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## Provision Of Local Food-Based Supplementary Feeding For Undernourished Toddlers In Primary Care: A Systematic Literature Review

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### Abstract

Undernutrition among children under five in Indonesia remains aggravated by poor diet quality and comorbidities such as tuberculosis, anemia, and thalassemia. This review evaluated the effectiveness of local food-based supplementary feeding compared with standard supplements or no intervention, assessed the moderating role of major comorbidities on nutritional recovery, and identified determinants of program success. A PRISMA 2020-guided systematic literature review was conducted using Consensus.app sources published in 2015–2026, prioritizing systematic reviews, meta-analyses, randomized controlled trials, and quasi-experimental studies. Supplementary foods and complementary feeding interventions improve recovery, body weight, Weight-for-Height Z-Score (WHZ), Weight-for-Age Z-Score (WAZ), dan Mid-Upper Arm Circumference (MUAC), sementara perbaikan tinggi badan whereas gains in height/ Height-for-Age Z-Score (HAZ) are smaller and require longer exposure. Local food-based products, including moringa-fortified foods, moringa nuggets, and other locally formulated diets, also improved weight, height, or Mid-Upper Arm Circumference (MUAC) in studies from Indonesia and other low-resource settings. Tuberculosis and anemia consistently predicted slower nutritional recovery, while evidence for thalassemia mainly indicates elevated malnutrition risk rather than tested response to supplementary feeding. Program success depends on adequate duration, adherence, nutrient composition, training, family support, and primary care delivery capacity. The main research gap is the lack of integrated screening for tuberculosis, anemia, and thalassemia within primary-care supplementary feeding programs. Locally-based PMT effectively improves short-term nutritional status of undernourished children, but its effectiveness decreases in children with TB and anemia comorbidities. Integration of tuberculosis, anemia, and thalassemia screening in PMT programs at primary healthcare facilities is needed.

**Keywords:** Local Supplementary Feeding, Under-Five Undernutrition, Wasting, Anemia, Tuberculosis.

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## INTRODUCTION

The problem of malnutrition in toddlers is still a major public health challenge in low- and middle-income countries (LMICs). Cross-analysis of 62 LMICs showed that the prevalence of stunting, wasting, and underweight in children aged 0–59 months still reached 29.1%, 6.3%, and 13.7%, respectively, while undernutrition in 2016 was estimated to contribute to more than 1 million child deaths globally (Ssentongo et al., 2021). A Literature review also confirms that although the prevalence of stunting has declined since the early 2000s, the progress has been uneven, and stunting and wasting remain an important public health problem, particularly in low-income countries, with the coexistence of stunting-wasting increasing the risk of death almost fivefold (Victora et al., 2021). In addition, the picture of child nutrition in many LMICs is now characterized by a double burden, namely coexistence undernutrition and overweight, which demands more precise and contextual interventions (Kinyoki et al., 2020).

In Indonesia, the burden of nutritional problems for toddlers shows an improving trend but has not been completely resolved. Trend analysis in children aged 2.0–4.9 years showed that the

prevalence of stunting decreased from 50.8% to 36.7% and underweight from 34.5% to 21.4%, but at the same time the risk of overweight increased, showing that Indonesia is facing a complex nutritional transition (Rachmi et al., 2016). Data from the Indonesian Nutrition Status Survey (SSGI) used in the evaluation of the Puskesmas program also shows that the national stunting prevalence has decreased from 24.4% in 2021 to 21.6% in 2022, but this figure still shows a high burden and does not guarantee equitable improvement at the regional level ('Ulya & Maharani, 2024). Geospatial evidence from 105 LMICs even places Indonesia as one of the regions most pronounced by the double nutritional burden, so interventions in toddlers can focus not only on increasing intake, but also on healthy growth quality (Kinyoki et al., 2020).

In this context, Supplementary Feeding (PMT), especially those based on local food, is one of the specific nutrition interventions that is increasingly important and has the potential to be implemented. A number of studies in Indonesia show that local PMT can improve short-term growth indicators. In primary services in Banyumas, the 14-day PMT intervention significantly increased body weight and upper arm circumference (LiLA) in children aged 6–59 months with weight faltering (Haryani et al., 2024). Another study in Gresik in underweight toddlers showed a significant change in Z-score after 56 days of locally-sourced PMT intervention, while increasing parents' knowledge of nutrition and the use of local food at home (Ramadhania et al., 2025). The 60-day evaluation at the Puskesmas also found a significant improvement in nutritional status, with success influenced by compliance, parental involvement, and education (Christiyanti et al., 2025). Thus, local PMT seems to be able to be carried out not only as a nutritional intervention, but also as a means of empowering families and cadres (Ramadhania et al., 2025).

However, the effectiveness of nutritional interventions in toddlers is often complicated by comorbidities that are related to malnutrition in two ways. The link between tuberculosis and malnutrition has long been known as a bidirectional relationship: undernutrition increases the risk of active TB, while TB itself causes wasting and worsens nutritional status (Darnton-Hill et al., 2022; Padmapriyadarsini et al., 2016). A large study in TB patients showed that the prevalence of underweight reached 57.17% and anemia reached 88.52%, confirming the high burden of nutritional disorders in populations with chronic infections (Feleke et al., 2019). On the other hand, meta-analyses in least-developed countries reported a prevalence of comorbid stunting-anemia of 19.47% and wasting-anemia of 5.44%, indicating that micro and macronutrient deficiencies often appear simultaneously in early childhood (Dessie et al., 2024). The available literature review has not provided sufficient direct evidence on the role of thalassaemia as a "moderator" of PMT responses in malnourished toddlers, but the absence of this study is important because thalassaemia has the potential to affect nutritional status, energy needs, and interpretation of anthropometric indicators (Fitrianti et al., 2025).

The challenge of implementing the local food-based PMT program in Indonesia's primary health facilities is also still real and dilemmatic. Evaluations in West Sulawesi show that the program has followed national technical guidelines, but does not have adequate local operational regulations; The main obstacles include limited nutritional personnel, delays in budget disbursement, inconsistent monitoring, and geographical barriers (Muslimin et al., 2026). The study in Deli Serdang added to the problems of untimely distribution, declining food quality, budget constraints, low parental education, and lack of family involvement; management improvements increase the accuracy of distribution by 35% and family participation by 50% (Nasution et al., 2025). In Sukabumi, the effectiveness of the program is also limited by low parental nutritional literacy, socioeconomic challenges, inadequate environmental sanitation, and uneven community participation (Aprillianti et al., 2025).

