Scoping Review

Nutritional Behavior Change in Pregnancy: Mapping Evidence through a Scoping Review

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Abstract
Introduction: Nutritional practices during pregnancy are crucial for maternal and fetal health, yet suboptimal dietary behaviors persist globally, particularly in low-resource settings. Behavior-change interventions (BCIs) have emerged as a promising strategy. This scoping review examines the evidence of BCIs aimed at enhancing nutritional practices during pregnancy and suggests recommendations for future interventions.
Methods: A systematic search using PRISMA-ScR guidelines was conducted across MEDLINE (PubMed), Scopus, and CINAHL to identify theory-based studies on behavior change interventions (BCIs) aimed at improving nutritional practices during pregnancy.
Results: Nine studies met the inclusion criteria. The interventions spanned diverse geographic regions and employed various theoretical frameworks such as the Theory of Planned Behavior, Social Cognitive Theory, and the Health Belief Model. Delivery methods included education, counseling, and mobile health (mHealth) tools. Improvements included increased dietary diversity (OR = 4.18, $P < 0.01$), higher micronutrient intake (iron, folate, calcium; $P < 0.001$), and enhanced nutritional knowledge (3 studies, $P < 0.001$). Positive shifts were observed in behavior change constructs such as self-efficacy ($P < 0.0001$) and intention ($P < 0.001$). Favorable maternal and neonatal health outcomes included increased birth length ($P = 0.043$) and maternal weight gain ($P < 0.05$).
Conclusion: The review highlights the effectiveness of education-based BCIs but identifies limitations such as small sample sizes and lack of process evaluations. Sustaining behavior change remains a challenge. Future research should focus on process evaluation, sustainability, and scalability of BCIs.
Keywords: Behavior, Education, Health behavior, Maternal nutrition, Pregnancy

Introduction

Maternal nutrition is a critical determinant of pregnancy outcomes, influencing both maternal health and fetal development. Adequate nutrition during pregnancy reduces the risks of low birth weight, preterm delivery, and maternal anemia, while supporting long-term health for mothers and children. Ramakrishnan et al[1] highlight these benefits in their review. In low- and middle-income countries (LMICs) like Malawi, micronutrient deficiencies and low birth weight remain prevalent, with 12% of infants born underweight, as shown by Ziyenda Katenga-Kaunda et al[2] Globally, especially in resource-limited settings, poor dietary behaviors are compounded by socioeconomic disparities, cultural norms, and limited food access. Black et al[3] and Ngwira & Stanley[4] report these persistent issues.

Behavior-change interventions (BCIs) offer a strategic approach to address these challenges by targeting psychological, social, and environmental determinants of behavior. Often grounded in behavioral theories such as the theory of planned behavior (TPB), as introduced by Ajzen[5] ,social cognitive theory (SCT), and the transtheoretical model (TTM), described by Heffernan[6]

,these interventions integrate components like nutrition education and counseling (NEC) to improve dietary practices. Kamudoni et al[7] demonstrated that context-specific NEC interventions in rural Malawi significantly improved birth length and abdominal circumference, highlighting the value of tailored approaches in food-insecure settings.

This review focuses on BCIs targeting pregnant women to improve nutrition. These interventions often draw from theoretical frameworks and leverage innovative methods, including mobile health (mHealth) tools and community-based strategies. The studies reviewed span various geographic and cultural settings, including LMICs such as India, as described by Patel et al[8] and Malawi, where Ziyenda Katenga-Kaunda et al[2] emphasize maternal nutrition vulnerabilities. Many interventions seek to address socio-economic and cultural barriers to adequate nutrition, as discussed by Ngwira & Stanley[4].

Despite promising evidence, gaps remain. Many pregnant women still face limited access to nutrient-rich foods, as noted by Kamudoni et al[7] and Ramakrishnan et al[1] There is also a lack of detailed documentation on

the mechanisms behind successful BCIs. While models like mHealth show potential, challenges persist around scalability and sustainability.

This scoping review was initiated to better understand the effectiveness of BCIs in LMICs. Key questions include: What theoretical frameworks underpin these interventions? How do modalities like community-based education and mHealth affect outcomes? What are the barriers to scale and sustainability? The findings aim to guide researchers, practitioners, and policymakers in designing scalable, contextually relevant maternal nutrition interventions.

