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QR Code-Based Digital Education to Prevent Low Birth Weight Risk Factors in Pregnancy: A Systematic Review

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ABSTRACT

Introduction *Low birth weight (LBW) remains a challenge to maternal and neonatal health and is associated with modifiable maternal factors, including anemia, inadequate nutritional intake, chronic stress, and insufficient antenatal care. Digital education may strengthen maternal health literacy and promote preventive health behaviours, but its contribution to LBW prevention remains insufficiently established. Objective: This systematic literature review aimed to synthesize evidence on digital educational strategies for improving maternal health literacy, knowledge, and behaviours associated with the prevention of modifiable LBW risk factors among pregnant women, with attention to Quick Response (QR) Code-based education.*

Methods *A systematic literature review with narrative synthesis was conducted following PRISMA 2020. Searches were performed in Scopus, PubMed, and ScienceDirect. Of 52 identified records, 4 duplicates were removed and 48 records were screened. Following title and abstract screening, 34 full-text reports were assessed for eligibility, and all 34 met the eligibility criteria and were included in the synthesis. Study quality was assessed using the Joanna Briggs Institute Critical Appraisal Checklist. Findings were synthesized thematically by comparing patterns and differences across studies.*

Results *Digital educational strategies were associated with improved maternal health literacy, knowledge, antenatal care engagement, self-management, and health-related behaviours. These outcomes may contribute to reducing exposure to modifiable LBW risk factors. However, direct evidence linking QR Code-based education with reduced LBW incidence remains limited.*

Discussion *Digital education may support maternal health promotion as a complementary approach. QR Codes may provide accessible support for maternal health education, but their effectiveness in preventing LBW requires experimental evaluation.*

Keywords*: low birth weight, digital health education, health literacy, pregnant women, qr code*

INTRODUCTION

Low birth weight (LBW), defined as a birth weight of less than 2,500 grams, remains a major public health challenge worldwide and is recognized as an important indicator of maternal and neonatal health. According to the World Health Organization (WHO), LBW reflects the cumulative effects of maternal nutritional status, health conditions, socioeconomic circumstances, and the quality of healthcare received during pregnancy. Recent global estimates indicate that approximately 14.7% of newborns are born with low birth weight, demonstrating that LBW continues to be a significant burden despite ongoing international efforts to improve maternal and child health outcomes [1].

Low birth weight is associate d with substantial short-term and long-term health consequences. Newborns with LBW are at increased risk of neonatal morbidity and mortality, infections, impaired growth, developmental delays, and chronic health conditions later in life. In addition, LBW contributes significantly to healthcare costs and remains an important determinant of child survival and quality of life. Therefore, preventing LBW has become a priority within global maternal and child health programs [2].

The occurrence of LBW is influenced by multiple maternal risk factors, many of which are preventable. Previous studies have identified maternal anemia, inadequate nutritional intake, chronic stress, and insufficient utilization of antenatal care services as important contributors to LBW. These findings suggest that interventions targeting maternal knowledge and health behaviors during pregnancy may play a critical role in reducing the incidence of LBW and improving neonatal outcomes [3], [4].

Health education is one of the most effective approaches for supporting healthy pregnancy behaviors and promoting informed decision-making among pregnant women. Through appropriate educational interventions, mothers can improve their understanding of nutritional requirements, recognize pregnancy-related risks, and adopt preventive practices that support maternal and fetal health. However, conventional educational approaches are often limited by geographical barriers, time constraints, and unequal access to healthcare services, particularly in low-resource settings [5].

The rapid advancement of information and communication technology has accelerated the implementation of digital health interventions in maternal healthcare. Digital platforms such as mobile health (mHealth) applications, online educational programs, and digital communication tools have increasingly been used to provide health information and support

maternal care. These technologies offer flexible, accessible, and cost-effective alternatives to traditional educational approaches, enabling pregnant women to access health information anytime and anywhere [6], [7].

Evidence from recent studies indicates that digital educational interventions can improve maternal knowledge, strengthen health literacy, increase engagement with antenatal care services, and encourage healthier pregnancy-related behaviors. Furthermore, digital platforms facilitate repeated access to educational materials, which may enhance information retention and support sustainable behavioral change. Consequently, digital health interventions have emerged as promising strategies for addressing modifiable risk factors associated with low birth weight [8], [9].

Among the various forms of digital health innovation, Quick Response (QR) Code technology has attracted growing attention because of its simplicity, affordability, and ease of implementation. QR Codes enable rapid access to digital educational resources through smartphone devices and can be integrated with videos, websites, electronic booklets, and other learning materials. Previous studies have demonstrated that QR Code-based interventions improve information accessibility and support health education in different healthcare settings, indicating their potential application in maternal health promotion programs [10], [11].

