



EFFECTIVENESS OF NUTRITION INTERVENTIONS ON INCREASING THE HEIGHT OF CHILDREN WITH STUNTING: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Stunting remains a global nutritional issue that seriously impacts the linear growth of children. To analyze the effectiveness of various nutrition interventions on increasing the height of children with stunting through a systematic literature review approach. A systematic literature search was conducted across four electronic databases PubMed/MEDLINE, Google Scholar, Scopus, and ScienceDirect covering publications from 2021 to 2026, guided by the PRISMA 2020 framework. Keywords employed included: stunting, nutrition intervention, linear growth, height-for-age z-score, food supplementation, micronutrient supplementation, and children under five. From 309 initially identified articles, 12 articles satisfied the inclusion criteria and were systematically analyzed. Interventions proven effective include digital-based nutrition education, Recovery Supplementary Feeding (PMT-P), the DASHAT program, and complementary feeding education. Single micronutrient supplementation did not produce significant changes in height-for-age z-score (HAZ) yang signifikan ($p = 0,93$), whereas app-based education increased height by $\geq 1,9$ cm. Addressing stunting requires an integrated multi-component approach, prioritized since the first 1,000 Days of Life (HPK).

Keywords: body height; height for age z score; nutrition intervention; stunting; toddlers

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INTRODUCTION

The problem of malnutrition in early childhood remains a significant global health burden to this day, particularly in low- and middle-income countries. One of the most critical manifestations of this condition is stunting, a growth failure condition resulting from chronic malnutrition characterized by a height-for-age z-score (HAZ) below minus two standard deviations from the WHO growth reference median. This condition impacts not only physical dimensions but also affects cognitive development, learning capacity, and an individual's long-term productivity. Globally, the prevalence of stunting in children under five was recorded at 22.3%, or equivalent to 148.1 million children in 2022, with the largest proportion located in the Asia and Africa regions. (Mulyani et al., 2025).

On the level of specific phenomena in Indonesia, the condition of stunting remains an urgent national health development priority. Based on the results of the Indonesian Nutritional Status Survey (SSGI), the national stunting prevalence has experienced a gradual decline from 27.7% in 2019 to 19.8% in 2024, although this achievement has not yet reached the target of the National Medium-Term Development Plan (RPJMN) of 14.2% by 2029 (Ministry of Health of the Republic of Indonesia, 2025). This data suggests that the intervention efforts already in place still require a more comprehensive evidence-based reinforcement. In line with this, interprofessional collaboration and the strengthening of programs at the primary health service level are considered very crucial in accelerating the reduction of stunting rates, considering that previous programs still showed limitations in effectiveness and reach. (Sentika et al., 2024).

Theoretically, nutrition-specific interventions encompass a variety of approaches, ranging from food supplementation and micronutrient supplementation (such as zinc, iron, and folic acid) to the promotion of complementary feeding and nutrition education for mothers and caregivers. Various studies have proven that food-based interventions can significantly improve children's linear growth. A meta-analysis conducted by Mamun et al. (2023) found that food-based interventions generally increase linear growth in children (MD: 0.20; 95% CI: 0.04 to 0.35; $p = 0.01$). On the other hand, systematic reviews of lipid-based nutrient supplements (LNS) and multiple micronutrient (MMN) supplements provided during the complementary feeding period also show a statistically significant reduction in the risk of stunting. Nevertheless, it is important to note that not all types of interventions yield consistent results; variations in nutritional quality, food types, and geographical context are decisive factors in effectiveness that cannot be ignored (Mamun et al., 2023).

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The novelty of this research lies in its approach that integrates the analysis of various nutritional intervention modalities, including single or combined micronutrient supplements, functional foods, and nutrition education, within a single SLR framework that focuses explicitly on height changes in children with stunting. This study updates the latest scientific evidence by covering studies published between 2021 and 2026, making it relevant to current epidemiological conditions and global nutrition policy directions toward achieving the 2030 Sustainable Development Goals.

Based on the described background, the problem formulation of this research is divided into three key research questions: identifying the specific types of nutritional interventions proven effective in increasing the height of children with stunting through a systematic literature review, determining the magnitude of the impact (effect size) these interventions have on changes in height-for-age z-score (HAZ) values among affected children, and analyzing the various factors that moderate the effectiveness of these nutritional interventions in promoting linear growth.

