

Early Detection of High-Risk Pregnancy Through Antenatal Care Monitoring: A Systematic Review of Current Evidence and Future Perspectives

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Abstract

Background: Early detection of high-risk pregnancy is essential for reducing maternal and neonatal morbidity and mortality. Antenatal care (ANC) monitoring plays a critical role in identifying pregnancy-related risks, facilitating timely intervention, and improving maternal and neonatal health outcomes. However, evidence regarding its specific contribution to early risk detection remains fragmented.

Objective: This systematic review aimed to synthesize current global evidence on the role of ANC monitoring in the early detection of high-risk pregnancy, including the contribution of maternal education, social support, and digital health innovations to maternal health surveillance and improved maternal and neonatal health outcomes.

Methods: A systematic literature review was conducted following the PRISMA 2020 guidelines. Literature searches were performed in PubMed, Scopus, Web of Science, and ScienceDirect for studies published between 2020 and 2025. After screening and eligibility assessment, 20 studies were included and analyzed using a thematic narrative synthesis approach.

Results: Six major themes emerged: ANC monitoring practices, pregnancy risk detection, maternal education and women's empowerment, family and community support, barriers to ANC monitoring, and digital health innovations. Comprehensive ANC monitoring facilitated early identification of pregnancy complications, timely referral, and appropriate clinical management. Maternal education, women's participation in healthcare decision-making, and social support were associated with improved ANC utilization and risk recognition. Common barriers included limited healthcare access, financial constraints, and low health literacy. Digital health interventions, particularly mobile health (mHealth) technologies, showed promise in strengthening pregnancy monitoring and supporting early risk detection.

Conclusion: Effective ANC monitoring is fundamental to the early detection of high-risk pregnancy. Strengthening ANC quality standards, expanding maternal health education, promoting family and community support, improving access to services in underserved areas, and integrating digital health innovations may enhance risk detection and contribute to better maternal and neonatal outcomes.

Keywords: Antenatal Care Monitoring; High-Risk Pregnancy; Maternal Health Surveillance; Maternal Education; Women's Empowerment; mHealth.

1.0 Introduction

Maternal health remains a global public health priority despite considerable progress in reducing maternal mortality over the past decades. Nevertheless, preventable pregnancy-related complications continue to contribute substantially to maternal and neonatal morbidity and mortality, particularly in low- and middle-income countries (LMICs). According to the World Health Organization, most maternal deaths are preventable when pregnancy-related risks are identified early and managed appropriately through timely healthcare interventions (World Health Organization, 2025). Furthermore, a recent global analysis highlighted that persistent inequalities in access to quality maternal healthcare remain a major challenge to improving maternal outcomes worldwide (Souza *et al.*, 2024). High-risk pregnancy refers to a condition in which maternal, fetal, or obstetric factors increase the likelihood of adverse outcomes during pregnancy, childbirth, or the postpartum period. Early recognition of these risks is essential because delayed identification often leads to preventable complications, including severe maternal morbidity, preterm birth, stillbirth, and neonatal mortality. Consequently, strengthening strategies for early detection has become a key component of contemporary maternal healthcare systems.

Antenatal care (ANC) monitoring refers to the continuous assessment of maternal and fetal health throughout pregnancy through risk screening, clinical follow-up, and timely management of identified complications. Effective ANC monitoring is an essential component of maternal health surveillance because it facilitates the systematic collection, interpretation, and use of maternal health information to support clinical decision-making and improve pregnancy outcomes. According to the WHO Maternal and Perinatal Death Surveillance and Response framework, maternal surveillance involves ongoing monitoring to identify risks and prevent avoidable maternal morbidity and mortality (World Health Organization, 2021). Similarly, the WHO antenatal care monitoring framework emphasizes that ANC should extend beyond service attendance and focus on the quality, continuity, and effectiveness of risk assessment throughout pregnancy (Lattot *et al.*, 2020). Within this context, high-risk pregnancy detection refers to the identification of maternal, fetal, or obstetric conditions that increase the likelihood of adverse outcomes and require closer monitoring or specialized care. Unlike general ANC attendance, which primarily reflects service utilization, ANC monitoring focuses on the continuous evaluation of maternal and fetal well-being and the early recognition of emerging complications.

