

A Narrative review

Urinary Tract Infections and Their Role in Disseminated Intravascular Coagulation and Miscarriages: A Narrative Review with Special Focus on Pakistan

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ABSTRACT

Objective: To review the available evidence regarding the association between urinary tract infections (UTIs), disseminated intravascular coagulation (DIC), and miscarriage, with special emphasis on the burden, antimicrobial resistance patterns, and maternal health implications in Pakistan.

Methods: A narrative review was conducted using PubMed, Scopus, Google Scholar, PakMediNet, and relevant organizational reports. Literature published in English up to 2025 was screened using predefined keywords related to UTIs, pregnancy, maternal sepsis, DIC, miscarriage, and Pakistan. Relevant original studies, systematic reviews, clinical guidelines, and case reports were included.

Results: UTIs are among the most common bacterial infections during pregnancy and are associated with increased risks of pyelonephritis, maternal sepsis, miscarriage, preterm birth, and adverse neonatal outcomes. Progression to severe infection may trigger systemic inflammatory responses leading to DIC. Pakistani studies report a high prevalence of bacteriuria and increasing antimicrobial resistance among uropathogens, particularly *Escherichia coli*. Delayed diagnosis and inadequate treatment contribute substantially to maternal morbidity and pregnancy loss.

Conclusion: UTIs in pregnancy represent a significant but preventable contributor to maternal and fetal complications. Early screening, appropriate antimicrobial therapy, antimicrobial stewardship, and prompt recognition of maternal sepsis are essential to reduce the risks of DIC, miscarriage, and maternal mortality in Pakistan.

Keywords

urinary tract infection; pregnancy; asymptomatic bacteriuria; maternal sepsis; disseminated intravascular coagulation; miscarriage; antimicrobial resistance; Pakistan.

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INTRODUCTION

Urinary tract infections (UTIs) are among the most common bacterial infections affecting women during pregnancy and represent a significant cause of maternal morbidity worldwide [1,2]. Physiological changes during pregnancy, including ureteral dilatation, urinary stasis, and altered immune responses, increase susceptibility to both asymptomatic bacteriuria and symptomatic urinary tract infections [3,4]. If left untreated, these infections may progress to pyelonephritis, maternal sepsis, preterm labor, and adverse fetal outcomes, thereby contributing substantially to maternal and neonatal healthcare burdens [5]. Maternal infections remain a major contributor to global maternal mortality, particularly in low- and middle-income countries (LMICs), where limited access to antenatal screening and timely treatment often results in preventable complications [6]. Among infectious causes, severe UTIs and urosepsis are increasingly recognized as important triggers of systemic inflammatory responses that may lead to disseminated intravascular coagulation (DIC), a life-threatening condition characterized by widespread activation of the coagulation cascade, microvascular thrombosis, and subsequent hemorrhagic complications [7]. Pregnancy itself is a hypercoagulable state, which may further increase vulnerability to sepsis-induced coagulopathy and poor maternal outcomes [8]. In addition to maternal complications, UTIs have been associated with miscarriage, fetal loss, and other adverse pregnancy outcomes. Ascending bacterial infection, placental inflammation, maternal fever, and endotoxin-mediated tissue injury may impair fetal viability and contribute to spontaneous pregnancy loss [9]. Several studies have demonstrated that untreated asymptomatic bacteriuria and recurrent UTIs during pregnancy are associated with increased risks of miscarriage, intrauterine infection, and adverse neonatal outcomes [10]. Pakistan continues to face a substantial burden of maternal morbidity and mortality despite improvements in maternal healthcare services. Maternal sepsis remains an important contributor to preventable maternal deaths, while urinary tract infections are frequently underdiagnosed because of inadequate screening, delayed healthcare access, and increasing antimicrobial resistance among uropathogens [11]. These challenges are particularly pronounced in rural and resource-limited settings, where diagnostic and treatment resources remain limited. Given the significant burden of UTIs during pregnancy and their potential role in precipitating severe maternal complications such as sepsis, DIC, and miscarriage, a comprehensive evaluation of the available evidence is warranted. Therefore, this narrative review aims to examine the relationship between urinary tract infections, disseminated intravascular coagulation, and pregnancy loss, with special emphasis on epidemiology, pathophysiological mechanisms, antimicrobial resistance trends, and maternal health implications in Pakistan.