Although digital health interventions have been widely studied in maternal healthcare, most previous studies have focused on improving maternal knowledge, service utilization, and general maternal health outcomes. Evidence specifically examining the contribution of digital educational strategies to the prevention of low birth weight risk factors remains limited. Moreover, the potential role of QR Code technology in supporting maternal health education has not been comprehensively synthesized, resulting in a gap in the existing literature [7], [12].

The novelty of this review lies in its integrated analysis of digital educational strategies, maternal health literacy, behavioral change, and the prevention of low birth weight risk factors among pregnant women. In addition, this review highlights the potential utilization of QR Code technology as an innovative educational medium that may strengthen maternal health promotion efforts in both clinical and community settings.

Therefore, this systematic literature review aims to analyze the effectiveness of digital educational strategies in improving maternal knowledge, health literacy, and health-related

behaviors associated with the prevention of low birth weight risk factors among pregnant women. Furthermore, this review seeks to identify the potential role of QR Code-based educational media as an innovative digital approach to support maternal health education and low birth weight prevention efforts.

METHODS

This systematic literature review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency, reproducibility, and methodological rigor. The review aimed to synthesize evidence regarding digital educational strategies for preventing low birth weight (LBW) risk factors among pregnant women and to explore the potential utilization of Quick Response (QR) Code technology as an innovative educational medium in maternal health services.

A comprehensive literature search was performed using three electronic databases, namely Scopus, PubMed, and ScienceDirect. These databases were selected because they provide extensive coverage of high-quality peer-reviewed international publications in maternal health, digital health, health promotion, and maternal education. The literature search was conducted between May and June 2026.

The search strategy was developed using a combination of Medical Subject Headings (MeSH) terms and free-text keywords relevant to the objectives of the review. Boolean operators (AND, OR) were applied to refine the search process and increase precision. The keywords included: (“pregnant women” OR pregnancy OR maternal health) AND (“digital health” OR mHealth OR mobile health OR digital education OR health literacy) AND (“low birth weight” OR LBW OR birth weight) AND (“QR code” OR “quick response code” OR digital media). Additional manual searches were conducted through the reference lists of selected articles to identify potentially eligible studies.

The inclusion criteria were: (1) articles published between 2018 and 2026; (2) peer-reviewed journal articles; (3) articles available in full text; (4) articles written in English; and (5) studies discussing low birth weight risk factors, maternal health education, digital health interventions, mobile health (mHealth), health literacy, behavioral change, or QR Code-based educational media among pregnant women. To strengthen the conceptual foundation of the review, a limited number of highly relevant studies published before 2021 were retained when they provided essential evidence regarding QR Code utilization in healthcare education or established risk factors associated with low birth weight. Supporting studies that did not

directly investigate low birth weight were retained when they provided relevant evidence regarding digital educational media, health literacy, mobile health interventions, or QR Code utilization that could inform maternal health education and behavioral change strategies.

The exclusion criteria included duplicate records, conference abstracts without full papers, editorials, commentaries, letters to editors, studies with incomplete information, inaccessible full-text articles, and publications that did not align with the objectives of this review. Studies focusing solely on clinical management of low birth weight infants without discussing preventive strategies during pregnancy were also excluded.

To ensure the methodological quality and reliability of the included studies, a quality appraisal was conducted using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist. The appraisal process was performed according to the design of each study to evaluate methodological rigor, risk of bias, data collection procedures, and validity of findings. Only studies that met acceptable quality standards were retained in the final review.

The article selection process was conducted in several stages following the PRISMA 2020 guidelines. Initially, 52 records were identified from the selected databases, including Scopus (n = 20), PubMed (n = 16), and ScienceDirect (n = 16). After removing 4 duplicate records, 48 articles remained for title and abstract screening. During this stage, 14 articles were excluded because they did not meet the inclusion criteria or were not relevant to the research objectives. Subsequently, 34 full-text articles were retrieved and assessed for eligibility. All 34 articles met the predefined inclusion criteria and were included in the final review. The study selection process is illustrated in Figure 1.

The included studies were analyzed using a narrative synthesis approach. The selected articles were categorized into four major themes: (1) risk factors of low birth weight among pregnant women, (2) digital health and mHealth interventions in maternal care, (3) health literacy and behavioral change through digital education, and (4) the potential utilization of Quick Response (QR) Code technology as an educational medium. Data extraction focused on study characteristics, research objectives, study design, participant characteristics, intervention types, and key findings.

The study selection process was conducted systematically and is illustrated in Figure 1, which follows the PRISMA 2020 flow diagram to ensure transparency and reproducibility.