Antenatal care (ANC) is widely recognized as the primary platform for monitoring maternal and fetal well-being throughout pregnancy. In addition to providing routine clinical assessments, ANC facilitates risk screening, health education, counseling, and referral when complications are detected. Emerging evidence suggests that the quality of ANC monitoring plays a crucial role in identifying pregnancy-related risks. A multicountry study conducted across Ethiopia, India, Kenya, and South Africa demonstrated that comprehensive ANC services significantly improved the detection of maternal risk factors during pregnancy (Arsenault *et al.*, 2024). However, recent findings also indicate that conventional risk stratification approaches used during ANC may fail to identify a substantial proportion of adverse pregnancy outcomes, highlighting the need for more effective monitoring strategies (Cooper *et al.*, 2025). Beyond clinical assessment, successful antenatal care monitoring also depends on women's knowledge, awareness, and ability to

recognize danger signs and respond appropriately when complications arise. A systematic review conducted across developing countries reported considerable variation in pregnant women's awareness of obstetric danger signs, with inadequate knowledge remaining a major barrier to timely healthcare-seeking behavior (Yunitasari *et al.*, 2023). Limited awareness may reduce opportunities for early intervention and contribute to delays in accessing essential maternal healthcare services.

Women's empowerment has also emerged as an important determinant of antenatal care utilization and engagement in pregnancy monitoring. Empowerment enables women to participate actively in healthcare decision-making, access health information, and seek professional care when needed. Previous studies have consistently demonstrated that women with greater autonomy and decision-making capacity are more likely to attend ANC services and utilize maternal healthcare resources effectively (Winters *et al.*, 2023). Similarly, a recent multicountry analysis reported that women's empowerment significantly influences the uptake of maternal health services across LMICs, emphasizing its role in improving maternal healthcare engagement and outcomes (Mohammadi *et al.*, 2023). In recent years, digital health technologies have created new opportunities to strengthen antenatal care monitoring. Mobile health (mHealth) interventions, digital decision-support systems, and remote monitoring platforms have shown promising effects in improving ANC attendance, enhancing maternal knowledge, and supporting early identification of pregnancy-related risks. A systematic review by Rahman *et al.* (2022) found that mHealth interventions significantly improved utilization of antenatal care and skilled delivery care. More recently, digital innovations have been recognized as effective tools for enhancing maternal and fetal outcomes by improving continuity of care and risk surveillance (Capasso *et al.*, 2025).

Despite these advancements, significant barriers continue to hinder the effectiveness of antenatal care monitoring. Challenges related to healthcare accessibility, service quality, socioeconomic inequalities, health literacy, and health system capacity remain prevalent in many resource-constrained settings. A recent scoping review identified persistent structural and contextual barriers that limit both the provision and utilization of maternal health services, ultimately affecting the timely detection of pregnancy complications (Sarikhani *et al.*, 2024). Although substantial research has examined antenatal care utilization, maternal health services, and pregnancy outcomes, evidence regarding the specific contribution of ANC monitoring to the early detection of high-risk pregnancy remains fragmented. Existing studies have investigated clinical risk assessment, maternal education and knowledge, women's empowerment, social support, and digital health interventions; however, these findings have rarely been synthesized within a comprehensive maternal surveillance framework. Furthermore, increasing attention has been directed toward the integration of digital technologies and person-centered approaches into pregnancy monitoring, particularly in low- and middle-income countries. Therefore, a systematic review is needed to consolidate current evidence, identify knowledge gaps, and explore future opportunities for strengthening maternal health surveillance. This systematic review aimed to synthesize current global evidence on the role of antenatal care monitoring in the early detection of high-risk pregnancy, including the contribution of maternal education, social support, and digital health innovations to maternal health surveillance and improved maternal and neonatal health outcomes.

