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Microbiological Profile, Virulence Attributes and Antifungal Susceptibility of Vulvovaginal Candidiasis Among Pregnant Women: A Cross-Sectional Study

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ABSTRACT

Background: Vulvovaginal candidiasis (VVC) is one of the most common fungal infections encountered during pregnancy. Hormonal alterations, immunological modulation, and changes in vaginal microenvironment predispose pregnant women to Candida colonization and symptomatic infection. The increasing emergence of non-albicans Candida species and antifungal resistance has posed diagnostic and therapeutic challenges, particularly in pregnancy where treatment options are limited.

Aim and Objectives: To determine the prevalence of vulvovaginal candidiasis among pregnant women, identify the species distribution of Candida isolates, evaluate associated risk factors and virulence determinants, and assess antifungal susceptibility patterns.

Materials and Methods: This cross-sectional study included 50 pregnant women presenting with symptoms suggestive of VVC at a tertiary care center. High vaginal swabs were collected and processed using standard mycological techniques. Candida isolates were identified to species level. Virulence factors such as biofilm formation and phospholipase activity were assessed. Antifungal susceptibility testing was performed using the CLSI disc diffusion method.

Results: Out of 50 pregnant women, 28 (56%) were culture positive for Candida species. Non-albicans Candida (57.1%) predominated over Candida albicans (42.9%). The highest culture positivity was observed in the third trimester. Biofilm production was detected in 71.4% of isolates, while phospholipase activity was observed in 21.4%. Amphotericin-B (96.4%) and voriconazole (85.7%) showed the highest antifungal sensitivity, whereas fluconazole and nystatin demonstrated moderate resistance.

Conclusion: Vulvovaginal candidiasis remains highly prevalent among pregnant women, with an emerging dominance of non-albicans Candida species exhibiting significant virulence traits. Routine species identification and antifungal susceptibility testing are essential for optimal management and prevention of recurrent infections during pregnancy.

Keywords: *Vulvovaginal candidiasis, Pregnancy, Candida species, Biofilm, Antifungal susceptibility, Non-albicans Candida*

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1. INTRODUCTION

Vulvovaginal candidiasis (VVC) is one of the most prevalent mucosal fungal infections affecting women of reproductive age, with Candida species being the primary etiological agents [1]. It is estimated that nearly 75% of women experience at least one episode of VVC during their lifetime, and up to 40–50% suffer from recurrent infections [2]. Pregnancy represents a unique physiological state that significantly increases susceptibility to Candida colonization and infection due to hormonal, immunological, and metabolic changes. **Prevalence and bacteriological profile of UTI –** *Escherichia coli* was the most common pathogen; many isolates exhibited resistance to commonly used antibiotics, emphasizing the importance of culture-guided treatment [3].

During pregnancy, elevated estrogen levels lead to increased vaginal epithelial glycogen deposition, which serves as a substrate for Candida growth [4]. Additionally, pregnancy is associated with a relative suppression of cell-mediated immunity, particularly Th1-mediated responses, thereby reducing the host's ability to control fungal proliferation [5]. These factors collectively contribute to increased rates of both asymptomatic colonization and symptomatic vulvovaginal candidiasis among pregnant women [6].

Candida albicans has traditionally been regarded as the predominant causative agent of VVC due to its ability to form germ tubes, adhere to epithelial cells, and evade host immune responses [7]. However, recent studies have demonstrated an increasing prevalence of non-albicans Candida (NAC) species such as *C. tropicalis*, *C. glabrata*, *C. krusei*, and *C. parapsilosis* [8,9]. The emergence of NAC species is of particular concern because they often exhibit reduced susceptibility or intrinsic resistance to commonly used azole antifungals [10].

Virulence factors play a crucial role in the pathogenesis of VVC. Biofilm formation is one of the most important virulence mechanisms, allowing Candida species to adhere to mucosal surfaces, resist antifungal agents, and evade host defenses [11]. Phospholipase and protease enzymes further enhance tissue invasion and inflammatory responses [12]. Biofilm-associated infections are especially difficult to eradicate and are frequently implicated in recurrent VVC [13].

Clinically, VVC presents with vulvar pruritus, thick curdy vaginal discharge, burning sensation, dysuria, and dyspareunia [14]. However, these symptoms are nonspecific and may overlap with other causes of vaginitis, making laboratory confirmation essential [15]. Microscopy and culture remain the cornerstone of diagnosis, particularly in pregnancy where empirical treatment should be avoided [16].