Methods

To ensure transparency and rigor, the study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR). These guidelines offered a comprehensive and systematic framework for synthesizing evidence on behavior change interventions (BCIs) designed to enhance nutritional practices during pregnancy. The PRISMA flow diagram is summarized in Figure 1.

Inclusion/ Exclusion Criteria

The eligibility criteria for this review included studies that focused on BCIs targeting pregnant women, aimed at improving nutritional practices, and grounded in established theoretical frameworks. Eligible studies were conducted across diverse geographic and socio-economic settings and included randomized controlled trials (RCTs) and cluster RCTs. Articles were excluded if they were study protocols, non-educational interventions, quasi-experimental designs, longitudinal studies, qualitative studies, or cross-sectional studies, or if they lacked a specific focus on nutrition during pregnancy or measurable outcomes. Additionally, studies not grounded in behavioral theories or published in languages other than English were excluded.

Search Strategy

A comprehensive search strategy was developed in collaboration with a research librarian at Southwestern R-1 University to ensure relevance and breadth. Searches were conducted in MEDLINE (PubMed), Scopus, and CINAHL using Medical Subject Headings (MeSH) and Boolean operators. Key terms included "behavior change," "maternal nutrition," "education," "pregnancy," and "theory." Search strings included combinations such as "behavior AND maternal nutrition AND education AND theory," and (("Behavior") AND ("Maternal nutrition")) AND ("Education"). Advanced queries included terms like "maternal nutrition" AND "education" AND
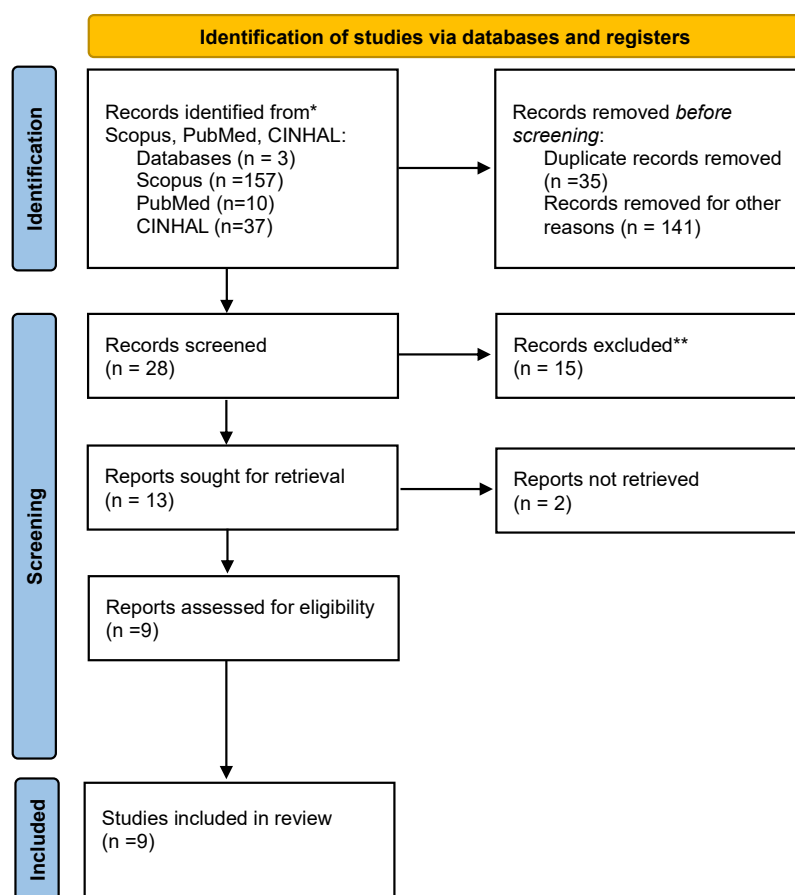

Figure 1. PRISMA Diagram

"theory" AND "behavior change" with filters: PUBYEAR > 2013 AND < 2025, DOCTYPE "ar", and LANGUAGE "English." The search was limited to studies from 2014 to 2024 to capture recent developments in BCIs. Additional expanders, including equivalent terms and proximity search modes, were used to ensure a comprehensive article pool.

