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The Role of Prenatal Screening in Early Detection of Pregnancy Problems According to Obstetrics and Gynecology Literature

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Abstract: This study aims to analyze the role of prenatal examination (antenatal care/ANC) in the early detection of pregnancy complications based on recent obstetric and gynecological literature. Using a qualitative descriptive approach through library research, data were collected from peer-reviewed journals, official reports, and relevant academic documents published between 2015 and 2025. The analysis involved thematic identification, data reduction, concept categorization, and inductive synthesis to obtain a comprehensive understanding of prenatal care practices. The findings reveal that structured and systematic prenatal examinations—encompassing community-based education, risk scoring tools such as the Poedji Rochjati Score Card (KSPR), laboratory screening, blood pressure monitoring, biomarker testing, ultrasound, and advanced molecular diagnostics (cfDNA and nanoflower biosensors)—significantly enhance early detection of maternal and fetal complications. Furthermore, family involvement, especially spousal participation and cadre empowerment, strengthens awareness and timely referral for high-risk pregnancies. These results underscore the integration of preventive, technological, and educational dimensions within modern prenatal care. The study concludes that prenatal examination functions as a multilayered system linking biomedical innovation with community engagement, thereby contributing to the reduction of maternal and neonatal morbidity and mortality. The findings provide valuable implications for clinical practice, health education, and policy formulation, while recommending further interdisciplinary research to expand the scope of preventive precision obstetrics.

Keywords: Prenatal Examination, Early Detection, Maternal Health, Antenatal Care, Pregnancy Complications

Introduction

Prenatal examination, also referred to as antenatal care (ANC), is a cornerstone of maternal and fetal health surveillance. It plays a pivotal role in identifying early signs of complications and potential risks during pregnancy to ensure timely intervention and improved pregnancy outcomes (Ada, 2021) (Diana et al, 2022). In the global context, maternal and neonatal mortality remain major public health challenges, particularly in developing countries. According to the World Health Organization, nearly 295,000 women died from pregnancy-related causes in 2017, with most deaths being preventable through effective prenatal monitoring and early detection. Therefore, comprehensive prenatal care remains essential in bridging the gap between maternal health needs and the timely provision of obstetric services.

Recent trends in obstetric research underscore a growing emphasis on evidence-based prenatal screening methods. Studies demonstrate that structured prenatal checkups contribute significantly to reducing maternal morbidity and neonatal complications through the identification of high-risk pregnancies (Windari & Lohy, 2019) (Silaban et al, 2024). Tools such as the Poedji Rochjati Score Card (KSPR) have proven effective in classifying maternal risk levels and enabling community health workers to detect and manage high-risk pregnancies more efficiently (Sirait et al, 2022) (Anita & Diana, 2025). This approach has been instrumental in empowering community-level detection and fostering early interventions.

Despite this progress, disparities in the accessibility and quality of prenatal care persist, particularly in rural and low-resource settings. Many pregnant women still lack routine access to standardized ANC visits, laboratory tests, and ultrasound services, which hinders early detection of complications such as anemia, hypertension, urinary tract infections, and preeclampsia (Abdullah & Duhita, 2023) (Ari et al, 2025). Such conditions, if undetected, can lead to preterm birth, low birth weight, or even maternal death. Thus, strengthening prenatal screening systems remains a public health priority.

The integration of laboratory testing into ANC packages has shown significant promise in early diagnosis of maternal complications. Simple tests such as hemoglobin and urine analyses can detect anemia and urinary tract infections, both of which have been correlated with adverse pregnancy outcomes (Septiyaningsih et al, 2020). These findings underline the importance of including low-cost diagnostic tools in community-based prenatal programs to improve the detection and management of preventable maternal conditions.

Moreover, ultrasound examinations have emerged as a vital diagnostic tool in prenatal care, enabling clinicians to identify fetal anomalies, placental disorders, and other structural abnormalities that may complicate pregnancy outcomes (Elnita et al, 2019). The capacity of ultrasound to inform clinical decision-making, particularly regarding delivery management and neonatal preparedness, highlights its indispensable role in modern obstetric practice.

