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Bacterial Vaginosis in Pregnancy as a Risk Factor for Obstetric Complications – Analysis of Current Evidence and Management Strategies

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Abstract

Background. Bacterial vaginosis (BV) is a common condition in pregnancy associated with an increased risk of adverse obstetric outcomes, particularly preterm birth. However, the underlying mechanisms and the effectiveness of screening and treatment strategies remain uncertain.

Aim. This review aimed to evaluate the role of bacterial vaginosis as a risk factor for obstetric and neonatal complications and to assess current approaches to its diagnosis and management.

Material and methods. A narrative literature review was conducted using the PubMed database with predefined keywords related to bacterial vaginosis, pregnancy, and obstetric outcomes.

Results. The available evidence indicates that BV is associated with an increased risk of preterm birth, low birth weight, premature rupture of membranes, and selected neonatal complications. BV reflects a disruption of the vaginal microbiome characterized by reduced Lactobacillus dominance and increased microbial diversity, which may promote inflammatory responses and ascending infection. Despite strong epidemiological associations, antibiotic treatment during pregnancy does not consistently reduce adverse outcomes, particularly in low-risk populations. Variability in diagnostic methods further contributes to inconsistent findings.

Conclusions. Bacterial vaginosis should be considered an important risk marker rather than a direct causal factor in all cases. Routine screening and uniform treatment strategies do not provide consistent clinical benefit. Future approaches should focus on individualized, risk-based management and microbiome-oriented strategies.

Keywords: bacterial vaginosis, pregnancy, preterm birth, microbiome, screening, treatment

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1. Introduction

Bacterial vaginosis (BV) is increasingly recognized as a clinically relevant condition in pregnancy due to its association with adverse obstetric outcomes, particularly preterm birth, regardless of symptom presentation. This issue is further complicated by the fact that BV should not be interpreted solely as a localized disruption of the vaginal microbiota. Microorganisms characteristic of BV have been identified in intrauterine environments, including the placenta and amniotic fluid, suggesting a potential role in ascending infection and the pathogenesis of pregnancy complications (1–4).

These observations have led to increased interest in screening and treatment strategies, especially among asymptomatic pregnant women. However, the clinical value of such approaches remains controversial. This uncertainty is primarily due to inconsistent evidence regarding treatment effectiveness, as well as concerns about the long-term consequences of antibiotic exposure on maternal and neonatal microbiomes (1,3).

Despite extensive research, the mechanisms linking BV to adverse pregnancy outcomes remain incompletely elucidated. It is still unclear whether BV acts as a direct causal factor or rather reflects an increased susceptibility to complications. Furthermore, current evidence indicates that treatment of BV during pregnancy does not consistently reduce the incidence of preterm birth, despite its widespread use in clinical practice. While some studies suggest potential benefits in selected populations, others fail to demonstrate significant improvement in outcomes (2,5).

Emerging data suggest that the relationship between BV and preterm birth is complex and may depend on factors such as gestational timing, host characteristics, and underlying microbiome composition (3,4). Taken together, these findings indicate that, despite its clinical relevance, no clearly effective management strategy has been established, and both screening and treatment remain subjects of ongoing debate (2).

The aim of this study is to critically evaluate current evidence regarding bacterial vaginosis as a risk factor for obstetric complications and to assess existing management strategies.

2. Clinical Significance of Bacterial Vaginosis in Pregnancy

2.1 BV as a Risk Indicator

Bacterial vaginosis is widely recognized as an important factor influencing pregnancy outcomes, including in asymptomatic women. It has been consistently associated with preterm birth (PTB), low birth weight (LBW), premature rupture of membranes (PROM), and other maternal–fetal complications (5–9). The high prevalence of asymptomatic cases presents a significant challenge for early detection and prevention.