2.0 Methods

A systematic literature review was conducted to synthesize current evidence regarding the role of antenatal care (ANC) monitoring in the early detection of high-risk pregnancy. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure methodological transparency and rigor. A comprehensive literature search was undertaken in four electronic databases: PubMed, Scopus, Web of Science, and ScienceDirect. The search was conducted between April and May 2026 and included studies published between 2020 and 2025. Search terms were developed using combinations of Medical Subject Headings (MeSH) and free-text keywords related to antenatal care monitoring, prenatal care, high-risk pregnancy, pregnancy risk detection, maternal health surveillance, maternal education, women's empowerment, social support, pregnancy complications, digital health, and mobile health (mHealth). Boolean operators (AND, OR) were used to refine the search strategy. An example of the search string was: ("antenatal care" OR "prenatal care") AND ("monitoring" OR "surveillance") AND ("high-risk pregnancy" OR "risk detection" OR "pregnancy complications"). Search terms were adapted to the indexing systems and search functionalities of each database to maximize the retrieval of relevant studies.

Studies were eligible for inclusion if they were peer-reviewed articles published in English between 2020 and 2025 and addressed topics related to ANC monitoring, pregnancy risk detection, maternal education, women's empowerment, social support, maternal health service utilization, digital health interventions, or factors influencing the effectiveness of antenatal care. Quantitative, qualitative, mixed-methods, systematic review, and meta-analysis studies were considered. Conference abstracts, editorials, commentaries, dissertations, duplicate records, and studies unrelated to antenatal monitoring or high-risk pregnancy detection were excluded. All retrieved records were imported into reference management software for duplicate removal and screening. Titles and abstracts were initially reviewed against the eligibility criteria, followed by full-text assessment of potentially relevant articles. The study selection process was documented using a PRISMA 2020 flow diagram.

Data were extracted using a standardized form that captured information on study characteristics, country and setting, study design, sample characteristics, ANC monitoring components, approaches to pregnancy risk detection, and key findings. The extracted data were independently reviewed and organized into predefined categories to facilitate thematic synthesis. Methodological quality was assessed according to study design using established critical appraisal tools. Quantitative studies were evaluated using the Joanna Briggs Institute (JBI) Critical Appraisal Checklists, qualitative studies were assessed using the JBI Checklist for Qualitative Research, and systematic reviews were appraised using the AMSTAR-2 tool. Studies were categorized as having high, moderate, or low methodological quality. Only studies meeting acceptable methodological quality standards were retained in the final synthesis.

Given the heterogeneity of study designs and outcomes, findings were synthesized narratively using a thematic approach. The included studies were grouped into six themes: (1) ANC monitoring practices, (2) pregnancy risk detection, (3) maternal education and women's empowerment, (4) family and community support, (5) barriers to ANC monitoring, and (6) digital health innovations and future perspectives. The synthesized findings were used to identify current evidence, research gaps, and implications for strengthening antenatal care monitoring and improving maternal and neonatal health outcomes.

3.0 Results

3.1 Study Selection

The literature search identified records from PubMed, Scopus, Web of Science, and ScienceDirect. After duplicate removal, titles and abstracts were screened according to the predefined eligibility criteria. Potentially relevant studies underwent full-text assessment for eligibility. Studies that did not address ANC monitoring, pregnancy risk detection, maternal surveillance, maternal education, women's empowerment, social support, or digital health interventions were excluded. Following the screening and eligibility assessment process, 20 studies met the inclusion criteria and were included in the final synthesis. The detailed study selection process is presented in the PRISMA 2020 flow diagram (Figure 1).