Antifungal therapy for VVC during pregnancy poses unique challenges. While oral azoles are commonly used in non-pregnant women, their use during pregnancy is restricted due to concerns about teratogenicity [17]. Topical azoles remain the treatment of choice, but increasing antifungal resistance has led to treatment failures and recurrence [18]. Therefore, antifungal susceptibility testing is increasingly advocated, especially in recurrent and refractory cases [19].

Despite the high prevalence of VVC in pregnancy, data on species distribution, virulence traits, and antifungal resistance patterns remain limited in many regions [20]. Understanding local epidemiology is essential for guiding effective management strategies and preventing complications [21]. Although the association between VVC and adverse pregnancy outcomes remains controversial, symptomatic infection significantly impacts maternal comfort and quality of life [22].

Given the emerging trends of non-albicans Candida predominance, biofilm-mediated resistance, and limited therapeutic options in pregnancy, this study was undertaken to evaluate the microbiological profile, virulence factors, and antifungal susceptibility of Candida species isolated from pregnant women attending a tertiary care center [23–25].

2. MATERIALS AND METHODS

Study Design and Setting

This was a **hospital-based cross-sectional study** conducted in the Department of Microbiology at a tertiary care centre for a period of 12 months.

Study Population
A total of **50 pregnant women** attending the antenatal outpatient department and presenting with symptoms suggestive of vulvovaginal infection were enrolled in the study.

Inclusion Criteria
Pregnant women fulfilling the following criteria were included:

1. Pregnant women of any trimester
2. Presence of symptoms suggestive of vulvovaginal candidiasis such as vaginal discharge, vulval itching, burning sensation, dysuria, or dyspareunia
3. Willingness to participate and provide informed consent

Exclusion Criteria
Pregnant women were excluded if they met any of the following criteria:

1. Receipt of antifungal therapy (topical or systemic) within the preceding two weeks
2. Presence of active vaginal bleeding
3. Known immunocompromised states such as HIV infection or long-term corticosteroid therapy
4. Coexisting diagnosed sexually transmitted infections other than candidiasis
5. Unwillingness to provide consent

Sample Collection
Under strict aseptic precautions, **high vaginal swabs** were collected using sterile cotton swabs during speculum examination. Care was taken to avoid contamination from the vulva or cervix. The samples were transported immediately to the microbiology laboratory for processing.

Microbiological Processing and Identification
Vaginal swabs were inoculated onto **Sabouraud's Dextrose Agar (SDA)** with chloramphenicol and incubated at 37°C for 24–48 hours. Suspected Candida colonies were identified based on colony morphology, Gram staining, germ tube test, chlamydospore formation on cornmeal agar, and species differentiation using CHROMagar Candida. Species identification was confirmed using standard biochemical tests.

Detection of Virulence Factors

- **Biofilm production** was assessed using the tube adherence method and graded based on visible film formation along the walls of the tube.
- **Phospholipase activity** was detected using egg yolk agar, and enzyme production was determined by the presence of a precipitation zone around the colony.

Antifungal Susceptibility Testing
Antifungal susceptibility testing was performed using the **CLSI M44-A disc diffusion method** against fluconazole, itraconazole, voriconazole, amphotericin-B, micafungin, and nystatin. Results were interpreted as sensitive or resistant according to CLSI guidelines.

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using SPSS software. Results were expressed as frequencies and percentages.