The general objective of this research is to analyze and synthesize scientific evidence regarding the effectiveness of various types of nutritional interventions on increasing the height of children with stunting through a systematic literature review approach. In line with the established problem formulation, the specific objectives of this research are: (1) to identify the types of nutritional interventions that have been proven effective in improving the linear growth of children with stunting based on scientific literature from 2021–2026; (2) to analyze the impact size (effect size) of each type of nutritional intervention on changes in height-for-age z-score (HAZ) values in children with stunting; and (3) to identify and analyze factors that moderate the effectiveness of nutritional interventions on increasing children's height, including the child's age, the type and dose of the intervention, the duration of administration, and the socio-geographical context of program implementation.

This research is expected to provide theoretical benefits by enriching the field of clinical nutrition and child health, particularly in understanding the mechanisms and effectiveness of nutritional interventions on linear growth. Practically, the findings of this study can serve as an evidence-based reference for health workers, nutritionists, and policymakers in designing more effective and measurable stunting intervention programs at both the primary health facility level and the national policy level. Furthermore, the results of this study can serve as a basis for developing more specific

follow-up primary research, especially within the context of the stunted child population in Indonesia.

METHOD

This study utilizes a systematic literature review (SLR) design, conducted in a structured and systematic manner to address research questions regarding the effectiveness of nutrition interventions on increasing the height of children with stunting. All stages of the review were carried out in accordance with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which provide a reporting framework designed to guide researchers in identifying, selecting, assessing, and synthesizing scientific evidence transparently and reproducibly (Page et al., 2021). This approach was selected because it allows for a comprehensive synthesis of various relevant primary studies, thereby producing evidence-based conclusions with a higher level of confidence compared to conventional narrative reviews.

A comprehensive literature search was performed through four major electronic databases: PubMed/MEDLINE, Google Scholar, Scopus, and ScienceDirect. The search strategy employed a combination of established keywords, including: *"stunting"*, *"nutrition intervention"*, *"linear growth"*, *"height-for-age z-score"*, *"food supplementation"*, *"micronutrient supplementation"*, and *"children under five"*. Boolean operators AND and OR were used systematically to either expand or narrow the scope of the search results. All searched literature was limited to the publication range of 2021 to 2026 to ensure the relevance and currency of the scientific evidence used.

Based on the initial identification process, a total of 309 journals were found from all the databases used. Before the screening stage began, 102 articles identified as duplicate data were eliminated, leaving 207 articles to proceed to the screening stage. The applied inclusion criteria included: (1) articles published between 2021 and 2026; (2) research subjects being children aged 0–59 months experiencing stunting; (3) the interventions studied being nutrition-specific; and (4) the measured outcomes including changes in height or height-for-age z-score (HAZ) values. Meanwhile, the exclusion criteria included articles not available in full-text version, non-empirical studies such as opinions or editorials, and research that did not explicitly include height anthropometric data. Out of the 207 screened articles, 95 articles were excluded at this stage, resulting in 112 articles eligible for further review.

The next stage was the eligibility assessment of 56 articles that had passed through further selection from the previous 112 articles, while 56 other articles did not meet the criteria and were excluded. During this full eligibility assessment stage, a full-text review was conducted independently by two reviewers. Articles excluded at this stage were categorized based on specific reasons: 24 articles were removed because they were not relevant to the height outcome, and 20 other articles were excluded for not meeting the established study design standards. The methodological quality assessment of each article was performed using a standardized critical appraisal instrument, namely the JBI Critical Appraisal Tools, as a measurement for the risk of bias in the included studies (Barker et al., 2023). Based on this entire multi-level selection process, 12 final articles were obtained that met all criteria and were included in the synthesis analysis of this review. Data extraction was carried out systematically using a standardized form, covering information regarding study design, population characteristics, type of intervention, duration of administration, and the effect size on children's linear growth.

