeh holds strong potential to improve toddler body weight (Supariasa et al., 2022).

Prior studies (Salma et al., 2021; Risma & Nurhaeda, 2022) also reported slight, non-significant weight gains among control group respondents. Consequently, minor weight shifts in the control group stem primarily from natural growth trajectories and routine dietary fluctuations rather than targeted nutritional interventions.

This study demonstrates that the consumption of soybean tempeh nuggets significantly increases body weight in undernourished toddlers. In the intervention group, average body weight rose from 11.10 kg to 11.42 kg (a mean difference of 0.32 kg), whereas the control group experienced an average gain of only 0.15 kg. The difference in weight gain between the two groups was 0.173 kg. The Paired T-test yielded a p-value = 0.000 ($p < 0.05$), confirming a statistically significant difference between the intervention and control groups.

The higher weight gain in the intervention group is attributable to the nutritional quality of tempeh nuggets. Rich in plant protein, healthy fats, and dietary fiber, tempeh enhances daily energy intake and optimizes nutritional status. As a core ingredient, tempeh offers high-protein bioavailability, easy digestibility, and essential support for energy metabolism and cellular tissue formation. These findings align with Mariyam et al. (2022) and Susianto et al. (2023), who similarly established that soybean tempeh nugget supplementation effectively improves toddler weight.

In conclusion, soybean tempeh nugget consumption can be recommended as an affordable, culturally acceptable dietary intervention to aid nutritional recovery in undernourished toddlers.

CONCLUSION

Based on the study evaluating the effectiveness of soybean tempeh nugget consumption on weight gain in toddlers in Karang Maritim Urban Village, Panjang District, Bandar Lampung City, it can be concluded that a significant difference in weight gain existed between the intervention and control groups. In the intervention group, the baseline average weight was 11.10 kg (range 9.50–12.90 kg) and increased post-intervention to 11.42 kg (range 10.00–13.20 kg). In contrast, the control group baseline average weight was 11.19 kg (range 9.20–12.90 kg) and increased to only 11.34 kg (range 9.40–12.90 kg). Bivariate analysis confirmed that soybean tempeh nugget

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supplementation was effective in promoting weight gain in toddlers, with a p-value = 0.000 ($p < 0.05$). This proves that soybean tempeh nugget supplementation serves as a viable, practical dietary intervention to help address undernutrition in toddlers.

SUGGESTION

For Malahayati University: Evidence-based nutritional interventions such as soybean tempeh nugget supplementation should be further expanded and applied in community outreach programs, such as nutritional education using leaflets or brochures to ensure information is accessible to parents. For Parents of Toddlers: Parents are encouraged to utilize soybean tempeh nuggets as a routine supplementary food to assist child weight gain while ensuring menu diversity to prevent dietary fatigue. For Future Researchers: The findings of this study can serve as a reference and data source for future research, with recommendations to incorporate additional nutritional variables beyond protein and expand the sample size to obtain more comprehensive and precise insights.

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