3. RESULTS

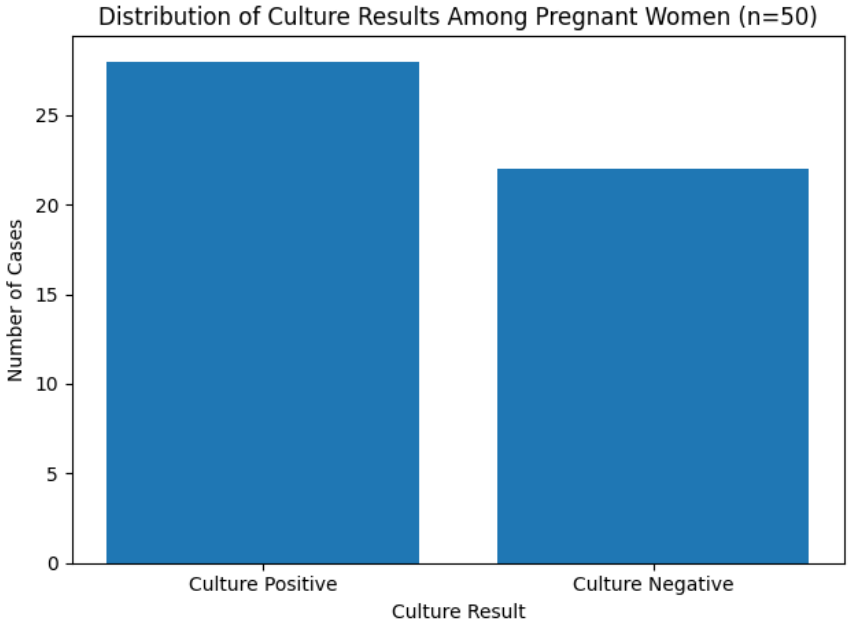
The distribution of culture positivity among the 50 pregnant women included in the study. Candida species were isolated from 28 women, yielding a prevalence rate of 56%. The remaining 22 women (44%) were culture negative. This high prevalence highlights vulvovaginal candidiasis as a common clinical problem in pregnancy and underscores the need for routine mycological evaluation in symptomatic antenatal patients.

Table 2 demonstrates the trimester-wise distribution of Candida positivity. The prevalence of VVC increased progressively with advancing gestational age, with the highest positivity observed in the third trimester (70%), followed by the second trimester (55.5%) and first trimester (33.3%). This trend supports the role of rising estrogen levels and increased vaginal glycogen deposition in late pregnancy, creating a favorable environment for Candida overgrowth.

Table 1: Culture Positivity Among 50 Pregnant Women

Culture Result	Frequency (n=50)	Percentage (%)
Culture Positive (Candida spp.)	28	56%
Culture Negative	22	44%
Total	**50**	**100%**

Interpretation:
Out of 50 symptomatic pregnant women, 28 (56%) were culture positive for Candida species, indicating a high burden of vulvovaginal candidiasis.



Graph 1: Culture Positivity Among Pregnant Women

Table 2: Trimester-wise Distribution of VVC Cases

Trimester	Total Women	Candida Positive	Percentage (%)
First (≤12 weeks)	12	4	33.3%
Second (13–28 weeks)	18	10	55.5%
Third (≥29 weeks)	20	14	70%
Total	**50**	**28**	**56% overall**

Interpretation:
The highest positivity was observed in the third trimester (70%), supporting the role of hormonal influence in late pregnancy.

Table 3: Species Distribution of Candida Isolates (n=28)

Species	Number of Isolates	Percentage (%)
C. albicans	12	42.9%
C. tropicalis	8	28.6%
C. glabrata	4	14.3%
C. krusei	3	10.7%
C. parapsilosis	1	3.5%
Total	**28**	**100%**

Interpretation:
Non-albicans Candida (57.1%) slightly predominated over C. albicans (42.9%), indicating an epidemiological shift.
Table 3 shows the species-wise distribution of Candida isolates recovered from vaginal swabs. *Candida albicans* accounted for 42.9% of isolates, while non-albicans Candida species collectively constituted 57.1%. Among non-albicans species, *C. tropicalis* was the most frequent, followed by *C. glabrata* and *C. krusei*. This shift toward non-albicans Candida species is clinically significant due to their reduced susceptibility to commonly used azole antifungals.

Table 4: Clinical Presentation Among Candida Positive Cases (n=28)

Symptom	Frequency	Percentage (%)
Thick curdy discharge	24	85.7%
Vulval itching	22	78.6%
Burning sensation	16	57.1%
Dysuria	10	35.7%
Dyspareunia	6	21.4%

Interpretation:
Curdy discharge and itching were the most common symptoms.

Table 5: Associated Risk Factors Among Candida Positive Women (n=28)

Risk Factor	Frequency	Percentage (%)
Recent antibiotic use	9	32.1%
Gestational diabetes	7	25%
Previous history of VVC	8	28.6%
Poor genital hygiene	11	39.3%
Anemia	6	21.4%

Interpretation:
Poor genital hygiene and recent antibiotic exposure were major associated factors.