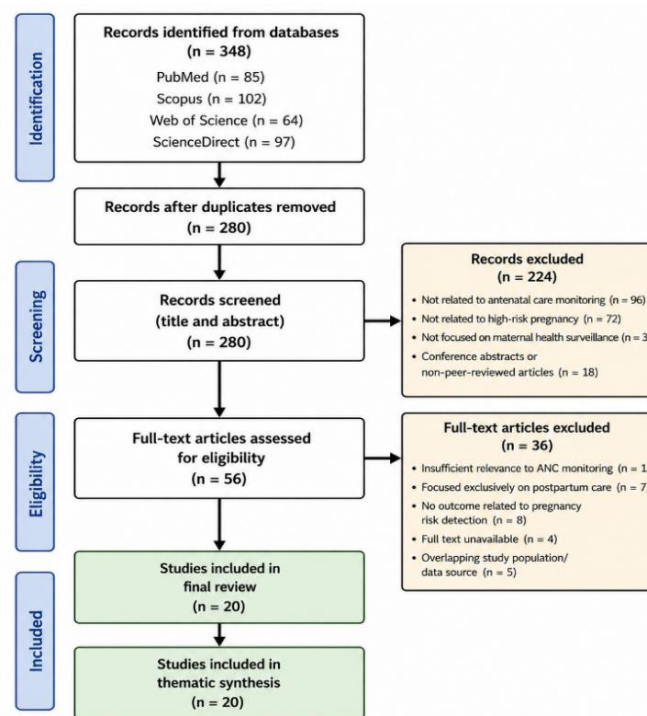


Figure 1. PRISMA 2020 Flow Diagram of the Study Selection Process

3.2 Characteristics of Included Studies

The included studies were published between 2020 and 2025 and represented diverse geographical settings, predominantly from low- and middle-income countries, including Ethiopia, Bangladesh, Rwanda, Ghana, Kenya, Tanzania, India, Indonesia, and several multicountry settings. The studies employed a variety of methodological approaches, including cross-sectional surveys, cohort studies, qualitative studies, systematic reviews, meta-analyses, and scoping reviews. Although the study contexts varied considerably, most focused on antenatal care quality, maternal health surveillance, pregnancy risk detection, maternal education, knowledge of danger signs, and women's engagement in maternal healthcare, barriers to service utilization, and the use of digital technologies to strengthen pregnancy monitoring. Overall, the reviewed studies highlighted the

important role of antenatal care monitoring in improving maternal health outcomes and facilitating the early identification of pregnancy-related risks. The characteristics of the included studies are summarized in Table 1.

Table 1
Characteristics of Included Studies

Author (Year)	Country	Design	Focus Area	Key Findings
Arsenault <i>et al.</i> (2024)	Multi-country	Observational	ANC quality	Improved risk detection
Massenga <i>et al.</i> (2023)	Tanzania	Cross-sectional	ANC components	Enhanced maternal monitoring
Cooper <i>et al.</i> (2025)	Kenya	Cohort	Risk stratification	Missed adverse outcomes
Abebe & Debelew (2025)	Ethiopia	Cross-sectional	ANC utilization	Supported pregnancy monitoring
Abdo <i>et al.</i> (2023)	Ethiopia	Cross-sectional	Early ANC	Improved risk identification
Yunitasari <i>et al.</i> (2023)	Multi-country	Systematic Review	Maternal education and danger signs	Improved awareness
Uwiringiyimana <i>et al.</i> (2022)	Rwanda	Cross-sectional	Maternal education and danger signs	Better care-seeking behavior
Fenta <i>et al.</i> (2024)	Ethiopia	Cross-sectional	Maternal education	Enhanced risk recognition
Mesele <i>et al.</i> (2023)	Ethiopia	Cross-sectional	Maternal education and danger signs	Knowledge gaps remained
Lahole <i>et al.</i> (2024)	India	Cross-sectional	Maternal education	Increased ANC attendance
Winters <i>et al.</i> (2023)	Bangladesh	Cross-sectional	Women's empowerment	Improved ANC utilization
Majumder <i>et al.</i> (2024)	Bangladesh	Cross-sectional	Women's empowerment and decision-making	Increased service use
Rizkianti <i>et al.</i> (2020)	Indonesia	Cross-sectional	Maternal health services	Better healthcare utilization
Gebeyehu <i>et al.</i> (2022)	Ethiopia	Cross-sectional	Maternal autonomy	Supported ANC attendance
Abanga <i>et al.</i> (2025)	Ghana	Cross-sectional	ANC quality	Improved pregnancy outcomes
Mohammadi <i>et al.</i> (2023)	Iran	Qualitative	High-risk pregnancy care	Facilitated risk identification
Ebrahim <i>et al.</i> (2024)	Multi-country	Review	ANC screening	Improved complication detection
Rahman <i>et al.</i> (2022)	LMICs	Systematic Review	mHealth	Increased ANC utilization

