Prenatal Health Education as an Evidence-Based Intervention for Stunting Prevention and Child Nutritional Outcomes in Low- and Middle-Income Countries: A Systematic Review

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Abstract: *Background*: Stunting is a major global public health problem that mainly affects children in low- and middle-income countries. Research suggests that educating mothers about health during pregnancy can increase the use of prenatal care and improve nutritional practices, which helps the growth of the unborn child.

Objectives: This systematic review aims to evaluate the effectiveness of health education programs for pregnant women in preventing childhood stunting and improving children's health outcomes.

Methods: A systematic review was conducted following PRISMA 2020 guidelines. We searched PubMed, Scopus, and Google Scholar for studies published between 2015 and 2025. In total, 13 eligible studies were included and analyzed using thematic synthesis.

Results: Educational programs, such as multimedia-based education, structured counseling, and modular learning approaches, consistently improved mothers' knowledge, attitudes, and practices regarding nutrition and prenatal care. These programs led to greater compliance among mothers and to positive behavioral changes during pregnancy. Also, social support, which includes emotional, informational, and practical help, increased the effectiveness of educational strategies by encouraging adherence to recommended health practices. Implementing these programs in the first 1,000 days of life has shown promise in reducing the risk of stunting.

Conclusions: Educating pregnant women is an effective and scalable way to prevent stunting and improve child health outcomes. It is strongly recommended to integrate educational initiatives with social support into routine prenatal care services to maximize their impact.

Keywords: Stunting, child health, child nutrition, integrated child health programs.

INTRODUCTION

Stunting, defined as low height-for-age and impaired linear growth, remains a major and persistent global health problem. In 2022, about 148 million children under five years of age were affected by stunting, most of whom lived in low- and middle-income countries (LMICs) [1]. The consequences of stunting extend beyond physical growth retardation, affecting neurological development, immune competence, and human capital and economic productivity. Increasing evidence indicates that the etiology of stunting starts in utero, highlighting the critical importance of addressing maternal health and nutrition during pregnancy and preconception as a fundamental strategy for prevention [2].

Among the various interventions examined, antenatal health education for pregnant women has emerged as a cost-effective, scalable approach to mitigate the risk of stunting. Providing education to pregnant women on important issues such as nutrition, antenatal care (ANC), hygiene practices, and appropriate infant feeding has been shown to improve outcomes for mother and baby by enhancing maternal health literacy.

Evidence from different geographic settings in Indonesia, Kenya, and Rwanda suggests that structured, context-specific educational interventions can improve maternal practices and are associated with lower incidences of low birth weight and stunting in their offspring [3, 4]. For instance, a quasi-experimental study in Indonesia found that interactive group-based education on nutrition and reproductive health had a significant impact on the dietary behavior and healthcare utilization of pregnant women [5].

Similarly, a longitudinal intervention conducted in Nairobi's informal settlements found that regular counseling sessions during pregnancy helped to substantially reduce under-five stunting rates [6].

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Despite these positive findings, the literature is still subject to several limitations. The challenge in identifying the most effective components of health education programs stems from variation in program content, delivery formats, intensity, and duration [7].

Additionally, although some interventions have documented short-term improvements in knowledge and birth outcomes, there is limited evidence on long-term effects on child growth beyond infancy. Moreover, sociocultural and economic determinants that influence uptake and effectiveness of educational interventions, including low maternal literacy, limited access to health care, and entrenched gender norms, are often poorly integrated into program design [8].

Another major gap is the underrepresentation of vulnerable subgroups, including adolescent mothers, women of short stature, and people residing in rural or impoverished urban areas. These individuals are at a higher risk of unfavorable maternal and newborn outcomes; yet, little research has investigated personalized educational solutions to meet their specific needs [9, 10].

Furthermore, inconsistent use of outcome indicators and measurement tools across studies impedes cross-comparison and meta-synthesis. Given these limitations and the ongoing prevalence of childhood stunting in many LMICs, a thorough synthesis of existing evidence is urgently necessary. Despite these limitations, there remains a lack of integrative synthesis that systematically examines how intervention components, delivery strategies, and contextual factors interact to influence stunting results. The existing research remains fragmented, making it difficult to identify the most effective and scalable approaches.