Study Selection Process

The study selection process involved three stages. First, one independent reviewer screened the titles and abstracts of identified articles based on the predefined inclusion criteria. Next, articles passing the initial screening underwent a detailed full-text review to assess their eligibility. Finally, the reviewer comprehensively evaluated the selected studies to confirm their inclusion based on the eligibility criteria.

Scoping Review Management, Data Charting, and Analysis

Data from the selected studies were collected, charted, and analyzed systematically. Information was synthesized and organized in a Microsoft Excel spreadsheet to facilitate categorization and thematic analysis. Key data points included study title, author(s), year, study design, method, sample size, intervention and control arm sample sizes, study location, measured outcomes, limitations, behavioral theories used, and key results. Data entries were verified for accuracy and completeness to ensure reliability.

Key Insights from Data Synthesis

Findings were synthesized narratively and organized by theoretical frameworks, intervention modalities, geographic/socio-economic context, and nutritional outcomes. Theories such as TPB and SCT illuminated psychological and social influences on dietary behavior. Interventions included community-based programs, mHealth tools, and antenatal care (ANC) integration, each addressing cultural and logistical barriers.

Outcomes fell into four categories: dietary diversity, micronutrient intake, behavioral change, and health outcomes. Increased consumption of nutrient-rich foods and improved iron and folic acid intake were common. Behavioral gains included improved knowledge, attitudes, and self-efficacy; health outcomes included reduced low birth weight and better maternal weight gain.

Emerging themes highlighted the value of culturally tailored strategies, especially in LMICs. Socio-economic and logistical barriers hindered delivery, while long-term sustainability, scalability, and family engagement were insufficiently addressed. Psychological factors such as stress and emotional eating were underexplored. This synthesis underscores BCIs' potential to improve maternal nutrition and health outcomes globally.

Results

The initial database search yielded 61 records. After removing 35 duplicates, 28 unique articles remained for title and abstract screening. Using predefined inclusion and exclusion criteria, studies classified as "study protocols," "quasi-experimental," "mixed methods," "cross-sectional," "reviews," and "service evaluations" were excluded, as they did not meet the criteria focusing on behavior change interventions (BCIs) with measurable outcomes on maternal nutritional practices.

Of the 28 screened records, 9 met all inclusion criteria and underwent full-text review. These studies aligned with the review's scope, focusing on BCIs grounded in established theories (e.g., theory of planned behavior, social cognitive theory) and evaluating outcomes related to dietary behaviors among pregnant women. All 9 studies were included in the final review.

The PRISMA flow diagram in Figure 1 summarizes the search and selection process. This comprehensive approach ensured alignment with the review's objectives and inclusion of studies offering meaningful insights into the effectiveness of BCIs in improving maternal nutrition. The discussion section presents key themes, identified gaps, and barriers to implementation.

Characteristics of Included Studies

The nine included studies varied in geography, methodology, and intervention design. Most were conducted in LMICs, Ethiopia (n=4), Malawi (n=2), and India (n=1), with two in high-income countries: Ireland and the USA (n=1 each). Interventions ranged from community-based education to mHealth approaches. Study designs included randomized controlled trials (RCTs; n=3) and cluster RCTs (cRCTs; n=6), with durations spanning from under one year to four years.

Theoretical frameworks included SCT (n=2), SCT with control theory (n=1), TPB (n=1), TPB with HBM (n=3), HBM alone (n=1), and TPB with the social-ecological model (n=1). Intervention modalities comprised education and materials (n=5), home-based counseling (n=3), and tech-based self-monitoring (n=1). Most participants were enrolled before 16 weeks of gestation (n=7).

All studies targeted iron intake (n=9); six addressed folate, calcium, and protein-rich foods; and others included animal-sourced foods (n=7), diversified meals (n=5), and additional micronutrients. Outcomes included dietary practices (n=9), anthropometrics (n=7), nutritional knowledge (n=3), physical activity (n=3), health beliefs (n=2), and glycemic/energy intake (n=1).

All studies reported significant improvements in at least one outcome domain, including dietary diversity, micronutrient intake, self-efficacy, and maternal health indicators. These findings affirm the effectiveness of

theory-based BCIs across diverse populations.

