Studies in Fungi

ARTICLE

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https://doi.org/10.48130/sif-0026-0031

Studies in Fungi **2026**, 11: e032

Association between intrauterine contraceptive device use and vulvovaginal candidiasis among symptomatic women in Calabar, Nigeria

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Abstract

Vulvovaginal candidiasis (VVC) is a common fungal infection affecting millions of women worldwide. Intrauterine contraceptive devices (IUCDs) are widely used contraceptive methods and have been implicated as potential risk factors for VVC. This comparative cross-sectional study investigated the association between IUCD use and VVC among symptomatic women of reproductive age in Calabar, Nigeria. The study was conducted between February 2023 and February 2024 following ethical approval. A total of 250 women were enrolled, comprising 150 IUCD users and 100 non-IUCD users. Socio-demographic and clinical data were collected using structured questionnaires. High vaginal swabs were obtained and processed by microscopy and culture. Candida species were identified using CHROMagar Candida and API 20 Candida, while antifungal susceptibility testing was performed using the E-test method. The prevalence of VVC was significantly higher among IUCD users (115/150; 76.7%) than non-IUCD users (30/100; 30.0%) ($\chi^2 = 53.6$, $p < 0.001$). *Candida albicans* was the predominant species isolated, accounting for 44.8% of all isolates. VVC occurrence increased significantly with duration of IUCD use, with the highest prevalence observed among women who had used the device for four to five years (92.0%) and the lowest among those with zero to one year of use (53.3%) ($\chi^2 = 19.2$, $p = 0.004$). Genital pruritus was the most frequently reported symptom among IUCD users. The findings indicate a significant association between IUCD use and VVC, with risk increasing with duration of use. Routine screening and targeted counselling may help reduce VVC among IUCD users and improve reproductive health outcomes.

Keywords: Vulvovaginal candidiasis, Intrauterine device, *Candida*, Women's health, Biofilm formation

Citation: Ogba OM, Ibe H, Inah IO, Akpan NG, Nyambi ES, et al. 2026. Association between intrauterine contraceptive device use and vulvovaginal candidiasis among symptomatic women in Calabar, Nigeria. *Studies in Fungi* 11: e032 https://doi.org/10.48130/sif-0026-0031

Introduction

Vulvovaginal candidiasis (VVC) is one of the most common fungal infections affecting women of reproductive age worldwide. It is estimated that approximately 70%–75% of women experience at least one episode of VVC during their lifetime, while 5%–8% develop recurrent disease. Although *Candida* species are normal commensals of the vaginal microbiota and may colonize the vagina without causing symptoms, vulvovaginal candidiasis occurs when an overgrowth of *Candida* species triggers an inflammatory response resulting in characteristic clinical manifestations such as vulvar pruritus, burning sensation, soreness, irritation, dyspareunia, dysuria, and abnormal vaginal discharge[1,2].

The distinction between *Candida* colonization and symptomatic VVC is clinically important. Vaginal colonization refers to the presence of *Candida* species in asymptomatic women without evidence of inflammation, whereas VVC is diagnosed when compatible symptoms and signs occur in association with *Candida* detection after alternative causes of vaginitis have been excluded[1,3]. Because the symptoms of VVC overlap with those of bacterial vaginosis, trichomoniasis, and other genital tract infections, laboratory confirmation remains essential for accurate diagnosis. Recent advances in culture-based and molecular diagnostic methods have enhanced the identification of *Candida* species and mixed infections, thereby improving diagnostic accuracy and patient management[3].

Candida albicans remains the predominant cause of VVC worldwide; however, an increasing prevalence of non-*albicans Candida* (NAC) species, including *Candida glabrata, Candida tropicalis, Candida parapsilosis*, and *Candida krusei*, has been reported in recent years. This epidemiological shift is of clinical concern because several NAC species exhibit reduced susceptibility or intrinsic resistance to commonly used azole antifungal agents, potentially leading to treatment failure and recurrent infections[4,5].

Intrauterine contraceptive devices (IUCDs) are among the most widely used reversible contraceptive methods globally because of their effectiveness, affordability, and long duration of action. However, concerns remain regarding their potential influence on the vaginal microbiota and the development of genital tract infections. Some studies have reported no significant association between IUCD use and VVC, whereas others suggest that IUCDs may facilitate *Candida* adherence and biofilm formation on the device surface, creating a reservoir that promotes persistence and recurrence of infection[6,7]. Biofilm-producing *Candida* isolates are particularly important because they demonstrate enhanced virulence and increased resistance to antifungal agents.