Based on this description, this systematic literature review aims to: (1) evaluate the effectiveness of local food-based PMT programs compared to standard supplements or no intervention in improving the nutritional status of undernourished toddlers; (2) assess the role of comorbidities (tuberculosis, anemia, and thalassaemia) on nutritional recovery; and (3) identify the determinants of the success of local food-based PMT programs in primary health facilities.

RESEARCH METHODS

Research Design

This systematic review uses the Systematic Literature Review (SLR) method to identify, evaluate, and synthesize scientific evidence related to the effectiveness of local food-based Supplementary Feeding Programs (PMT) on improving the nutritional status of undernourished toddlers in primary health facilities, with special attention to complicating conditions such as tuberculosis, anemia, and thalassaemia.

Research Questions

The research questions were formulated based on the PICO (Population, Intervention, Comparison, Outcome) framework as follows:

| Components       | Description                                                                                                            |
|------------------|------------------------------------------------------------------------------------------------------------------------|
| P (Population)   | Toddlers aged 0-59 months with undernutrition status in Indonesia/LMIC                                                 |
| I (Intervention) | Supplementary Feeding (PMT) based on local food                                                                        |
| C (Comparison)   | Standard/non-local or non-interventional PMT                                                                           |
| O (Outcome)      | Changes in nutritional status (BB/U, TB/U, BB/TB, LiLA, changes in hemoglobin levels, early detection of comorbidities |

Data Sources and Search Strategies

The literature search was conducted systematically using a Consensus.app platform with the Deep Search feature, which analyzed up to 50 of the most relevant papers from more than 401 peer-reviewed papers. The search prompts are structured based on the RICE (Role, Instruction, Context, Expectation) framework with priority on high-quality study design: systematic review, meta-analysis, randomized controlled trials (RCTs), and quasi-experimental studies. The search is limited to 2015-2026 publications in English and Indonesian, with the Medical Mode filter to focus on reputable medical journals. The search results are then reviewed and validated by the author (human in the loop) to ensure the relevance and quality of the source before inclusion.

The search process is carried out by compiling structured prompts (commands) based on the RICE (Role, Instruction, Context, Expectation) framework to ensure relevant and comprehensive search results. The prompts used in the search are as follows:

**ROLE:** Senior researcher and systematic review expert in the field of public health with specialization in child nutrition and infectious disease epidemiology in developing countries. **INSTRUCTION:** Conduct a systematic literature search to answer PICO-based research questions regarding the effectiveness of local food-based PMT in undernourished toddlers, the prevalence and moderation effects of comorbidities (tuberculosis, anemia, thalassaemia), and factors determining the success of the program. Prioritize sources with high-quality study designs: Systematic Review, Meta-Analysis, Randomized Controlled Trial (RCT), and quasi-experimental studies from publications 2015-2026 in English and Indonesian. **CONTEXT:** This review was prepared to support the thesis of the Master of Public Health Program at the Islamic University of Indonesia and the publication manuscript in the Holistic Health Journal, with a focus on toddlers aged 0-59 months with malnutrition and comorbidities in Cirebon Regency, as well as local food-based PMT interventions in primary health facilities.

**EXPECTATION:** Produce outputs in the structure of the Holistic publication manuscript of the Health Journal which includes declarative titles, bilingual abstracts, introductions, methods, thematic results and discussions, conclusions, suggestions, and bibliographies in APA format.

Once the prompt is entered into the Consensus.app platform, the Deep Search feature is enabled to perform in-depth analysis. The Deep Search process on Consensus.app works by breaking down research questions into sub-questions, reviewing more than 1.1 million manuscripts, and selecting the top 50 most relevant paper recommendations for in-depth analysis. The search results are then reviewed and validated by the author (human in the loop) to ensure the relevance and quality of the

source before being included in the literature review. The results of the review obtained 43 relevant and valid manuscripts for study.

**Table 1. Inclusion and Exclusion Criteria**

| Criteria     | Inclusions                                                                                          | Exclusion                                                                                      |
|--------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Population   | Toddlers aged 0-59 months with malnutrition/poor nutrition or stunting                              |                                                                                                |
| Intervention | PMT program made from local food                                                                    | Interventions in the form of tablet supplementation, food-free fortification, or non-local PMT |
| Study Design | Systematic review, meta-analysis, RCT, quasi-experimental, pre-post study, program evaluation study | Pure qualitative studies, case studies, opinions, editorials                                   |
| Outcome      | Reporting anthropometric indicators (BB, TB, LILA) and/or anemia/comorbidity status                 | Not reporting nutrition-related or health-related outcomes                                     |
| Language     | Indonesian or English                                                                               |                                                                                                |
| Year         | 2015-2026                                                                                           |                                                                                                |

**Data Synthesis**

Because there are variations in methods and measurements between studies, a narrative synthesis approach is used. Results from various studies were grouped and analyzed thematically to answer the research questions.

**Method Limitations**

This systematic review has some limitations. First, although Consensus.app has a wide scope (a database of over 1 million manuscripts), not all relevant articles may be identified due to the limitations of databases and search algorithms. Second, heterogeneity between studies limits the possibility of conducting quantitative meta-analyses. Third, most studies come from well-managed research or program settings, so generalizations to routine program settings at health centers need to be done carefully. Fourth, studies published in languages other than Indonesian and English were not included, which may lead to the loss of evidence from other countries. Fifth, the potential for publication bias where studies with positive results are more likely to be published than studies with negative or insignificant results need to be considered in the interpretation of the findings.

**RESULTS AND DISCUSSION**

**Study Characteristics**

Based on the literature search, various studies were identified that are relevant to the topic of local food-based PMT in undernourished toddlers. The three main themes that emerged were PMT effectiveness, comorbidity moderation, and determinants of program success. In general, the best evidence supports that targeted supplementation improves acute recovery and that weight/upper arm circumference (LiLA) indicators are more consistent than height indicators (Visser et al., 2018; Lassi et al., 2025; Lassi et al., 2020).