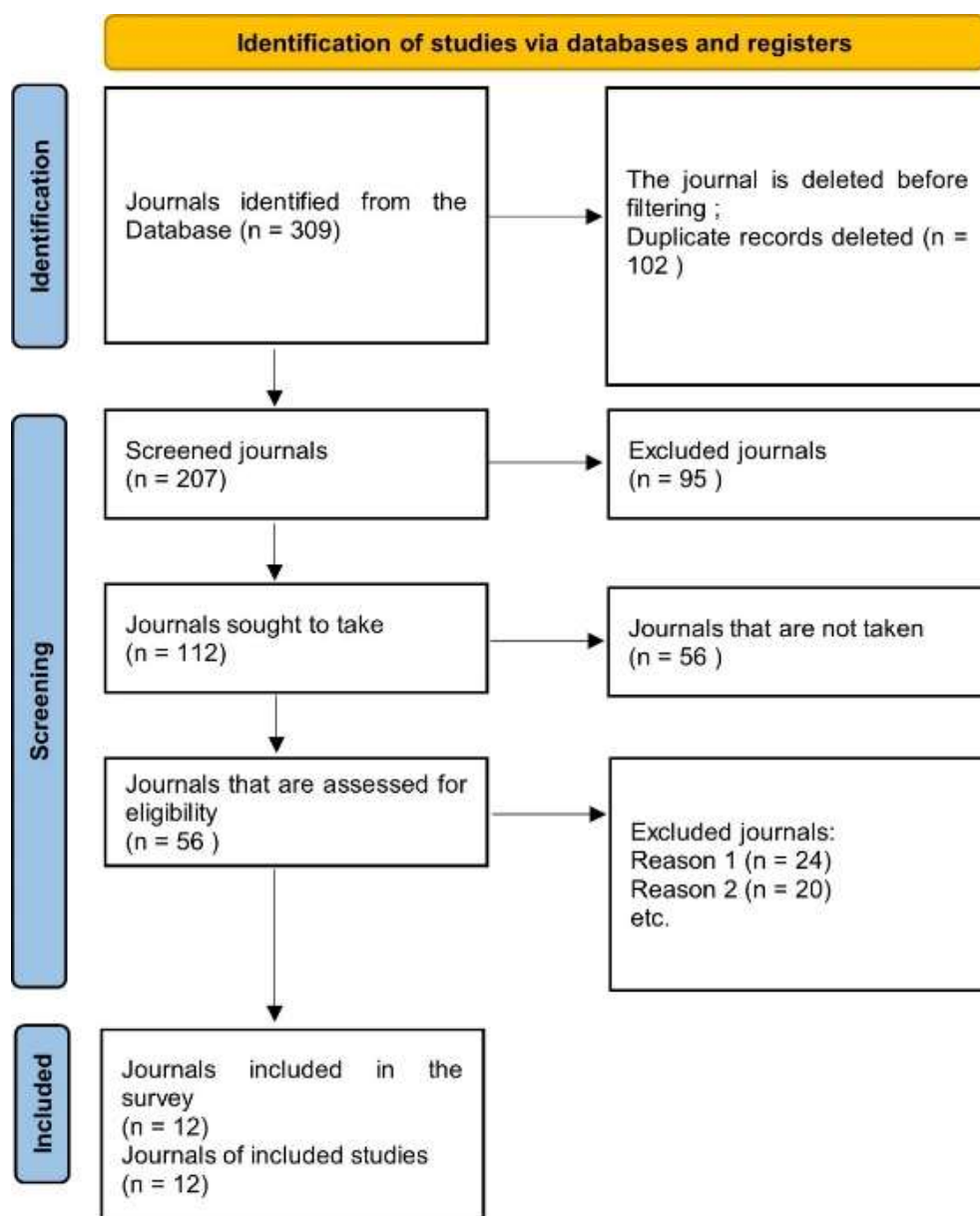


Figure 1. PRISMA Flowchart

RESULT

Out of the 12 articles analyzed, the sample variation was quite broad, ranging from 22 to 52,640 subjects with diverse population contexts (Ethiopia, Pakistan, Indonesia, and LMICs). In general, interventions based on maternal education, supplementary feeding, and community empowerment showed a positive impact on child growth. However, direct effects on increasing the height-for-age z-score (HAZ) require a longer intervention duration and an integrated multi-component approach.

Table 1.
Synthesis Table

No	Author, Year	Research Title	Method	Sample	Results	Implikasi
1	(Benjamin-Chung et al., 2023)	Early-childhood linear growth faltering in low- and middle-income countries	<i>Pooled analysis longitudinal; 32 kohort; negara LMIC</i>	52,640 children aged 0–24 months	Highest stunting incidence occurs at 0–3 months. Reversibility is very low (0–15 months). Recovered children often relapse, especially those born stunted.	Interventions must start prenatally and be strengthened for children < 6 months; a life-course approach is essential.