Significant Findings

Nine studies were included in this review. Nine studies were included in this review. The key significant findings are presented in Table S1 (see Supplementary Data 1). Overall, the results highlight the positive impact of BCIs on maternal nutrition, including improved dietary diversity, micronutrient intake, and nutritional practices, while also noting challenges in sustaining behavior change. Table 1 summarizes the thematic analysis of these findings.

This scoping review offers a comprehensive analysis of BCIs aimed at improving maternal nutrition during pregnancy across diverse geographic and socio-economic contexts. It identifies key patterns, insights, and challenges, providing a nuanced understanding of their effectiveness. Table 2 categorizes the studies based on how interventions addressed psychological, social, and environmental factors.

Discussion

This review examined education-based behavior change interventions (BCIs) aimed at improving maternal nutrition during pregnancy. Grounded in theories such as the theory of planned behavior (TPB), as described by Ajzen[5], social cognitive theory (SCT), and the health belief model (HBM), these interventions addressed behavioral determinants like attitudes, self-efficacy, and perceived barriers. Beressa et al[15] and Heffernan[6] emphasized how these models shape nutritional behaviors during pregnancy.

Community-based programs, ANC integration, and multicomponent approaches effectively improved dietary diversity and micronutrient intake. Tailored strategies in LMICs were particularly impactful due to contextual adaptation and resource-sensitive implementation , as demonstrated by Demilew et al[12] and Ngwira & Stanley[4]. In high-income settings, mHealth tools offered personalized dietary support and real-time feedback, Ainscough et al[10] and Shrivastava & Shrivastava[16] reported promising outcomes, though their use remains limited in LMICs due to infrastructure, digital literacy, and access challenges, as noted by Patel et al[8] and Shannon et al.[17]

Socio-cultural barriers, such as food insecurity, taboos, and dietary restrictions continue to constrain nutrition outcomes. Black et al[3] and Ngwira & Stanley[4] have discussed these limitations in detail. Psychological barriers, including stress and emotional eating, are underexplored and should be integrated into future interventions. Beressa et al[15] and Chia et al[18] highlight the need for mental health considerations within nutritional programs.

Community engagement and culturally adapted education have proven effective in LMICs. Kamudoni

Table 1. Thematic Analysis of Key Findings from Studies in the Review

Thematic Areas	Key Insights
Theoretical Frameworks Employed	Theory of planned behavior, social cognitive theory, control theory, developmental origins of health and disease
Intervention Delivery Methods	Community-based programs, mHealth applications, antenatal care integration, multicomponent interventions
Geographic and Socio-economic Context	Low- and middle-income countries (e.g., Ethiopia, Malawi), high-income countries (e.g., Ireland), and socio-economic disparities
Outcomes Related to Nutritional Practices	Improved dietary diversity, increased micronutrient intake, enhanced knowledge and behavior change, improved health outcomes (e.g., reduced LBW)
Emerging Themes, Challenges, and Gaps	Tailored interventions, socio-economic constraints, gaps in long-term sustainability, and the scalability of studies

Table 2. Categorization of Studies based on Type of Change (n = 9)

Author	Psychological Factors	Social Factors	Environmental Factors
Diddana et al. (2018)[9]	HBM emphasized perceived benefits and self-efficacy.	Family and peer support motivated adherence.	mHealth bridged rural isolation and access barriers.
Ainscough et al. (2020)[10]	Used Social Cognitive Theory and Control Theory; enhanced motivation and readiness for change.	Midwife and dietitian-led support with motivational features in the app.	App-based resources and remote follow-up reduced the need for clinical contact.
Ziyenda Katenga-Kaunda et al. (2020)[2]	TPB emphasized attitudes, perceived behavior control, and norms.	Lay counsellors enhanced social pressure and self-initiative.	Food powders and demos addressed cost and food availability.
Demilew et al. (2020)[11]	HBM and TPB addressed perceived risk and enhanced self-efficacy.	Support from CHWs and family-maintained adherence.	Tailored advice considered local food availability.
Demilew et al. (2021)[12]	Self-monitoring raised awareness of dietary benefits.	Social norms were influenced by community support.	Cooking demos addressed affordability and availability.
Wilcox et al. (2022)[14]	SCT emphasized self-monitoring and goal setting.	Support from family, healthcare providers, and online groups.	Home-based guidance addressed the lack of facilities.
Arefi et al. (2022)[13]	SCT emphasized self-efficacy, outcome expectations, and knowledge.	Training sessions improved understanding and confidence.	COVID-19 limited social support and household help.
Beressa et al. (2023)[15]	Used HBM and TPB to alter beliefs and attitudes; focus on self-efficacy and perceived barriers.	Family and CHW support improved adherence.	A food-based approach using local foods addressed access issues.
Kamudoni et al. (2024)[7]	TPB targeted attitudes and perceived control.	Community involvement overcame cultural food taboos.	Emphasis on local, affordable food sources.