This systematic review aims to address these gaps by providing an integrative synthesis of maternal health education interventions and examining how and under what conditions these interventions may contribute to the prevention of childhood stunting. It investigates the interactions between program components, delivery mechanisms, and contextual determinants, such as sociocultural and demographic characteristics, which have frequently been ignored in past research. In addition, this review examines the potential scalability and adaptability of maternal education within broader public health frameworks, particularly in low- and middle-income countries such as Indonesia.

This study aims to provide insights into improving intervention design and implementation by synthesizing evidence from various settings. It will also identify gaps in targeting high-risk individuals and using standardized outcome measures. These findings are expected to help build a stronger evidence base to inform policy and enhance multisectoral programs aimed at reducing stunting.

MATERIALS AND METHODS

This systematic review assessed the efficacy of maternal health education during pregnancy in preventing childhood stunting and improving child health outcomes. The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 standards to enhance methodological transparency and reproducibility.

Research Framework

The review was guided by the Population, Intervention, Comparator, and Outcome (PICO) framework:

1. Population

Pregnant women (preconception, antenatal and postpartum)

2. Intervention

Maternal health education, nutritional counseling, antenatal education, and behavior change communication

3. Comparator

Usual care or lack of a structured educational intervention

4. Outcomes

Child growth indicators, such as stunting prevalence, weight at birth, and fetal growth.

Eligibility Criteria

Studies were included if they met the following criteria:

1. Published in peer-reviewed journals between January 2015 and April 2025.
2. Written in English.
3. Involved structured educational programs targeting pregnant women.

4. Reported results on maternal behavior, birth outcomes, or child growth.

Eligible study designs included randomized controlled trials, quasi-experimental studies, cohort studies, and cross-sectional studies with clear interventions.

Studies were excluded if they:

1. Focused on non-pregnant populations;

2. Lacked an educational intervention;

3. Were reviews, editorials, or conference abstracts without primary data, or

4. did not report maternal or child health outcomes.

Studies were selected based on predetermined criteria guided by the PICO framework. The detailed inclusion and exclusion criteria are presented in Table **1**. These criteria were used to select relevant, high-quality studies examining maternal education interventions and their impact on child health outcomes.

Search Strategy and Information Sources

A literature search was done across multiple electronic databases, including PubMed, Scopus, and Google Scholar, covering publications from January 1, 2015, to April 30, 2025. The final search took place on April 30, 2025. Filters were applied to include only English-language publications and studies involving human participants. This review aimed to look at maternal health education programs in areas with a high rate of stunting. Therefore, the search focused on studies conducted in low- and middle-income countries (LMICs), including Indonesia.

The search process combined relevant keywords and Boolean operators (AND, OR), including: “maternal health education,” “nutrition counseling,” “antenatal education,” “pregnant women,” “stunting,” “child growth,” and “low birth weight,” along with geographical terms such as “developing countries,” “low- and middle-income countries,” and “Indonesia.” The reference lists of the included studies were manually reviewed to identify additional relevant articles. The details of the included studies are shown in Table **2**.

Study Selection

All identified records were imported into Mendeley reference management software, and duplicates were removed. Two reviewers independently screened the titles and abstracts, then assessed full texts based on eligibility criteria. Disagreements were resolved through discussion. If disagreements persisted, a third reviewer was consulted. Inter-rater reliability was measured to ensure consistency in the screening process.

Data Extraction

Data were collected using a standardized form that included: author(s), year of publication, study location, design, sample size, population characteristics, intervention details (type, duration, and delivery), outcomes measured, and key findings. Data extraction was conducted independently by two reviewers to ensure accuracy and consistency.