A key determinant of PTB risk appears to be the composition of the vaginal microbiota. Women who deliver preterm often exhibit increased microbial diversity and higher bacterial load compared with those who deliver at term. This is typically accompanied by a reduction in Lactobacillus dominance and an increased prevalence of anaerobic bacteria, including *Gardnerella*, *Prevotella*, *Sneathia*, *Atopobium*, *Mycoplasma*, *Mobiluncus*, and *Ureaplasma* species (5,10–14). Among these, *Gardnerella* species have been particularly implicated in the pathogenesis of preterm birth, possibly through immune activation or disruption of protective microbial functions (13).

Systematic reviews indicate that preterm birth remains the most frequent complication associated with BV, with a global prevalence of approximately 17.9% (95% CI 13–23.3%). BV has been shown to more than double the risk of preterm delivery. It is also associated with increased rates of low birth weight (14.2%, 95% CI 9.1–20.1%) and PROM (13.2%, 95% CI 6.1–22.3%) (9,10).

Additional complications include intrauterine infection, miscarriage, neonatal asphyxia, and the need for mechanical ventilation. The clinical impact of BV varies depending on gestational age at diagnosis and population-specific factors. Detection in early pregnancy, particularly before 16–20 weeks of gestation, is associated with the highest risk of preterm birth, whereas later diagnosis appears to confer a lower, though still relevant, risk (4).

Ethnic and geographic differences also influence susceptibility. For example, higher proportions of strictly anaerobic bacteria have been reported in certain populations, which may increase vulnerability to BV and its associated complications (11,15).

Overall, BV should be regarded both as a marker of increased obstetric risk and as a potential contributor to adverse pregnancy outcomes, underscoring the importance of targeted monitoring strategies that account for microbiome variability, gestational timing, and population-specific factors.

2.2 Mechanisms Linking BV to Pregnancy Complications

Although the association between BV and adverse pregnancy outcomes is well established, the underlying biological mechanisms remain incompletely understood. Disruption of the vaginal microbiota may impair local defense mechanisms, facilitating the ascent of pathogenic microorganisms into the upper reproductive tract and triggering intrauterine infection or inflammation (5,16,17).

BV has also been associated with alterations in immune response, including increased concentrations of proinflammatory cytokines in vaginal secretions, which have been linked to preterm birth and other complications (18).

It is likely that interactions between microbial composition, host immune responses, and individual susceptibility collectively contribute to the development of adverse outcomes. However, the relative importance of these factors remains uncertain.

In summary, BV appears to function both as a marker of increased risk and as a potential mediator of complications through multifactorial pathways involving microbial imbalance, ascending infection, and immune activation. Further research is required to better understand these mechanisms.

2.3 Clinical Controversies and Implications

Despite the well-documented association between BV and adverse pregnancy outcomes, its clinical management remains a subject of debate. Antibiotic treatment during pregnancy is commonly implemented; however, evidence supporting its effectiveness in reducing complications such as preterm birth is limited and inconsistent (7,16).

Some studies suggest that treatment may be beneficial in specific subgroups or when administered at particular stages of pregnancy, but these findings are not consistently reproducible.

The role of screening is similarly controversial. Although early detection could theoretically reduce the risk of complications, the high prevalence of asymptomatic cases and the lack of evidence supporting universal screening raise concerns regarding feasibility and cost-effectiveness (6,16).

Additionally, growing concerns about the impact of antibiotics on maternal and neonatal microbiomes further complicate clinical decision-making.

These uncertainties highlight the need for individualized management strategies that balance potential benefits with uncertain outcomes, while also considering broader implications for maternal and neonatal health.

3. Evidence Linking BV with Obstetric Complications

3.1 Preterm Birth (PTB) and Bacterial Vaginosis

The relationship between bacterial vaginosis and preterm birth has been extensively investigated, with the majority of studies demonstrating a positive association. However, the magnitude of this effect varies across studies, which may partly reflect methodological limitations, including inadequate adjustment for confounding variables such as maternal age, sexual behavior, and prior antibiotic exposure (19–24).

More consistent evidence is provided by meta-analyses, which indicate a significantly increased risk of preterm delivery among women with bacterial vaginosis. Reported estimates suggest that BV is associated with nearly a twofold increase in preterm birth risk (OR 1.79; 95% CI 1.32–2.43), with similar findings observed in other analyses (OR 1.98; 95% CI 1.55–2.54) (25,26).