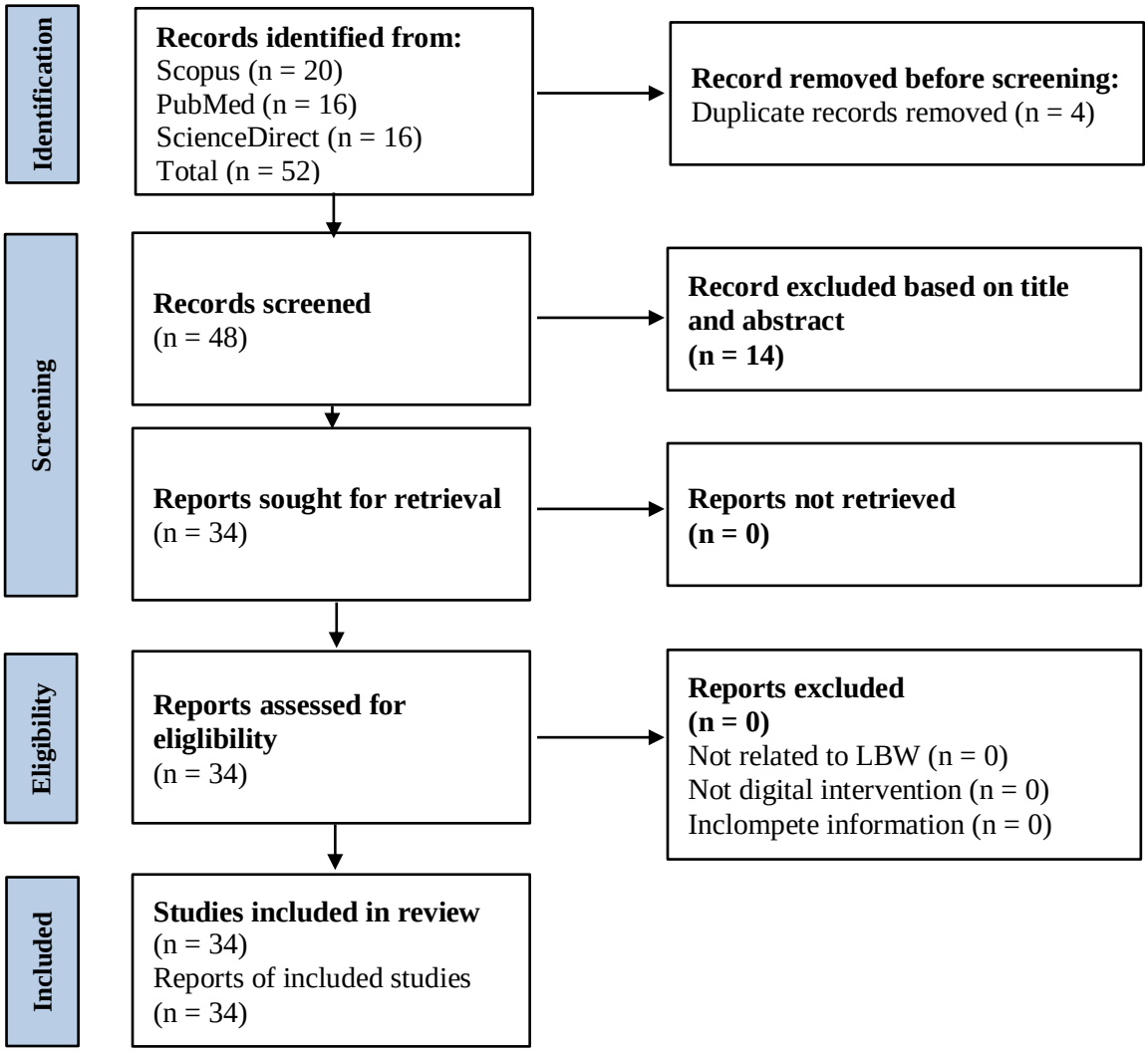


Figure 1. Study Identification and Inclusion Process Based on PRISMA 2020 Flow Diagram

RESULT

A total of 34 articles met the inclusion criteria and were included in this systematic literature review. The selected studies were published between 2018 and 2026 and represented a wide range of geographical settings, including high-income countries, low- and middle-income countries, and multinational contexts. The included studies employed diverse research designs, including systematic reviews, meta-analyses, randomized controlled trials, quasi-experimental studies, cross-sectional studies, observational studies, and guideline-based evidence syntheses. Most studies focused on digital health interventions, maternal health

education, low birth weight (LBW) risk factors, health literacy, behavioral change, and QR Code-based educational approaches.

Table 1. Summary of Articles Included in the Review

No	Title of Article	Country	Research Objective	Research Design	Number and Type of Participants	Main Findings
1	Digital Health Interventions for Pregnant Women and Mothers with Under 5-Year-Olds in LMICs	Multiple LMICs	To explore digital health interventions in maternal and child healthcare	Scoping Review	Studies involving pregnant women and mothers of children under five	Digital interventions improved health education, service accessibility, and maternal healthcare utilization.
2	Effectiveness of mHealth Apps for Maternal Health Care Delivery	Multiple Countries	To evaluate the effectiveness of mHealth applications in maternal healthcare	Systematic Review of Reviews	Review studies involving pregnant women	mHealth applications improved healthcare engagement and maternal service utilization.
3	The Maternal Factors Associated with Infant Low Birth Weight	Multiple Countries	To identify maternal determinants of LBW	Umbrella Review	Studies involving pregnant women	Maternal anemia, poor nutrition, and inadequate ANC were major risk factors.
4	QR Codes for Management of Systemic Diseases in Dental Clinics	Iran	To assess QR code utilization in healthcare	Review Study	Patients and healthcare users	QR codes facilitated rapid access to health information and educational resources.
5	Effectiveness of Motivational Interviewing and Messaging Applications Among Pregnant Women	India	To evaluate digital counseling interventions	Randomized Controlled Trial	Pregnant women	Digital counseling improved maternal knowledge and healthy behaviors.
6	Effectiveness of mHealth-Based Nutritional Interventions on Iron Status of Pregnant Women	Multiple Countries	To evaluate nutritional interventions using mHealth	Systematic Review	Pregnant women	mHealth interventions improved iron status and nutritional outcomes.