Materials and Methods Study

Design

This study was conducted as a narrative review to evaluate the available evidence regarding the association between urinary tract infections (UTIs), disseminated intravascular coagulation (DIC),

and miscarriage, with particular emphasis on maternal health implications in Pakistan.

Literature Search Strategy

A comprehensive literature search was performed using electronic databases, including PubMed, Scopus, Google Scholar, PakMediNet, and the World Health Organization (WHO) database. Literature published in English from database inception through June 2025 was considered for inclusion. The search strategy utilized combinations of Medical Subject Headings (MeSH) terms and keywords, including: “urinary tract infection,” “asymptomatic bacteriuria,” “pregnancy,” “maternal sepsis,” “urosepsis,” “disseminated intravascular coagulation,” “DIC,” “miscarriage,” “pregnancy loss,” “antimicrobial resistance,” “maternal mortality,” and “Pakistan.”

Eligibility Criteria Inclusion

Criteria

- Studies were included if they met one or more of the following criteria:
- Original research articles involving pregnant women with urinary tract infections.
- Systematic reviews and meta-analyses addressing UTIs and pregnancy-related outcomes.
- Clinical guidelines and consensus statements from recognized professional organizations.
- Relevant case reports and case series describing UTI-associated maternal complications.
- Studies reporting maternal sepsis, DIC, miscarriage, or pregnancy loss associated with urinary tract infections.
- Publications available in the English language.

Exclusion Criteria

- The following studies were excluded:
- Studies involving non-pregnant populations.
- Animal and experimental laboratory studies.
- Conference abstracts without full-text availability.

Study Selection and Data Extraction

Titles and abstracts identified through the search strategy were screened for relevance. Full-text articles were subsequently reviewed to determine eligibility. Relevant information regarding study characteristics, prevalence estimates, microbial patterns, antimicrobial resistance, maternal outcomes, fetal outcomes, and healthcare implications was extracted and summarized.

Data Synthesis

Data were narratively synthesized and organized into thematic domains, including epidemiology of UTIs during pregnancy, pathophysiological mechanisms linking UTIs with DIC and miscarriage, antimicrobial resistance patterns, maternal and fetal outcomes, and Pakistan-specific healthcare challenges. Owing to the heterogeneity of study designs and reported outcomes, quantitative meta-analysis was not performed.

Ethical Considerations

As this study was based exclusively on previously published literature and did not involve human participants or identifiable patient data, ethical approval and informed consent were not required.

Results

Epidemiology of Urinary Tract Infections During Pregnancy

The available literature suggests that urinary tract infections (UTIs) are among the most common bacterial infections encountered during pregnancy worldwide. The reported prevalence of asymptomatic bacteriuria ranges from 2% to 15%, while symptomatic UTIs affect approximately 1% to 10% of pregnant women. *Escherichia coli* remains the predominant causative organism, accounting for the majority of infections, followed by *Klebsiella pneumoniae*, *Proteus mirabilis*, and *Enterococcus faecalis* [1–5]. In Pakistan, the reported prevalence of bacteriuria and UTIs during pregnancy ranges from 14% to 30%, exceeding many global estimates. Several hospital-based studies have identified *E. coli* as the most common pathogen isolated from urine cultures, with increasing reports of multidrug-resistant strains [6–8].

Urinary Tract Infections and Maternal Sepsis

Multiple studies identified UTIs as an important source of maternal sepsis. Untreated asymptomatic bacteriuria may progress to acute pyelonephritis, bacteremia, and systemic inflammatory responses. Severe infections have been associated with prolonged hospitalization, intensive care unit admission, and increased maternal morbidity [9,10].

Urinary Tract Infections and Disseminated Intravascular Coagulation

The reviewed literature indicates that severe urosepsis may trigger disseminated intravascular coagulation (DIC) through widespread activation of inflammatory and coagulation pathways. Case reports and observational studies have documented maternal DIC following severe urinary tract infections and pyelonephritis, often resulting in significant maternal and fetal complications [11–14].

Urinary Tract Infections and Miscarriage

Several studies reported an association between UTIs during pregnancy and adverse fetal outcomes, including miscarriage,

intrauterine fetal death, preterm birth, and neonatal morbidity. Proposed mechanisms include ascending infection, maternal fever, placental inflammation, and impaired uteroplacental perfusion. The risk appears to be higher among women with recurrent infections or delayed treatment [15–18].