This association is further supported by microbiological data. A reduction in Lactobacillus dominance, accompanied by an increased prevalence of anaerobic bacteria such as *Gardnerella*, *Ureaplasma*, and *Sneathia*, has been linked to a higher likelihood of preterm birth. In contrast, the presence of *Lactobacillus crispatus* appears to confer a protective effect (13).

Gestational timing of diagnosis also appears to influence outcomes. BV identified in early pregnancy, particularly before 16 weeks of gestation, has been associated with a markedly elevated risk of preterm delivery, with some studies reporting up to a seven-fold increase (7). Conversely, BV diagnosed later in pregnancy may retain predictive value in specific populations (27).

Overall, despite variability in study findings, the available evidence supports a clinically relevant association between bacterial vaginosis and preterm birth, indicating that BV should be considered a significant risk factor rather than an incidental finding.

3.2 Low Birth Weight (LBW) and Other Neonatal Outcomes

In addition to preterm birth, bacterial vaginosis has been associated with a range of adverse neonatal outcomes, most notably low birth weight. Several studies have demonstrated a positive association between BV and LBW, although this relationship is not consistently observed

across all populations, likely due to confounding variables such as parity and maternal characteristics (21,22,28).

Pooled data indicate that low birth weight occurs in approximately 14.2% of cases (95% CI 9.1–20.1) (27). Furthermore, BV has been linked to additional neonatal complications, including birth asphyxia, requirement for mechanical ventilation, and admission to neonatal intensive care units (13).

Although less frequently examined, the need for respiratory support reflects severe neonatal compromise and underscores the broader clinical impact of bacterial vaginosis (18). These outcomes are particularly relevant given the well-established association between preterm birth and long-term neonatal morbidity and mortality (10).

Collectively, these findings indicate that bacterial vaginosis is associated not only with preterm delivery but also with a wider spectrum of adverse neonatal outcomes.

3.3 Maternal Outcomes: PROM, Miscarriage, and Intrauterine Infection

Bacterial vaginosis has also been associated with several maternal complications, including premature rupture of membranes (PROM), intrauterine infection, and miscarriage. Among these, PROM represents one of the most consistently reported outcomes, with multiple studies demonstrating a clear association (27).

The underlying mechanisms are thought to involve activation of inflammatory pathways induced by BV-associated microorganisms. These bacteria may stimulate toll-like receptors, leading to increased production of proinflammatory cytokines and subsequent tissue damage within the reproductive tract (18). Such processes may contribute to membrane weakening, chorioamnionitis, and the initiation of preterm labor.

Although BV has also been linked to intrauterine infection, the strength of this association varies across studies and is not always statistically significant. Similarly, the relationship between BV and miscarriage remains inconclusive. While some studies do not demonstrate a significant association (29), others suggest a potential link, particularly with second-trimester pregnancy loss (7,18).

These inconsistencies may reflect differences in study design, population characteristics, and underlying ethnic or geographic variability (22,25). Overall, bacterial vaginosis appears to contribute to multiple maternal complications, although the consistency of these associations varies.

3.4 Population and Regional Variability

The impact of bacterial vaginosis on pregnancy outcomes varies considerably across populations and geographic regions. Differences in prevalence, vaginal microbiota composition, and healthcare access contribute to this variability.

Higher rates of maternal–fetal complications have been reported in regions such as South-East Asia and West Africa (4). At the country level, increased prevalence has been observed in Nigeria, Thailand, and India, whereas lower rates are generally reported in European populations (30).

These differences may be attributed to socioeconomic factors, variations in diagnostic practices, and differences in microbiome composition. For instance, a higher prevalence of strictly anaerobic bacteria has been documented in certain populations, which may increase susceptibility to BV and its associated complications (31).