7	Safety Considerations for Assessing the Quality of Apps Used During Pregnancy	Multiple Countries	To evaluate quality and safety of pregnancy applications	Scoping Review	Pregnancy-related mobile applications	App quality influenced educational effectiveness and user trust.
8	Efficacy of the Flo App in Improving Health Literacy	United States	To evaluate app effectiveness in improving health literacy	Pilot Randomized Controlled Trial	Women of reproductive age	Application use improved health literacy outcomes.
9	Comparative Effect of Different Types of Physical Exercise on Low Birth Weight	Multiple Countries	To examine exercise effects on LBW-related outcomes	Systematic Review and Network Meta-analysis	Pregnant women	Appropriate physical activity reduced LBW-related risk factors.
10	WhatsApp-Based Education on Maternal Health	Multiple Countries	To assess WhatsApp-based maternal education	Systematic Review	Pregnant women	WhatsApp interventions improved knowledge and communication.
11	Digital Nutrition Education via WhatsApp and mHealth	Multiple Countries	To evaluate digital nutrition education	Systematic Review	Pregnant women	Digital nutrition education improved dietary practices and nutritional awareness.
12	Maternal Anemia and Low Birth Weight	Multiple Countries	To assess the relationship between maternal anemia and LBW	Systematic Review and Meta-analysis	Pregnant women	Maternal anemia significantly increased the risk of LBW.
13	Using QR Codes as a Form of eHealth to Promote Health Among Women	United States	To evaluate QR code utilization in women's health promotion	Cross-sectional Study	Adult women	QR codes improved access to digital health information.
14	Effects of mHealth Interventions on Institutional Delivery and Postnatal Care	LMICs	To evaluate maternal healthcare utilization outcomes	Meta-analysis	Pregnant women	mHealth interventions increased institutional delivery and postnatal care utilization.

15	Mobile Health Interventions for Maternal and Child Health Behaviors	Multiple Countries	To evaluate behavioral outcomes of mobile health interventions	Systematic Review	Mothers and children	Mobile health positively influenced maternal and child health behaviors.
16	Evaluating the Adoption of mHealth Technologies by Community Health Workers	Multiple Countries	To assess adoption of mHealth technologies	Systematic Review	Community health workers	mHealth adoption improved maternal healthcare support and service delivery.
17	Mobile App-Based Training on Health Literacy Among Pregnant Women	Iran	To evaluate digital health literacy interventions	Experimental Study	Pregnant women	Health literacy improved significantly following intervention.
18	Uses of Quick Response Codes in Healthcare Education	Multiple Countries	To review the application of QR codes in healthcare education	Scoping Review	Healthcare learners and patients	QR codes enhanced accessibility and effectiveness of educational resources.
19	Impact of mHealth Interventions on Maternal, Newborn, and Child Health Outcomes	Multiple Countries	To evaluate the impact of mHealth interventions on maternal and child health	Systematic Review	Mothers and children from included studies	mHealth interventions improved maternal and child health indicators.
20	Effective Communication Supported by an App During Pregnancy	Sweden	To evaluate app-supported communication in maternal care	Longitudinal Study	Pregnant women	Digital communication strengthened patient engagement and information exchange.
21	Digital Intervention During Pregnancy and Maternal Health Outcomes	Multiple Countries	To assess the effectiveness of digital interventions during pregnancy	Intervention Study	Pregnant women	Digital interventions supported healthier pregnancy management.
22	Chronic Stress in Pregnancy Is Associated with Low Birth Weight	Multiple Countries	To evaluate the relationship between maternal stress and LBW	Meta-analysis	Pregnant women from included studies	Chronic stress significantly increased the risk of low birth weight.