Quality Assessment

The quality of the included studies was evaluated using suitable tools based on study design. The Cochrane Risk of Bias tool was used for randomized controlled trials, while the ROBINS-I tool was applied to non-randomized studies. Each study was categorized

Table 1: Inclusion and Exclusion Criteria Based on the PICO Framework

Criteria	Inclusion	Exclusion
Population	Pregnant women (antenatal and postpartum periods)	Infants, toddlers, adolescents, non-pregnant populations
Intervention	Maternal health education (e.g., antenatal classes, counseling, brochures, leaflets, audiovisual media)	Non-educational interventions
Comparison	With or without comparator	-
Outcomes	Stunting, child growth indicators, maternal knowledge, attitudes, and practices	Outcomes not related to maternal or child health
Study Design	RCTs, quasi-experimental, cohort, cross-sectional studies with intervention	Reviews, editorials, conference abstracts

as having low, moderate, or high risk of bias. Any discrepancies were resolved through consensus.

Data Synthesis

Due to differences in study designs, interventions, and outcome measures, a meta-analysis was not possible. Therefore, a narrative synthesis approach was used. Studies were grouped based on similarities in intervention type, study design, and reported outcomes. Data were compared across studies to find consistent patterns, differences, and relationships between maternal health education interventions and outcomes.

The findings were organized into three main categories:

1. characteristics of educational interventions;
2. effects on maternal knowledge and behavior; and
3. impacts on child health outcomes, including birth weight and stunting.

This approach enabled a clearer understanding of the evidence despite methodological differences.

Ethical Considerations

This study was based on secondary analysis of published literature and did not require ethical approval. All sources were appropriately cited to maintain academic integrity.

RESULTS

Study Selection

The literature search yielded 617 entries across electronic databases, including PubMed (n = 210), Scopus (n = 210), and Google Scholar (n = 407). Before screening, 150 duplicate records were removed, along with 132 records excluded by automated screening tools and 140 records discarded for other reasons. After these exclusions, 195 records remained and were screened based on titles and abstracts. Of these, 120 records were excluded because of irrelevant populations.

A total of 75 reports were requested for retrieval; however, 35 reports were not retrieved due to unsuitable study designs (non-quasi-experimental). As a result, 40 full-text articles were evaluated for eligibility, with 25 excluded due to mismatches. In the end, 15 studies met the inclusion criteria and were included in the review.

The overall study selection process is shown in Figure **1** (PRISMA Flow Diagram), and adherence to PRISMA 2020 guidelines is further detailed in Supplementary File 1 (PRISMA Checklist).

