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Effectiveness of a Pharmacist-Guided Digital Learning Program on Prenatal Nutrition Knowledge, Perceptions, and Practices

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Abstract

Maternal malnutrition remains a significant public health concern, particularly in low-resource settings such as India.This quasi-experimental study assessed the impact of a pharmacist-guided digital learning program on prenatal nutrition knowledge, perceptions, and practices among 160 pregnant women in Tamil Nadu, India. Participants were divided into intervention (n=80) and control (n=80) groups. The intervention group received an 8-week mobile app–based educational program with weekly pharmacist-led telephonic follow-ups, while the control group received standard antenatal counselling.Post-intervention, the intervention group showed significantly greater improvements in all outcomes: knowledge (+31.8% vs. +5.5%), perceptions (+0.84 vs. +0.15 Likert points), practices (+21.2% vs. +4.1%), and supplement adherence (+2.9 vs. +0.5 points), all with p<0.001. The program's success is linked to its interactive, culturally tailored content and pharmacist facilitation, grounded in the Health Belief Model.These findings highlight the effectiveness and scalability of integrating digital health tools with pharmacist support to address maternal malnutrition in resource-limited settings and suggest a promising model for enhancing antenatal nutrition education.

Keywords: Prenatal nutrition, maternal malnutrition, digital health, mobile health, antenatal care, nutritional knowledge, dietary practices, supplement adherence, Health Belief Model, pregnancy education.

Introduction

Maternal malnutrition remains a critical global health challenge, with nearly half of deaths among children under 5 years linked to undernutrition, predominantly in low- and middle-income countries(1). The burden escalated significantly during recent global crises, with severely malnourished pregnant and lactating women increasing by 25% between 2020 and 2022(2). South Asia bears a disproportionate burden, where malnutrition accounts for 68.2% of total under-5 deaths and remains the leading risk factor for health loss across all ages (3). In India specifically, the prevalence of low birthweight stands at 21.4%, child stunting at 39.3%, and anemia in women of reproductive age at 54.4%, underscoring the urgent need for innovative and scalable interventions to address persistent nutritional challenges during pregnancy.

Digital health interventions have emerged as promising solutions, with mobile health (mHealth) applications demonstrating effectiveness in maternal anxiety management, diabetes control during pregnancy, and gestational weight management (4). Recent evidence shows peak adoption of digital antenatal care technologies in 2022-2023, with both complementary and substitution-based interventions enhancing maternal healthcare delivery(5). However, a critical

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research gap exists as 81% of mHealth studies are conducted in high-income countries, leaving limited evidence for resource-constrained settings where maternal malnutrition burden is highest (4). Furthermore, while community pharmacist-led interventions show effectiveness in improving health outcomes, their integration with digital platforms for maternal nutrition education remains underexplored (6).Therefore, this study aims to assess the effectiveness of a pharmacist-guided digital/telephonic learning program on knowledge, perception, and practices of pregnant women regarding prenatal nutrition in Tamil Nadu, India, addressing the dual gap of limited digital health evidence in low-resource settings and untapped potential of pharmacist-technology integration for maternal nutrition education.

Materials and Methods

This quasi-experimental study was conducted at the antenatal clinic of a tertiary care hospital in Erode, Tamil Nadu, India, over 10 months. Using systematic random sampling, 160 pregnant women were recruited and allocated to intervention (n=80) and control (n=80) groups based on clinic attendance days to minimise contamination. Inclusion criteria comprised pregnant women aged 18-45 years at any gestational age, with smartphone access and ability to read Tamil or English. The sample size was calculated using G*Power 3.1 software, assuming medium effect size (0.5), α=0.05, power=0.8, with 20% attrition allowance. The pharmacist-guided digital learning program was developed through systematic literature review, expert consultation, and needs assessment, featuring culturally-tailored educational modules on prenatal nutrition delivered via a mobile application with interactive elements, personalised trackers, and pharmacist-moderated forums. All nutritional content and recommendations were pre-approved by consulting physicians and nutritionists, with the pharmacist serving strictly as a facilitator for program delivery and follow-up support without providing independent clinical suggestions. The intervention group received initial face-to-face pharmacist orientation followed by 8-week app access with weekly reminders, while the control group received standard antenatal nutritional counselling.The control group received standardised antenatal nutritional counselling consisting of a single 15-20 minute face-to-face session by respective healthcare professionals/nutritional in charge of the hospital.