23	Leveraging Quick Response Codes in Patient Education	United States	To assess QR code-based patient education strategies	Retrospective Study	Healthcare users and patients	QR codes increased access to educational resources and patient engagement.
24	Adoption of Quick Response Codes as a Digital Microlearning Tool	India	To evaluate QR code-based microlearning approaches	Quasi-Experimental Study	Healthcare professionals and learners	QR codes supported flexible and efficient learning processes.
25	Digital Maternal Health Education Interventions	Multiple Countries	To synthesize evidence on digital maternal health education	Systematic Review	Pregnant women from included studies	Digital education improved maternal knowledge and health behaviors.
26	Potential Maternal Risk Factors for Low Birth Weight in Indonesia	Indonesia	To identify maternal determinants of LBW in Indonesia	Systematic Review	Studies involving pregnant women in Indonesia	Multiple maternal factors contributed to the occurrence of LBW.
27	WHO Recommendations for Care of the Preterm or Low-Birth-Weight Infant	Global	To provide evidence-based recommendations for LBW infant care	WHO Guideline	Guideline document	WHO recommends comprehensive interventions to improve outcomes among LBW infants.
28	Nutrition and Reproductive Health Education Among Pregnant Women	Indonesia	To evaluate reproductive health education interventions	Quasi-Experimental Study	Pregnant women	Educational interventions improved maternal knowledge and awareness.
29	Maternal and Infant Health App Development and Evaluation	Multiple Countries	To examine the development of maternal health applications	Development Study	Pregnant women and mothers	Mobile applications demonstrated strong educational potential.
30	Effects of mHealth on Psychosocial Health Among Pregnant and Postpartum	Multiple Countries	To evaluate psychosocial outcomes of mHealth interventions	Systematic Review	Pregnant and postpartum women	mHealth interventions improved psychosocial well-being.

	Women					
31	Maternal and Environmental Factors Associated with Low Birth Weight	Multiple Countries	To identify maternal and environmental determinants of LBW	Review Study	Studies involving pregnant women	Environmental and maternal factors contributed to LBW incidence.
32	Integrated Online Health Coaching During Pregnancy	Multiple Countries	To evaluate online health coaching interventions	Randomized Controlled Trial	Pregnant women	Online coaching improved healthy lifestyle behaviors and self-management.
33	Nutritional Guidance Through Digital Media Among Women with Gestational Diabetes	Multiple Countries	To evaluate digital nutritional guidance interventions	Randomized Controlled Trial	Women with gestational diabetes mellitus	Digital guidance improved nutritional management and health outcomes.
34	Low Birthweight Estimates	Global	To estimate the global prevalence and burden of low birth weight	Global Report	Population-level data	Low birth weight remains a significant global public health challenge.

Based on Table 1, the reviewed studies demonstrated increasing interest in the utilization of digital technologies to improve maternal health outcomes. The majority of studies reported positive effects of digital health interventions on maternal knowledge, health literacy, healthcare utilization, and behavioral outcomes. Several studies also identified key modifiable risk factors associated with low birth weight and highlighted the potential role of digital educational strategies in addressing these factors.

Table 2. Risk Factors of Low Birth Weight Identified in the Reviewed Studies

Risk Factor	Description	Supporting Studies
Maternal anemia	Maternal anemia was consistently associated with an increased risk of low birth weight due to impaired oxygen delivery and fetal growth restriction.	[3], [4]
Inadequate maternal nutrition	Poor nutritional status and insufficient dietary intake negatively affected fetal development and birth outcomes.	[3], [13]
Chronic stress during pregnancy	Maternal stress was associated with adverse pregnancy outcomes, including low birth weight.	[14]
Inadequate antenatal care utilization	Limited ANC attendance reduced opportunities for early risk detection and intervention.	[3], [13]

Environmental and socioeconomic factors	Environmental exposures and unfavorable socioeconomic conditions contributed to the occurrence of low birth weight.	[15], [1]
Physical inactivity and unhealthy lifestyle	Lifestyle-related factors influenced maternal health and fetal growth.	[16]

As shown in Table 2, maternal anemia, inadequate nutrition, chronic stress, and insufficient antenatal care utilization were the most frequently reported modifiable risk factors associated with low birth weight. Several studies also identified environmental and socioeconomic determinants that may adversely affect fetal growth and pregnancy outcomes. These findings indicate that preventive efforts should focus on improving maternal health status, nutritional practices, and access to quality antenatal care services during pregnancy.

Table 3. Digital Health and mHealth Interventions in Maternal Healthcare

Intervention Type	Description	Main Outcomes	Supporting Studies
Mobile health (mHealth) applications	Smartphone-based maternal health applications	Improved maternal knowledge and healthcare utilization	[7], [17]
Digital educational platforms	Web-based educational resources	Increased access to health information	[6], [5]
WhatsApp-based education	Health education delivered through messaging applications	Improved communication and maternal knowledge	[18], [19]
Online counseling and coaching	Remote counseling and health coaching services	Better health behaviors and self-management	[20], [21]
Telehealth and digital communication	Technology-assisted communication between providers and patients	Enhanced service accessibility and engagement	[22], [8]

Table 3 demonstrates that digital health interventions consistently improved maternal access to health information and facilitated communication between pregnant women and healthcare providers. Mobile health applications, digital educational platforms, and messaging-based interventions were the most frequently reported approaches. Across the reviewed studies, these interventions were associated with improvements in maternal knowledge, healthcare utilization, and engagement in healthy pregnancy-related behaviors.