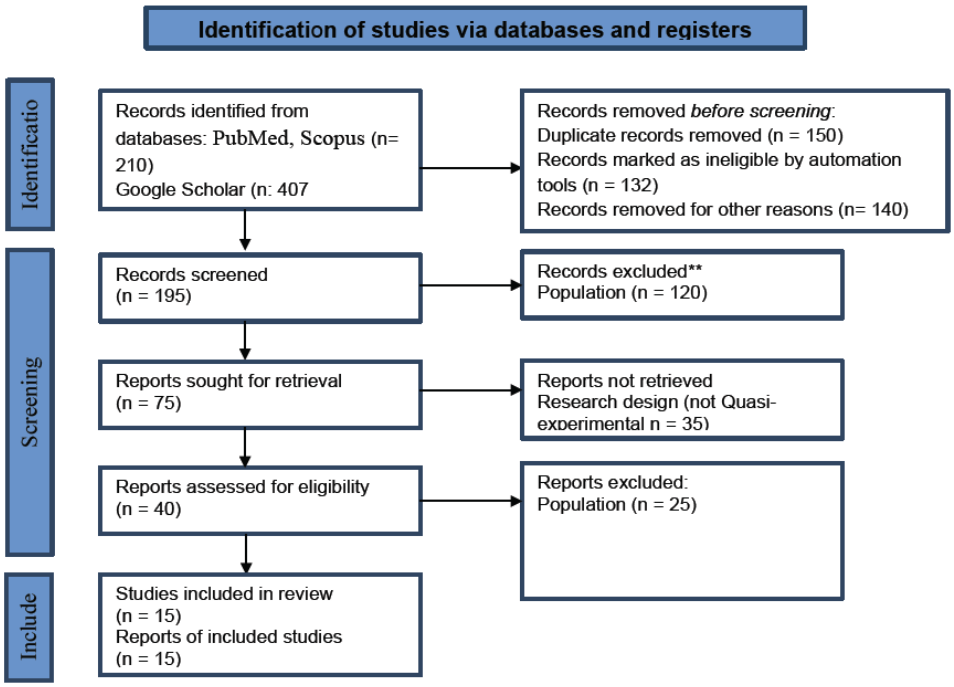

Figure 1: PRISMA Flow Diagram.

Risk of Bias Assessment

The results of the risk-of-bias assessment are presented in Table **2**. Most included studies were classified as having a moderate to high risk of bias. Quasi-experimental studies with control groups were generally rated as having a moderate risk. In contrast, studies using one-group pre-post designs had a high risk due to the lack of control groups. Only one study, a cluster randomized controlled trial, was identified as having a low risk of bias.

Characteristics of Included Studies

The characteristics of the included studies are summarized in Table **3**. Most studies were conducted in Indonesia, while one was conducted in Ethiopia. This shows a strong focus on low- and middle-income settings. The majority of studies used quasi-experimental designs, followed by pre-experimental designs, and one study used a cluster randomized controlled trial. The study populations mainly included pregnant women with various characteristics, particularly high-risk groups such as women with short stature and those in early pregnancy. Sample sizes ranged from 17 to 194 participants.

Types of Interventions

The maternal health education interventions reviewed in the included studies varied greatly in format and delivery methods. These interventions included face-to-face education, such as group sessions and pregnancy classes. They also used printed materials, such as leaflets, booklets, and modules, as well as audiovisual media, such as videos and multimedia tools. Additionally, some studies applied community-based approaches, including cadre assistance and peer group support. Others used hybrid models combining online and offline strategies. Interactive methods such as role-playing, simulations, and group discussions were common and proved more effective at engaging participants.

Effects on Maternal Knowledge, Attitudes, and Practices

All studies analyzed reported improvements in maternal knowledge. Several also noted significant improvements in attitudes and practices regarding nutrition and antenatal care. Interventions that used audiovisual media and interactive group education were particularly effective in enhancing knowledge retention and participant engagement. Moreover,

Table 2: Risk of Bias Assessment

No	Author (Year)	Study Design	Tool	Overall Risk
1	Permatasari *et al*. (2021)	Quasi-experimental (with control)	ROBINS-I	Moderate
2	Muhamad *et al*. (2023)	Quasi-experimental (with control)	ROBINS-I	Moderate
3	Patty *et al*. (2023)	Quasi-experimental (with control)	ROBINS-I	Moderate
4	Unnisa *et al*. (2023)	Quasi-experimental (with control)	ROBINS-I	Moderate
5	Nugraha *et al*. (2025)	Quasi-experimental (with control)	ROBINS-I	Moderate
6	Kartini *et al*. (2016)	Quasi-experimental (with control)	ROBINS-I	Moderate
7	Qosim *et al*. (2024)	One-group pre-post	ROBINS-I	High
8	Arsyati (2019)	One-group pre-post	ROBINS-I	High
9	Ekayanthi (2019)	One-group pre-post	ROBINS-I	High
10	Sapnita *et al*. (2022)	Quasi-experimental (with control)	ROBINS-I	Moderate
11	Anggraini *et al*. (2020)	One-group pre-post	ROBINS-I	High
12	Agritubella & Jannah (2022)	One-group pre-post	ROBINS-I	High
13	Eny & Dwiyanti (2025)	One-group pre-post	ROBINS-I	High
14	Yuliana & Lestari (2022)	One-group pre-post	ROBINS-I	High
15	Diddana *et al*. (2018)	Cluster RCT	Cochrane RoB	Low
16	Heriyanti *et al*. (2023)	One-group pre-post	ROBINS-I	High

