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Complementary Feeding and Stunting Incidence in Toddlers - Literature Review

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Abstract: Stunting remains a critical global nutritional challenge, reflecting linear growth failure due to chronic malnutrition. The first 1,000 days of life constitute a vital "golden period" where complementary feeding quality significantly determines nutritional outcomes. This study aims to review scientific evidence regarding the relationship between complementary feeding practices, specifically Minimum Dietary Diversity (MDD) and Minimum Meal Frequency (MMF) and stunting incidence in toddlers. A systematic literature review was conducted using Google Scholar, Garuda, and ScienceDirect databases. Using the PICO framework and the inclusion criteria consisting of cross-sectional, experimental, and cohort studies in 2020 - 2024. The review reveals that poor dietary diversity is a significant determinant of stunting, with one study showing children with inadequate MDD are 2.91 times more likely to be stunted (AOR: 2.91; p=0.017). The stability of diet quality over time is crucial, as unstable feeding patterns are closely linked to linear growth faltering. Furthermore, integrated interventions combining *Specialized Nutritious Foods* (SNF) with *Social and Behavior Change Communication* (SBCC) have proven effective. External factors, such as the consumption of wild food biodiversity, also serve as critical nutritional buffers during hunger season. Stunting is a multidimensional issue requiring systemic interventions that prioritize the quality and diversity of complementary feeding. Effective prevention strategies must integrate clinical nutritional support with community-based behavior change empowerment and the adoption of updated global standards to ensure optimal growth during the critical early years.

Keywords: Toddlers, stunting, complementary feeding, Minimum Dietary Diversity (MDD), Minimum Meal Frequency (MMF).

1. INTRODUCTION

Stunting remains one of the primary nutritional challenges globally, particularly in low- and middle-income countries. This condition represents linear growth failure resulting from long-term chronic malnutrition, recurrent infections, and inadequate healthcare. The impact of stunting extends beyond physical growth, affecting cognitive development and long-term productivity, thereby positioning it as a public health issue requiring serious attention (WHO, 2025). In Indonesia, stunting continues to be a major indicator of child health status. Data from the Indonesian Nutritional Status Survey (SSGI) indicates that stunting prevalence has reached 15.6%, with severe stunting at 4.2%. In the Bogor region, the stunting rate is higher than the national prevalence, recorded at 18.9%. These figures remain above the targets set by the 2020–2024 National Medium-Term Development Plan, which aims for 14% by 2024 (Kementerian Kesehatan Republik Indonesia, 2025).

The first 1,000 days of life (1000 HPK) constitute a critical window for determining a child's future nutritional and health status. During this phase, nutritional fulfilment must be optimized, beginning with exclusive breastfeeding followed by appropriate complementary feeding. If nutritional requirements are not met during this sensitive period, the risk of growth disturbances, including stunting, increases significantly (Rosianti et al., 2022). Complementary feeding plays a vital role as a source of energy and supplementary nutrients when breast milk alone can no longer meet the child's total nutritional needs. The quality and quantity of complementary feeding are decisive factors for toddler nutritional status, providing the foundation for micro- and macronutrient fulfilment required for growth and development. Improper in providing the complementary feeding, either in timing, type, or frequency can contribute to chronic nutritional problems (World Health Organization, 2023).

Inappropriate complementary feeding, whether in terms of timing, type, or frequency, can lead to chronic nutritional problems. Complementary feeding introduced too early or too late risks disrupting the fulfillment of a child's nutritional needs, while poor quality complementary feeding, such as lacking energy, protein, and essential micronutrients, can accelerate linear growth deficits. (Rahmawati, et all. 2024) The timing and method of introducing complementary feeding can significantly impact a child's nutritional status and growth trajectory. Research shows that children who receive complementary feeding in a timely and appropriate manner not only have better dietary diversity but also demonstrate improved cognitive and physical development, which is crucial during the crucial 1,000-day window from conception to age two. Conversely, delaying the introduction of complementary feeding can lead to increased susceptibility to infection and malnutrition, as a child's nutritional needs exceed what can be met through breastfeeding alone.(Ha, et all. 2023) Novianti's research in Lampung showed a highly significant relationship between complementary feeding practices, including timeliness, adequate quality, food safety, and responsive feeding, and the incidence of stunting in the UPT Negeri Agung Public Health Center (Puskesmas Negeri Agung) work area. Statistical findings indicate that toddlers who do not receive adequate complementary feeding have the most extreme risk of stunting, reaching 98.274 times higher than toddlers with a balanced nutritional intake. In addition to nutritional quality factors, unresponsive feeding practices to children's hunger and satiety cues and a lack of education regarding safe food storage significantly increase the risk of stunting (Novianti, 2025).