Table 4. Effects of Digital Education on Health Literacy and Behavioral Change

Outcome Category	Description of Findings	Supporting Studies
Health literacy	Improved understanding of pregnancy-related information and health recommendations	[17], [23]
Maternal knowledge	Increased awareness of maternal and fetal health issues	[20], [24]
Nutritional behavior	Improved dietary practices and nutrition management during pregnancy	[19], [25]
Antenatal care adherence	Increased participation in recommended ANC services	[26], [27]
Self-management skills	Enhanced ability to manage pregnancy-related health needs	[28], [9]

As presented in Table 4, digital educational interventions contributed substantially to improvements in maternal health literacy and knowledge. Enhanced understanding of pregnancy-related information was frequently accompanied by positive behavioral changes, including healthier nutritional practices, greater adherence to antenatal care recommendations, and improved self-management during pregnancy. These outcomes suggest that digital education may support the prevention of modifiable risk factors associated with low birth weight.

Table 5. Potential Utilization of QR Code Technology in Maternal Health Education

QR Code Function	Educational Benefit	Supporting Studies
Access to digital educational materials	Rapid retrieval of maternal health information	[10], [11]
Integration with videos and multimedia	Enhanced learning experience and user engagement	[12], [29]
Access to websites and electronic resources	Continuous availability of educational content	[30], [10]
Microlearning approach	Flexible and self-paced learning opportunities	[29]
Patient education support	Increased utilization of educational resources	[11]

Table 5 indicates that QR Code technology provides a simple, accessible, and cost-effective mechanism for delivering digital health education. The reviewed studies reported that QR Codes facilitated rapid access to educational resources and enhanced user engagement with health information. Although evidence specifically related to maternal healthcare remains limited, the available findings suggest considerable potential for integrating QR Code-based educational media into maternal health promotion and low birth

weight prevention programs.

DISCUSSION

This systematic literature review synthesized evidence regarding digital educational strategies for preventing modifiable low birth weight (LBW) risk factors among pregnant women. The findings suggest that maternal anemia, inadequate nutrition, chronic stress, and insufficient antenatal care utilization remain the most frequently reported determinants of LBW. In addition, digital educational interventions were consistently associated with improvements in maternal health literacy, knowledge, and health-related behaviors. The review also identified QR Code technology as a promising educational medium that may strengthen maternal health promotion efforts through improved accessibility to health information. Previous studies also reported that mHealth-based nutritional interventions can improve maternal dietary practices and iron status during pregnancy, thereby supporting efforts to reduce modifiable risk factors associated with low birth weight [31].

The findings confirm that LBW remains a multifactorial condition influenced by biological, behavioral, and social determinants. Maternal anemia was among the most consistently reported risk factors across the reviewed studies. This finding is consistent with previous evidence demonstrating that reduced maternal hemoglobin levels may impair oxygen transport to the fetus, resulting in restricted fetal growth and increased risk of LBW [3], [4]. Similarly, inadequate maternal nutrition was frequently associated with poor fetal development and adverse birth outcomes. Maternal nutritional deficiencies may limit the availability of essential nutrients required for fetal growth and placental function, thereby increasing susceptibility to low birth weight [13]. These findings reinforce the importance of preventive interventions that focus on improving maternal nutritional status throughout pregnancy. Mobile health interventions have also demonstrated positive effects on maternal health behaviors and health service utilization among diverse populations, including underserved communities [32]. Furthermore, the successful implementation of digital health programs depends on the acceptance and adoption of technology by healthcare providers and community health workers [33].

Beyond biological determinants, this review identified chronic stress and inadequate antenatal care utilization as important contributors to LBW. Chronic maternal stress may affect pregnancy outcomes through neuroendocrine mechanisms, including increased cortisol

production and dysregulation of physiological processes involved in fetal development [14]. Furthermore, stress may indirectly influence pregnancy outcomes by reducing adherence to healthy dietary practices and healthcare recommendations. Inadequate utilization of antenatal care services may also increase LBW risk because opportunities for early identification and management of maternal complications become limited. Consistent with previous findings, women who regularly attend antenatal care services are more likely to receive nutritional counseling, risk assessment, and preventive interventions that support healthy pregnancy outcomes [3], [13].

An important contribution of this review is the identification of digital education as a potential strategy for addressing modifiable LBW risk factors. The reviewed studies demonstrated that mobile health applications, digital educational platforms, telehealth services, and messaging-based interventions improved access to maternal health information and facilitated communication between healthcare providers and pregnant women [6], [7]. Unlike conventional educational approaches that are generally limited to scheduled healthcare visits, digital interventions provide continuous access to information and allow pregnant women to obtain educational content whenever needed. This increased accessibility may contribute to better understanding of pregnancy-related health issues and facilitate timely decision-making. Previous studies have demonstrated the feasibility of QR Code technology as an efficient tool for accessing educational materials, collecting feedback, and increasing user participation in educational and health promotion programs [27].

