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The Empowerment of Nugget AYEM (Chicken-Tempeh Nugget) Training on Health Cadres' Knowledge in Managing Undernutrition Among Children Aged 9–60 Months

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ABSTRACT

Background: *Undernutrition among children under five remains a public health priority in Indonesia. In Leses Village, Manisrenggo, Klaten, the prevalence of childhood undernutrition (11.9%) exceeds the sub-district average (8.8%). The village has an established local tempeh (fermented soybean) industry that had not yet been optimised to address this problem. This study aims to Enhancing the knowledge and skills of health volunteers in Leses Village regarding the production of "AYEM" nuggets (chicken-tempeh nuggets)—a local food innovation designed to address undernutrition in children aged 9–60 months.*

Methods: *This program trains 38 integrated health post (posyandu) cadres and village midwives in the preparation of Nugget AYEM (Chicken-Tempeh Nugget), a locally formulated complementary food. Knowledge was assessed with an identical pre- and post-test questionnaire. Data were analysed descriptively*

Results: *The mean of Health Cadres' Knowledge pre-test score was 73.55, while the mean post-test score was 88.29. The mean gain was 14.74 points, corresponding to a relative increase of 20.0% over the baseline. Overall, participants' knowledge improved after the intervention. Individually, 26 of 38 participants (68.4%) improved, 10 (26.3%) stayed the same, and 2 (5.3%) scored lower on the post-test. The largest gain was +60 points (from 40 to 100). 11 participants (28.9%) achieved a perfect post-test score of 100, and the lowest post-test score (70) was higher than the lowest pre-test score (40). The standard deviation of scores decreased from 12.08 to 9.46, indicating that post-test results were more homogeneous across participants.*

Conclusion: *Training in Nugget AYEM preparation significantly improved health cadres' knowledge of undernutrition management using a local-food innovation, supporting its adoption as a sustainable, community-based nutrition strategy. Cadres can implement a variety of supplementary feeding (PMT) menu options at the *posyandu* (integrated health post) by preparing chicken-tempeh nuggets as a snack for infants and young children (MPASI), helping to prevent undernutrition and stunting.*

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INTRODUCTION

Undernutrition among children under five continues to challenge public health systems worldwide. The 2023 Joint Child Malnutrition Estimates released by UNICEF, the World Health Organization (WHO), and the World Bank Group reported that approximately 148 million children under five were stunted and 45 million were wasted globally, with a global wasting prevalence of 6.8%(1). Undernutrition during the first 1,000 days of life is associated with long-term consequences for cognitive development, immune function, and adult productivity.

In Indonesia, the 2022 Indonesian Nutritional Status Survey (Survei Status Gizi Indonesia, SSGI) recorded a national wasting prevalence of 7.7% and a stunting prevalence of 21.6%, while Central Java Province recorded a stunting prevalence of 20.8%. Within the working area of Puskesmas Manisrenggo, Klaten Regency, 8.8% of children under five were classified as undernourished; in Leses Village specifically, this figure was higher at 11.9%, exceeding the sub-district average. Undernourished children face elevated short-term risks of impaired brain and physical development and, in the long term, an increased risk of stunting, reduced immunity, and non-communicable disease in adulthood.

Leses Village, Manisrenggo, is home to an established local tempeh (fermented soybean) industry whose products are marketed beyond the sub-district, yet this local resource had not been systematically optimised to address childhood undernutrition. Tempeh is a fermented soy product with a distinctive nutritional profile: fermentation involving *Rhizopus oligosporus* together with naturally occurring microbiota such as *Klebsiella* sp. and *Saccharomyces cerevisiae* can yield vitamin B12 concentrations of up to 3.15 mg/100 g, making tempeh one of the few plant-based sources of vitamin B12 (2). Tempeh also provides a complete essential amino acid profile and folate, supporting its role as a high-value alternative protein source for children, and its isoflavone content has been associated with improved haemoglobin status in vulnerable groups (3).