et al[7] and Ziyenda Katenga-Kaunda et al[2] demonstrated how localized approaches enhance dietary outcomes. Incorporating BCIs into routine ANC services ensures sustainability, as shown by Beressa et al[15] and Demilew et al[12] Multicomponent approaches, including education, counseling, and demonstrations, address broader behavioral needs , as described by Diddana et al.[9]

Traditional counseling remains effective. Demilew et al[12] and Diddana et al[9] reported significant improvements using these strategies. mHealth platforms like *Smarter Pregnancy* improve engagement and outcomes, as shown by Rhodes et al[19] and van Dijk et al[20] A combined approach leveraging both traditional and digital tools may enhance scalability, accessibility, and sustained impact.

Strengths of the review

This review has several strengths. A 10-year comprehensive search ensured inclusion of current studies across diverse global contexts. The use of established behavioral theories provided a structured lens to assess psychological, social, and environmental influences. Inclusion of both mHealth and community-based approaches demonstrated BCI adaptability. Emphasis on cultural relevance and methodological rigor enhances the review's applicability for researchers and policymakers.

Limitations of the review

This review has several limitations. The database search was restricted to selected sources, possibly excluding studies indexed elsewhere. Gray literature was not included, which may have omitted relevant non-peer-reviewed findings. The review focused on theory-based RCTs, potentially overlooking valuable non-RCT evidence. Additionally, publication bias may exist, as studies with positive outcomes are more likely to be published.

Limitations of the studies

The included studies had notable limitations. Many inadequately operationalized behavioral theories or failed to measure theoretical constructs. The absence of process evaluations limited understanding of behavior change mechanisms. Few studies incorporated fourth-generation behavior change theories, relying instead on models like TPB, SCT, and HBM. Beressa et al,[15] Kapukotuwa et al,[21] and Sharma[22] highlighted this reliance in their evaluations. Inadequate reporting of sample size or power calculations raised concerns about generalizability. Nutritional outcomes were also inconsistently measured or reported, limiting impact assessment.

Implications for Research, Practice, and Policy

This review highlights several priorities. Longitudinal studies are needed to assess sustained behavior change and long-term health outcomes. Research should explore BCI scalability and cost-effectiveness, especially in LMICs. Greater focus on male and family involvement, and psychological factors such as stress and emotional eating, is essential.

In practice, multicomponent, context-specific interventions should be prioritized. mHealth tools must be adapted for LMICs with attention to access and usability. Integrating BCIs into ANC services can support sustained delivery.

Policymakers should address structural barriers, invest in digital infrastructure, and promote inclusive programs that engage families in supporting maternal nutrition.

Emerging Themes, Challenges, and Research Gaps

This review identified key themes across diverse contexts. Tailored interventions using local resources, such as food powders in Malawi, proved effective. Yet, socio-economic barriers like food insecurity and limited access to nutrient-dense foods remain significant in LMICs. Psychological factors, including stress and emotional eating, are underexplored but critical to behavior change.

Long-term sustainability and the influence of family members, particularly male partners, are insufficiently studied. Addressing these factors could improve intervention reach and durability.

Most interventions used established theories like TPB, SCT, and HBM, as described by Ajzen[5], Beressa et al[15], and Heffernan[6], to target attitudes, self-efficacy, and perceived barriers. Community-based programs, ANC integration, and multicomponent strategies were effective in improving dietary diversity and micronutrient intake. Culturally tailored approaches had greater impact in LMICs, while mHealth tools showed success in high-income settings. Ainscough et al[10] and Demilew et al[11] demonstrated these outcomes.