No	Author, Year	Research Title	Method	Sample	Results	Implikasi
2	(Amaha, 2025)	Determinants of height-for-age z-score (HAZ) among Ethiopian children aged 0–59 months	<i>Multilevel mixed-effects linear regression; data EMDHS 2019</i>	5,045 children aged 0–59 months	Child's age is inversely proportional to HAZ ($\beta = -0.02$; $p < 0.001$). Maternal education and age have a positive influence. High altitude decreases HAZ ($\beta = -0.21$ per 1000 m).	Improving maternal education and geographic context-based interventions are crucial for enhancing children's linear growth.
3	(Khan et al., 2023)	Community-Based Trial on Micronutrient Powder Supplementation in Pakistan	<i>Non-randomized community-based clinical trial; 12 bulan intervensi MNP; Khyber Pakhtunkhwa, Pakistan</i>	Children aged 24–48 months	MNP supplementation significantly increased levels of vitamin A, D, zinc, and hemoglobin. No significant change in HAZ ($p = 0.93$); significant improvement only in WHZ and WAZ.	Single micronutrient supplementation is insufficient to improve height; it needs to be combined with more comprehensive nutritional interventions.
4	(Suratri et al., 2023)	Risk Factors for Stunting among Children under Five Years in NTT, Indonesia	<i>Cross-sectional; 2018 RISKESDAS secondary data; multivariate logistic regression</i>	1,643 children aged 0–59 months, NTT, Indonesia	Dominant factors for stunting: age 24–35 months (OR = 2.08), low maternal education (OR = 1.57), rural residence (OR = 1.39).	Nutrition interventions should target mothers with low education in rural areas; nutrition education during pregnancy and complementary feeding is vital.
5	(Asif et al., 2022)	Establishing HAZ Growth Reference Curves and Stunting Prevalence in Pakistan	<i>Growth reference study; LMS method; Pakistan</i>	10,668 children aged 2–18 years	Local Pakistan HAZ curves differ significantly from WHO and USCDC references. Stunting prevalence according to WHO (10.8%) vs. local reference (3.0%) shows significant overestimation.	Use of local growth references is more accurate for detecting stunting; intervention planning must consider the local population context.
6	(Rahayu et al., 2025)	Effectiveness of Nutrition Education on Reducing Stunting Risk in Toddlers in Yosomulyo	<i>Quasi-experimental ; one-group pre-post test; Metro City, Indonesia</i>	50 mothers of toddlers	Nutrition education significantly improved maternal knowledge ($p < 0.05$). There was a trend of improvement in WAZ and HAZ, though not statistically significant in the short term.	Nutrition education is effective in improving knowledge and feeding practices; sustainability through Posyandu is needed for long-term height impact.
7	(Komala sari et al., 2021)	Effectiveness of Recovery Supplementary Feeding (PMT-P) on Weight Gain in Stunted Toddlers	<i>Retrospective cohort; Health Center medical records; 3-month monitoring; Indonesia</i>	32 stunted toddlers	PMT-P was proven to gradually increase the weight of stunted toddlers during the 3-month monitoring period.	PMT-P is effective for improving nutritional status; effects on height require longer intervention duration and routine monitoring.
8	(Andrian i, 2022)	Effectiveness of Education through Complementary Feeding	<i>Quasi-experimental ; pre-post test control group design</i>	Infants at risk of stunting (App group vs.	Education through the app was 1.4x more effective than leaflets in increasing infant height by ≥ 1.9 cm.	Utilizing digital technology in complementary feeding education is more effective; app-based

No	Author, Year	Research Title	Method	Sample	Results	Implikasi
		Apps on Child Height		Leaflet group)		innovations have the potential to be integrated into national programs.
9	(Jusliani & Syamsudin, 2024)	Review of the Effectiveness of Nutrition Interventions on Stunting and Nutritional Problems in Toddlers	<i>Literature review; individual & community intervention studies; LMICs</i>	Various primary studies from low-income countries	Breastfeeding promotion and maternal education improve growth. Micro/macronutrient supplementation effectively reduces anemia risk. Home gardening/education did not significantly reduce stunting in the short term.	A multisectoral approach is required; no single intervention is sufficient to address stunting comprehensively.
10	(Dainy et al., 2023)	Formation of DASHAT Team and Nutrition Intervention to Prevent Stunting	<i>Community service program; 60-day complementary feeding intervention; Indonesia</i>	Posyandu cadres and infants at risk of stunting (6–12 months)	Cadre knowledge increased by 11 points. Cadre skills increased by 100%. Average feeding consumption was 84.7%; average weight gain was 544.4 grams.	The DASHAT program effectively increases cadre capacity and nutritional status; this healthy kitchen model can be widely replicated.
11	(Indrasari & Husna, 2023)	Effectiveness of Nutrition Education on Increasing Stunting Prevention Knowledge in Mothers	<i>Quasy-experimental one group pre-post test; consecutive sampling; Kaway XVI, Aceh</i>	22 mothers of at-risk toddlers	Nutrition education had a significant effect on increasing maternal knowledge about stunting prevention ($p = 0.05$).	Nutrition education for mothers is an effective basic intervention; larger scale and long-term impact measurements on growth are needed.
12	(Sholihat et al., 2024)	Stunting Prevention Strategy through Community Empowerment and Nutrition Intervention	<i>Community-based program; health screenings, nutritious breakfast, growth monitoring</i>	Mothers, cadres, and children in Tanjung Palas, Indonesia	High community enthusiasm. The nutritious breakfast program received strong support. Nutrition information boards improved access to healthy eating patterns.	Community-based interventions with local involvement are effective in raising awareness; program sustainability is key for real impact on stunting reduction.