According to the World Health Organization (WHO) and UNICEF guidelines updated in 2021 and 2023, adequate complementary feeding is measured through a suite of indicators, primarily Minimum Dietary Diversity (MDD), Minimum Meal Frequency (MMF), and the composite Minimum Acceptable Diet (MAD). A fundamental shift occurred with the transition from the 2008 model (MDD-7FG) to the 2021 standard (MDD-8FG), which incorporates breast milk as the eighth distinct food group (World Health Organization, 2023). In the past, non-breastfed infants consuming formula were classified under the "dairy" group in nutritional assessments, but breastfed children were frequently considered has inadequate MDD because breast milk was not including a food group. This led to a biased comparison of diet quality. The current standard has been improved by adding breast milk

and increasing the achievement threshold from 4 out of 7 groups to 5 out of 8 groups. Some of literature still use the 4-out-of-7 indicator that can provide the biased interpretations and the certain micronutrient deficiencies cannot be captured, such iron, zinc, and vitamin A, which are proximal predictors of linear growth faltering (WHO & UNICEF, 2017).

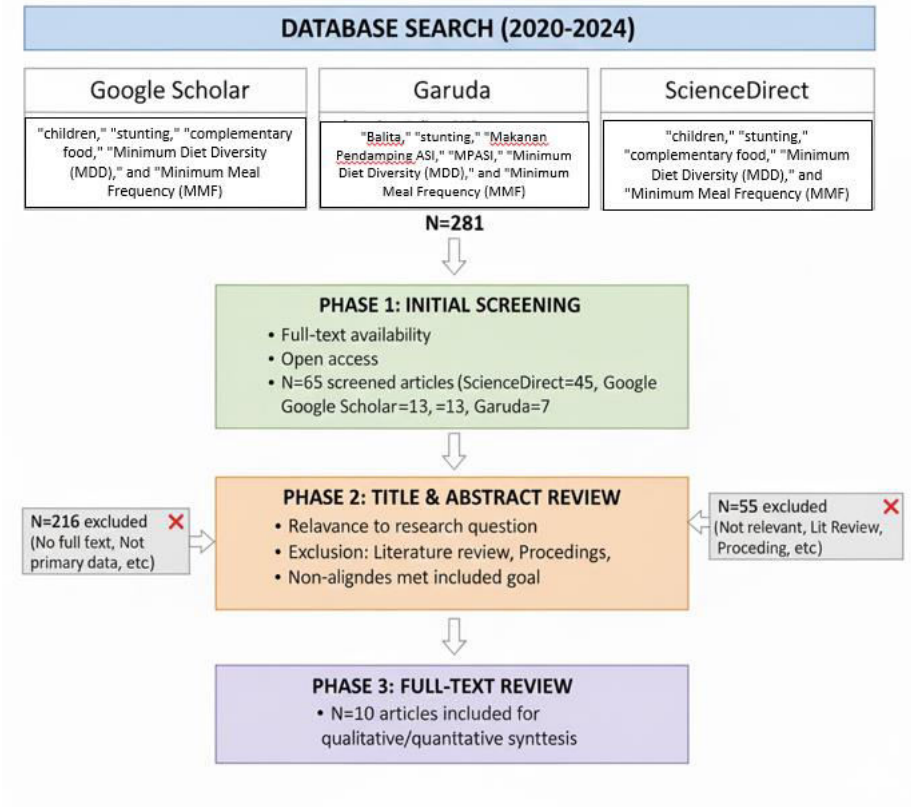
From a scientific perspective, MDD is an essential population-level indicator for micronutrient density (Paramashanti et al., 2022). A varied diet is necessary to promote biological developments like bone elongation and cognitive maturation because there is no single food group can provide the full variety of nutrients needed for rapid development (White et al., 2017) . Research shows that reaching the MDD threshold is positively related to greater height-for-age Z-scores (HAZ), supporting the idea that dietary variety is a biological necessity for preventing stunting rather than just a personal preference (Ahmad et al., 2018) and Thobias's research in Kupang showed a strong correlation between Minimum Dietary Diversity (MDD) and Minimum Meal Frequency (MMF) and stunting. Minimum dietary diversity (MDD) was the most dominant factor, with children who did not meet dietary diversity standards having a 12.3 fold higher risk of stunting (Thobias, 2021). Public health interventions may be unable to identify the most vulnerable subpopulations if this update is the evidence-based guidelines are not followed, which would impede the achievement of the 2030 Sustainable Development Goal (SDG) targets.