Prior formulation studies support the translation of tempeh into acceptable complementary foods for children. Nuggets formulated from a combination of tempeh and chicken meat have been shown to achieve favourable nutritional and organoleptic quality(4), and the provision of tempeh-nugget-based supplementary feeding has been reported to significantly improve the weight and height of stunted children(5). Supplementary feeding accompanied by structured nutrition counselling has similarly been shown to be more effective in improving children's nutritional status than supplementary feeding alone (6)

The success of community-based nutrition interventions ultimately depends on the capacity of Posyandu (integrated health post) cadres, who serve as the frontline of maternal and child health services. Indonesian studies employing pre-post training designs have consistently reported significant improvements in cadre knowledge following structured, hands-on education ($p < 0.001$–0.05), while also highlighting the need for repeated reinforcement to sustain practical skills (7)

Building on this evidence, the community service team, in collaboration with the nutritionist of Puskesmas Manisrenggo, developed “Nugget AYEM” (Nugget Ayam Tempe / Chicken-Tempeh Nugget), a complementary food formulated with calorie, protein, carbohydrate, and fat content adapted for children aged 9–60 months with undernutrition. This report describes the design, implementation, and outcomes of a structured training program for Leses Village health cadres in the preparation of Nugget AYEM, aiming of this community service initiative is to enhance the knowledge of

community health volunteers regarding the preparation of various complementary foods for infants and young children (MPASI) using local food ingredients, with the aim of preventing undernutrition and stunting in toddlers.

METHODS

This community service program was implemented during two days, on July 10 and July 14, 2026, at the Leses Village Hall, Manisrenggo District, Klaten in Leses Village, Manisrenggo Sub-district, Klaten Regency, Central Java, Indonesia, over two training days (with a four-day interval between them). Participants comprised all Posyandu health cadres and village midwives from Leses Village who attended and completed both training days; a total of 38 participants, all female, aged 38–63 years, were enrolled using a total sampling technique. The activity was implemented under the auspices of the Research and Community Service Centre of Poltekkes Kemenkes Surakarta, in partnership with the Leses Village Government and Puskesmas Manisrenggo.

Stage 1: Preparation and Coordination

Preparation began with coordination meetings involving the Leses Village government, Puskesmas Manisrenggo, and Posyandu cadre representatives to finalise the training schedule, participant list, and logistical requirements. The Nugget AYEM recipe, previously developed collaboratively by Poltekkes Kemenkes Surakarta lecturers and the Puskesmas Manisrenggo nutritionist, was finalised with calorie, protein, carbohydrate, and fat content adjusted for children aged 9–60 months with undernutrition. Cooking equipment (including choppers) and raw materials for Nugget AYEM production were procured in advance as an investment for each participating Posyandu.

Stage 2: Training and Demonstration

On the first day, a pre-test was administered before an education session covering childhood undernutrition, stunting, and the nutritional advantages of Nugget AYEM. This was followed by demonstration and hands-on redemonstration of Nugget AYEM preparation, directly supervised by the Puskesmas Manisrenggo nutritionist. At the close of the first day, each Posyandu received a complete set of cooking equipment and raw ingredients for Nugget AYEM, to be used for the balitas registered at their respective Posyandu. How to Make Chicken-Tempeh Nuggets.

Chicken-Tempeh Nuggets

Ingredients:

1) 200 g skinless chicken breast fillet
2) 250 g tempeh (steamed and mashed)
3) 1 carrot, coarsely grated
4) 1 egg, lightly beaten
5) 1 tbsp breadcrumbs
6) 2 tbsp tapioca starch (sago flour)
7) 2 cloves of garlic
8) Salt
9) Celery leaves

Coating Ingredients:
1) 1 egg white
2) 2 tbsp cornstarch
3) 1 tbsp water
4) Breadcrumbs (for the outer coating)

Instructions for Making Chicken-Tempeh Nuggets:
1) Combine all the prepared nugget ingredients and seasonings; mix well.
2) Grease a baking pan with cooking oil, pour in the nugget mixture, and steam for 20 minutes. Remove from the steamer and let cool.
3) Once cooled, cut into desired shapes.
4) Prepare the coating ingredients.
5) Coat the nugget pieces with the prepared coating mixture, then roll them in breadcrumbs.
6) Refrigerate for 2 hours.
7) Heat oil and fry the chicken-tempeh nuggets until golden brown. Remove, drain, and serve.