Table 3: Study Characteristics of Included Studies

No	First Author, Year	Setting/ Country	Study Design	Characteristic's Subject	Type of Intervention/Most Important Results
1	Permatasari *et al*., 2021. [11]	Indonesia	Quasi-experimental design in the intervention group and the control group	194 pregnant women. The pregnant women were randomly selected from four different villages in Bogor Regency	The intervention group (n = 97) received 2 hours of nutrition and reproductive health education in small groups of four or five mothers. This interactive education was conducted every 2 weeks for 3 consecutive months, with facilitators using techniques such as lectures, role-playing, simulation, and games. The control group (n = 97) received standard health education materials. Providing nutrition and reproductive health education through small groups with interactive methods improved the knowledge, attitudes, and practices of pregnant women.
2	Muhamad, Zuriati, *et al*., 2023. [6]	Indonesia	Quasi-experimental design in the intervention group and the control group	82 short pregnant women (a height < 150 cm).	Participants were divided into two groups, each consisting of 41 individuals. The control group received only leaflets, while the intervention group received both leaflets and cadre assistance for 6 months. Research results indicated differences in the knowledge, attitudes, and actions of pregnant women regarding prenatal care services before and after the intervention. There were also changes in their nutrition knowledge. Support from the cadres had a significant impact on the intervention group compared to the control group, which received only one module.
3	Patty *et al*., 2023. [10]	Indonesia	Quasi-experimental design in the Intervention group and the control group	60 pregnant	Two groups were formed: one used video media, while the other used booklet media. This means that there was an impact from providing education through video and booklet media on pregnant women's knowledge retention about nutrition to prevent stunting.
4	Dina Ikhya 'Unnisa *et al*., 2023. [11]	Indonesia	Quasi-experimental design in the intervention group and the control group	34 pregnant women were selected using a purposive sampling technique, with 16 in the intervention group (audiovisual media) and 18 in the control group (leaflets).	Stunting education through audiovisual media influenced the knowledge of pregnant women, but did not significantly impact their attitudes.
5	Nugraha, *et al*., 2025. [12]	Indonesia	Quasi-experimental design in the intervention group and the control group	157 pregnant women and their husbands	The study included both offline and online components. The sample consisted of 157 pregnant women and their husbands, with 64 participating offline and 93 online. Health education and offline therapy significantly reduced the risk factors for stunting and depression during pregnancy.
6	Kartini, *et al.,* 2016. [13]	Indonesia	Quasi-experimental design in the intervention group and the control group	Seventy-eight of the 4-month pregnant women were selected by purposive sampling.	The group that received educational intervention using a modified module from the MHC book of the Department of Health demonstrated that education influenced the knowledge, attitudes, and behaviors related to pregnancy care.
7	Qosim *et al*., 2024.[14]	Indonesia	Quasi-experimental I (one group pre-test post-test)	The study subjects were 50 pregnant women.	Using audiovisual media on stunting prevention, the "GEMAKIN" nutrition education significantly improved pregnant women's knowledge and attitudes.
8	Arsyati, 2019. [15]	Indonesia	Quasi-experimental I (one group pre-test post-test)	17 pregnant women	The study showed that knowledge increased after the intervention, including changes in unhealthy food consumption and the smoking status of their partners.

(Table 3). Continued.