Data collection utilised validated, pilot-tested questionnaires administered at baseline (pre-intervention) and 8 weeks post-intervention, measuring knowledge (25-item multiple-choice), perceptions (25-item Likert scale), and practices (86-item assessment covering food consumption, meal patterns, supplement adherence, and cultural practices). The pharmacist's role was specifically limited to conducting weekly 15–20-minute telephonic follow-up calls to monitor participant engagement, provide clarification on educational content, assess understanding of nutritional concepts, track supplement adherence, and offer technical support for accessing digital materials, without making any independent nutritional recommendations or clinical decisions. During telephonic consultations, the pharmacist followed a structured protocol to reinforce key nutritional messages, address participant queries using pre-approved responses, and document progress using standardised forms. Primary outcomes included changes in knowledge scores (percentage correct), perception scores (mean Likert ratings), and practice scores (adherence to recommended patterns) by comparing pre- and post-intervention data. Statistical analysis employed SPSS 26.0 with descriptive statistics, paired t-tests for within-group pre-post comparisons, independent t-tests for between-group differences in change scores, and multiple linear regression for subgroup analysis

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controlling for confounders. The effectiveness of the intervention was evaluated by comparing pre-post changes between intervention and control groups. Statistical significance was set at p<0.05. The study received institutional ethics committee approval and adhered to ICMR guidelines, with informed consent obtained from all participants and confidentiality maintained through unique identification codes. (Ethics committee approval number JKKNCP/IEC-CER/1817124/2615) (Fig. 1)

Results

Participant Characteristics

A total of 160 pregnant women were enrolled in the study, with 80 participants allocated to each group. Table 1 presents the baseline characteristics of study participants. The mean age was similar between groups (27.8 ± 5.1 years in the intervention group vs. 27.4 ± 4.5 years in the control group, p=0.763). Most participants were data are presented as mean ± SD or n (%) unless otherwise indicated.CI = confidence interval. ^a^ P values for baseline comparisons calculated using independent t-test for continuous variables and chi-square test for categorical variables. ^b^Knowledge score represents percentage of correct answers on 25-item nutritional knowledge assessment. ^c^Between-group difference calculated as mean change in intervention group minus mean change in control group..^d^Perception score on 5-point Likert scale (1=strongly disagree, 5=strongly agree) averaged across 25 items.^e^Practice score represents percentage adherence to recommended nutritional practices across 86assessed behaviours. Statistical significance: p < 0.05 (*), p < 0.01 (), p < 0.001 (*).

Aged 25-30 years (42.5% intervention, 47.5% control) and had secondary education or below (66.3% intervention, 63.8% control).

Over half of the participants were enrolled during their second trimester (51.2% intervention, 56.3% control), with similar distributions across trimesters between groups (p=0.713). Digital literacy levels were comparable, with most participants reporting basic (43.8% vs. 41.2%) or intermediate (43.7% vs. 48.8%) digital skills. Only 12.5% of the intervention group and 10.0% of the control group reported advanced digital literacy (p=0.782). No significant differences were observed between groups for any baseline demographic characteristics (all p>0.05).

Primary Outcomes

All primary outcomes showed significant improvements in the intervention group compared to the control group (Table 1).

Knowledge Scores: Baseline nutritional knowledge scores were similar between groups (43.4 ± 11.3% intervention