The effectiveness of digital educational interventions can be interpreted through the Health Literacy Framework. According to this framework, improved access to health information enhances an individual's ability to obtain, understand, evaluate, and apply health-related knowledge in everyday life. The reviewed studies consistently reported that digital educational interventions improved maternal health literacy, which subsequently influenced health-related decision-making and pregnancy behaviors [17], [23]. In addition, ensuring the quality, safety, and usability of pregnancy-related mobile applications is essential to maximize user engagement and the effectiveness of digital health interventions [34]. As illustrated in Figure 2, digital educational strategies may contribute to LBW prevention through a sequential pathway involving improved access to information, enhanced health literacy, increased knowledge, and positive behavioral change.

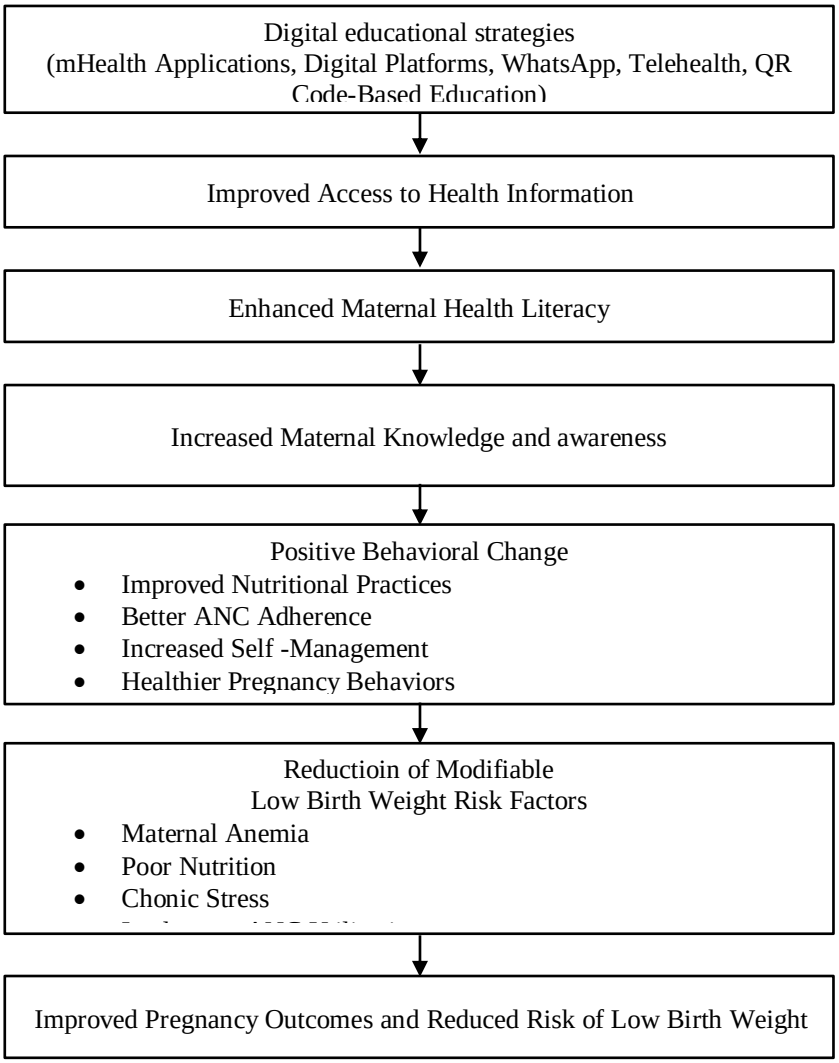


Figure 2. Conceptual Pathway of Digital Educational Strategies for Preventing Low Birth Weight Risk Factors

As illustrated in Figure 2, digital educational strategies may contribute to the prevention of low birth weight through a sequential pathway involving improved access to health information, enhanced maternal health literacy, increased knowledge, and positive behavioral change. These behavioral improvements may subsequently reduce modifiable risk factors such as maternal anemia, inadequate nutrition, chronic stress, and insufficient antenatal care utilization, thereby supporting improved pregnancy outcomes.

Another important finding of this review is that improvements in maternal knowledge were frequently accompanied by behavioral changes relevant to pregnancy outcomes. Several studies reported improvements in dietary practices, adherence to antenatal care recommendations, self-management skills, and engagement with maternal health services following digital educational interventions [26], [27]. These findings suggest that digital

education should not be viewed merely as a tool for information dissemination. Rather, it functions as a mechanism that facilitates behavioral change by increasing awareness, strengthening self-efficacy, and supporting informed decision-making. Consequently, improvements in maternal health literacy may serve as an indirect pathway for reducing modifiable LBW risk factors.