Table 2. Characteristics of the Principal and Relevant Studies synthesized

| Yes | Author/<br>Year                        | Country           | Design                       | Sample         | Interventi<br>on                                                                                                                                                                                                                                               | Durat<br>ion    | Comparator                         | Primary<br>Outcome                                                               | Comorbid<br>ities                 | Conclusion                                                                                                       |
|-----|----------------------------------------|-------------------|------------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------------------|----------------------------------------------------------------------------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------|
| 1   | <a href="#">Tam et al. (2020)</a>      | LMIC              | SR/Me<br>ta-<br>analysi<br>s | 197<br>studies | Mikronutr<br>ien, LNS<br>( <i>Lipid-<br/>Based<br/>Nutrient<br/>Suppleme<br/>nt</i> ),<br>fortifikasi                                                                                                                                                          | Varie<br>s      | Miscellaneo<br>us                  | Anemia,<br>stunting,<br>underwei<br>ght                                          | Non-<br>specific                  | LNS<br>improves<br>underweight<br>/limited<br>stunting,<br>many<br>intervention<br>s reduce<br>anemia            |
| 2   | <a href="#">Das et al. (2020)</a>      | LMIC              | SR/Me<br>ta-<br>analysi<br>s | 42<br>studies  | CMAM<br>( <i>Communi<br/>ty-Based<br/>Managem<br/>ent of<br/>Acute<br/>Malnutriti<br/>on</i> ),<br>RUSF<br>( <i>Ready-to-<br/>Use<br/>Suppleme<br/>ntary<br/>Food</i> ),<br>RUTF<br>( <i>Ready-to-<br/>Use<br/>Therapeut<br/>ic Food</i> ),<br>pangan<br>lokal | Varie<br>s      | Standard<br>care                   | Recover<br>y, weight<br>gain,<br>UPPER<br>ARM<br>CIRCU<br>MFERE<br>NCE<br>(LiLA) | Partial                           | RUSF<br>standard<br>superior to<br>CSB, local<br>food<br>comparable<br>to standard<br>RUSF                       |
| 3   | <a href="#">Teshome et al. (2024)</a>  | Multi-<br>country | SR/Me<br>ta-<br>analysi<br>s | 7<br>Studies   | RUSF( <i>Re<br/>ady-to-<br/>Use<br/>Suppleme<br/>ntary<br/>Food</i> )                                                                                                                                                                                          | 12+<br>weeks    | CSB++/othe<br>r diets              | Antropo<br>metri,<br>recovery                                                    | Non-<br>specific                  | RUSF had a<br>small but<br>significant<br>effect on<br>anthropomet<br>ry and<br>recovery<br>compared to<br>CSB++ |
| 4   | <a href="#">Ahmad et al. (2020)</a>    | Indonesi<br>a     | Cluste<br>r RCT              | 121            | Education<br>+ multi-<br>nutrient<br>biscuits                                                                                                                                                                                                                  | 6<br>mont<br>hs | Single<br>control/inter<br>vention | Berat,<br>underwei<br>ght,<br>ferritin                                           | Anemia/ir<br>on<br>deficienc<br>y | The<br>combination<br>of education<br>and food<br>improves<br>weight and<br>iron status                          |
| 5   | <a href="#">Ariesthi et al. (2021)</a> | Indonesi<br>a     | Quasi-<br>experi<br>mental   | 90             | Moringa<br>nuggets                                                                                                                                                                                                                                             | 30<br>days      | Controls                           | Nutrition<br>al status,<br>BB/U,<br>BB/TB                                        | No                                | BB/U<br>improved,<br>BB/TB was<br>insignificant                                                                  |

Source: Processed from various sources (Tam et al., 2020; Das et al., 2020; Teshome et al., 2024; Ahmad et al., 2020; Ariesthi et al., 2021)

Table 3. Summary of Characteristics of Screening Results Study

| Yes | Author<br>/Year        | Country       | Design                    | Sample               | Intervention | Duration         | Comp<br>arator | Primary<br>Outcome                    | Comorb<br>idities | Conclusio<br>n                                                                        |
|-----|------------------------|---------------|---------------------------|----------------------|--------------|------------------|----------------|---------------------------------------|-------------------|---------------------------------------------------------------------------------------|
| 1   | Ulya & Maharani (2024) | Indonesi<br>a | Program<br>evaluati<br>on | Not<br>mention<br>ed | PMT local    | Not<br>mentioned | None           | Nutritiona<br>l status of<br>stunting | No                | Obstacles<br>to<br>implement<br>ation: lack<br>of<br>educationa<br>l media,<br>family |

|   |                            |           |                      |               |                                      |               |                             |                              |                         |                                                                                                                                                                                                                 |
|---|----------------------------|-----------|----------------------|---------------|--------------------------------------|---------------|-----------------------------|------------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                            |           |                      |               |                                      |               |                             |                              |                         | rejection, weak supervision, non-optimal achievement DOI: <a href="https://doi.org/10.21831/medikora.v23i2.79393">10.21831/medikora.v23i2.79393</a>                                                             |
| 2 | Adem et al. (2020)         | Ethiopia  | Cohort prospective   | 344           | Inpatient SAM Management             | Varies        | None                        | Recovery, mortalitas         | TB, anemia, HIV         | TB and anemia significantly lower recovery hazards DOI: <a href="https://doi.org/10.2147/pj.hmt.s253396">10.2147/pj.hmt.s253396</a>                                                                             |
| 3 | Ahmad et al. (2020)        | Indonesia | Cluster RCT          | 121           | Education + multi-nutrient biscuits  | 6 months      | Single control/intervention | Berat, underweight, ferritin | Anemia/iron deficiency  | Combination of education and food improves iron weight and status DOI: <a href="https://doi.org/10.3177/jnsv.66.s380">10.3177/jnsv.66.s380</a>                                                                  |
| 4 | Amelia & Kaswandani (2024) | Indonesia | Cohort retrospective | 50            | TB therapy + nutritional restoration | 2 months      | None                        | Nutritional status           | TB, other comorbidities | Nutritional status improved after 2 months, improvement was better in children without comorbidities DOI: <a href="https://doi.org/10.58427/apghn.3.3.2024.1-11">10.58427/apghn.3.3.2024.1-11</a>               |
| 5 | April Anti et al. (2025)   | Indonesia | Qualitative          | Not mentioned | PMT for stunting acceleration        | Not mentioned | None                        | Program effectiveness        | No                      | Effectiveness is limited by low parental nutritional literacy, socioeconomic, sanitation, uneven community participation DOI: <a href="https://doi.org/10.62201/i-codss.v2i1.203">10.62201/i-codss.v2i1.203</a> |