Educational interventions have also been recognized as critical components of effective prenatal care. Programs such as the Self-Management Education for Pregnancy Risk (SMEERI) model have been proven to enhance maternal knowledge regarding warning signs and early detection of pregnancy complications (Nisma et al, 2024). By integrating health education within ANC visits, pregnant women are empowered to recognize potential danger signs and seek timely medical assistance (Nisma et al, 2023) (Astuti et al, 2020).

In addition to clinical and educational dimensions, prenatal examination contributes significantly to the development of preventive health behavior. Regular ANC attendance is strongly associated with increased awareness and proactive detection of danger signs, ultimately promoting maternal self-efficacy and adherence to recommended health practices (Diana et al, 2022) (Ada, 2021). Consequently, fostering consistent ANC utilization is essential to enhancing maternal and neonatal health outcomes.

Nonetheless, the persistence of preventable pregnancy-related complications signals gaps in the implementation of ANC protocols. Factors such as inadequate health literacy, limited access to diagnostic tools, and insufficiently trained health personnel remain critical barriers to effective prenatal screening (Insani et al, 2019). Addressing these constraints requires a multifaceted approach that integrates clinical, educational, and community-based strategies.

Recent studies have highlighted that involving trained community health cadres in prenatal screening significantly reduces delays in referral during obstetric emergencies (Sirait et al, 2022) (Anita et al, 2023). This finding reinforces the value of community-based health interventions as an extension of formal healthcare systems. Empowering local health workers with diagnostic and educational tools can bridge the gap between underserved populations and essential obstetric care.

The roll-out of the Roll Over Test for hypertension screening between 28 and 32 weeks of gestation exemplifies the importance of targeted screening measures within ANC (Ari et al, 2025). This test, with a reported sensitivity of 78% and specificity of 84%, allows for early diagnosis and management of hypertensive disorders, which remain leading causes of maternal mortality. Such evidence underscores the ongoing need for integrating evidence-based clinical tools into prenatal programs.

The role of recordkeeping and monitoring within prenatal care also warrants attention. Accurate and continuous documentation of screening results is vital for ensuring continuity of care and timely intervention (Rahmatiqa et al, 2025). Data-driven ANC practices can strengthen surveillance systems, allowing health professionals to identify trends, allocate resources effectively, and tailor interventions to specific community needs.

Despite the well-documented benefits of prenatal examinations, gaps persist in maternal awareness and the translation of knowledge into practice. Educational and outreach initiatives must be complemented by health system strengthening to ensure sustainable improvements in maternal and fetal outcomes. A coordinated strategy involving healthcare providers, policymakers, and community actors is required to enhance the accessibility and quality of ANC services (Anita & Diana, 2025).

The present article aims to explore the role of prenatal examinations in the early detection of pregnancy-related complications through a synthesis of recent obstetric and gynecological literature. By analyzing key studies on screening tools, laboratory diagnostics, ultrasound, and educational models, this paper seeks to identify best practices and highlight persisting challenges in prenatal care delivery.

The expected theoretical contribution of this article lies in providing an integrative understanding of prenatal screening mechanisms within the framework of maternal-fetal health. Practically, it offers evidence-based recommendations for improving ANC implementation, with a focus on early detection, community empowerment, and interprofessional collaboration. Strengthening these elements collectively contributes to the global agenda of reducing maternal and neonatal morbidity and mortality.

Methodology

This study employs a qualitative research design with a descriptive approach using library-based research (literature study) as the primary methodological framework. The qualitative-descriptive method was chosen to provide a comprehensive understanding of the role of prenatal examination in early detection of pregnancy complications based on obstetric and gynecological literature. The focus of this study lies in analyzing and synthesizing academic sources to interpret patterns, relationships, and meanings related to prenatal care practices (Bingham, 2023) (Pratt, 2025). The descriptive approach allows the researcher to systematically portray the current state of knowledge and identify gaps that require further empirical investigation (Doyle et al, 2019) (Abraham & P, 2024).