Based on this background, this study aims to review scientific evidence regarding complementary feeding and stunting incidence in toddlers through a literature review. This review is expected to provide deeper insights, synthesize previous research findings, and identify the most influential aspects of complementary feeding in stunting prevention efforts.

2. METHODS

This research uses a literature review method through systematic and planned article searches. This approach aims to produce focused results based on predetermined keywords and inclusion criteria. Article searches were conducted using the PICO (Population, Intervention, Comparison, Outcome) framework. Indonesian keywords included "Balita," "stunting," "Makanan Pendamping ASI," "MPASI," "Minimum Diet Diversity (MDD)," and "Minimum Meal Frequency (MMF)." English keywords included "children," "stunting," "complementary food," "Minimum Diet Diversity (MDD)," and "Minimum Meal Frequency (MMF)." Keywords were combined using AND and OR Boolean operators to refine the results. Searches were conducted across several online databases: Google Scholar, Garuda, and ScienceDirect. Inclusion criteria for this study were articles examined the relationship between complementary feeding (specifically MDD and MMF) and stunting in toddlers, published between 2020–2024, in Indonesian or English language, and available as full-text academic journals. The study designs included were cross-sectional, experimental and cohort using primary data. The exclusion criteria for the articles consist of articles of the literature/systematic review type, proceedings, or unpublished articles. The initial search yielded 281 articles. The first selection phase involved reviewing the availability of full text, open access, utilization of English or Indonesia language, as well as the primary data. From the first phase resulted 65 screened articles (45 from ScienceDirect, 13 from Google Scholar,

and 7 from Garuda). The second phase through the reviewing the titles and abstracts for relevance then it was resulting in 10 articles met all inclusion criteria (6 from ScienceDirect, 2 from Google Scholar, and 2 from Garuda). Some of the articles were not relevance because it has literature review design study, include as proceeding, or the goal of research is not in line with this study. Then, for the final phase, 10 articles that has been met the inclusion criteria and can be proceed to read in full text.



Picture 1. Systematic Literature Review Proses

3. RESULTS AND DISCUSSION

The phenomenon of stunting results from a complex interaction between dietary diversity, primary healthcare systems, household economic stability, and the integrity of food-providing ecosystems. Through the synthesis of data from various clinical and observational studies, this report explores the effectiveness of functional food interventions, the crucial role of wild biodiversity, and the impact of standardized *Infant and Young Child Feeding* (IYCF) practices. The following table summarizes various observational and experimental studies regarding dietary diversity as measured by MDD in relation to child nutritional status growth:

Table 1. Table 1. Complementary Feeding and Stunting Incidence in Toddlers in Several Studies