Author (Year)	Country	Design	Focus Area	Key Findings
Gupta <i>et al.</i> (2021)	India	Intervention	Digital monitoring	Supported risk detection
Capasso <i>et al.</i> (2025)	Global	Review	Digital health	Strengthened surveillance

3.3 Quality Assessment

Overall, the methodological quality of the included studies was considered acceptable. Most quantitative studies met the majority of the JBI critical appraisal criteria and were rated as moderate to high quality. The included systematic reviews demonstrated satisfactory methodological rigor based on the AMSTAR-2 assessment. No studies were excluded due to critical methodological limitations. Therefore, all 20 studies were retained for thematic synthesis. The detailed quality assessment results are presented in Table 2.

Table 2
Methodological Quality Assessment of Included Studies

Author (Year)	Study Design	Appraisal Tool	Quality Rating
Arsenault <i>et al.</i> (2024)	Observational	JBI	High
Massenga <i>et al.</i> (2023)	Cross-sectional	JBI	Moderate
Cooper <i>et al.</i> (2025)	Cohort	JBI	High
Abebe & Debelew (2025)	Cross-sectional	JBI	Moderate
Abdo <i>et al.</i> (2023)	Cross-sectional	JBI	Moderate
Yunitasari <i>et al.</i> (2023)	Systematic Review	AMSTAR-2	High
Uwiringiyimana <i>et al.</i> (2022)	Cross-sectional	JBI	Moderate
Fenta <i>et al.</i> (2024)	Cross-sectional	JBI	Moderate
Mesele <i>et al.</i> (2023)	Cross-sectional	JBI	Moderate
Lahole <i>et al.</i> (2024)	Cross-sectional	JBI	Moderate
Winters <i>et al.</i> (2023)	Cross-sectional	JBI	High
Majumder <i>et al.</i> (2024)	Cross-sectional	JBI	High
Rizkianti <i>et al.</i> (2020)	Cross-sectional	JBI	High
Gebeyehu <i>et al.</i> (2022)	Cross-sectional	JBI	Moderate
Abanga <i>et al.</i> (2025)	Cross-sectional	JBI	High
Mohammadi <i>et al.</i> (2023)	Qualitative	JBI-QARI	High
Ebrahim <i>et al.</i> (2024)	Review	AMSTAR-2	Moderate
Rahman <i>et al.</i> (2022)	Systematic Review	AMSTAR-2	High
Gupta <i>et al.</i> (2021)	Intervention Study	JBI	High
Capasso <i>et al.</i> (2025)	Review	AMSTAR-2	High