The data sources in this study consist of secondary materials drawn from books, peer-reviewed scientific articles, and official reports relevant to prenatal examination and maternal health. These sources were carefully selected based on their credibility, publication recency (2015–2025), and relevance to the themes of obstetrics, gynecology, and health education. The key references include studies that discuss prenatal screening methods such as the Poedji Rochjati Score Card (Sirait et al, 2022) (Anita et al, 2023), hypertension detection through Roll Over Test (Ari et al, 2025), and the educational model SMEERI (Nisma et al, 2024). The inclusion of both empirical and conceptual works enhances the robustness of the data and ensures theoretical depth in interpreting the findings (Togia & Malliari, 2017) (Bandaranayake, 2024).

The data collection technique was conducted through systematic literature tracing across scholarly databases and institutional repositories. The process included identifying, screening, and reviewing relevant publications according to predefined inclusion and exclusion criteria. The inclusion criteria were (a) peer-reviewed journal articles published between 2015 and 2025, (b) studies discussing prenatal examination, maternal risk detection, or obstetric screening, and (c) publications in English or Indonesian with valid DOI. Excluded were sources lacking methodological rigor or empirical grounding. The process of literature selection followed the principles of transparency and replicability to maintain scientific reliability (Granikov et al, 2020) (Jimenez et al, 2024).

The data analysis procedure followed a multi-stage qualitative framework encompassing identification of themes, data reduction, concept categorization, and inductive synthesis. Initially, key themes were identified from the reviewed literature, including risk screening, laboratory testing, ultrasound utilization, and maternal education. Subsequently, the data were condensed to highlight patterns of findings and conceptual relationships among studies. The categorization phase involved clustering findings into conceptual domains reflecting clinical, educational, and preventive dimensions of prenatal care. Finally, an inductive conclusion was drawn to capture holistic insights about how prenatal examination contributes to early complication detection (Belotto, 2018) (Kalpokaite & Radivojevic, 2018) (Vila-Henninger et al, 2022).

To ensure data validity and credibility, the study applied conceptual triangulation and peer debriefing. Triangulation was performed by cross-referencing findings from multiple independent studies to verify consistency and strengthen interpretation reliability.

Conceptual peer review was implemented by comparing the thematic outcomes with established theoretical frameworks in qualitative research (Bingham, 2023) (Fife & Gossner, 2024). Additionally, an audit trail documenting each analytic step was maintained to preserve transparency and enhance the trustworthiness of the conclusions.

Through this qualitative-descriptive, literature-based approach, the study seeks to generate a theoretically sound and practically relevant synthesis of prenatal examination practices. The methodological rigor—manifested through systematic literature review, transparent analysis, and critical interpretation—ensures that the findings are both valid and accountable. This design aligns closely with the article's objective: to elucidate the role of prenatal care in early pregnancy complication detection and its implications for obstetric health outcomes, policy formulation, and maternal education (Pratt, 2025) (Abraham & P, 2024).

Resultt and Discussion

The results of this literature study reveal that prenatal examination (antenatal care/ANC) serves as the principal system for the early detection of pregnancy-related complications, integrating clinical, community, and technological dimensions. Analysis across multiple obstetric and gynecologic studies demonstrates that regular ANC, comprehensive screening tools, and the incorporation of advanced diagnostics collectively contribute to significant reductions in maternal and neonatal morbidity and mortality (Windari & Lohy, 2019) (Anita & Diana, 2025). The findings are categorized into major thematic domains, which are systematically summarized below to present a holistic view of current practices and innovations in prenatal screening.

1. The Role of ANC in Reducing Morbidity and Mortality

Consistent prenatal visits—at least four throughout pregnancy—are proven to reduce delays in referral and treatment of high-risk pregnancies. Structured screening protocols, including the Maternal and Child Health Book (Buku KIA), P4K, and Poedji Rochjati Score Card (KSPR), facilitate the early identification of maternal risk factors and potential emergencies (Windari & Lohy, 2019) (Sirait et al, 2022). The deployment of trained community cadres further enhances early detection outside clinical settings, extending surveillance to underserved populations (Anita et al, 2023).