Figure 1. Demonstration of making chicken-tempeh nuggets

Stage 3: Evaluation and Follow-up

Four days after the first session, an evaluation day was held in the form of an inter-Posyandu Nugget AYEM cooking competition. Each Posyandu brought a self-prepared batch of Nugget AYEM, assessed by a panel comprising the Puskesmas Manisrenggo nutrition team, the head of the village women's association (PKK), and the program coordinator, using taste, aroma, hygiene, presentation, and creativity as scoring criteria. Immediately after the core activities concluded, a post-test using an instrument identical to the pre-test was administered to all 38 participants. Knowledge scores (range 0–15) from both time points were compiled and analysed.

The mean is calculated by summing all scores and dividing by the number of participants (n). Three indicators were computed:

- Mean pre-test score = Σ pre-test scores ÷ n
- Mean post-test score = Σ post-test scores ÷ n
- Mean gain = Σ (post-test − pre-test) ÷ n, which is equal to the mean post-test minus the mean pre-test. The relative increase is expressed as (mean gain ÷ mean pre-test) × 100%

The evaluation of the chicken-tempeh nugget-making activity involved dividing all the participating community health post (*posyandu*) volunteers into seven groups organized according to their respective *posyandu* and providing them with the necessary equipment and ingredients. Four days later, an evaluation took place: each of the seven groups presented the chicken-tempeh nuggets they had prepared. A panel of judges consisting of the village head's wife, a nutritionist from the Manisrenggo (Klaten) Community Health Center (*puskesmas*), and a lecturer from the Health Polytechnic of the Ministry of Health in Surakarta assessed the entries based on taste, texture, presentation, and hygiene. The three best-performing *posyandu* groups were selected, recognized for their creative approaches to crafting chicken-tempeh nuggets that would appeal to children.



Figure 2. Evaluation of the chicken-tempeh nuggets produced by each *posyandu* (integrated health post)



Figure 3. Presentation of prizes based on the evaluation results for the production of chicken-tempeh nuggets from the best *posyandu* (integrated healthcare posts)

RESULTS

All 38 enrolled participants, comprising Posyandu health cadres and village midwives from Leses Village, completed the full two-day program (100% attendance). Participant characteristics are summarised in Table 1, Table 2, and picture 1.

Table 1. Comparison of Health Cadres' Knowledge Scores Before and After Nugget AYEM Training (n = 38)

Indicator	Pre-test	Post-test	Gain
Mean	73.55	88.29	+14.74
Median	80.0	90.0	+10.0
Standard deviation	12.08	9.46	17.32
Minimum	40	70	-10
Maximum	100	100	+60

The mean pre-test score was 73.55, while the mean post-test score was 88.29. The mean gain was 14.74 points, corresponding to a relative increase of 20.0% over the baseline. Overall, participants' knowledge improved after the intervention. Individually, 26 of 38 participants (68.4%) improved, 10 (26.3%) stayed the same, and 2 (5.3%) scored lower on the post-test. The largest gain was +60 points (from 40 to 100). 11 participants (28.9%) achieved a perfect post-test score of 100, and the lowest post-test score (70) was higher than the lowest pre-test score (40). The standard deviation of scores decreased from 12.08 to 9.46, indicating that post-test results were more homogeneous across participants.