Additionally, host genetic and immunological factors may influence individual susceptibility and clinical outcomes (18). These observations highlight the importance of interpreting the relationship between BV and obstetric complications within a population-specific context.

3.5 Diagnostic Methods and Their Impact on Outcome Associations

The association between bacterial vaginosis and pregnancy outcomes is strongly influenced by the diagnostic methods used. Variability in diagnostic criteria affects both prevalence estimates and the strength of observed associations.

The most commonly used diagnostic approaches include the Amsel criteria and the Nugent scoring system, both based on microscopic evaluation of vaginal samples. While widely applied, these methods are subject to operator variability and differences in sensitivity, which may range from 37% to 70% for Amsel criteria, despite high specificity (94–99%) (29).

Such variability can contribute to inconsistencies across studies. Differences in diagnostic thresholds, interpretation, and timing of assessment may affect classification of BV and, consequently, the observed relationship with outcomes such as preterm birth or PROM (32).

To overcome these limitations, point-of-care diagnostic tools have been developed. One example is the BVBlue test, a chromogenic assay based on detection of elevated sialidase activity in vaginal fluid (33–35). Sialidases produced by bacteria such as *Gardnerella*, *Prevotella*, and *Bacteroides* contribute to mucosal degradation, bacterial adhesion, and immune evasion, linking diagnostic markers with pathogenic mechanisms (34,35).

BVBlue offers rapid results and ease of use, allowing diagnosis within minutes compared to conventional microscopy. Studies have reported high specificity and relatively good sensitivity (81–91.7%, up to 100% specificity) (36), supporting its clinical applicability.

However, test performance varies across populations. Reduced sensitivity observed in some settings may reflect differences in microbiota composition, including the presence of sialidase-negative strains (1,33,35). Additionally, sialidase-based assays may fail to detect certain organisms and do not exclude coexisting infections such as candidiasis or *Trichomonas vaginalis* (34).

External factors, including recent sexual activity or intravaginal practices, may further influence diagnostic accuracy (25,30). Consequently, the choice of diagnostic method may significantly affect the observed relationship between BV and pregnancy outcomes.

Overall, diagnostic variability represents a key challenge in interpreting BV as a risk factor. Standardization of diagnostic approaches is essential for improving comparability and reliability of future research.

4. Does Treatment Improve Pregnancy Outcomes?

4.1 Clinical Rationale for Treatment

Management of bacterial vaginosis during pregnancy is primarily driven by its established association with adverse obstetric outcomes, particularly preterm birth (37). BV should be considered a manifestation of broader microbiome disruption rather than a localized infection, as it may facilitate ascending infection and intrauterine inflammation (38).

Despite this rationale, antibiotic treatment has not consistently demonstrated improvement in pregnancy outcomes (39,40). This discrepancy suggests that BV may not act as a direct causal factor in all cases, but rather reflects a more complex interaction between microbiological and host-related factors.

4.2 Lack of Consistent Benefit of Antibiotic Therapy

Current evidence indicates that treatment of BV during pregnancy does not significantly reduce the incidence of preterm birth (38–41). Meta-analyses consistently show no statistically significant effect of commonly used antibiotics, such as metronidazole or clindamycin, particularly in low-risk populations (42–44).

This limited efficacy may be explained by the polymicrobial nature of BV. Although antibiotics can reduce bacterial load, they do not reliably restore a Lactobacillus-dominant microbiome, which is essential for maintaining vaginal homeostasis (2). Consequently, underlying inflammatory processes may persist despite treatment.

4.3 Heterogeneity of Treatment Effects

Although routine treatment does not appear universally effective, certain subgroups may benefit. Women with a history of preterm birth or those classified as high-risk have shown more favorable responses in some studies (2,41–44).

This suggests that the impact of BV varies depending on individual susceptibility, microbiome composition, and host immune response. Therefore, BV may be more accurately described as a risk-modifying condition rather than a direct cause of preterm birth.

4.4 Role of Timing

Gestational timing appears to play an important role in treatment effectiveness. Early detection and intervention may be associated with improved outcomes compared to treatment initiated later in pregnancy (41).