Reference	Objective	Sample	Method	Results	Suggestions
(Nai & Renyoet, 2020)	Analyze the correlation between MDD/MMF and stunting prevalence.	135 children aged 6–23 months.	Cross-sectional; household interviews and Food Frequency Questionnaire (FFQ).	Poor dietary diversity significantly associated with stunting (p=0.012; adjusted OR=2.91, p=0.017).	Strengthen community education through IYCF training for cadres using SBCC approaches.
(Jalil et al., 2024)	Evaluate maternal Knowledge, Attitude, and Practice (KAP) regarding IYCF.	200 mothers with children aged 18–24 months.	Cross-sectional; interview with sociodemographic and the dimensions questionnaire.	Significant positive correlation between knowledge/attitude and attitude/practice.	Continuous IYCF education via primary health facilities; expansion to rural areas for representativeness.
(Roy et al., 2022)	Compare MDD estimation differences between 2008 (MDD-7FG) and 2021 (MDD-8FG) definitions.	1,992 children aged 0–23 months.	Cross-sectional; direct standardized interviews.	54.7% met MDD (old definition) vs. 46.2% (new definition). New definition shows clearer breastfed vs. non-breastfed differences.	Policy makers should adapt the new MDD definition for more accurate monitoring.
(Bottin et al., 2025)	Assess IYCF practices and food intake in healthy children.	407 healthy children aged 6–36 months.	Cross-sectional; 24-h dietary intake questionnaire.	74% of children did not meet minimum dietary diversity.	Strategy interventions required to address micronutrient deficiencies in this age group.
(Duong et al., 2023)	Analyze the relationship between	781 children aged 6–25 months.	Prospective cohort study.	Children with "timely-unstable" and	Emphasize education on food variety,

Reference	Objective	Sample	Method	Results	Suggestions
	dietary diversity and growth in rural areas.			"super-delayed" patterns had higher stunting risk (OR: 1.78 and 1.98).	not just the introduction of solid foods.
(Iannotti et al., 2024)	Examine the link between wild food consumption and growth in Madagascar.	305 children under 5 years.	Cross-sectional; 24-h recall, WHO anthropometry, and ethnobotany.	Wild food consumption positively associated with dietary diversity and HAZ scores.	Integrate ecosystem conservation with local food systems to optimize nutrition.
(Soofi et al., 2024)	Assess the effectiveness of SNF and SBCC interventions.	2,928–3,205 households in Afghanistan.	Quasi-experimental; provision of Super Cereal and MQ-LNS with behavior change education.	Significant reduction in stunting and underweight prevalence; improved IYCF practices.	Prioritize integrated SBCC and functional nutritional supplements during the first 1,000 days.
(Tafese et al., 2020)	Identify risk factors for stunting in food-insecure regions in Ethiopia.	464 mother-child dyads (6–23 months).	Cross-sectional; multivariate logistic regression.	Stunting prevalence 43.1%; risks include lack of zinc supplements, no iodized salt, and close birth spacing.	Strengthen primary care in micronutrient supplementation and family planning.
(Zulkifli & Wee, 2025)	Determine the link between MDD quality and nutritional status in Malaysia.	287 children aged 6–24 months.	Cross-sectional; maternal interviews and WHO anthropometry.	Dairy consumption significantly associated with stunting prevention (p=0.001).	Emphasize continuous dairy consumption in g nutritional health promotion programs.
Waladhiyaputri & Chandra,	Examine MDD and	102 subjects aged 6–23	Cross-sectional; 24-	52% achieved MDD;	Future analysis must

Reference	Objective	Sample	Method	Results	Suggestions
2023	nutritional status during the COVID-19 pandemic in Indonesia.	months.	h recall based MDD questionnaire.	stunting prevalence 20.6%; gender significantly related to stunting risk (p=0.003).	consider intake quantity (portions) alongside variety quality.