Although the overall findings support the effectiveness of digital educational interventions, variations in outcomes were observed across studies. Some interventions reported substantial improvements in maternal knowledge and behavior, whereas others demonstrated more modest effects. These discrepancies may be explained by differences in intervention design, duration, participant characteristics, digital literacy levels, and healthcare settings. Interventions incorporating interactive components such as counseling, coaching, and two-way communication generally produced stronger outcomes than interventions relying solely on passive information delivery. Similarly, technological accessibility and socioeconomic conditions may influence participants' ability to engage with digital health interventions. These findings highlight the importance of considering contextual factors when implementing digital education programs in maternal healthcare.

One of the most distinctive findings of this review concerns the potential role of QR Code technology in maternal health education. Compared with many digital health interventions, QR Codes offer several practical advantages, including low implementation costs, ease of use, and compatibility with widely available smartphone devices [10], [11]. QR Codes can be integrated into printed educational materials, maternal health handbooks, posters, brochures, and antenatal care records, thereby connecting conventional educational resources with digital content. This characteristic is particularly relevant in settings where internet access is available but the implementation of more complex digital platforms may be constrained by financial or technical limitations.

The educational value of QR Code technology may be explained by its ability to support continuous and self-directed learning. Unlike traditional printed materials that provide static information, QR Codes enable direct access to multimedia educational resources, including videos, electronic booklets, websites, and interactive learning materials [12], [29]. Such resources may increase user engagement and facilitate repeated exposure to educational content. Educational theory suggests that repeated exposure to information enhances retention and comprehension, thereby increasing the likelihood that individuals will

adopt recommended behaviors. Therefore, QR Code-based education has considerable potential to strengthen maternal health promotion and support preventive efforts targeting LBW risk factors.

From a practical perspective, the findings of this review have important implications for midwifery practice and maternal health policy. Midwives play a central role in providing health education during pregnancy and are strategically positioned to integrate digital educational strategies into routine antenatal care services. QR Code-based educational media may be incorporated into maternal classes, antenatal counseling sessions, community health programs, and maternal health handbooks to provide continuous access to reliable health information beyond healthcare visits. At the policy level, integrating digital educational approaches into maternal health programs may support national efforts to improve maternal health literacy and reduce preventable pregnancy-related risks.

This review also contributes to the existing literature by addressing a gap that has received limited attention in previous reviews. Most earlier studies focused primarily on the effectiveness of digital health interventions in improving maternal knowledge, healthcare utilization, or general maternal health outcomes. In contrast, this review synthesizes evidence linking digital education, maternal health literacy, behavioral change, and prevention of LBW risk factors within a single conceptual framework. Furthermore, the review highlights the potential role of QR Code technology, which remains relatively underexplored in maternal healthcare despite its practical advantages and broad accessibility.

Several limitations should be acknowledged. First, the included studies employed diverse research designs, intervention approaches, and outcome measures, resulting in considerable heterogeneity across findings. Second, only a limited number of studies specifically investigated QR Code utilization in maternal healthcare settings, restricting the availability of direct evidence regarding its effectiveness in preventing LBW. Third, most studies evaluated intermediate outcomes such as knowledge, literacy, and behavior rather than direct reductions in LBW incidence. Future research should therefore employ robust experimental designs to evaluate the effectiveness of QR Code-based educational interventions on both maternal behavioral outcomes and pregnancy outcomes.

Overall, the evidence suggests that digital educational strategies have substantial potential to improve maternal health literacy and promote positive behavioral changes during pregnancy. Through enhanced access to information and strengthened health literacy, digital

education may contribute indirectly to the reduction of modifiable LBW risk factors. Among the available digital approaches, QR Code technology represents a practical, accessible, and scalable innovation that warrants further investigation and implementation within maternal healthcare programs.

CONCLUSIONS

This systematic literature review highlights the potential of digital education to prevent modifiable low birth weight (LBW) risk factors by improving maternal health literacy, knowledge, and healthy behaviors related to nutrition, antenatal care, and pregnancy self-management. QR Code technology offers an accessible, practical, and cost-effective approach to delivering reliable maternal health information. Integrating QR Code-based education into antenatal services, maternal classes, community health programs, and maternal health handbooks may complement conventional counseling and support continuous learning. These findings also support incorporating digital education into maternal health promotion policies to reduce preventable LBW risk factors. By integrating evidence on LBW prevention, digital education, maternal health literacy, and QR Code technology, this review provides a conceptual foundation for future experimental studies evaluating maternal behavioral changes and neonatal outcomes.

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AUTHOR CONTRIBUTIONS

Author 1 contributed to the conceptualization of the study, literature search, study selection, data extraction, data analysis, manuscript drafting, and manuscript preparation. Author 2 contributed to the development of the methodology, study screening, data validation, and critical review of the manuscript. Author 3 contributed to data interpretation, manuscript editing, and supervision of the research process. Author 4 contributed to research supervision, methodological guidance, critical revision of the manuscript, and overall oversight of the study. All authors reviewed, approved, and agreed to the final version of the manuscript.

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