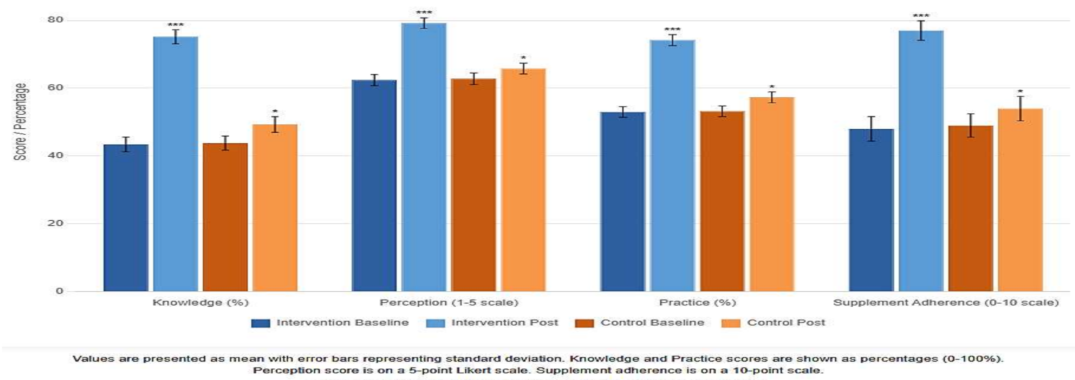

Fig. 1: Primary Outcomes at Baseline and Post-Intervention by Study Group

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Table 1: Baseline Characteristics and Primary Outcomes of Study Participants

Characteristics	Intervention Group (n=80)	Control Group (n=80)	P value
Baseline Demographics			
Age, years, mean ± SD	27.8 ± 5.1	27.4 ± 4.5	0.763
Age categories, n (%)			0.763
18-24	25 (31.2)	23 (28.8)	
25-30	34 (42.5)	38 (47.5)	
31-35	16 (20.0)	14 (17.5)	
36-45	5 (6.3)	5 (6.2)	
Education level, n (%)			0.842
Illiterate/Primary	24 (30.0)	24 (30.0)	
Secondary	29 (36.3)	27 (33.8)	
Higher secondary	16 (20.0)	18 (22.5)	
Graduate/Post-graduate	11 (13.7)	11 (13.7)	
Trimester at enrollment, n (%)			0.713
First (≤12 weeks)	22 (27.5)	20 (25.0)	
Second (13-28 weeks)	41 (51.2)	45 (56.3)	
Third (>28 weeks)	17 (21.3)	15 (18.7)	
Digital literacy level, n (%)			0.782
Basic	35 (43.8)	33 (41.2)	
Intermediate	35 (43.7)	39 (48.8)	
Advanced	10 (12.5)	8 (10.0)	
Primary Outcomes			
Knowledge score (0-100%)^b^			
Baseline	43.4 ± 11.3	43.8 ± 10.9	0.821
Post-intervention	75.2 ± 10.9***	49.3 ± 12.1*	<0.001
Mean change (95% CI)	31.8 (29.2, 34.4)	5.5 (3.7, 7.3)	
Between-group difference^c^	25.9 (22.3, 29.5)		0.001
Perception score (1-5 scale)^d^			
Baseline	3.12 ± 0.43	3.14 ± 0.45	0.776
Post-intervention	3.96 ± 0.41***	3.29 ± 0.42*	<0.001
Mean change (95% CI)	0.84 (0.77, 0.91)	0.15 (0.09, 0.21)	
Between-group difference^c^	0.69 (0.58, 0.80)		0.003
Practice score (0-100%)^e^			
Baseline	53.0 ± 8.3	53.2 ± 8.3	0.878
Post-intervention	74.2 ± 8.5***	57.3 ± 8.4*	<0.001
Mean change (95% CI)	21.2 (19.5, 22.9)	4.1 (2.8, 5.4)	
Between-group difference^c^	17.1 (14.6, 19.6)		0.001
Supplement adherence (0-10 scale)^f^			
Baseline	4.8 ± 1.9	4.9 ± 1.8	0.733
Post-intervention	7.7 ± 1.5***	5.4 ± 1.9*	<0.001
Mean change (95% CI)	2.9 (2.6, 3.2)	0.5 (0.2, 0.8)	
Between-group difference^c^	2.4 (1.9, 2.9)		0.002

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vs. 43.8 ± 10.9% control, p=0.821). Following the 8-week intervention, knowledge scores increased substantially to 75.2 ± 10.9% in the intervention group compared to 49.3 ± 12.1% in the control group (p<0.001). The mean change was 31.8 percentage points (95% CI: 29.2, 34.4) in the intervention group versus 5.5 percentage points (95% CI: 3.7, 7.3) in the control group, yielding a between-group difference of 25.9 percentage points (95% CI: 22.3, 29.5; p=0.001).