High-quality complementary feeding is a main pillar in supporting linear growth and preventing stunting. The quality of complementary feeding is often measured via the MDD indicator, ensuring sufficient micro- and macronutrient intake. Research in Yogyakarta, Indonesia, found that poor dietary diversity is significantly associated with stunting in children aged 6–23 months. This demonstrates that nutritional adequacy during the "golden period" is highly dependent on the variety of food provided. Failure to meet MDD standards can permanently hinder physical growth (Nai & Renyoet, 2020). Consistent with these findings, the stability of providing diverse foods substantially is a crucial determinant. A longitudinal study in Vietnam revealed that unstable or delayed dietary diversity patterns are closely linked to stunting risk. Children who fail to maintain consistent dietary diversity showed slower linear growth compared to those with stable patterns from an early age. This emphasizes that nutritional interventions must focus on the sustainability of diet quality particularly in critical growth periods (Duong et al., 2023).

Gaps in complementary feeding practices remain a major challenge in developing countries like Bangladesh. The change in the WHO guideline regarding the MDD definition from 4 to 5 food groups revealed that the actual prevalence of diet quality is much lower than previously estimated. Many children in both urban and rural Bangladesh have not achieved the Minimum Acceptable Diet (MAD), that combination of adequate diversity and frequency. These low indicators are often influenced by maternal education levels and household economic status (Roy et al., 2022). Similar conditions are observed in The Gading Beach Primary Health Care, where feeding practices for children aged 6–36 months are still inappropriate. While cereal and dairy consumption is relatively high, the intake of animal proteins (meat and eggs) and fruits is very low.

The lack of variety results in low dietary diversity scores and increased risk of micronutrient deficiencies, such as iron and vitamin A, which directly contribute to physical and cognitive growth inhibition (Bottin et al., 2025). Internal factors from caregivers, especially maternal Knowledge, Attitude, and Practice (KAP), significantly influence complementary feeding quality. In Malaysia, research indicates that most mothers have good knowledge and attitudes, which correlate positively with daily feeding practices. Mothers with adequate knowledge tend to be more compliant with recommendations for introducing adequate complementary foods at 6 months (Jalil et al., 2024). The increasing caregiver's knowledge is a potential factor to improve the diet diversity practice. The recent study found there is significant relationship between mother's access to social and MDD-8,

that has been also observed in Ethiopia and India. The mass media was regarded as a reputable provider of information that might have an impact on behavior. For instance, the Ten Balanced Nutrition Messages, which include "Be thankful and eat a variety of food," a crucial message for enhancing dietary diversity, have been disseminated by the Indonesian Ministry of Health through various mass media (Paramashanti et al., 2022).

In Badakhshan, Afghanistan, where stunting prevalence often exceeds the WHO emergency threshold of 40%, integrated interventions using *Specialized Nutritious Foods* (SNF) and *Social and Behavior Change Communication* (SBCC) have shown significant results. An 18-month quasi-experimental study targeting the first 1,000 days showed a significant reduction in stunting by 5% (95%, CI: -9.9 – (-0.2) and underweight by 4.6% (95%, CI: -8.6 – (-0.5). The success was driven not only by food supply but also by key SBCC messages regarding early initiation of breastfeeding and MAD (Soofi et al., 2024).

The global nutrition suggests the inclusive Social and Behavior Change Communication (SBCC) strategies has a priority target, specifically as household decision-makers, such as fathers and grandmothers, are essential to prevent stunting (Save the Children, 2021). In order to ensure that children, particularly girls in high-stress circumstances, receive sufficient attention throughout the crucial 12-23-month transition to supplemental foods, it is crucial that sociocultural gender biases in food distribution be eliminated (Frumence et al., 2023). The success of SBCC in Afghanistan, which improved Minimum Acceptable Diet (MAD) by 13.1%, underscores that behavioral empowerment is as vital as the food supply itself. Global stunting reduction targets for 2030 can be successfully achieved by converting from a reactive "aid" paradigm to a proactive "systemic" model that integrates behavioral, ecological, and therapeutic methods (Soofi et al., 2024).