Antimicrobial Resistance Patterns

Antimicrobial resistance among uropathogens was consistently reported across the reviewed studies. High resistance rates were observed against ampicillin, co-trimoxazole, and third-generation cephalosporins. Nitrofurantoin and fosfomycin retained comparatively favorable susceptibility profiles and remain among the preferred therapeutic options during pregnancy in many settings [19–22].

Pakistan-Specific Findings

Evidence from Pakistan highlights a substantial burden of UTIs during pregnancy, coupled with increasing antimicrobial resistance and limited implementation of routine antenatal screening programs. Maternal sepsis continues to contribute significantly to maternal morbidity and mortality, particularly in rural and underserved regions where diagnostic facilities and timely treatment may be limited [23–30].

Figure 1. Antibiotic resistance trends in *E. coli* isolates from pregnant women in Pakistan (2005–2022)

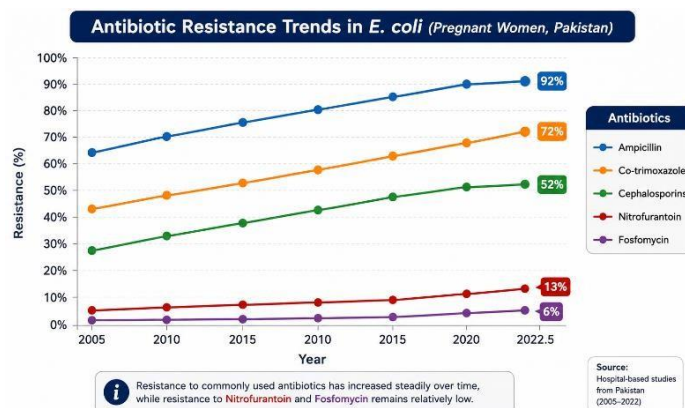
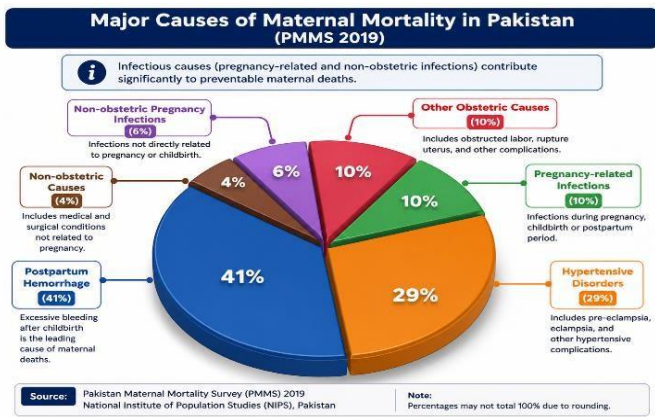


Figure 1: The figure demonstrates the increasing resistance of *Escherichia coli*, the predominant uropathogen causing urinary tract infections during pregnancy, to commonly prescribed antibiotics in Pakistan between 2005 and 2022. Resistance to ampicillin, co-trimoxazole, and cephalosporins increased substantially over the study period, whereas nitrofurantoin and fosfomycin maintained relatively low resistance rates. These findings highlight the growing challenge of antimicrobial resistance and emphasize the importance of culture-guided antibiotic therapy and antimicrobial stewardship during pregnancy.

Figure 2. Major causes of maternal mortality in Pakistan according to the Pakistan Maternal Mortality Survey (PMMS) 2019.



Postpartum hemorrhage remains the leading cause of maternal mortality, followed by hypertensive disorders and pregnancy-related infections. Infectious causes continue to contribute substantially to preventable maternal deaths.

Table 1. Global and Pakistan-Specific Prevalence of Urinary Tract Infections During Pregnancy

Region/Study	Prevalence (%)	Predominant Pathogen	Key Findings
Global studies	2-15	Escherichia coli	Most common bacterial infection during pregnancy
Pakistan (Karachi)	21.8	Escherichia coli	High prevalence among antenatal attendees
Pakistan (Peshawar)	28.4	Escherichia coli	Significant burden in community-based populations
Pakistan (Lahore)	14.5	Escherichia coli	Increasing antimicrobial resistance reported
Rural Sindh	18.0	Mixed uropathogens	Limited diagnostic and laboratory facilities

UTI = urinary tract infection. Escherichia coli was the predominant uropathogen across most studies. Reported prevalence rates vary according to study population, diagnostic criteria, and geographic location. Data compiled from studies included in the narrative review.