|    |                              |           |                    |               |                                    |               |               |                                 |                    |                                                                                                                                                                                                                   |
|----|------------------------------|-----------|--------------------|---------------|------------------------------------|---------------|---------------|---------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6  | Ariesthi et al. (2021)       | Indonesia | Quasi-experimental | 90            | Moringa nuggets                    | 30 days       | Controls      | Nutritional status, BB/U, BB/TB | No                 | BB/U improved, BB/TB insignificant DOI: <a href="https://doi.org/10.15294/kemas.v17i1.25862">10.15294/kemas.v17i1.25862</a>                                                                                       |
| 7  | Ayukar ningsih et al. (2022) | Indonesia | Cross-sectional    | Not mentioned | None                               | None          | None          | Nutritional status              | Thalassemia        | Children with thalassemia are at risk of malnutrition, MUAC is useful for assessment especially when there is organomegaly DOI: <a href="https://doi.org/10.54052/jhds.v2n1.p39-52">10.54052/jhds.v2n1.p39-52</a> |
| 8  | Christi yanti et al. (2025)  | Indonesia | Program evaluation | Not mentioned | PMT local                          | 60 days       | None          | Status gizi underweight         | No                 | Improvement of nutritional status is meaningful, success is influenced by compliance, parental involvement, education DOI: <a href="https://doi.org/10.71341/bmwj.v2i2.35">10.71341/bmwj.v2i2.35</a>              |
| 9  | Cichon et al. (2023)         | LMIC      | SR/Meta-analysis   | 15 studies    | Diet management for MAM            | Varies        | Miscellaneous | Recovery, anthropometry         | Non-specific       | Differences in food composition are less important than programmatic factors: adherence, frequency, season, childhood disease, HIV DOI: <a href="https://doi.org/10.3390/nu15051076">10.3390/nu15051076</a>       |
| 10 | Darnton-Hill et al. (2022)   | Global    | Policy review      | Not mentioned | Management of undernutrition in TB | Not mentioned | None          | Outcome TB                      | TB, undernutrition | Undernutrition increases the risk of TB, TB                                                                                                                                                                       |

|    |                      |                           |                            |            |                              |        |                       |                                 |         |                                                                                                                                                                                               |
|----|----------------------|---------------------------|----------------------------|------------|------------------------------|--------|-----------------------|---------------------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                      |                           |                            |            |                              |        |                       |                                 |         | causes wasting; nutritional supplementation in TB is associated with faster sputum conversion , weight gain, better outcome<br><a href="#">DOI: 10.5588/ijtld.21.0488</a>                     |
| 11 | Das et al. (2020)    | LMIC                      | SR/Meta-analysis           | 42 studies | CMAM, RUSF, RUTF, local food | Varies | Standard care         | Recovery, weight gain, MUAC     | Partial | Standard RUSF superior to CSB, local food comparable to standard RUSF on multiple outputs<br><a href="#">DOI: 10.3390/nu12010116</a>                                                          |
| 12 | Dessie et al. (2024) | Least-developed countries | SR/Meta-analysis           | 19 studies | None                         | None   | None                  | Stunting-anemia, wasting-anemia | Anemia  | Pooled prevalence of stunting-anemia 19.47%, wasting-anemia 5.44%; macro and micro nutritional problems are inseparable in vulnerable toddlers<br><a href="#">DOI: 10.1093/nutrit/nuae063</a> |
| 13 | Feleke et al. (2019) | Ethiopia                  | Cross-sectional komparatif | 5.045      | None                         | None   | Population without TB | Underweight, anemia             | TB      | Prevalence of underweight in TB patients 57.17% vs 23.37% in non-TB; 88.52% of TB patients had anemia                                                                                         |

|    |                         |                        |                             |               |                                          |               |      |                               |             |                                                                                                                                                                                                                                                |
|----|-------------------------|------------------------|-----------------------------|---------------|------------------------------------------|---------------|------|-------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                         |                        |                             |               |                                          |               |      |                               |             | DOI: <a href="https://doi.org/10.1186/s12890-019-0953-0">10.1186/s12890-019-0953-0</a>                                                                                                                                                         |
| 14 | Fetriyuna et al. (2023) | Indonesia              | Review                      | Not mentioned | RUTF/RUSF from local foods               | Not mentioned | None | Effectiveness, sustainability | No          | RUTF/RUSF based on local ingredients tends to be more child-friendly and sustainable when raw material supply and government support are stable DOI: <a href="https://doi.org/10.1016/j.heliyon.2023.e22478">10.1016/j.heliyon.2023.e22478</a> |
| 15 | Fitrianti et al. (2025) | Indonesia              | Cross-sectional             | 50            | Transfusion-dependent thalassemia        | None          | None | Status gizi (SGNA)            | Thalassemia | Children with thalassemia are at risk of malnutrition, risk increases with age; no studies have tested thalassemia moderating PMT response DOI: <a href="https://doi.org/10.60110/medforum.360404">10.60110/medforum.360404</a>                |
| 16 | Guo et al. (2025)       | South & Southeast Asia | Cross-sectional time series | 791.897       | None                                     | 1996-2022     | None | Coexisting malnutrition       | Anemia      | Anemia-stunting coexistence reaches 23.4% in South and Southeast Asia DOI: <a href="https://doi.org/10.1186/s12889-025-23482-w">10.1186/s12889-025-23482-w</a>                                                                                 |
| 17 | Haryani et al. (2024)   | Indonesia              | Cohort prospective          | 120           | Local PMT (11 interludes + 3 main meals) | 14 days       | None | Weight, MUAC                  | No          | Weight 11.2→12.9 kg, MUAC 13.4→15.0 cm increased significantly DOI: <a href="https://doi.org/10.30659/sainsmed.v">10.30659/sainsmed.v</a>                                                                                                      |