This supports the hypothesis that early microbial imbalance may initiate inflammatory processes that become difficult to reverse once established. Additionally, treatment outcomes differ according to baseline risk, with high-risk women potentially benefiting more than low-risk populations (2,39,40).

4.5 Methodological Limitations

Interpretation of treatment efficacy is further complicated by heterogeneity in diagnostic criteria and study design. Differences in case definition, particularly between Amsel and Nugent methods, contribute to variability in findings (45).

The natural course of BV also affects interpretation. Spontaneous resolution occurs in some cases, while recurrence after treatment is common (2,38–44). These dynamics indicate that short-term microbiological improvement does not necessarily translate into sustained clinical benefit.

4.6 Emerging Microbiome-Based Approaches

Given the limitations of antibiotic therapy, alternative strategies have gained attention, particularly probiotic interventions aimed at restoring a healthy vaginal microbiome (2).

Although biologically plausible, current evidence supporting their effectiveness remains limited and inconsistent (2,45,46). Nevertheless, restoration of Lactobacillus dominance represents a promising direction for future research.

4.7 Clinical Implications

Overall, current evidence does not support a consistent reduction in adverse pregnancy outcomes following treatment of BV (37,40–42,46). While potential benefits may exist in selected populations, these findings are not universally reproducible.

This discrepancy suggests that BV should be interpreted as a complex marker of host–microbiome interaction rather than a direct causal factor. Consequently, clinical management should shift toward individualized, risk-based approaches.

5. Future Directions in Prevention and Management

5.1 Toward Improved Prevention: Risk Stratification, Early Detection, and Microbiome-Based Prediction

Future strategies aimed at preventing adverse pregnancy outcomes associated with bacterial vaginosis (BV) are increasingly moving away from universal screening and toward more selective, risk-adapted approaches.

BV is now understood not merely as a localized vaginal infection, but as a manifestation of broader disruption within the vaginal microbial ecosystem, which may facilitate ascending infection and subsequent intrauterine inflammatory responses (1,11,13). This conceptual shift is clinically relevant because it redefines BV from a simple infectious disorder to a dynamic marker of reproductive tract instability, potentially relevant even before the onset of symptoms.

Within this framework, early pregnancy appears to represent a critical period for intervention. Nevertheless, current evidence indicates that routine screening in unselected populations does not consistently improve obstetric outcomes (38,41), thereby limiting the justification for universal screening programs. Consequently, future preventive strategies are increasingly focused on targeted screening among women with identifiable risk factors, such as a history of preterm birth or BV diagnosed early in gestation (2,42–45).

An important direction for future research is the incorporation of microbiome profiling into predictive models of obstetric risk. Reduced dominance of *Lactobacillus* species, increased microbial diversity, and overgrowth of anaerobic bacteria have been consistently associated with preterm birth and other pregnancy complications (10,12–14). These findings suggest that vaginal microbiota composition may have value not only as a diagnostic indicator but also as a predictive biomarker of adverse obstetric outcomes.

In addition, the pathophysiology of BV-related complications appears to extend beyond microbial dysbiosis alone. Activation of the maternal immune response, including elevated concentrations of proinflammatory cytokines, has also been linked to both BV and unfavorable pregnancy outcomes (18). This suggests that future prevention models may benefit from integrating microbiological, immunological, and clinical variables into multimodal risk assessment frameworks.

5.2 Toward Personalized Management: Microbiome Restoration, Precision Therapy, and Individualized Care

Despite the well-established epidemiological association between BV and adverse pregnancy outcomes, the available literature suggests that antibiotic treatment during pregnancy does not consistently reduce the risk of preterm birth or other complications (38,40–43,46). This discrepancy highlights an important gap between disease association and therapeutic efficacy, suggesting that BV cannot be adequately addressed through bacterial eradication alon

One of the most promising future directions involves the development of microbiome-restoring therapies, particularly probiotic or symbiotic interventions designed to re-establish Lactobacillus dominance within the vaginal environment (45). The rationale for these approaches is supported by evidence demonstrating that Lactobacillus species play a central role in maintaining vaginal homeostasis, suppressing pathogen overgrowth, and preserving mucosal barrier integrity (12,13). However, despite strong biological plausibility, current clinical data remain inconsistent, and no conclusive evidence has yet confirmed their effectiveness in preventing preterm birth or other obstetric complications (2,45,46).