Table 2. Antimicrobial Resistance Patterns of Common Uropathogens in Pregnancy

Antibiotic	Resistance Rate (%)	Clinical Implication
Ampicillin	70-90	Poor empirical choice
Co-trimoxazole	60-75	High resistance limits use
Third-generation cephalosporins	40-60	Extended-spectrum beta-lactamase (ESBL) production increasingly reported
Nitrofurantoin	5-15	Remains effective for uncomplicated lower UTIs
Fosfomycin	<10	Effective and generally safe during pregnancy

ESBL = extended-spectrum beta-lactamase; UTI = urinary tract infection. Resistance rates represent ranges reported across studies conducted in Pakistan. Nitrofurantoin and fosfomycin demonstrated the highest susceptibility profiles among commonly used antibiotics.

Table 3. Reported Maternal and Fetal Complications Associated with Severe Urinary Tract Infections

Clinical Condition	Maternal Consequences	Fetal Consequences
Asymptomatic bacteriuria	Progression to pyelonephritis	Increased risk of preterm birth
Acute pyelonephritis	Sepsis, hospitalization	Fetal distress, preterm labor
Urosepsis	Septic shock, DIC	Fetal compromise, intrauterine death
Disseminated intravascular coagulation	Hemorrhage, organ dysfunction	Pregnancy loss, fetal mortality
Recurrent UTIs	Maternal morbidity	Miscarriage, adverse neonatal outcomes

DIC = disseminated intravascular coagulation; UTI = urinary tract infection. Severe or untreated urinary tract infections may progress to systemic infection and contribute to both maternal and fetal complications.

Discussion

Urinary tract infections (UTIs) remain among the most common bacterial infections encountered during pregnancy and continue to represent a substantial cause of maternal and fetal morbidity worldwide [2,6,16-19]. Pregnancy predisposes women to UTIs because of physiological and anatomical changes, including ureteral dilatation, urinary stasis, vesicoureteral reflux, and alterations in immune function that facilitate bacterial colonization and ascending infection [16,18,20]. If left untreated, asymptomatic bacteriuria may progress to symptomatic infection, acute pyelonephritis, maternal sepsis, and adverse obstetric outcomes [2,6,17,19]. Numerous studies have demonstrated that routine screening and treatment of asymptomatic bacteriuria significantly reduce the risk of maternal complications and improve pregnancy outcomes [16,17,21].The

present review highlights the important relationship between severe urinary tract infections and maternal sepsis. Infection-induced systemic inflammatory responses may trigger endothelial injury, activation of coagulation pathways, and widespread microvascular thrombosis, ultimately resulting in disseminated intravascular coagulation (DIC). Although DIC is more frequently associated with obstetric emergencies such as placental abruption, severe preeclampsia, and amniotic fluid embolism, infection-related DIC remains a recognized and potentially preventable cause of maternal morbidity and mortality [7,13,22-24]. The pathogenesis involves excessive cytokine release, endothelial dysfunction, platelet activation, and consumption of coagulation factors, resulting in simultaneous thrombosis and hemorrhage [22,23]. Early recognition of sepsis and prompt treatment are therefore critical to preventing progression to DIC and multi-organ dysfunction [24,25]. Another important finding is the association between maternal urinary tract infections and pregnancy loss. Several studies have reported that untreated infections may contribute to miscarriage, fetal growth restriction, preterm birth, low birth weight, and adverse neonatal outcomes through mechanisms including placental inflammation, maternal fever, endotoxin release, and impaired uteroplacental perfusion [2,6,13,26-28]. Maternal inflammatory responses may further compromise placental function and fetal development, increasing the likelihood of spontaneous pregnancy loss and other obstetric complications [26,27]. These findings emphasize the importance of early diagnosis and treatment of urinary tract infections during pregnancy. Antimicrobial resistance represents a growing challenge in the management of UTIs during pregnancy. The increasing prevalence of resistant *Escherichia coli* strains, particularly against ampicillin, co-trimoxazole, and selected cephalosporins, has complicated empirical treatment strategies in many regions [6,17,29,30]. As illustrated in Figure 1, resistance rates have increased substantially over the past two decades, whereas nitrofurantoin and fosfomycin continue to demonstrate comparatively favorable susceptibility profiles [6,29]. The emergence of multidrug-resistant organisms threatens the effectiveness of conventional therapies and underscores the importance of antimicrobial stewardship, surveillance programs, and culture-guided treatment approaches [29-31]. The burden of maternal infections appears particularly significant in Pakistan. Limited access to routine antenatal screening, delayed healthcare-seeking behavior, socioeconomic disparities, poor sanitation, and increasing antimicrobial resistance contribute to higher rates of infection-related maternal morbidity [11,30,32]. Figure 2 demonstrates that pregnancy-related and non-obstetric infections remain important contributors to maternal mortality in Pakistan. Strengthening antenatal care services, expanding screening programs, improving laboratory diagnostic capacity, and ensuring timely treatment are therefore critical public health priorities [11,32,33]. From a clinical perspective, routine screening for asymptomatic bacteriuria should remain a cornerstone of antenatal care. Early diagnosis and timely antimicrobial therapy can substantially reduce the risk of pyelonephritis, maternal sepsis, DIC, miscarriage, and other adverse pregnancy outcomes [2,6,16,17,21]. Furthermore, antimicrobial stewardship programs are needed to address the growing threat of resistance and preserve the effectiveness of currently available treatment options [29-31]. This review also highlights several gaps in the available literature. Most published studies are observational and exhibit considerable heterogeneity in study design, patient populations, diagnostic criteria, and reported outcomes. Moreover, high-quality prospective studies from Pakistan remain limited