|    |                       |           |                     |               |                                        |           |                       |                                            |              |                                                                                                                                                                                                                                          |
|----|-----------------------|-----------|---------------------|---------------|----------------------------------------|-----------|-----------------------|--------------------------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                       |           |                     |               |                                        |           |                       |                                            |              | <a href="#">15i2.40402</a>                                                                                                                                                                                                               |
| 18 | Juffrie et al. (2020) | Indonesia | Review              | Not mentioned | None                                   | None      | None                  | Anemia nutrisi                             | Anemia       | There have been no studies that adequately evaluate the coexistence of anaemia and malnutrition in children in Indonesia; evidence of moderation in local contexts is still weak<br><a href="#">DOI: 10.6133/apjcn.20201229(s1).0003</a> |
| 19 | Kinyoki et al. (2020) | 105 LMIC  | Geospatial analysis | 2.6 million   | None                                   | 2000-2017 | None                  | Overweight, wasting                        | No           | Wasting fell 8.4%→6.4%; more than half of LMICs have not reached the WHO target of <5%; Indonesia is a double burden area<br><a href="#">DOI: 10.1038/s41591-020-0807-6</a>                                                              |
| 20 | Lassi et al. (2025)   | LMIC      | SR/Meta-analysis    | 69 studies    | Community-based food interventions     | Varies    | Standard care/plasebo | Wasting, WHZ, WAZ, MUAC                    | Non-specific | Community-based food interventions are effective in preventing wasting, improving WHZ and WAZ<br><a href="#">DOI: 10.1093/nutrition/nuaf041</a>                                                                                          |
| 21 | Lassi et al. (2020)   | LMIC      | SR/Meta-analysis    | 42 studies    | Infant and child feeding interventions | Varies    | Miscellaneous         | Growth, breastfeeding practices, mortality | Non-specific | Feeding interventions improve breastfeeding                                                                                                                                                                                              |

|    |                          |           |                      |               |                             |               |               |                              |                           |                                                                                                                                                                       |
|----|--------------------------|-----------|----------------------|---------------|-----------------------------|---------------|---------------|------------------------------|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                          |           |                      |               |                             |               |               |                              |                           | practices and growth, effects on limited mortality<br><a href="#">DOI: 10.3390/nut12030722</a>                                                                        |
| 22 | Martin et al. (2020)     | LMIC      | Mixed-methods SR     | 82 studies    | Behavioral interventions    | Varies        | Miscellaneous | Family support for nutrition | No                        | Involvement of fathers, grandmothers, other family members increases support of children's eating behaviors<br><a href="#">DOI: 10.1093/cdn/nzaa085</a>               |
| 23 | Melaku et al. (2024)     | Ethiopia  | Cohort retrospective | 697           | MAM Program with RUSF/CSB++ | 16 weeks      | CSB++         | Recovery, anthropometry      | No                        | RUSF accelerates recovery compared to CSB++; median recovery is about 16 weeks<br><a href="#">DOI: 10.3389/fnut.2024.1369419</a>                                      |
| 24 | Moram arco et al. (2016) | Zambia    | Cohort prospective   | 699           | CMAM                        | Not mentioned | None          | Mortalities                  | HIV, nutritional severity | HIV infection and early nutritional severity increase the risk of death; PMT without inadequate comorbidity management<br><a href="#">DOI: 10.3390/ijerph13070666</a> |
| 25 | Mudhofar et al. (2024)   | Indonesia | Program evaluation   | Not mentioned | PMT + nutrition education   | Not mentioned | None          | Nutritional status           | No                        | Weak supervision, limited parental involvement, lack of educational facilities, coverage targets have not                                                             |

|    |                         |           |                           |               |                            |               |      |                                |    |                                                                                                                                                                                                                                                       |
|----|-------------------------|-----------|---------------------------|---------------|----------------------------|---------------|------|--------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                         |           |                           |               |                            |               |      |                                |    | been achieved, menu acceptance is not always good <a href="https://doi.org/10.69855/mgj.v1i3.64">DOI: 10.69855/mgj.v1i3.64</a>                                                                                                                        |
| 26 | Musli min et al. (2026) | Indonesia | Implementation evaluation | Not mentioned | PMT local                  | Not mentioned | None | Nutritional status             | No | The program follows national technical guidelines but there are no local operational regulations ; constraints : nutrition, budget, monitoring , geography <a href="https://doi.org/10.30867/action.v1i1.1.3089">DOI: 10.30867/action.v1i1.1.3089</a> |
| 27 | Nastiti et al. (2025)   | Indonesia | Quasi-experimental        | Not mentioned | Moringa leaf fortification | Not mentioned | None | Nutritional status of stunting | No | Local PMT fortification of moringa leaves improves the nutritional status of stunted toddlers <a href="https://doi.org/10.53713/htechj.v3i2.338">DOI: 10.53713/htechj.v3i2.338</a>                                                                    |
| 28 | Nasution et al. (2025)  | Indonesia | Qualitative case studies  | 8 report      | PMT local                  | Not mentioned | None | Program implementation         | No | Barriers: untimely distribution, declining quality, limited budget, low education, minimal families; management improvements improve distribution                                                                                                     |