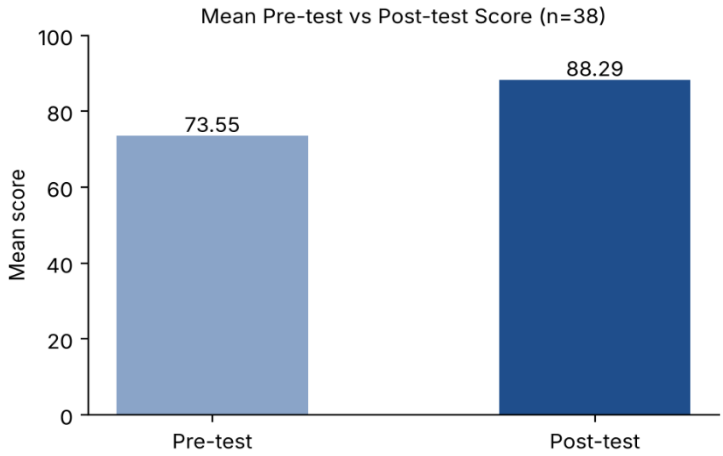


Figure 1. Mean Pre-Test and Post-Test Score

Table 2. Distribution of Score Changes of Health Cadres' Knowledge Scores Before and After Nugget AYEM Training

Category	Participants	Percentage
Score increased	26	68.4%
Score unchanged	10	26.3%
Score decreased	2	5.3%
Total	**38**	**100.0%**

DISCUSSION

This community empowerment program demonstrated a statistically significant and practically meaningful improvement in health cadres' knowledge of childhood undernutrition management following hands-on training in Nugget AYEM preparation, with the mean pre-test score was 73.55, while the mean post-test score was 88.29. The mean gain was 14.74 points, corresponding to a relative increase of 20.0% over the baseline. Overall, participants' knowledge improved after the intervention. Individually, 26 of 38 participants (68.4%) improved, 10 (26.3%) stayed the same, and 2 (5.3%) scored lower on the post-test. The largest gain was +60 points (from 40 to 100). 11 participants (28.9%) achieved a perfect post-test score of 100, and the lowest post-test score (70) was higher than the lowest pre-test score (40). The standard deviation of scores decreased from 12.08 to 9.46, indicating that post-test results were more homogeneous across participants (8) suggesting that structured, hands-on training is a broadly effective strategy for rapidly strengthening cadre capacity, regardless of the specific delivery medium.

The significant gain observed here is consistent with published cadre-training studies. (9) trained 30 Posyandu cadres in Yogyakarta in a two-day course on growth monitoring, development monitoring and infant and young child feeding (IYCF); average knowledge rose from 71.23 to 77.43 immediately after the course and to 81.08 four weeks later (adjusted gain 6.20 and 9.84 points, $p < 0.05$), with the largest delayed gain in the IYCF domain (71.33 to 83.03). Our baseline (73.55) was similar, and our immediate gain (14.74) was larger, although differences in instruments and content mean the figures are comparable only in direction, not in precise magnitude.

A recent systematic review of 52 studies on cadre mentoring in stunting-prevention programmes (10) found that most studies reported higher cadre knowledge, skills and engagement after training or mentoring, and that structured training was the most common approach. It reported pre-to-post gains such as 32.8 to 87.1 and 72.01 to 93.31 in individual studies, a range within which our result (73.55 to 88.29) sits. The review also found that participatory methods and training combined with supervision or home visits were more often linked to positive outcomes than one-off sessions. A hands-on product demonstration such as nugget preparation is a participatory format, which is a plausible reason for the strong gain, although this study did not test the mechanism.

The magnitude of improvement observed here is likely attributable to the program's multimodal design, which combined cognitive education (lectures and discussion on stunting and undernutrition) with psychomotor learning (demonstration and redemonstration of Nugget AYEM preparation) and a competitive, practice-based evaluation four days later. This approach aligns with WHO health-promotion principles emphasising active participation, awareness-building, and problem-solving capacity among target groups (7).