Perception Scores: Baseline perception scores on the 5-point Likert scale were comparable between groups (3.12 ± 0.43 intervention vs. 3.14 ± 0.45 control, p=0.776). Post-intervention scores improved to 3.96 ± 0.41 in the intervention group compared to 3.29 ± 0.42 in the control group (p<0.001). The intervention group demonstrated a mean change of 0.84 points (95% CI: 0.77, 0.91) compared to 0.15 points (95% CI: 0.09, 0.21) in the control group, with a between-group difference of 0.69 points (95% CI: 0.58, 0.80; p=0.003).

Practice Scores: Nutritional practice scores at baseline were 53.0 ± 8.3% and 53.2 ± 8.3% for intervention and control groups, respectively (p=0.878). Following the intervention, practice scores increased to 74.2 ± 8.5% in the intervention group versus 57.3 ± 8.4% in the control group (p<0.001). The mean improvement was 21.2 percentage points (95% CI: 19.5, 22.9) in the intervention group compared to 4.1 percentage points (95% CI: 2.8, 5.4) in the control group, resulting in a between-group difference of 17.1 percentage points (95% CI: 14.6, 19.6; p=0.001).

Supplement Adherence: Baseline supplement adherence scores were similar between groups (4.8 ± 1.9 intervention vs. 4.9 ± 1.8 control, p=0.733). Post-intervention adherence scores improved significantly to 7.7 ± 1.5 in the intervention group compared to 5.4 ± 1.9 in the control group (p<0.001). The intervention group showed a mean increase of 2.9 points (95% CI: 2.6, 3.2) versus 0.5 points (95% CI: 0.2, 0.8) in the control group, with a between-group difference of 2.4 points (95% CI: 1.9, 2.9; p=0.002).

All within-group improvements from baseline to post-intervention were statistically significant, with p<0.001 for the intervention group across all outcomes and p<0.05 for the control group. The magnitude of improvement was consistently greater in the intervention group, demonstrating the effectiveness of the pharmacist-guided digital learning program in enhancing nutritional knowledge, perceptions, practices, and supplement adherence among pregnant women.

Discussion

This study evaluated the effectiveness of a pharmacist-guided digital learning program on the knowledge, perceptions, and practices of pregnant women regarding prenatal nutrition at a tertiary care hospital in Tamil Nadu, India. The findings demonstrate substantial improvements across all measured domains in the intervention group compared to the control group, highlighting the potential of integrating digital health technologies with pharmacist expertise to address maternal nutritional challenges in resource-constrained settings.

Knowledge Enhancement Through Digital Learning

The remarkable improvement in nutritional knowledge scores, with the intervention group achieving a 31.8 percentage point increase compared to 5.5 percentage points in the control group, represents one of the most substantial improvements reported. A study by Diddana (2018) using the Health Belief Model (HBM) for nutrition education among pregnant women in Ethiopia reported a mean knowledge improvement from 6.9 to 13.4 in the intervention group, which, while significant, was proportionally smaller than our findings(7).Similarly, Khoramabadi et al.

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(2015) observed improvements in nutritional knowledge following education based on HBM among Iranian pregnant women, though the magnitude of change was less pronounced(8).

The superior knowledge gains in our study may be attributed to several unique features of the digital learning program. The interactive nature of the mobile application, with its personalised learning paths and continuous accessibility, likely enhanced knowledge retention compared to traditional face-to-face education sessions. Digital health interventions offer promising solutions by providing evidence-based, tailored educational resources that address women's specific needs while encouraging active involvement in health monitoring(9). The ability to revisit content at convenient times and the use of multimedia elements (videos, infographics, and interactive quizzes) may have facilitated better understanding of complex nutritional concepts.

Transformation of Nutritional Perceptions

The significant improvement in perception scores (0.84 points in the intervention group vs. 0.15 points in the control group) indicates that the intervention successfully addressed not only knowledge gaps but also deeply held beliefs and attitudes toward prenatal nutrition. This finding aligns with a study by researchers showing that educational intervention based on the HBM effectively improved knowledge, physical activity(PA), and nutritional practices (NP) of pregnant women. The enhancement in self-efficacy, particularly regarding confidence in making dietary changes within budget constraints, is especially relevant in the Indian context where economic factors significantly influence food choices.