No	First Author, Year	Setting/ Country	Study Design	Characteristic's Subject	Type of Intervention/Most Important Results
9	Ekayanthi, 2019. [16]	Indonesia	The pre-experimental design method (one-group pre-test-post-test),	There were 35 normal pregnant women in the first trimester without complications, given a pregnancy class intervention for 3 meetings.	There was a notable effect from the pregnancy class on enhancing knowledge and attitudes of pregnant women about preventing stunting.
10	Sapnita *et al*., 2022. [17]	Indonesia	Quasi-experimental design in the intervention group and the control group	30 pregnant women	Using visual media in the form of booklets alongside a promotion group using audiovisual tools like videos ("Isi Piringku") found that health promotion with audiovisual media is more effective than booklet media in increasing knowledge about stunting prevention. However, the booklet group proved more effective in improving the attitudes of pregnant women regarding stunting prevention.
11	Anggraini, *et al.,* 2020. [18]	Indonesia	Quasi-experimental I (one group pre-test post-test)	42 pregnant women	The effect of audiovisual media on knowledge and attitudes showed a significant difference in pregnant women's knowledge and attitudes before and after the intervention. The results showed that pregnant women had a significant difference between their knowledge and attitudes of pregnant women before and after the intervention using audiovisual media.
12	Agritubella and Fathul Jannah, 2022. [19]	Indonesia	Quasi-experimental I (one group pre-test post-test)	20 pregnant women	A pregnancy class required at least 3 meetings. Education increased pregnant women's knowledge about stunting prevention during pregnancy.
13	Eny and Dwiyanti, 2025 [20]	Indonesia	Quasi-experimental I (one group pre-test post-test)	38 pregnant women In the first and second trimesters	This study aimed to determine the effect of cadre assistance (KPM) on knowledge and attitudes about prevention. Results showed that KPM assistance positively affected the knowledge and attitudes of pregnant women regarding stunting prevention.
14	Yuliana, A and Lestari, D 2022 [21]	Indonesia	Quasi-experimental I (one group pre-test post-test)	The study subjects were 50 pregnant women.	Education using booklet media for 3 meetings in the pregnancy class is effective in increasing pregnant women's knowledge about stunting prevention.
15	Diddana *et al*., 2018 [22]	Northeast Ethiopia	A Cluster Randomized Control Trial	A total of 138 pregnant women participated, 69 in the intervention group and 69 in the control group.	An intervention based on the Health Belief Model (HBM) was provided for 15 consecutive days over five months, with nutrition counseling from public health personnel. Education was delivered at the start for three consecutive days. The results revealed an increase in knowledge, perceived dietary behaviors, and actual dietary practices of pregnant women regarding nutrition after receiving the HBM education.
16	Heriyanti, Hera *et al*. [23]	Indonesia	Quasi-experimental I (one group pre-test post-test)	20 pregnant women	The implementation of peer group support improved pregnant women's behavior in stunting prevention. The findings demonstrate the positive impact of peer group support on the behavior of pregnant women regarding stunting prevention.

studies that included additional support, such as cadre involvement or peer support, showed greater improvements than those that relied only on educational materials.

Effects on Child Health Outcomes

While most studies focused primarily on maternal outcomes, some also documented indirect effects on child health indicators. These effects included reduced

risk factors for stunting, improved birth outcomes, such as a lower incidence of low birth weight, and increased maternal adherence to recommended health behaviors vital to proper fetal growth. A notable cluster randomized controlled trial in Ethiopia showed significant improvements in dietary practices and nutritional behaviors among pregnant women, suggesting potential long-term benefits for child growth and development.

Role of Social Support

Social support played a key role in enhancing the effectiveness of maternal health education interventions. Support mechanisms like cadre assistance, peer group involvement, and family support helped improve adherence to health recommendations and reinforced behavioral changes among pregnant women.

The findings suggest that maternal health education is an effective way to boost maternal knowledge, attitudes, and practices. Its effectiveness increases when interactive and multimedia approaches are used, coupled with strong social support systems. These combined strategies show promise in reducing the risk of stunting by promoting sustained improvements in maternal behavior.

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DISCUSSION

This systematic review shows that maternal health education during pregnancy is an effective way for improving knowledge, attitudes, and practices (KAP) related to nutrition and antenatal care. These factors are essential for child growth and preventing stunting. The findings are consistent across different types of interventions, such as interactive group education, audiovisual media, and community support [6]. Improved maternal KAP is likely to lead to better fetal growth and child health outcomes, given the vital role of maternal nutrition and health behaviors during pregnancy in shaping birth outcomes and early child development.