From a nutritional standpoint, the selection of tempeh as the principal raw material for Nugget AYEM is well supported by existing evidence. Tempeh is among the few plant-based foods that naturally contain fermentation-derived vitamin B12 (11) (10), and its combination with chicken meat in a nugget formulation has been shown to yield favourable nutritional and organoleptic quality acceptable to children, consistent with reports that tempeh-nugget-based supplementary feeding significantly improves the weight and height of stunted children (5). These findings support the pairing of nutritionally adjusted local-food supplementary feeding with structured nutrition

counselling as a more effective approach to improving children's nutritional status than supplementary feeding alone(6).

From a community-impact perspective, this program illustrates how a locally embedded food resource, tempeh production, can be systematically translated into a nutrition intervention led by trained community health workers. The direct involvement of health cadres and the investment of cooking equipment and raw materials at each Posyandu support a task-shifting model in which routine supplementary-food preparation is sustained by cadres beyond the training period, with periodic technical support from Puskesmas nutritionists. This model is consistent with the broader recognition that sustainable, community-based nutrition interventions require alignment with existing health-service structures and active engagement of local stakeholders, including cadres, village government, and primary health care providers.(8)

This program has several limitations. First, the *one-group pre-post test* design without a comparison group cannot fully rule out testing effects or secular changes in knowledge unrelated to the intervention. Second, evaluation was limited to the knowledge domain; Third, the four-day interval to post-test evaluation is too short to assess knowledge retention or long-term adherence to Nugget AYEM preparation practices. Future community service activities should incorporate a comparison group where feasible, extend follow-up to assess retention and practice sustainability, and directly measure anthropometric outcomes among children receiving Nugget AYEM as supplementary feeding. Tempeh is a fermented soybean product. A narrative review (12) summarises that fermentation lowers phytic acid by roughly 65%, raises soluble iron from about 24% to 67%, and improves protein quality (PDCAAS) while total protein remains similar to soybean (about 20 g per 100 g in the cited database entry). The same review notes that small studies in Indonesian children aged about 2–5 years found that tempeh nuggets improved energy intake and weight gain, while cautioning that the human evidence is limited to small trials. Adding chicken contributes animal-source protein, which supports the product's suitability as a complementary or supplementary food.

CONCLUSIONS AND SUGGESTIONS

This community empowerment program demonstrated a statistically significant and practically meaningful improvement in health cadres' knowledge of childhood undernutrition management following hands-on training in Nugget AYEM preparation, with the mean pre-test score was 73.55, while the mean post-test score was 88.29. The mean gain was 14.74 points, corresponding to a relative increase of 20.0% over the baseline. Overall, participants' knowledge improved after the intervention. Individually, 26 of 38 participants (68.4%) improved, 10 (26.3%) stayed the same, and 2 (5.3%) scored lower on the post-test. The largest gain was +60 points (from 40 to 100). 11 participants (28.9%) achieved a perfect post-test score of 100, and the lowest post-test score (70) was higher than the lowest pre-test score (40). The standard deviation of scores decreased from 12.08 to 9.46, indicating that post-test results were more homogeneous across participants.

The present results show that the training improved knowledge; they do not show reduced stunting. The systematic review by (8) states explicitly that gains in cadre knowledge did not consistently translate into improved child outcomes, that only a smaller share of studies found improvements in stunting or anthropometric measures, and that many programmes were short with limited evidence on long-term impact.

Knowledge is a necessary first step: cadres must understand why protein-rich local foods matter and how to prepare them safely before they can educate caregivers. However, achieving effects on child growth also requires continued supervision, home visits, access to ingredients, and actual consumption by children.

From a practice perspective, Nugget AYEM preparation can be integrated into routine Posyandu supplementary-feeding activities, supported by the cooking equipment and raw-material investment provided to each Posyandu. From a policy perspective, this program supports the inclusion of locally sourced, fermented-soy-based complementary foods within community-level undernutrition prevention strategies. Continued collaboration between academic institutions, Puskesmas, village government, and health cadres is recommended to sustain the program, and future activities should incorporate comparison-group designs and direct anthropometric monitoring to strengthen the evidence base for policy adoption at the sub-district and district levels and also for respondents, mothers of toddlers can be directly involved in training in making chicken and tempeh nuggets

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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