3.4 Thematic Findings

The thematic synthesis identified six interrelated themes highlighting the contribution of antenatal care (ANC) monitoring to the early detection of high-risk pregnancy. Overall, the evidence demonstrates that ANC monitoring is a critical component of maternal health surveillance, facilitating continuous assessment of maternal and fetal conditions, timely risk identification, and appropriate referral for further management (Abanga *et al.*, 2025; Arsenault *et al.*, 2024; Massenga *et al.*, 2023). Risk detection emerged as a central function of ANC monitoring. Routine assessments supported the identification of pregnancy-related complications, including hypertensive disorders, gestational diabetes, anemia, and fetal growth restriction. Nevertheless, several studies reported limitations in conventional risk assessment and risk stratification approaches, indicating that routine screening methods may fail to identify a substantial proportion of women who subsequently experience adverse pregnancy outcomes. These findings highlight the need for more comprehensive and context-sensitive monitoring systems, particularly in resource-constrained settings (Cooper *et al.*, 2025; Ebrahim *et al.*, 2024; Mohammadi *et al.*, 2023). Maternal education and women’s empowerment were consistently associated with improved healthcare-seeking behavior and engagement in ANC services. Women who possessed adequate knowledge of pregnancy danger signs and greater decision-making autonomy were more likely to attend ANC visits regularly and seek timely professional care when complications occurred (Fenta *et al.*, 2024; Uwiringiyimana *et al.*, 2022; Yunitasari *et al.*, 2023; Winters *et al.*, 2023). In addition, family involvement and community support strengthened participation in pregnancy monitoring and maternal healthcare utilization (Majumder *et al.*, 2024; Rizkianti *et al.*, 2020). Despite these benefits, several barriers continue to undermine the effectiveness of ANC monitoring, including limited access to healthcare, financial constraints, low health literacy, workforce shortages, and sociocultural influences. Such barriers were particularly evident among women living in rural and underserved communities, where delays in accessing care may compromise early risk detection (Abebe & Debelew, 2025; Sarikhani *et al.*, 2024). Finally, digital innovations have emerged as promising strategies for strengthening maternal health surveillance. Mobile health (mHealth) interventions, digital monitoring systems, and remote communication platforms were shown to improve ANC attendance, enhance maternal knowledge, and support earlier identification of pregnancy-related risks. These findings suggest that integrating digital technologies into maternal healthcare systems may enhance the effectiveness of ANC monitoring and contribute to improved detection of high-risk pregnancies in diverse settings (Rahman *et al.*, 2022; Gupta *et al.*, 2021; Capasso *et al.*, 2025). The main findings derived from the thematic synthesis are summarized in Table 3.

Table 3
Summary of Thematic Findings

Theme	Key Findings	Supporting Studies
ANC Monitoring Practices	Comprehensive and high-quality ANC monitoring improves maternal health surveillance, facilitates risk identification, and supports timely referral and management of pregnancy complications.	Arsenault <i>et al.</i> (2024); Massenga <i>et al.</i> (2023); Abanga <i>et al.</i> (2025)
Risk Detection During Pregnancy	Routine ANC assessments enable early detection of hypertensive disorders, gestational diabetes, anemia, fetal	Cooper <i>et al.</i> (2025); Mohammadi <i>et al.</i>

Theme	Key Findings	Supporting Studies
	growth restriction, and other obstetric complications. However, conventional screening approaches may not identify all women at risk.	(2023); Ebrahim <i>et al.</i> (2024)
Maternal Education and Women's Empowerment	Maternal education, knowledge of pregnancy danger signs, and women's autonomy were associated with improved healthcare-seeking behavior, ANC attendance, and timely recognition of pregnancy-related risks.	Yunitasari <i>et al.</i> (2023); Uwiringiyimana <i>et al.</i> (2022); Fenta <i>et al.</i> (2024)
Family and Community Support	Family involvement, women's autonomy, and community support contribute to greater participation in pregnancy monitoring and maternal healthcare utilization.	Winters <i>et al.</i> (2023); Majumder <i>et al.</i> (2024); Rizkianti <i>et al.</i> (2020)
Barriers to ANC Monitoring	Limited healthcare access, financial constraints, low health literacy, workforce shortages, and sociocultural factors hinder effective ANC monitoring, particularly in rural settings.	Sarikhani <i>et al.</i> (2024); Abebe & Debelew (2025)
Digital Innovations and Future Perspectives	mHealth interventions, digital monitoring platforms, and remote communication systems strengthen maternal surveillance, improve ANC attendance, and support early risk detection.	Rahman <i>et al.</i> (2022); Gupta <i>et al.</i> (2021); Capasso <i>et al.</i> (2025)

4.0 Discussion

This review synthesized recent evidence on the role of antenatal care (ANC) monitoring in the early detection of high-risk pregnancy and confirms that effective monitoring remains a key component of maternal health surveillance. Across a wide range of settings, ANC monitoring was associated with improved identification of pregnancy-related risks, earlier referral, and more timely clinical intervention, all of which contribute to better maternal and neonatal outcomes (Abanga *et al.*, 2025; Arsenault *et al.*, 2024; Massenga *et al.*, 2023). Taken together, these findings reinforce the growing recognition that the value of ANC lies not only in increasing service coverage but also in ensuring that care is timely, responsive, and capable of identifying complications before they progress to more serious conditions.