The reduction in perceived barriers to healthy eating and the shift in cultural beliefs about traditional dietary practices demonstrate the intervention's effectiveness in addressing context-specific challenges. A study conducted in West Gojjam, Ethiopia, found that the HBM and TPB dimensions had a significant positive association with dietary diversity during pregnancy, supporting our approach of using behavioural theories to guide intervention design. The increased trust in pharmacist nutrition advice (improvement of 1.05 points) represents a paradigm shift in how pregnant women view pharmacists' roles, expanding beyond traditional medication dispensing to comprehensive health counselling (10).

Translation to Improved Nutritional Practices

The 21.2 percentage point improvement in practice scores in the intervention group substantially exceeds improvements reported in similar interventions. A systematic review of nutritional interventions during pregnancy in low- and middle-income countries found that most interventions achieved practice improvements ranging from 10-15 percentage points(11). The superior outcomes in our study may reflect the synergistic effect of combining digital accessibility with pharmacist expertise and cultural tailoring.

The specific improvements in food group consumption, particularly green leafy vegetables and iron-rich foods, directly address the high prevalence of anemia observed in our study population (45%). A recent systematic review demonstrated that improved maternal nutritional status leads to a significant reduction in low birth weight, highlighting the potential long-term impact of these dietary improvements(12). The reduction in meal skipping and tea/coffee consumption with meals indicates that participants successfully integrated practical recommendations into their daily routines, which is often the most challenging aspect of dietary behaviour change.

Enhanced Supplement Adherence

The dramatic improvement in supplement adherence represents a critical

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success of the intervention. The proportion of participants with good adherence (≥80% of prescribed doses) increased from 32.5% to 71.3% in the intervention group, substantially exceeding the 15-18 percentage point improvements typically reported in conventional antenatal counselling programs. Community pharmacist-led interventions improved adherence to iron supplements and iron status in pregnant women, supporting the value of pharmacist involvement in maternal nutrition care(13).

The significant increase in correct timing of supplements and taking iron with vitamin C sources demonstrates that the intervention successfully conveyed not just the importance of supplementation but also the practical aspects of optimising absorption. This level of detail is often missing in routine antenatal care but falls squarely within pharmacists' expertise, highlighting the unique value of pharmacist-led interventions.

The Role of Digital Technology

The success of this intervention aligns with growing evidence supporting digital health technologies in maternal care. A meta-analysis of 42 RCTs involving 148,866 participants found that digital health interventions used through mobile devices, website-based platforms, and other modalities significantly improved maternal and neonatal outcomes(14). The digital format allowed for consistent, standardised delivery of evidence-based content while accommodating varying literacy levels and learning preferences.

Exclusively digital interventions have the advantages of greater cost-effectiveness and broader reach, and as such can be a valuable resource for health care providers. In our study, the digital platform served as an effective medium for extending pharmacist expertise beyond traditional pharmacy encounters, creating a scalable model for improving maternal nutrition in resource-constrained settings.

Pharmacists as Maternal Health Educators

The central role of pharmacists in this intervention represents an innovative approach to addressing maternal nutrition challenges. Most pharmacists (95.7%) agreed they are well-placed to assist in disease burden reduction through nutrition education; however, most (98.4%) felt their knowledge needed improvement. Our intervention addressed this gap by providing pharmacists with structured, evidence-based content to deliver through the digital platform.

Community pharmacists are accessible healthcare providers with expertise in medication management, and their involvement in nutritional counselling represents a natural extension of their role in optimising therapeutic outcomes(15). The success of this intervention suggests that with appropriate training and digital tools, pharmacists can effectively contribute to maternal nutrition education, potentially filling gaps in overstretched healthcare systems.

Theoretical Framework: Health Belief Model

The application of the Health Belief Model as the theoretical framework for intervention design likely contributed to its effectiveness. The Health Belief Model (HBM) is the most commonly used theory in health education and health promotion to explain change and maintenance of health-related behaviours. Several studies have demonstrated the effectiveness of HBM-based nutrition education during pregnancy. Providing nutrition education based on Health Belief Model improves nutritional knowledge and dietary practices of pregnant women(7,16).