These findings align with previous research. Muhamad *et al*. reported that targeted nutrition education significantly enhances knowledge and health behaviors among pregnant women, especially those at higher risk, like short-statured mothers [22-24]. Similarly, Patty *et al*. discovered that video-based education improves knowledge retention, showing the effectiveness of multimedia methods [10].

Nugraha *et al*. also showed that combining health education with therapeutic group activities reduced risk factors linked to stunting, such as poor nutrition and negative maternal psychological conditions [21-24]. Moreover, peer group support has been found to boost maternal behaviors aimed at preventing stunting [23].

Additional evidence strengthens these results. Waryana *et al*. emphasized the strong link between maternal health literacy and nutritional practices, highlighting the need for educational strategies that account for context [25].

Likewise, Salan *et al*. showed that nutrition counseling from trained health workers improved dietary intake and lowered the risk of anemia among pregnant women [26]. A meta-analysis by Lassi *et al*. confirmed that maternal health education interventions improve maternal KAP and reduce low birth weight and neonatal complications [27].

The success of these interventions can be understood through behavior change theories, especially the Health Belief Model (HBM). Improvements in maternal KAP suggest that women are more aware of their susceptibility and the benefits of healthy practices, which are key ideas of the HBM. This finding is supported by Saaka *et al*., who reported that mothers' perceptions of their situation affect their

dietary behavior [28], and by Yadav *et al*., who emphasized the importance of self-efficacy in adherence to antenatal care [3].

Importantly, this review highlights the essential role of social support in making educational interventions more effective. Support from family, community health workers, and government programs, which includes emotional, informational, and practical help, enhances adherence to recommended health behaviors [25, 29]. This shows that stunting is not just a nutritional issue but also a social and behavioral one.

Despite these strengths, several limitations must be noted. Most of the studies included are quasi-experimental and conducted in Indonesia, which may limit the extent to which the findings can be applied elsewhere. Furthermore, many studies depend on self-reported outcomes, which might introduce bias [30]. The absence of standardized outcome measures and limited reporting on long-term child growth outcomes further restricts the ability to draw clear conclusions about reducing stunting [31].

Future research should focus on longitudinal and randomized controlled designs to evaluate lasting effects on child growth. Incorporating psychosocial support, involving male partners, and customizing interventions for specific cultural contexts may further improve program effectiveness [32-34].

LIMITATIONS

This review has several limitations. First, the majority of included studies were conducted in Indonesia. This may limit how widely the findings can apply to other places with different cultures and healthcare systems. While maternal health education is common worldwide, differences in how programs are designed, delivered, and adapted in various countries can affect their success.

Second, the relatively small number of included studies (n = 13) weakens the evidence and makes the conclusions less applicable to broader contexts. Furthermore, differences in study designs, intervention methods, and outcome measures make it hard to compare the findings directly or combine them effectively.

CONCLUSION

This review shows that maternal health education during pregnancy effectively improves knowledge, attitudes, and practices (KAP) among pregnant women. Interactive, multimedia, and community-based methods, especially those that include social support, are better at improving maternal behaviors related to nutrition and antenatal care. These improvements could help prevent stunting, but there is still limited evidence on long-term child growth outcomes. More high-quality, long-term studies are needed to build the evidence base. These findings highlight the need to include maternal health education in standard antenatal care services and in national strategies to reduce stunting, especially in low- and middle-income countries.

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AUTHORS' CONTRIBUTIONS

Delima and Neviyarni were responsible for developing the study and the research framework. Afdal and Firman helped with the study design, methodology, and data analysis. Yarmis Syukur and Yeni Karneli participated in the literature search, screening process, and data extraction. Tisnawati and Zolla Amely Ilda worked on drafting and revising the manuscript, focusing on important intellectual content. Asep Irfan provided overall supervision and contributed to interpreting the findings. All authors reviewed and approved the final version of the manuscript and agreed to take responsibility for all aspects of the work.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest related to this paper's publication. All research activities, analyses, and interpretations were done independently, without influence from funding bodies or external organizations.

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