[32,34]. Future multicenter investigations are needed to better define the epidemiology of UTIs during pregnancy, characterize antimicrobial resistance patterns, evaluate risk factors for DIC and miscarriage, and assess the effectiveness of screening and prevention strategies within local healthcare settings [33,34]. Overall, the available evidence suggests that urinary tract infections during pregnancy are a significant but largely preventable cause of maternal and fetal complications. Early screening, prompt treatment, antimicrobial stewardship, and improved access to maternal healthcare services may substantially reduce the burden of infection-related morbidity and mortality in Pakistan [16,17,21,32-35].

Limitations

This review has several limitations. First, it is a narrative review and therefore lacks the methodological rigor of a systematic review or meta-analysis. Second, the included studies demonstrated substantial heterogeneity in study design, sample size, diagnostic criteria, and reported outcomes, limiting direct comparisons across studies. Third, much of the available evidence regarding the association between urinary tract infections, disseminated intravascular coagulation, and miscarriage is derived from observational studies and case reports, which may be subject to selection bias and confounding factors. Finally, data specific to Pakistan remain limited, highlighting the need for high-quality prospective research to better characterize the burden and consequences of urinary tract infections during pregnancy.

Conclusion

Urinary tract infections are among the most common infectious complications encountered during pregnancy and remain a significant contributor to maternal and fetal morbidity. Untreated or inadequately managed infections may progress to maternal sepsis, disseminated intravascular coagulation, miscarriage, preterm birth, and adverse neonatal outcomes. The growing burden of antimicrobial resistance further complicates management and underscores the importance of culture-guided therapy and antimicrobial stewardship. In Pakistan, limited access to routine antenatal screening and increasing resistance among uropathogens continue to pose major healthcare challenges. Strengthening antenatal care services, promoting early diagnosis and treatment, and implementing effective infection prevention strategies are essential to reducing preventable maternal and fetal complications.

Conflict of Interest

The authors declare that there are no conflicts of interest related to this study.

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Ethical Approval

Ethical approval was not required for this study because it was based exclusively on previously published literature and did not involve human participants, patient data, or identifiable information.

Data Availability Statement

No new data were generated or analyzed during this study. All information presented in this review was obtained from previously published literature. Data supporting the findings of this review are available within the cited references.

AI Disclosure Statement

Artificial intelligence (AI) tools were used solely to assist with language editing, grammar correction, formatting, and manuscript organization. All scientific interpretation, critical analysis, content development, and final manuscript approval were performed by the authors. The authors take full responsibility for the accuracy, integrity, and originality of the work.

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Author Contributions

Humaria Noreen: Conceptualization, literature search, data collection, manuscript drafting, and final approval of the manuscript.

Safia Khan: Literature review, data extraction, manuscript writing, critical revision, and final approval.

Zaib-un-Nisa: Supervision, manuscript review, interpretation of findings, and final approval.

All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work in accordance with the International Committee of Medical Journal Editors (ICMJE) authorship criteria.

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