One of the most consistent observations across the included studies was the role of ANC monitoring as an ongoing process of maternal risk surveillance rather than a series of isolated clinical encounters. While routine ANC visits traditionally focus on clinical examinations and health promotion, the evidence suggests that their greatest contribution may be the early identification of evolving maternal and fetal risks. Early recognition of conditions such as hypertensive disorders, gestational diabetes, anemia, and fetal growth restriction allows timely management and may reduce progression to severe complications. (Cooper *et al.*, 2025; Mohammadi *et al.*, 2023). At the same time, the review revealed important limitations in conventional risk stratification approaches. In many settings, risk assessment relies heavily on predefined clinical indicators collected during routine visits, which may not adequately capture changes in maternal health status, behavioral factors, social circumstances, or emerging complications throughout pregnancy. As a result, some women initially classified as low risk may later develop serious maternal or fetal complications (Cooper *et al.*, 2025; Ebrahim *et al.*, 2024).

This finding highlights the need for more comprehensive monitoring frameworks that integrate clinical assessment with behavioral, social, and contextual determinants of maternal health.

Although most studies reported positive effects of ANC monitoring, the findings also suggest that attendance alone is not sufficient to ensure improved pregnancy outcomes. Several studies reported situations in which women attended ANC services regularly but still experienced delayed identification of complications because monitoring processes were incomplete or insufficiently responsive to emerging risks (Abanga *et al.*, 2025; Cooper *et al.*, 2025). This distinction between service utilization and service quality is particularly important. The effectiveness of ANC monitoring depends not only on the number of visits attended but also on the quality of risk assessment, continuity of care, and the efficiency of referral mechanisms. Therefore, efforts to improve maternal outcomes should prioritize strengthening both access to care and the quality of monitoring practices.

Maternal education and women's empowerment emerged as closely interconnected factors influencing the effectiveness of ANC monitoring. Women who possess adequate knowledge of pregnancy danger signs and have greater autonomy in healthcare decision-making are more likely to seek timely care, adhere to recommended ANC schedules, and respond appropriately when complications arise (Fenta *et al.*, 2024; Uwiringiyimana *et al.*, 2022; Winters *et al.*, 2023; Yunitasari *et al.*, 2023). Women who are informed and actively involved in healthcare decisions are better positioned to recognize potential complications, communicate concerns, and participate in monitoring their own pregnancies. Nevertheless, disparities in education, health literacy, and access to information remain evident across different populations, particularly among women living in disadvantaged settings (Lahole *et al.*, 2024; Mesele *et al.*, 2023). These findings underscore the importance of integrating health education and empowerment strategies into routine ANC services to strengthen maternal engagement in pregnancy monitoring.

Beyond individual-level factors, the findings also highlight the contribution of family and community support to effective pregnancy monitoring. Family support, women's autonomy, and participation in healthcare decision-making were consistently associated with greater engagement in ANC services and maternal healthcare utilization (Majumder *et al.*, 2024; Rizkianti *et al.*, 2020; Winters *et al.*, 2023). Similarly, maternal autonomy has been linked to improved utilization of maternal healthcare services across low- and middle-income countries (Gebeyehu *et al.*, 2022). These findings suggest that successful pregnancy monitoring extends beyond clinical care and requires supportive social environments that encourage timely healthcare-seeking behavior and continued engagement with ANC services. Despite the demonstrated benefits of ANC monitoring, persistent barriers continue to limit its effectiveness in many settings. Structural challenges such as inadequate healthcare infrastructure, workforce shortages, transportation difficulties, and financial constraints remain major obstacles to timely maternal healthcare access (Abebe & Debelew, 2025; Sarikhani *et al.*, 2024). Sociocultural influences and limited health literacy may further contribute to delays in seeking care and reduced adherence to ANC recommendations. These barriers are particularly pronounced in rural and underserved communities, where inequalities in healthcare access continue to affect maternal outcomes.