Another important direction is the application of precision medicine to BV management. Available evidence suggests that treatment response is not uniform and may depend substantially on baseline obstetric risk and individual biological susceptibility (2,42–45). In particular, women with a history of preterm birth appear more likely to benefit from

intervention, whereas low-risk populations have not shown consistent improvement following treatment (40,41).

This heterogeneity supports a broader shift in clinical interpretation: BV should be viewed less as a direct causal agent and more as a risk-modifying condition embedded within a multidimensional host–microbiome–immune interaction network. Accordingly, future management strategies will likely move toward individualized care models in which clinical decisions are informed not only by diagnostic findings, but also by reproductive history, vaginal microbiome composition, and inflammatory profile (2,18,42–45).

An additional priority for future practice is diagnostic standardization. Current variability in diagnostic criteria contributes substantially to inconsistencies in reported associations and treatment outcomes across studies (46). Improved diagnostic precision will therefore be essential for both research comparability and evidence-based clinical decision-making.

Finally, further investigation is needed into the long-term effects of microbiome disruption and antibiotic exposure on maternal and neonatal health, as the currently available evidence remains limited and fragmented (1,11). This issue is particularly important in light of growing concerns regarding the developmental and immunological consequences of early-life microbiome alteration.

6. Conclusions

Bacterial vaginosis remains a clinically important condition in pregnancy because of its consistent association with a broad range of adverse obstetric and neonatal outcomes, particularly preterm birth, low birth weight, premature rupture of membranes, and intrauterine infection. Based on the evidence reviewed, BV should be understood not merely as a localized alteration of the vaginal microbiota, but as a multifactorial condition reflecting disturbed host–microbiome interactions that may contribute to inflammatory and infectious processes affecting pregnancy.

The relationship between BV and pregnancy complications appears to be multifactorial. Reduced Lactobacillus dominance, increased microbial diversity, and overgrowth of anaerobic organisms have been repeatedly associated with elevated obstetric risk. At the same time, the biological mechanisms underlying these associations remain incompletely

elucidated. Available evidence suggests that ascending infection, impairment of mucosal barrier function, and activation of proinflammatory immune pathways may collectively contribute to the development of complications such as preterm birth and PROM. Despite the strong epidemiological association between BV and adverse pregnancy outcomes, therapeutic management remains problematic. The data summarized in this review indicate that routine antibiotic treatment during pregnancy does not consistently reduce the risk of preterm birth or other complications, particularly in women without additional risk factors. This discrepancy between disease association and treatment efficacy suggests that BV should not be interpreted as a direct causal factor in all cases, but rather as a risk-modifying condition situated within a broader biological context.

Importantly, the potential effectiveness of intervention appears to depend on individual patient characteristics, including gestational age at diagnosis, prior obstetric history, and vaginal microbiome composition. Women with a history of preterm birth or other high-risk features may constitute subgroups in whom targeted intervention is more clinically justified. These observations support a move away from universal screening and treatment strategies toward more individualized, risk-based approaches.

Future progress in this field will likely depend on improved diagnostic standardization, better understanding of microbiome–immune interactions, and the development of microbiome-oriented therapeutic strategies aimed at restoring vaginal homeostasis rather than merely reducing bacterial burden. In this context, personalized prevention and management approaches may prove more clinically valuable than currently applied uniform strategies.

In conclusion, bacterial vaginosis should be regarded as an important obstetric risk marker with complex biological and clinical implications. Further high-quality research is required to clarify pathogenic mechanisms, improve diagnostic standardization, and establish evidence-based, individualized strategies for prevention and management during pregnancy.

7. Disclosure

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