The relationship between ecosystem health and nutritional fulfilment has been examined especially in communities near the Alandraza-Agnalavelo, Madagascar who living in the protected forest rely on forest products and wildlife to mitigate hunger during insecurity food seasons (October–December). Research shows that wild plant and animal consumption correlates positively with Household Dietary Diversity Scores (HDDS) ($\beta=0.29$, $p<0.001$) and child HAZ scores ($\beta=0.14$, $p=0.04$). Wild tubers and aquatic foods (small fish, crayfish, shrimp) provide essential micronutrients like iron and zinc in highly bioavailable forms (Iannotti et al., 2024).

The local and wild food sources serve as buffer stock during times of seasonal hunger; it is important to be optimized. The poorest households can receive affordable micronutrients by creating evidence-based guidelines for the sustainable harvesting of safe, plentiful wild species (such as nutrient-dense tubers and aquatic animal-source foods) (Moore et al., 2022). In Madagascar, wild food consumption was significantly linked to

higher HAZ scores, proving that biodiversity acts as a pillar of nutritional resilience when managed correctly.

In Ethiopia, where stunting prevalence is an alarming 43.1% in food-insecure areas, primary healthcare factors are key determinants. Children who never received zinc supplements for diarrhea were 2.41 times more likely to be stunted (AOR: 2.41; 95% CI: 1.33 - 4.38). Additionally, the lack of iodized salt in complementary foods increased stunting risk by 1.55 times, as iodine is essential for growth hormone synthesis (Tafese et al., 2020). This study showed that micronutrients particularly zinc and iodine have play role in addressing children's hygiene problems, that indirectly can prevent the stunting incidence.

Challenges in Southeast Asia differ, in Terengganu, Malaysia, despite a high MDD achievement rate of 90.2%, stunting remains high at 25.8%. However, dairy consumption was significantly associated with stunting prevention (p=0.001), as milk provides protein and minerals that stimulate Insulin-like Growth Factor-1 (IGF-1) for bone elongation (Zulkifli & Wee, 2025). In Jakarta, Indonesia, during the COVID-19 pandemic, only 52% of children met MDD targets, though no direct significant relationship between MDD and nutritional status was found in that specific sample, suggesting that total caloric volume and sanitation might have been more dominant during the crisis (Waladhiyaputri & Chandra, 2023). This result is in line with study from Ethiopia that reveal hygiene sanitation can become indirect factor for stunting among children. The handling of infectious disease is frequently not accompanied by adequate micronutrients such as zinc and iodine. The current study also found that children mothers who did not use iodized salt for supplemental foods and who never received zinc supplements for diarrhea were more likely to have stunting. This finding is consistent with children in developing nations having zinc and iodine shortages. Inadequate treatment and poor management of children with severe diarrhea in northern Ethiopia were also validated by another recent study. The fact that stunting and underweight in the research area were substantially correlated with children's low zinc supplementation achievement during diarrhea indicates that healthcare services need to be improved (Tafese et al., 2020).

Strategies for preventing stunting must shift from the emergency food aid paradigm to the development of robust, integrated nutrition systems. The first strategic recommendation is to improve primary health systems by integrating micronutrient distribution—specifically, education about zinc and iodized salt—into routine immunization and well-baby check-up services (Purwandini & Atmaka, 2023). Growth failing is mostly correlated with the lack of iodized salt in supplemental feeding and the inability to administer zinc supplements during diarrheal episodes, as seen in Ethiopia's food-insecure regions. Through systematic integration, children can get these high-impact, low-cost clinical interventions during the crucial "window of opportunity (Tafese et al., 2020)."

4. CONCLUSION

Based on data from various regions, stunting is not merely a result of food shortage but an interaction between four main pillars: diet quality, disease burden, caregiving practices, and environmental health. Linear growth failure is a systemic issue requiring systemic solutions. By integrating clinical nutritional interventions with biodiversity preservation and community behavioral empowerment, global targets for reducing stunting can be achieved, ensuring a healthier and more productive future for the next generation. Failure to act now will not only miss 2030 targets but also burden global health systems with chronic diseases and irreversible loss of human potential.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest in this study

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