Table 6: Virulence Factors Among Candida Isolates (n=28)

Virulence Factor	Frequency	Percentage (%)
Biofilm Production	20	71.4%
Phospholipase Activity	6	21.4%

Species-wise Biofilm Production

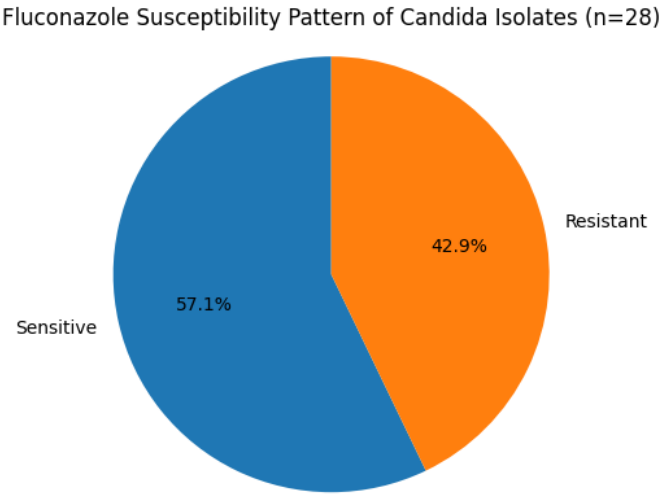
Species	Biofilm Positive	Percentage (%)
C. albicans (n=12)	9	75%
C. tropicalis (n=8)	6	75%
C. glabrata (n=4)	3	75%
C. krusei (n=3)	2	66.7%
C. parapsilosis (n=1)	0	0%

Interpretation:
Biofilm production was high (71.4%), contributing to persistence and possible resistance.

Table 7: Antifungal Susceptibility Pattern (n=28)

Antifungal Drug	Sensitive	Sensitive (%)	Resistant	Resistant (%)
Fluconazole	16	57.1%	12	42.9%
Itraconazole	18	64.3%	10	35.7%
Voriconazole	24	85.7%	4	14.3%
Amphotericin B	27	96.4%	1	3.6%
Micafungin	22	78.6%	6	21.4%
Nystatin	12	42.9%	16	57.1%

Interpretation:
Highest sensitivity was observed with Amphotericin-B (96.4%) and Voriconazole (85.7%), while moderate resistance was noted to Fluconazole and Nystatin.



Graph 2: Antifungal Susceptibility Pattern

Table 4: Clinical Presentation of Candida-Positive Cases

Table 4 outlines the clinical symptoms among women with culture-proven VVC. Thick curdy vaginal discharge was the most common complaint (85.7%), followed by vulvar itching (78.6%) and burning sensation (57.1%). Dysuria and dyspareunia were less frequently reported. These findings reaffirm the classical symptomatology of VVC, although clinical features alone are insufficient for definitive diagnosis.

Table 5 highlights the associated risk factors observed among Candida-positive pregnant women. Poor genital hygiene (39.3%) and recent antibiotic use (32.1%) were the most frequent risk factors, followed by previous history of VVC and gestational diabetes. These factors may disrupt normal vaginal flora and host immunity, facilitating Candida colonization and infection.

Table 6 illustrates the distribution of virulence factors among Candida isolates. Biofilm formation was detected in 71.4% of isolates, with comparable prevalence among *C. albicans* and non-albicans species. Phospholipase activity was observed in 21.4% of isolates. The high rate of biofilm production indicates enhanced pathogenic potential and explains the tendency for persistence and recurrence of infection.

Table 7 presents the antifungal susceptibility profile of Candida isolates. Amphotericin-B showed the highest sensitivity (96.4%), followed by voriconazole (85.7%) and micafungin (78.6%). Moderate resistance was noted with fluconazole and nystatin. These findings emphasize the growing antifungal resistance among vaginal Candida isolates and the importance of susceptibility-guided therapy, especially in recurrent cases.

4. DISCUSSION

Vulvovaginal candidiasis (VVC) is a common fungal infection among women of reproductive age, with pregnancy representing a particularly vulnerable period due to profound hormonal and immunological changes [1,2]. In the present study, Candida species were isolated from **56% of symptomatic pregnant women**, indicating a high burden of VVC in the antenatal population. Similar prevalence rates have been reported in multiple studies conducted in pregnant women, where positivity ranged from 40% to 60%, emphasizing that VVC remains a frequent clinical problem during pregnancy [6,21].