|    |                                 |           |                      |               |                                                                      |               |          |                                        |                    |                                                                                                                                                                                                                    |
|----|---------------------------------|-----------|----------------------|---------------|----------------------------------------------------------------------|---------------|----------|----------------------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                                 |           |                      |               |                                                                      |               |          |                                        |                    | n accuracy 35% and family participation 50%<br><a href="#">DOI: 10.30829/contagion.v7i1.24365</a>                                                                                                                  |
| 29 | Nnam et al. (2025)              | Nigeria   | RCT                  | Not mentioned | Local food formulas (cereals, soybeans, animals, fruits, vegetables) | Not mentioned | Controls | High, MUAC, Hb, Fe, Zn                 | No                 | Locally formulated diet increases high, MUAC, hemoglobin, iron, and zinc<br><a href="#">DOI: 10.3746/pnf.2025.30.2.110</a>                                                                                         |
| 30 | Padma priyadasini et al. (2016) | India     | Review the situation | Not mentioned | Nutritional supplementation in TB                                    | Not mentioned | None     | Outcome TB                             | TB, undernutrition | Nutritional supplementation in TB patients related to faster sputum conversion, weight gain, better treatment outcomes<br><a href="#">DOI: 10.4103/0971-5916.193278</a>                                            |
| 31 | Rachmah et al. (2025)           | Indonesia | Cross-sectional      | Not mentioned | PMT local                                                            | 60-90 days    | None     | Nutritional status of wasting/stunting | No                 | Compliance was influenced by taste preferences, fishy smell, oil content, maternal education, consistency of administration; 58.1% of respondents consumed PMT as recommended, 58.2% experienced an improvement in |

|    |                          |           |                         |               |                               |               |         |                                   |    |                                                                                                                                                                                                                                                |
|----|--------------------------|-----------|-------------------------|---------------|-------------------------------|---------------|---------|-----------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                          |           |                         |               |                               |               |         |                                   |    | nutritional status<br>DOI: <a href="https://doi.org/10.58545/ijkki.v5i2.549">10.58545/ijkki.v5i2.549</a>                                                                                                                                       |
| 32 | Rachmi et al. (2016)     | Indonesia | Train analysis          | 9.720         | None                          | 1993-2014     | None    | Stunting, underweight, overweight | No | Stunting decreased by 50.8%→36.7%, underweight 34.5%→21.4%, but the risk of overweight increased; Indonesia faces complex nutrition transition<br>DOI: <a href="https://doi.org/10.1371/journal.pone.0154756">10.1371/journal.pone.0154756</a> |
| 33 | Ramadhania et al. (2025) | Indonesia | Analytical experimental | 56            | 5-day cycle menu made locally | 56 days       | None    | Z-score, parental knowledge       | No | Z-score improves significantly, parents' knowledge of balanced nutrition increases<br>DOI: <a href="https://doi.org/10.35451/ijkg.v7i2.2701">10.35451/ijkg.v7i2.2701</a>                                                                       |
| 34 | Rashid et al. (2022)     | Ethiopia  | Cohort retrospective    | 491           | RUSF/CSB++                    | Varies        | CSB++   | Recovery, anthropometry           | No | RUSF accelerates recovery compared to CSB++; median recovery is about 16 weeks<br>DOI: <a href="https://doi.org/10.3389/fpubh.2022.914837">10.3389/fpubh.2022.914837</a>                                                                       |
| 35 | Siegal et al. (2022)     | Kenya     | Cluster RCT             | Not mentioned | PMT + monthly training        | Not mentioned | Control | Adherence                         | No | Monthly training and family encouragement improve adherence in clustered tests<br>DOI: <a href="https://doi.org/10.1111/mcn.13467">10.1111/mcn.13467</a>                                                                                       |

|    |                                   |                    |                          |                      |                                           |               |                           |                                          |                  |                                                                                                                                                                                                                                  |
|----|-----------------------------------|--------------------|--------------------------|----------------------|-------------------------------------------|---------------|---------------------------|------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 36 | Ssento<br>ngo et<br>al.<br>(2021) | 62<br>LMIC         | SR/Met<br>a-<br>analysis | 1,170<br>studies     | None                                      | 2006-<br>2018 | None                      | Stunting,<br>wasting,<br>underweig<br>ht | No               | Stunting<br>prevalence<br>29.1%,<br>wasting<br>6.3%,<br>underweig<br>ht 13.7%<br>in children<br>0-59<br>months;<br>Southeast<br>Asia above<br>global<br>average<br><a href="#">DOI:<br/>10.1038/s4<br/>1598-021-<br/>84302-w</a> |
| 37 | Tam et<br>al.<br>(2020)           | LMIC               | SR/Met<br>a-<br>analysis | 197<br>studies       | Micronutrie<br>nts, LNS,<br>fortification | Varies        | Miscel<br>laneou<br>s     | Anemia,<br>stunting,<br>underweig<br>ht  | Non-<br>specific | LNS<br>Improves<br>Underweig<br>ht/Limited<br>Stunting,<br>Many<br>Interventio<br>ns Reduce<br>Anemia<br><a href="#">DOI:<br/>10.3390/n<br/>u1202028<br/>9</a>                                                                   |
| 38 | Tan et<br>al.<br>(2024)           | Southea<br>st Asia | SR/Met<br>a-<br>analysis | 12<br>studies        | None                                      | None          | None                      | Triple<br>burden<br>malnutriti<br>on     | Anemia           | Pooled<br>prevalence<br>of anemia<br>in children<br>25%;<br>coexistenc<br>e of<br>anemia-<br>stunting<br>23.4% in<br>South and<br>Southeast<br>Asia <a href="#">DOI:<br/>10.1080/1<br/>0408398.2<br/>024.24195<br/>39</a>        |
| 39 | Tesho<br>me et<br>al.<br>(2024)   | Multi-<br>country  | SR/Met<br>a-<br>analysis | 7<br>Studies         | RUSF                                      | 12+<br>weeks  | CSB+<br>+/othe<br>r diets | Antropom<br>etri,<br>recovery            | Non-<br>specific | RUSF has<br>a small but<br>significant<br>effect on<br>anthropom<br>etry and<br>recovery<br>compared<br>to CSB++<br><a href="#">DOI:<br/>10.1017/jn<br/>s.2023.114</a>                                                           |
| 40 | Victora<br>et al.<br>(2021)       | LMIC               | Review<br>Lancet         | Not<br>mention<br>ed | None                                      | None          | None                      | Stunting,<br>wasting,<br>mortality       | No               | Stunting-<br>wasting<br>coexistenc<br>e increases<br>the risk of<br>death by<br>nearly 5                                                                                                                                         |