However, fourth-generation behavior theories were absent, and process evaluations were rare. Many studies lacked power analysis or comprehensive reporting of nutritional outcomes , as noted by Kapukotuwa et al[21] and Sharma[22]

Despite challenges, the evidence supports community-based, culturally relevant strategies. Kamudoni et al[7] and Ziyenda Katenga-Kaunda et al[2] provided strong examples. mHealth remains underutilized in LMICs due to digital gaps , as shown by Patel et al[8] and Shannon et al[17] Future BCIs should integrate psychological dimensions and address socio-cultural barriers to improve maternal nutrition, as recommended by Chia et al.[18]

Conclusion

This scoping review demonstrates that education-based behavior change interventions (BCIs) can effectively improve maternal nutrition by enhancing dietary practices and increasing micronutrient intake. The studies, conducted across five countries, generally had

adequate sample sizes, though some lacked detailed sample size calculations. While some studies included process evaluations, these were not consistent, leaving a gap in understanding intervention implementation. The interventions showed improvements in dietary behavior, nutritional knowledge, and health outcomes like birth weight, but challenges in sustaining these changes highlight the need for long-term follow-up studies. Future research should address these gaps, focusing on process evaluations, sustainability, and scalability of BCIs.

Authors' Contribution

Conceptualization: Anam Fatima, Manoj Sharma.
Data curation: Anam Fatima, Manoj Sharma.
Formal analysis: Anam Fatima, Manoj Sharma.
Investigation: Anam Fatima, Manoj Sharma.
Methodology: Anam Fatima, Manoj Sharma.
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Writing–review & editing: Anam Fatima, Manoj Sharma.
Supervision: Manoj Sharma.

Competing Interests

The authors declare they have no conflicts of interest.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Supplementary Files

Supplementary file 1 contains Table S1.