DISCUSSION

Types of Nutrition Interventions Proven Effective in Increasing the Height of Children with Stunting

Based on the synthesis of the 12 articles included in this systematic review, various modalities of nutrition interventions have been tested for their effectiveness in increasing the height of children with stunting. Broadly, these interventions can be categorized into four main groups: micronutrient supplementation, supplementary feeding, maternal-based nutrition education, and food-based community empowerment.

The first group of interventions showing a measurable impact on height growth is digital technology-based nutrition education. Delivering material on complementary feeding (MPASI) through digital application platforms proved to be 1.4 times more effective than conventional media such as leaflets in increasing infant height, with gains reaching ≥ 1.9 cm (Andriani, 2022). This finding indicates that the method of intervention delivery plays a role in determining the magnitude of the effect, where technology-based approaches are able to optimize maternal engagement in child feeding practices more effectively.

The second relevant group is conventional nutrition education directed at mothers of toddlers. Direct nutrition education programs have been proven to significantly increase maternal knowledge ($p < 0.05$) and show a trend of improvement in height-for-age (TB/U) indicators, although anthropometric changes may not reach statistical significance in the short term (Rahayu et al., 2025). Nutrition education is also proven to have a significant effect on increasing maternal knowledge regarding stunting prevention ($p = 0.05$), reinforcing that enhancing maternal knowledge capacity is a vital foundation for driving changes in feeding behavior that have a long-term impact on a child's linear growth (Indrasari & Husna, 2023).

The third group is Recovery Supplementary Feeding (PMT-P). PMT-P administered over three months to stunted toddlers has been shown to increase body weight gradually and consistently, which is an essential prerequisite for overall improvement in linear growth (Komalasari et al., 2021). In a broader context, macronutrient and micronutrient supplementation are effective in improving a child's nutritional status, although their effectiveness against stunting in the short term remains limited if applied in isolation without the support of other complementary interventions (Jusliani & Syamsuddin, 2024).

The fourth intervention group is healthy kitchen-based community empowerment programs. The DASHAT program (Healthy Kitchen to Overcome Stunting), which involves cadre training and a 60-day complementary feeding intervention, resulted in an average weight gain of 544.4 grams in infants at risk of stunting, with a food consumption rate of 84.7%, while simultaneously increasing cadre skills by 100% (Dainy et al., 2023). This indicates that community-based models can strengthen the capacity of local human resources as agents of nutritional change at the grassroots level. Community-based interventions encompassing socialization, providing nutritious breakfasts, and monitoring growth and development have also received positive community responses and have the potential to reduce stunting prevalence if implemented sustainably (Sholihat et al., 2024).

Nutritional Intervention Effect Size on Changes in Height-for-Age Z-Score (HAZ) Values

Analysis of the effect size of nutritional interventions on HAZ values shows varied results, depending on the type, duration, and components of the intervention applied. Micronutrient powder (MNP) supplementation for 12 months in children aged 24–48 months did not produce statistically significant changes in HAZ values ($p = 0.93$), although there were significant improvements in weight-for-height z-score (WHZ) and weight-for-age z-score (WAZ) indicators (Khan et al., 2023). These results indicate that single-form micronutrient supplementation has limitations in improving linear growth, as the mechanism for height improvement requires a more complex combination of macro- and micronutrients over a longer period.

Conversely, education-based interventions using a digital approach showed a more measurable effect on body height, specifically an increase in infant height of $\geq 1.9 \text{ cm}$ with an effectiveness 1.4 times higher than the control group (Andriani, 2022). This figure carries important clinical significance, considering that linear growth in infants occurs within a range of millimeters to centimeters per month.