|    |                                  |          |                             |              |                                    |        |                   |                                 |                                       |                                                                                                                                                                                                             |
|----|----------------------------------|----------|-----------------------------|--------------|------------------------------------|--------|-------------------|---------------------------------|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                                  |          |                             |              |                                    |        |                   |                                 |                                       | times;<br>uneven<br>progress<br><a href="#">DOI:<br/>10.1016/S<br/>0140-<br/>6736(21)0<br/>0394-9</a>                                                                                                       |
| 41 | Visser<br>et al.<br>(2018)       | LMIC     | Overvie<br>w SR             | 12 SR        | Community<br>-based PMT            | Varies | Standa<br>rd care | Antropom<br>etri,<br>mortalitas | Non-<br>specific                      | The effects<br>of PMT on<br>growth<br>varied,<br>complianc<br>e and<br>program<br>quality<br>greatly<br>influenced<br>the results<br><a href="#">DOI:<br/>10.1002/1<br/>4651858.c<br/>d010578.p<br/>ub2</a> |
| 42 | Wagne<br>w et al.<br>(2019a<br>) | Ethiopia | SR/Met<br>a-<br>analysis    | 9<br>Studies | Inpatient<br>SAM<br>Managemen<br>t | Varies | None              | Mortalites                      | Anemia,<br>diare,<br>dehydra<br>se    | Anemia,<br>diarrhea,<br>and<br>dehydratio<br>n increase<br>mortality<br>in SAM<br><a href="#">DOI:<br/>10.1186/s1<br/>2889-019-<br/>7466-x</a>                                                              |
| 43 | Wagne<br>w et al.<br>(2019b<br>) | Ethiopia | Cohort<br>retrospe<br>ctive | 572          | Inpatient<br>SAM<br>Managemen<br>t | Varies | None              | Recovery,<br>mortalitas         | Anemia,<br>other<br>comorbi<br>dities | TB and<br>anemia<br>significant<br>ly lower<br>recovery<br>hazards<br><a href="#">DOI:<br/>10.1371/jo<br/>urnal.pone<br/>.0211628</a>                                                                       |

Note: This table is compiled based on the results of a literature search using a Consensus.app platform with a Deep Search feature that analyzes the 43 most relevant papers. The selected studies covered three main themes: the effectiveness of local food-based PMT, the influence of comorbidities (tuberculosis, anemia, thalassaemia) on nutritional recovery, and the determinants of program success.

List of Abbreviations: SR = Systematic Review; LMIC = Low-and-Middle-Income Countries; RCT = Randomized Controlled Trial; LNS = Lipid-Based Nutrient Supplement; CMAM = Community-Based Management of Acute Malnutrition; RUSF = Ready-to-Use Supplementary Food; RUTF = Ready-to-Use Therapeutic Food; CSB = Corn-Soy Blend; SAM = Severe Acute Malnutrition; MAM = Moderate Acute Malnutrition; MUAC = Mid-Upper Arm Circumference; WAZ = Weight-for-Age Z-Score; WHZ = Weight-for-Height Z-Score; BB/U = Berat Badan menurut Umur; BB/TB = Berat Badan menurut Tinggi Badan; TB = Tuberkulosis; SGNA = Subjective Global Nutritional Assessment; HIV = Human Immunodeficiency Virus; Hb = Hemoglobin; SD = Standard Deviation; CI = Confidence Interval; OR = Odds Ratio; AHR = Adjusted Hazard Ratio.

**The Effectiveness of Local Food-Based PMT on Nutritional Status**

The majority of the evidence supports that PMT or food supplementation improves nutritional recovery, especially body weight, weight per height (BB/TB)/body weight per age (BB/U), and upper

arm circumference (LiLA). Effects on length/height are present, but they are smaller and usually appear on longer interventions or more nutrient-dense food compositions (Lassi et al., 2025; Visser et al., 2018; Teshome et al., 2024).

**Table 4. Summary of the Potential Effectiveness of Local Food PMT on Nutritional Status**

| Questions                                                        | Agree | Disagree | Unclear |
|------------------------------------------------------------------|-------|----------|---------|
| Local PMT improves nutritional status                            | 70%   | 10%      | 20%     |
| Local PMT is equivalent/better than certain standard supplements | 55%   | 15%      | 30%     |
| Local PMT improves height in the short term                      | 40%   | 20%      | 40%     |

Source: Processed from various sources (Lassi et al., 2025; Visser et al., 2018; Teshome et al., 2024)

Several Indonesian studies support the same direction. A combination of education and multi-nutrient biscuit interventions in Aceh resulted in the highest weight gain and meaningful underweight reduction, as well as improved iron deficiency (Ahmad et al., 2020). Local PMT 14 days in Banyumas significantly increased body weight and upper arm circumference (LiLA) in children 6–59 months by weight faltering (Haryani et al., 2024). Moringa nuggets in NTT improved BB/U but showed no significant change in BB/TB after 30 days, confirming that different outcomes were sensitive to duration (Ariesthi et al., 2021).

Evidence from local non-Indonesian foods is also consistent. Locally formulated diets in Nigeria increase height, upper arm circumference (LiLA), hemoglobin, iron, and zinc, especially formulations that combine grains, soy, animal sources, fruits, and vegetables (Nnam et al., 2025). A review of local food technology shows that RUTF/RUSF (Ready-to-Use Supplementary Food) based on local ingredients tends to be more acceptable to children and more sustainable if the supply of raw materials and government support is stable (Fetriyuna et al., 2023).

**Effect of Comorbidity on Intervention Response**

The evidence for TB and anemia is quite consistent: both relate to slower recovery or worse externally. In a prospective cohort of inpatient SAM children in Ethiopia, tuberculosis and anemia significantly reduced Height Per Age (TB/U) and recovery (Adem et al., 2020). Ethiopian meta-analyses also showed anemia increased mortality in SAM, along with diarrhea and dehydration (Wagnew et al., 2019).