2. Clinical Assessment and Community-Based Screening

Community empowerment emerges as a critical strategy for improving early risk detection. Training for community cadres and expectant mothers in using the Poedji Rochjati scoring system has significantly improved knowledge, risk awareness, and referral timeliness (Anita & Diana, 2025) (Sirait et al, 2022) (Yanti & Milindasari, 2023). Likewise, Self-Management Education for Pregnancy Risk (SMEERI) models have increased pregnant women's ability to recognize danger signs and seek timely healthcare (Nisma et al, 2024). This community-based integration contributes to broader public health impact by decentralizing early detection efforts.

3. Laboratory Examinations and Infection Screening

Laboratory-based screening remains essential for identifying infections and metabolic disturbances that may complicate pregnancy. Routine urine analysis has detected a high prevalence of both symptomatic and asymptomatic urinary tract infections (UTIs), which are strongly associated with preterm birth and low birth weight (Abdullah & Duhita, 2023). The use of human chorionic gonadotropin (hCG) testing—via latex and strip methods—provides an early diagnostic gateway, ensuring that pregnant women enter ANC programs promptly (Dewanti & Anwar, 2022).

4. Blood Pressure Monitoring and Hypertension Screening

Hypertensive disorders of pregnancy continue to represent a major cause of maternal morbidity. The Roll Over Test (ROT), conducted between 28–32 weeks of gestation, demonstrates high diagnostic value (sensitivity 78%, specificity 84%) and is recommended for routine third-trimester screening (Ari et al, 2025). This simple, non-invasive technique enables early prediction of gestational hypertension and preeclampsia, promoting timely interventions such as antihypertensive therapy and close monitoring (Poon et al, 2018) (Mavreli et al, 2021).

5. First-Trimester Screening and Biomarker-Based Prediction

Recent advancements emphasize the first trimester as a "window of opportunity" for predicting and preventing major complications. Biomarkers such as PAPP-A and PlGF, combined with uterine artery Doppler indices (UtA-PI) and mean arterial pressure (MAP), have demonstrated strong predictive power for preeclampsia and fetal growth restriction (FGR) (Poon et al, 2018) (Mavreli et al, 2021). Studies also reveal correlations between early biomarker levels and gestational diabetes mellitus (GDM), suggesting that multi-marker algorithms can significantly enhance screening accuracy (Snyder et al, 2020)

6. Ultrasound, cfDNA, and Genetic Screening

Ultrasonography remains the gold standard for detecting structural and chromosomal abnormalities. Second-trimester obstetric ultrasound identifies congenital malformations and growth anomalies, guiding clinical management (Chebl et al, 2025). Meanwhile, cell-free DNA (cfDNA) and non-invasive prenatal screening (NIPS) have expanded the scope of prenatal diagnostics to include aneuploidy, mosaicism, and uniparental disomy (UPD) (Vora & Hui, 2018) (Xue et al, 2025). First-trimester ultrasound "soft markers" such as increased nuchal translucency and nasal bone hypoplasia are key indicators of chromosomal and structural abnormalities (Mangla & Kumar, 2025).

7. Screening for Cancer and Non-Communicable Diseases in Pregnancy

Contemporary literature highlights the integration of maternal cancer and chronic disease screening into prenatal care. Cytological and HPV testing during pregnancy are found to be safe and effective for early detection of cervical dysplasia and cancer, allowing for tailored management without compromising fetal safety (Piórecka et al, 2025). Furthermore, early detection of maternal non-communicable diseases—such as diabetes

mellitus and chronic hypertension—has become a core component of modern ANC guidelines (Poon et al, 2018).

8. Sociocultural and Familial Dimensions

Beyond clinical examination, the role of family, especially spousal involvement, significantly influences early detection outcomes. Studies in Indonesia reveal limited participation of husbands in ANC visits due to cultural barriers and lack of health education (Sinulingga et al, 2025). Programs aimed at engaging men in maternal health awareness have proven to reduce obstetric emergencies and delay in care-seeking. These findings underscore the need for inclusive, gender-responsive prenatal education.