A progressive increase in culture positivity with advancing gestational age was observed in this study, with the **highest prevalence noted in the third trimester**. This finding is consistent with earlier studies that have demonstrated increased susceptibility to Candida infection in late pregnancy due to elevated estrogen levels, increased vaginal glycogen content, and reduced cell-mediated immunity [3–5]. Estrogen has been shown to enhance Candida adherence and immune evasion, thereby facilitating colonization and symptomatic infection [5].

Traditionally, *Candida albicans* has been considered the predominant etiological agent of VVC [1,7]. However, the present study demonstrated a **predominance of non-albicans Candida species (57.1%) over** *C. albicans* **(42.9%)**. This epidemiological shift has been increasingly reported worldwide [8–10]. Among the non-albicans species, *Candida*

tropicalis was the most frequently isolated organism, followed by *C. glabrata* and *C. krusei*. Similar trends have been documented in recent studies from different geographical regions, suggesting a global shift in species distribution [9,20,23]. The emergence of non-albicans Candida species is clinically significant because these organisms often exhibit reduced susceptibility or intrinsic resistance to commonly used azole antifungals [10,12]. The widespread empirical use of azoles, particularly fluconazole, is believed to exert selective pressure favoring non-albicans species, thereby altering the epidemiology of VVC [18,19].

Clinically, thick curdy vaginal discharge and vulval itching were the most common presenting symptoms in the present study. These findings are in agreement with classical descriptions of VVC reported in earlier literature [14]. However, clinical symptoms alone are not specific for candidiasis and may overlap with other causes of vaginitis, reinforcing the need for laboratory confirmation before initiating antifungal therapy, especially in pregnancy [15,16].

Several risk factors were found to be associated with Candida infection in this study, including poor genital hygiene, recent antibiotic use, previous history of VVC, and gestational diabetes. Antibiotic use disrupts the normal vaginal lactobacilli flora, thereby facilitating Candida overgrowth [6]. Hyperglycemia in gestational diabetes enhances fungal adherence and growth, increasing the likelihood of colonization and infection [15]. These observations are consistent with earlier reports highlighting the multifactorial nature of VVC pathogenesis [2,6].

Virulence factor analysis revealed **biofilm production in 71.4% of isolates**, underscoring its critical role in the pathogenesis of VVC. Biofilm formation enables Candida species to adhere firmly to mucosal surfaces, evade host immune responses, and exhibit reduced susceptibility to antifungal agents [11,13]. The high rate of biofilm production observed among both *C. albicans* and non-albicans species supports previous findings that biofilm formation is not species-restricted and plays a major role in recurrent and persistent infections [11,12].

Antifungal susceptibility testing in the present study showed **highest sensitivity to amphotericin-B and voriconazole**, while moderate resistance was observed to fluconazole and nystatin. These findings are in concordance with recent studies reporting increasing resistance to azole antifungals among vaginal Candida isolates [18,19,25]. Although amphotericin-B demonstrated excellent in vitro activity, its systemic use in pregnancy is generally reserved for severe infections due to potential toxicity, and topical azoles remain the first-line therapy [16,24].

The rising antifungal resistance observed among Candida species highlights the importance of **species-level identification and susceptibility testing**, particularly in recurrent or refractory cases of VVC. Current guidelines emphasize the judicious use of antifungal agents and discourage empirical therapy without laboratory confirmation in complicated cases [14,16].
Overall, the findings of this study reflect evolving trends in the epidemiology of vulvovaginal candidiasis during pregnancy, characterized by increasing non-albicans Candida prevalence, significant virulence attributes such as biofilm formation, and emerging antifungal resistance. These trends have important implications for diagnosis, treatment, and prevention strategies in antenatal care.

5. CONCLUSION

The present study highlights a **high prevalence of vulvovaginal candidiasis among pregnant women**, with a notable predominance of **non-albicans Candida species**. Advancing gestational age, particularly the third trimester, was associated with increased infection rates. The majority of isolates exhibited **biofilm-forming ability**, contributing to pathogenicity and antifungal resistance. While amphotericin-B and voriconazole showed the highest antifungal efficacy, resistance to commonly used agents such as fluconazole was evident.

Routine **species-level identification and antifungal susceptibility testing** should be encouraged, especially in recurrent or persistent cases, to guide effective and safe therapy during pregnancy. Early diagnosis and targeted treatment can significantly improve maternal comfort and reduce the risk of recurrent infection.

DECLARATIONS:
Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: There is consent to participate.

Consent for publication: There is consent for the publication of this paper.

Authors' contributions: Author equally contributed the work.

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