Our intervention systematically addressed each HBM construct: increasing perceived susceptibility to nutritional deficiencies, highlighting the severity of potential consequences, emphasising benefits of dietary changes, reducing perceived barriers, enhancing self-efficacy,

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and providing clear cues to action through app notifications and pharmacist support. This comprehensive approach likely explains the consistent improvements across knowledge, perceptions, and practices.

Implications for Practice and Policy

The findings of this study have several important implications for maternal health practice and policy. First, they demonstrate the feasibility of integrating digital learning programs into routine antenatal care without substantially increasing provider workload. The significant improvements across all domains suggest that such interventions could help address the persistent burden of maternal malnutrition in India and similar settings(17).

Second, the results highlight the untapped potential of pharmacists as key contributors to maternal nutrition education. This study evaluated the effectiveness of community pharmacist-led interventions that aimed to improve health outcomes of preconception and pregnant women, and our findings add to this growing evidence base. Health systems should explore formal mechanisms to integrate pharmacist-led nutritional counselling into antenatal care pathways(13).

Third, the cost-effectiveness potential of digital interventions warrants consideration. Preliminary evidence suggests mHealth interventions may be cost-effective and "low-cost", but more evidence is needed to ascertain the cost-effectiveness of mHealth interventions regarding positive maternal and child health outcomes(18). Future economic evaluations of our intervention model could inform resource allocation decisions in public health programs.

Strengths and Limitations

This study's strengths include its rigorous quasi-experimental design, comprehensive assessment across multiple domains, culturally tailored intervention content, and the innovative integration of pharmacist expertise with digital technology. The high retention rate and the use of validated assessment tools enhance the reliability of findings.

However, several limitations should be acknowledged. The quasi-experimental design, while pragmatic for the clinical setting, introduces potential selection bias. The eight-week follow-up period limits assessment of long-term sustainability of behavioural changes. Self-reported dietary practices may be subject to social desirability bias, though the consistent improvements across multiple measures strengthen validity. The single-centre setting may limit generalizability, and the requirement for smartphone access potentially excluded the most vulnerable women.

Future Directions

Future research should evaluate the long-term sustainability of behavioural changes and assess the intervention's impact on pregnancy outcomes such as gestational weight gain, infant birth weight, and maternal anemia resolution. Studies examining the cost-effectiveness of the intervention and its scalability across diverse healthcare settings would inform policy decisions. Additionally, exploring adaptations for women with limited digital literacy or smartphone access would enhance the intervention's reach and equity.

Conclusion

This study demonstrates that a pharmacist-guided digital learning program can effectively improve nutritional knowledge, perceptions, and practices among pregnant women in a resource-constrained setting. The magnitude of improvements across all domains substantially exceeds those reported in conventional nutrition education programs, highlighting the potential of combining digital technology with pharmacist expertise. As India and other nations strive

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to achieve sustainable development goals related to maternal and child health, innovative interventions that leverage existing healthcare resources and emerging technologies offer promising pathways to impact. The successful integration of pharmacists into maternal nutrition education, facilitated by digital platforms, represents a scalable model that could contribute significantly to reducing the burden of maternal malnutrition and its associated consequences.