9. Emerging Innovations: Nanotechnology and Precision Screening

The development of nanoflower biosensors marks a paradigm shift in early pregnancy diagnostics. These nanoscale devices can detect extremely low concentrations of biomarkers such as PlGF, cfDNA, and microRNA, offering unprecedented sensitivity for first-trimester complication screening (Andonotopo et al, 2025). Although still experimental, such technologies hold promise for point-of-care integration and precision obstetric care (Mavreli et al, 2021).

10. Thematic Synthesis: A Multilayered Prenatal System

Overall, current obstetric literature conceptualizes prenatal examination as a three-tiered system encompassing:

Table 1. Prenatal Screening Components, Pregnancy Problems That Can Be Detected Early

Level	Focus of Examination	Detected Complications	Key References
Community Level	Family and cadre education, SMEERI model	Early detection of social and behavioral risk factors	Sinulingga et al. (2025)) (Nisma et al. (2024)) (Anita & Diana (2025)
Clinical Level	Anamnesis, KSPR, ROT, and urine screening	Hypertension, UTI, anemia, obstetric complications	Abdullah & Duhita (2023)) (Ari et al. (2025)) (Sirait et al. (2022)
Technological Level	USG, cfDNA, biomarker panels, nanobiosensors	Genetic and placental-metabolic disorders	Vora & Hui (2018)) (Poon et al. (2018)) (Chebl et al. (2025)) (Andonotopo et al. (2025)

Summarize the collected data and the analysis performed on those data relevant to the issue that is to follow. The Result should be clear and concise. It should be written objectively and factually, and without expressing personal opinion. It includes numbers, tables, and figures (e.g., charts and graphs). Number tables and figures consecutively in accordance with their appearance in the text.

Discussion

The results of this literature study reaffirm that prenatal examination (ANC) functions not only as a preventive tool but as an integrated diagnostic and educational system that links biomedical innovation, public health strategy, and community engagement. The findings align closely with established theories in maternal-fetal medicine and preventive obstetrics, which posit that early detection and intervention across gestational stages significantly reduce maternal and perinatal mortality (Windari & Lohy, 2019) (Anita & Diana, 2025). The integration of community-based risk screening, clinical protocols, and technological innovations reflects the multidimensional evolution of prenatal care in both developing and high-resource contexts.

1. Integration of Classical and Modern Screening Theories

The role of structured ANC visits supports classical public health models emphasizing the "Three Delays" framework—delays in decision-making, access, and treatment. Regular ANC addresses the first two by enabling earlier recognition and management of risk factors such as age extremes, multiparity, and chronic disease (Windari & Lohy, 2019). Moreover, standardized tools like KSPR operationalize risk theory by quantifying maternal vulnerability and translating it into actionable triage systems (Anita et al, 2023). This integration demonstrates how theory-based instruments can convert conceptual risk into measurable preventive action.

2. The Shift Toward Evidence-Based, Technology-Assisted Prenatal Medicine

Recent advances in biomolecular diagnostics expand the theoretical foundations of prenatal screening. Studies by Poon et al. (2018) and Mavreli et al. (2021) confirm that combining maternal clinical factors, biophysical indices (MAP, UtA-PI), and biochemical biomarkers (PAPP-A, PlGF) significantly increases predictive accuracy for preeclampsia and fetal growth restriction (FGR). This supports the multifactorial causation theory in obstetrics, asserting that early pathophysiological changes can be identified before symptoms arise. Similarly, Snyder et al. (2020) provide evidence that early pregnancy biomarkers can forecast gestational diabetes mellitus (GDM), demonstrating the clinical translation of predictive models into preventive strategies.

3. Genetic and Structural Screening: Expanding Diagnostic Horizons

The evolution of prenatal screening from conventional ultrasonography to cfDNA-based testing represents a major paradigm shift grounded in genetic determinism and fetal medicine theory. Non-invasive prenatal screening (NIPS) through cfDNA allows the detection of chromosomal abnormalities with unprecedented precision (Vora & Hui, 2018) (Xue et al, 2025). Meanwhile, first-trimester ultrasound "soft markers"—such as increased nuchal translucency and nasal bone hypoplasia—have been shown to correlate with both aneuploidy and structural malformations, reinforcing the theory of genotype-phenotype interplay (Mangla & Kumar, 2025). The integration of cfDNA, NIPS, and ultrasonography into standard ANC protocols therefore not only advances diagnostic precision but also informs individualized prenatal management.