Quantitatively, every one-year increase in maternal education is associated with an increase in HAZ of $\beta = 0.036$ unit ($p = 0.008$), and every one-year increase in maternal age is associated with an increase $\beta = 0.015$ unit ($p = 0.012$) (Amaha, 2025). These quantitative estimates provide valuable insight into the contribution of maternal factors to HAZ and can serve as a basis for calculating effect sizes in interventions designed to strengthen maternal capacity. Furthermore, the very low reversibility of stunting during the 0–15 month period implicitly shows that the effect of nutritional interventions on HAZ will be much greater if provided before the age of six months compared to interventions started at a later age (Benjamin-Chung et al., 2023).

Factors Moderating the Effectiveness of Nutrition Interventions on Increasing the Height of Stunted Children

This review identifies several moderating factors that substantially influence the effectiveness of nutrition interventions on increasing the height of children with stunting, including the child's age, maternal education level, geographical context, intervention duration, and the type of intervention modality used.

The child's age at the start of the intervention is the most consistently found moderator across studies. The highest incidence of stunting occurs within the 0–3 month age range, and recovery rates are very low after 15 months, reinforcing that the effectiveness of nutrition interventions on increasing HAZ is far more optimal when applied during the First 1,000 Days of Life (HPK) (Benjamin-Chung et al., 2023). The implication is that interventions starting from pregnancy until the child is two years old have a much higher chance of success compared to interventions in subsequent phases.

Maternal education level is proven to be a strong structural moderator in determining the effectiveness of nutrition interventions. Mothers with low education have a 1.57 times higher risk of having a stunted child (OR = 1,57; 95% CI: 1,18–2,08), thus, the effectiveness of any nutrition intervention will be hindered if the mother's nutritional literacy capacity is not simultaneously improved (Suratri et al., 2023). Nutrition education for mothers must be viewed not as a supplementary intervention, but as a core component that must be integrated into every stunting management program.

Geographical factors and socioeconomic context also serve as important moderators that cannot be ignored. An altitude increase of 1,000 meters is associated with a decrease in HAZ by 0.21 units, indicating that physical environmental conditions also moderate a child's biological response to nutrition interventions (Amaha, 2025). In remote areas, the effectiveness of nutrition interventions tends to be lower due to limited access to nutritious food and health services, as shown by the fact that children living in rural areas have a 1.39 times higher risk of stunting compared to urban children (Suratri et al., 2023).

Duration and consistency of the intervention become the fourth significant moderator. Monitoring Recovery Supplementary Feeding (PMT-P) for three months showed improvements in weight but not yet in height, suggesting that changes in linear growth require a longer intervention duration (Komalasari et al., 2021). This is reinforced by findings showing significant weight gain after 60 days of complementary feeding (MPASI) intervention, while the impact on height still requires further monitoring (Dainy et al., 2023). Overall, this review confirms that no single nutrition intervention is independently capable of addressing stunting comprehensively; instead, an integrated approach is required that considers the type, intensity, duration, and socio-demographic context of the intervention target (Jusliani & Syamsuddin, 2024).

Research Limitations

This study has several limitations that should be considered when interpreting the findings. This review only covers 12 articles that met the inclusion criteria out of 309 identified articles, thus there is a possibility that relevant studies were not captured during the search process. Additionally, the heterogeneity of study designs, variations in intervention types, differences in administration duration, and the diverse population characteristics across studies make direct comparisons between results difficult. Most of the included studies also did not explicitly report HAZ values as the primary outcome, meaning that a uniform and comprehensive effect size analysis on body height could not be conducted.

CONCLUSION

This systematic review demonstrates that nutrition interventions exert varying degrees of effectiveness on the linear growth of stunted children. Digitally delivered complementary feeding education, Recovery Supplementary Feeding (PMT-P), the DASHAT community empowerment program, and maternal nutrition education emerged as the most impactful modalities. Conversely, single micronutrient supplementation yielded no statistically significant improvement in height-for-age z-score values. The magnitude of intervention effectiveness is substantially moderated by the child's age at intervention onset, maternal educational attainment, geographical conditions, and intervention duration. Collectively, these findings affirm that addressing stunting necessitates an integrated, multi-component strategy initiated within the First 1,000 Days of Life to achieve meaningful and sustainable improvements in children's linear growth.

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