**Table 5. The Impact of Tuberculosis and Anemia on Nutritional Recovery**

| Questions                                    | Agree | Disagree | Unclear |
|----------------------------------------------|-------|----------|---------|
| Tuberculosis slows down nutritional recovery | 85%   | 5%       | 10%     |
| Anemia slows down nutritional recovery       | 80%   | 10%      | 10%     |
| Thalassemia affects PMT response             | 20%   | 10%      | 70%     |

Source: Processed from various sources (Adem et al., 2020; Wagnew et al., 2019; Amelia & Kaswandani, 2024; Fitrianti et al., 2025)

Other studies have shown that comorbidities generally moderate treatment response. In pediatric TB patients in Jakarta, nutritional status improved after 2 months of therapy, but improvement was better in children without comorbidities, and TB type also had an effect (Amelia & Kaswandani, 2024). In the Zambian program, HIV infection and early nutritional severity increased the risk of death, confirming that PMT without comorbidity management was inadequate (Moramarco et al., 2016).

For anemia prevalence, Southeast Asian regional data shows that the pooled prevalence of anemia in children reaches 25%, while the anemia-stunting coexistence reaches 23.4% in South and Southeast Asia (Tan et al., 2024; Guo et al., 2025). In Indonesia, a review of child anemia confirms that there have been no studies that adequately evaluate the coexistence of anemia and malnutrition in children, so the evidence of moderation in the local context is still weak (Juffrie et al., 2020).

Evidence of thalassaemia is much more limited. The available literature shows children with thalassaemia are at risk of malnutrition and upper arm circumference (LiLA) is useful for assessment, especially when organomegaly is present (Ayukarningsih et al., 2022). Indonesian data on transfusion-dependent children with thalassemia show that the risk of malnutrition increases with age, but no studies have tested how thalassaemia moderates responses to FMD in undernourished toddlers (Fitrianti et al., 2025).

**Factors Determining Program Success**

| Sub-topics                                  | Test Data | Mechanism | Duration-Response | Screening comorbiditis | Generalization of Programs at Puskesmas |
|---------------------------------------------|-----------|-----------|-------------------|------------------------|-----------------------------------------|
| Local PMT and anthropometry                 | 8         | 6         | 5                 | 1                      | 4                                       |
| TB in nutrition programs                    | 3         | 3         | 2                 | 2                      | 2                                       |
| Anemia and PMT                              | 5         | 4         | 3                 | 2                      | 2                                       |
| Thalassemia and PMT                         | 1         | 2         | No research yet   | No research yet        | No research yet                         |
| Implementation of Indonesian Health Centers | 4         | 3         | 3                 | 1                      | 5                                       |

Source: Processed from various sources (Visser et al., 2018; Das et al., 2020; Juffrie et al., 2020)

Duration, compliance, food quality, and service support repeatedly emerge as determinants of outcomes. The MAM (Moderate Acute Malnutrition) program in Ethiopia shows a median recovery of about 16 weeks, and RUSF accelerates recovery compared to CSB++ (Rashid et al., 2022; Melaku et al., 2024). The 2023 review emphasizes that small differences in food composition are sometimes less important than programmatic factors such as adherence, frequency of distribution, season, childhood diseases, and HIV (Cichon et al., 2023).

Family support and interactive coaching are also important. The presence of monthly training and family encouragement increased adherence in clustered trials in Kenya (Siegal et al., 2022). Mixed-methods reviews show that the involvement of fathers, grandmothers, and other family members generally increases support for children's eating behaviors, although the evidence for complementary feeding is still not as much as the evidence for breastfeeding (Martin et al., 2020).

In the Indonesian context, the obstacles to the implementation of Puskesmas are quite uniform: weak supervision, limited parental involvement, lack of educational facilities, coverage targets have not been achieved, and menu acceptance is not always good ('Ulya & Maharani, 2024; Mudhofar et al., 2024). Local PMT consumption studies also showed that compliance was influenced by taste preferences, fishy odor, oil content, maternal education, and consistency of administration for 60–90 days (Rachmah et al., 2025).

**Research Gaps and Future Research Areas Potential**

The most prominent gap is the almost non-existent integrative studies that assess local PMT, comorbidity screening, and nutritional recovery outcomes in a single programmatic design. Malnutrition management reviews only mention the limited benefits of screening and community governance in general, not TB, anemia, or thalassaemia screening embedded in PMT (Das et al., 2020). At the same time, the Cochrane review confirms that important outcomes, program success factors, and combinations of interventions are still rarely reported, so research has not moved from "whether PMT is effective" to "how PMT should be combined with comorbidity detection" (Visser et al., 2018).

Future research priorities include: (1) integration of anemia screening in PMT Puskesmas through RCT clusters or quasi-experimental-based Puskesmas; (2) integration of TB screening in toddler PMT through a prospective cohort or stepped-wedge implementation trial; (3) development of multi-disease screening packages with referral algorithms and cost evaluation; (4) a cohort study of children with thalassaemia as a complicating condition; and (5) long-term post-PMT follow-up (Adem et al., 2020; Wagnew et al., 2019; Fitrianti et al., 2025).

## CONCLUSION

Local food-based PMT is effective in improving the short-term nutritional status of undernourished toddlers, especially body weight, weight per height (BB/TB)/body weight per age (BB/U), and upper arm circumference (LiLA), with an effect on height/height per age (TB/U) that is smaller and requires a longer duration. Tuberculosis and anemia consistently slow recovery, lowering Height Per Age (TB/U) and recovery by about 53% (AHR 0.47) and 25% (AHR 0.75), respectively, while evidence of thalassaemia is still very limited and only shows a risk of malnutrition without testing responses to PMT. The success of the program is determined by the minimum duration of 56-90 days, compliance, nutritional composition, cadre training, family support, and the capacity of the Health Center. The main research gap is the lack of a primary service test model that integrates comorbidity screening into PMT, so future research needs to test the effectiveness of PMT integrated with TB, anemia, and thalassemia screening through RCT clusters at health centers, develop local PMT formulations for toddlers with complicating conditions, and conduct long-term implementation and cohort studies. For policy makers, the integration of comorbidity screening, the determination of intervention duration of at least 90 days, strengthening local food availability, and a tiered monitoring system are very necessary, while health practitioners at health centers are advised to conduct routine screening, parent education, cadre involvement, and collaboration across TB, anemia, and thalassemia programs to optimize the management of undernourished toddlers with comorbidities.

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