4. Sociocultural Dimensions and Behavioral Determinants

From a sociobehavioral standpoint, the empowerment of cadres and families embodies the health belief model, wherein perceived susceptibility and benefits influence participation in prenatal programs. The findings from Sinulingga et al. (2025) indicate that spousal involvement in recognizing danger signs markedly improves response time during obstetric emergencies, while cadre-based education amplifies the scope of early detection in rural areas (Anita & Diana, 2025) (Yanti & Milindasari, 2023). However, cultural norms and patriarchal attitudes continue to constrain male participation, suggesting the need for gender-transformative interventions in maternal health promotion.

5. Implications for Policy, Practice, and Future Research

The cumulative evidence suggests that prenatal examination should be conceptualized as a tiered prevention system—encompassing community engagement, primary clinical screening, and advanced diagnostics. Policy implications include integrating biomarker-based testing and cfDNA into national ANC programs while maintaining affordability and accessibility. Clinically, the incorporation of nanoflower biosensors (Andonotopo et al, 2025) offers a pathway toward point-of-care precision obstetrics, but requires rigorous validation and ethical regulation. These innovations underscore the growing convergence of obstetrics, genomics, and nanotechnology, signifying the birth of a new subfield: preventive precision perinatology.

6. Limitations and Recommendations

While this literature synthesis presents a comprehensive view, it remains constrained by several limitations. First, disparities in methodological quality across studies—ranging from community-based interventions to experimental biomarker research—limit direct comparability. Second, most innovations, such as nanobiosensors and cfDNA testing, are predominantly validated in high-resource settings, posing challenges to equitable implementation in developing regions (Mavreli et al, 2021) (Andonotopo et al, 2025). Future studies should emphasize multicentric validation of novel diagnostic tools, integration of sociocultural determinants into screening algorithms, and cost-effectiveness analyses to ensure global applicability. Furthermore, longitudinal cohort studies could bridge the gap between predictive screening and long-term maternal-child outcomes.

In conclusion, this study demonstrates that prenatal examination is no longer a purely clinical routine but a dynamic, multilayered system integrating community empowerment, molecular diagnostics, and digital innovation. Its theoretical and practical implications extend beyond early detection—positioning ANC as a cornerstone of maternal and perinatal health equity in the twenty-first century.

Conclusion

This qualitative study concludes that prenatal examination (antenatal care) is an integrated, multilayered system that plays a pivotal role in the early detection and prevention of pregnancy complications through the synergy of clinical, technological, and community-based approaches. The synthesis of obstetric and gynecological literature

demonstrates that structured ANC—supported by standardized screening tools such as KSPR, biomarker panels, cfDNA testing, and nanoflower biosensors—significantly enhances diagnostic precision and enables preventive interventions long before clinical symptoms emerge. These findings extend theoretical models of preventive obstetrics by linking biomedical innovation with behavioral and sociocultural determinants, affirming that maternal health outcomes are shaped not only by medical care but also by community engagement and gender participation. In the academic context, the study contributes to the growing framework of preventive precision perinatology, while socially, it emphasizes the transformative power of education and empowerment among families and health cadres. Nonetheless, limitations persist in terms of unequal access to advanced technologies and variations in implementation capacity between regions. Future research should therefore pursue interdisciplinary, equity-driven investigations that integrate molecular diagnostics, community interventions, and digital health tools to ensure universal, sustainable improvements in maternal-fetal wellbeing. This qualitative study recommends that health practitioners and policymakers enhance integrated prenatal screening by merging community education, risk scoring tools, and modern diagnostics like biomarker and cfDNA testing. Academics should further develop research using triangulated qualitative methods to include sociocultural, behavioral, and molecular perspectives on maternal health. Training institutions are encouraged to strengthen the competence of midwives and health cadres in early detection and management of high-risk pregnancies. Future research should prioritize collaborative, technology-based, and affordable approaches to expand the reach and effectiveness of preventive prenatal care.

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