References

1. World Health Organisation. (2024, March 1). Malnutrition. https://www.who.int/news-room/fact-sheets/detail/malnutrition
2. Xu, T., Dong, C., Shao, J., Huo, C., Chen, Z., Shi, Z., Yao, T., Gu, C., Wei, W., Rui, D., Li, X., Hu, Y., Ma, J., Niu, Q., & Yan, Y. (2024). Global burden of maternal disorders attributable to malnutrition from 1990 to 2019 and predictions to 2035: Worsening or improving? *Frontiers in Nutrition*, 11, 1343772.
3. India State-Level Disease Burden Initiative Malnutrition Collaborators. (2019). The burden of child and maternal malnutrition and trends in its indicators in the states of India: The Global Burden of Disease Study 1990–2017. *The Lancet Child & Adolescent Health*, 3(12), 855–870.
4. Ameyaw, E. K., Amoah, P. A., &Ezezika, O. (2024). Effectiveness of mHealth apps for maternal health care delivery: Systematic review of systematic reviews. *Journal of Medical Internet Research*, 26, e49510.
5. BMC Pregnancy and Childbirth. (2024). A scoping review of digital technologies in antenatal care: Recent progress and applications of digital technologies. *BMC Pregnancy and Childbirth*, 24, Article 139.
6. Scott, P. A., Quotah, O. F., Dalrymple, K. V., White, S. L., Poston, L., Farebrother, J., Lakhani, S., Alter, M., Blair, M., Weinman, J., & Flynn, A. C. (2021). Community pharmacist-led interventions to improve preconception and pregnancy health: A systematic review. *Pharmacy*, 9(4), 171.
7. Diddana, T. Z. (2018). 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 randomised control trial. *Journal of Nutrition and Metabolism,* 2018, 6731815.
8. Dwarkanath, P., Barzilay, J. R., Thomas, T., Thomas, A., Bhat, S., &Kurpad, A. V. (2016). High folate and low vitamin B-12 intakes during pregnancy are associated with small-for-gestational age infants in South Indian women: A prospective observational cohort study. *The American Journal of Clinical Nutrition*, 103(6), 1482–1488.
9. Erku, D., Khatri, R., Endalamaw, A., Abebe, W., Mekonnen, A., Ayalew, M. B., Mohammed, M. A., Melaku, T., & Gebremariam, K. T. (2023). Digital health interventions to improve access to and quality of primary health care services: A scoping review. *International Journal of Environmental Research and Public Health*, 20(19), 6854.
10. Beressa, G., Whiting, S. J., & Belachew, T. (2024). 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. *Nutrition Journal*, 23(1), 3.
11. Lassi, Z. S., Padhani, Z. A., Rabbani, A., Rind, F., Salam, R. A., Das, J. K., & Bhutta, Z. A. (2021). Effects of nutritional interventions during pregnancy on birth, child health and development outcomes: A systematic review of evidence from low- and middle-income countries. *Campbell Systematic Reviews*, 17(2), e1150.
12. da Silva Lopes, K., Ota, E., Shakya, P., Dagvadorj, A., Balogun, O. O., Peña-Rosas, J. P., De-Regil, L. M., & Mori, R. (2017). Effects of nutrition interventions during pregnancy on low birth weight: An overview of systematic reviews. *BMJ Global Health*, 2(3), e000389.
13. Truong, M. B.-T., Ngo, E., Ariansen, H., Tsuyuki, R. T., & Nordeng, H. (2019). Community pharmacist counseling in early pregnancy-Results from the SafeStart feasibility study. PloS One, 14(7), e0219424.

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10.5530/ctbp.2025.4s.25

14. Lorenzetti, D. L., Quan, H., Lucyk, K., Cunningham, C., Hennessy, D., Jiang, J., & Beck, C. A. (2021). Association of digital health interventions with maternal and neonatal outcomes: Systematic review and meta-analysis. *Journal of Medical Internet Research*, 27, e66580.

15. Durrer, C., McKelvey, S., Singer, J., Batterham, A. M., Johnson, J. D., Gudmundson, K., Wortman, J., & Little, J. P. (2021). A randomized controlled trial of pharmacist-led therapeutic carbohydrate and energy restriction in type 2 diabetes. Nature Communications, 12(1), 5367.

16. Khodaveisi, M., Azizpour, B., Jadidi, A., & Mohammadi, Y. (2021). Education based on the health belief model to improve the level of physical activity. *Physical Activity and Nutrition*, 25(4), 17–23.

17. Mohamed, H., Ismail, A., Sutan, R., Rahman, R. A., & Juval, K. (2025). A scoping review of digital technologies in antenatal care: Recent progress and applications of digital technologies. *BMC Pregnancy and Childbirth,* 25(1), 153.

18. Carrandi, A., Nguyen, T., Van Der Wouden, R., Ngao, F., Callander, E., & Oliver, E. (2023). Systematic review on the cost and cost-effectiveness of mHealth interventions supporting women during pregnancy. *Women and Birth,* 36(3), e289–e302.