Differences were also observed between low- and middle-income countries (LMICs) and high-income settings. Studies conducted in LMICs primarily highlighted barriers related to healthcare accessibility, workforce limitations, transportation challenges, financial constraints, and low health literacy (Abebe & Debelew, 2025; Sarikhani *et al.*, 2024). In contrast, studies from high-income settings focused more on improving the accuracy of risk stratification, continuity of care,

and the integration of digital technologies into routine maternal healthcare (Capasso *et al.*, 2025; Ebrahim *et al.*, 2024). These differences suggest that strategies to strengthen ANC monitoring should be tailored to local contexts and health system capacities rather than relying on a single universal approach.

The growing use of digital technologies in maternal healthcare has created new opportunities to strengthen pregnancy monitoring and risk detection. Evidence from systematic reviews and intervention studies suggests that mobile health (mHealth) applications, telehealth services, and digital monitoring platforms can improve communication between healthcare providers and pregnant women, increase ANC attendance, and facilitate earlier identification of pregnancy-related risks (Capasso *et al.*, 2025; Gupta *et al.*, 2021; Rahman *et al.*, 2022). In addition to improving service utilization, digital innovations support continuous monitoring, remote follow-up, and more efficient management of maternal health information. However, their effectiveness depends on adequate technological infrastructure, digital literacy, and successful integration with existing healthcare systems. Therefore, digital health interventions should be viewed as complementary strategies that strengthen, rather than replace, routine ANC services.

Overall, the findings indicate that effective ANC monitoring requires a multidimensional approach that combines high-quality clinical care, comprehensive risk assessment, maternal education, women's empowerment, family and community support, and technological innovation. Although substantial progress has been made in maternal healthcare, important gaps remain in ensuring equitable access to comprehensive monitoring services, particularly among vulnerable populations. Future studies should move beyond evaluating individual interventions and examine integrated monitoring models that combine clinical assessment, maternal education, social support, and digital technologies within a single framework to improve the early detection of high-risk pregnancy and maternal health outcomes.

This review provides a comprehensive synthesis of recent evidence from diverse geographical settings and study designs, offering valuable insights into the role of ANC monitoring in the early detection of high-risk pregnancy. However, several limitations should be considered when interpreting the findings. The review included only English-language publications and studies published between 2020 and 2025, potentially excluding relevant evidence from other languages or earlier periods. Variations in study designs, populations, and outcome measures also limited direct comparison across studies and precluded quantitative synthesis. In addition, most included studies employed cross-sectional designs, limiting the ability to establish causal relationships. Many studies relied on self-reported measures of ANC attendance, maternal education, and healthcare utilization, which may be subject to recall bias and social desirability bias. Publication bias may also have influenced the available evidence, as studies reporting positive findings are generally more likely to be published than studies reporting null or negative results. Despite these limitations, the findings contribute to the growing evidence base on ANC monitoring and provide valuable directions for future research, policy development, and maternal healthcare practice.

Conclusion

This systematic review demonstrates that antenatal care (ANC) monitoring plays a critical role in the early detection of high-risk pregnancy by supporting timely risk identification, appropriate clinical management, and continuity of maternal healthcare. The findings indicate that effective ANC monitoring depends not only on the quality of clinical assessment but also on maternal education, women's empowerment, family and community support, and access to healthcare

services. Although significant challenges remain, particularly in resource-constrained settings, digital health innovations offer promising opportunities to strengthen maternal health surveillance and improve early risk detection. Strengthening ANC quality, expanding maternal education, promoting supportive social environments, and integrating digital technologies may contribute to improved maternal and neonatal health outcomes.

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