References

1. Ramakrishnan U, Grant FK, Goldenberg T, Bui V, Imdad A, Bhutta ZA. Effect of multiple micronutrient supplementation on pregnancy and infant outcomes: a systematic review. Paediatr Perinat Epidemiol. 2012;26 Suppl 1:153-67. doi: 10.1111/j.1365-3016.2012.01276.x.
2. Ziyenda Katenga-Kaunda L, Iversen PO, Holmboe-Ottesen G, Fjeld H, Mdala I, Kamudoni PR. Dietary intake and processes of behaviour change in a nutrition education intervention for pregnant women in rural Malawi: a cluster-randomised controlled trial. Public Health Nutr. 2020;23(13):2345-54. doi: 10.1017/s1368980020000294.
3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382(9890):427-51. doi: 10.1016/s0140-6736(13)60937-x.
4. Ngwira A, Stanley CC. Determinants of low birth weight in Malawi: Bayesian geo-additive modelling. PLoS One. 2015;10(6):e0130057. doi: 10.1371/journal.pone.0130057.
5. Ajzen I. The theory of planned behavior. In: van Lange PA, Kruglanski AW, Higgins ET, eds. Handbook of Theories of Social Psychology. New York: Lawrence Erlbaum Associates; 2012. p. 438-59. doi: 10.4135/9781446249215.n22.
6. Heffernan CJ. Social foundations of thought and action: a social cognitive theory, Albert Bandura Englewood Cliffs, New Jersey: Prentice Hall, 1986, xiii+617 pp. Hardback. US$39.50. Behav Change. 1988;5(1):37-8. doi: 10.1017/s0813483900008238.
7. Kamudoni PR, Kaunda L, Tharrey M, Mphande M, Chithambo S, Ferguson E, et al. Context-tailored food-based nutrition education and counseling for pregnant women to improve birth outcomes: a cluster-randomized controlled trial in rural Malawi. Curr Dev Nutr. 2024;8(12):104506. doi: 10.1016/j.cdnut.2024.104506.
8. Patel AB, Kuhite PN, Alam A, Pusdekar Y, Puranik A, Khan SS, et al. M-SAKHI-Mobile health solutions to help community providers promote maternal and infant nutrition and health using a community-based cluster randomized controlled trial in rural India: a study protocol. Matern Child Nutr. 2019;15(4):e12850. doi: 10.1111/mcn.12850.
9. Diddana TZ, Kelkay GN, Dola AN, Sadore AA. Effect of nutrition education based on health belief model on nutritional knowledge and dietary practice of pregnant women in Dessie town, Northeast Ethiopia: a cluster randomized control trial. J Nutr Metab. 2018;2018:6731815. doi: 10.1155/2018/6731815.
10. Ainscough KM, O'Brien EC, Lindsay KL, Kennelly MA, O'Sullivan EJ, O'Brien OA, et al. Nutrition, behavior change and physical activity outcomes from the PEARS RCT-an mHealth-supported, lifestyle intervention among pregnant women with overweight and obesity. Front Endocrinol (Lausanne). 2019;10:938. doi: 10.3389/fendo.2019.00938.
11. Demilew YM, Alene GD, Belachew T. Effect of guided counseling on dietary practices of pregnant women in West Gojjam Zone, Ethiopia. PLoS One. 2020;15(5):e0233429. doi: 10.1371/journal.pone.0233429.
12. Demilew YM, Alene GD, Belachew T. Effect of guided counseling on nutritional status of pregnant women in West Gojjam Zone, Ethiopia: a cluster-randomized controlled trial. Nutr J. 2020;19(1):38. doi: 10.1186/s12937-020-00536-w.
13. Arefi Z, Sadeghi R, Shojaeizadeh D, Yaseri M, Shahbazi Sighaldeh S. The effect of educational intervention on nutritional behavior in pregnant women based on social cognitive theory. J Matern Fetal Neonatal Med. 2022;35(25):9724-9. doi: 10.1080/14767058.2022.2050901.
14. Wilcox S, Liu J, Turner-McGrievy GM, Boutté AK, Wingard E. Effects of a behavioral intervention on physical activity, diet, and health-related quality of life in pregnant women with elevated weight: results of the HIPP randomized controlled trial. Int J Behav Nutr Phys Act. 2022;19(1):145. doi: 10.1186/s12966-022-01387-w.
15. Beressa G, Whiting SJ, Belachew T. Effect of nutrition education integrating the health belief model and theory of planned behavior on dietary diversity of pregnant women in Southeast Ethiopia: a cluster randomized controlled trial. Nutr J. 2024;23(1):3. doi: 10.1186/s12937-023-00907-z.
16. Shrivastava SR, Shrivastava PS. Role of mobile-related health interventions in improving the delivery of maternal and child health services and their outcomes in low-and middle-income nations. BLDE Univ J Health Sci. 2019;4(1):46-7. doi: 10.4103/bjhs.bjhs_9_19.
17. Shannon C, Hurt C, Soremekun S, Edmond K, Newton S, Amenga-Etego S, et al. Implementing effective community-based surveillance in research studies of maternal, newborn and infant outcomes in low resource settings. Emerg Themes Epidemiol. 2022;19(1):1. doi: 10.1186/s12982-021-00109-0.
18. Chia AR, Chen LW, Lai JS, Wong CH, Neelakantan N, van Dam RM, et al. Maternal dietary patterns and birth outcomes: a systematic review and meta-analysis. Adv Nutr. 2019;10(4):685-95. doi: 10.1093/advances/nmy123.
19. Rhodes A, Smith AD, Chadwick P, Croker H, Llewellyn CH. Exclusively digital health interventions targeting diet, physical activity, and weight gain in pregnant women: systematic review and meta-analysis. JMIR Mhealth Uhealth. 2020;8(7):e18255. doi: 10.2196/18255.

20. van Dijk MR, Koster MP, Oostingh EC, Willemsen SP, Steegers EA, Steegers-Theunissen RP. A mobile app lifestyle intervention to improve healthy nutrition in women before and during early pregnancy: single-center randomized controlled trial. J Med Internet Res. 2020;22(5):e15773. doi: 10.2196/15773.

21. Kapukotuwa S, Nerida T, Batra K, Sharma M. Utilization of the multi-theory model (MTM) of health behavior change to explain health behaviors: a systematic review. Health Promot Perspect. 2024;14(2):121-35. doi: 10.34172/hpp.42887.

22. Sharma M. Theoretical Foundations of Health Education and Health Promotion. Jones & Bartlett Learning; 2021. p. 338.