The distribution of *Candida* species and their antifungal susceptibility patterns vary according to geographical location, host characteristics, and contraceptive practices[5]. In Nigeria, most studies investigating VVC among women using contraceptive devices have been conducted in other regions of the country, with limited information available from South-South Nigeria. Furthermore, data

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https://doi.org/10.48130/sif-0026-0031

on *Candida* species distribution, biofilm production, antifungal susceptibility profiles, and the association between duration of IUCD use and VVC occurrence among symptomatic women in Calabar remain scarce.

This study aimed to determine the association between IUCD use, duration of use, *Candida* species distribution, and vulvovaginal candidiasis among symptomatic women of reproductive age in Calabar, Nigeria. The study also assessed biofilm production and the antifungal susceptibility profiles of the isolates. The findings will contribute to the understanding of VVC epidemiology in the region and provide evidence to guide clinical management and contraceptive counseling.

Materials and methods

Subjects and study design

Ethical approval for this study was obtained from the Ethics Research Committee of UCTH with reference number: NHREC/07/10/2012/UCTH/HREC/33/570. Informed consent was obtained from all participants before enrolment into the study. All the participants signed a written informed consent form. A structured questionnaire was administered to the subjects to obtain data on IUCD usage, socio-demographics, and history of vulvovaginal candidiasis and antifungal medication. The study was a comparative cross-sectional study on symptomatic women of childbearing age, 20–45 years (IUCD group) compared with symptomatic, age-matched women using other forms of contraceptives (non-IUCD group). All participants were using some form of contraception. Participants were women attending family planning and gynaecology clinics in selected public and private healthcare facilities in Calabar Municipality during the study period. They were recruited using a simple random sampling method. The duration of this research study was one year. It ran from February 2023 to February 2024. Two hundred and fifty participants were recruited for the study. They comprised 150 copper-T IUCD users and 100 women using other forms of contraceptives (non-IUCD group). The other contraceptive methods were oral contraceptive pills, Injectables, implants, and barrier methods.

All participants were symptomatic with one or more clinical symptoms, including vulvovaginal itching, abnormal vaginal discharge, soreness, irritation, burning sensation, or dyspareunia at presentation. Women with vaginal symptoms below 20 years or over 45 years, those on antifungal therapy for the past 30 d and pregnant women were excluded from the study. Participants included those with first-time and recurrent episodes of VVC.

Sample size determination

The minimum sample size for the comparative cross-sectional study was calculated using the formula[8] for comparison of two proportions:

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2[P_1(1-P_1) + P_2(1-P_2)]}{(P_1 - P_2)^2}$$

where, $Z_{\alpha/2}$ = 1.96 (95% confidence level); Z_{β} = 0.84 (80% power); P_1 = 0.18; P_2 = 0.406.

Using the prevalence by Okungbowa et al.[9] (P_1 = 18% = 0.18) and a comparison prevalence from a non-IUCD population of approximately 40.6% (0.406) reported by Enweani et al.[10] among non-contraceptive users in Nigeria, the sample size was estimated as follows.

$$n = \frac{(1.96 + 0.84)^2[0.18(0.82) + 0.406(0.594)]}{(0.18 - 0.406)^2} = \frac{7.84 \times 0.3888}{0.0511} = 59.6$$

$n \approx 60$ participants per group

Adjusting for 10% non-response $n_f = \frac{60}{1 - 0.10} = 67$ participants per group

Total sample size = 67 × 2 = 134 participants

The minimum sample size was calculated using the formula for comparing two proportions. An expected prevalence of vulvovaginal candidiasis of 18% among IUCD users was obtained from a previous study by Okungbowa et al.[9], while a prevalence of 40.6% among non-IUCD users was obtained from a Nigerian study by Enweani et al.[10]. Using a 95% confidence level, 80% study power, and a 10% allowance for non-response, the minimum sample size was calculated to be 67 participants per group (134 participants in total). However, a total of 250 participants comprising 150 IUCD users and 100 non-IUCD users were recruited for the study.

Specimen collection and analysis

High vaginal swab was collected from the subjects using a sterile cotton swab and sterile speculum. The specimen was collected by gynaecologists and attending nurses in the clinic. Samples were transported within 1 h of collection to the Microbiology/Parasitology Department, UCTH for processing. One hundred and fifty samples were collected from subjects with IUCD, while 100 samples were collected from the non-IUCD group.

The samples were subjected to microscopic examination using a wet mount for the detection of pus and yeast cells in physiological saline. Samples were cultured on Sabouraud dextrose agar (SDA) supplemented with 0.05 g/L of Chloramphenicol. Inoculated plates were incubated at 37 °C for 24 to 48 h. A diagnosis of VVC was established in symptomatic women with laboratory evidence of *Candida* species detected by microscopy and/or culture from high vaginal swab specimens. Culture positivity was considered the primary laboratory criterion for confirmation of *Candida* infection, while microscopy served as a supportive diagnostic method. Identification of *Candida* isolates was done using CHROMagar *Candida* medium (BioMérieux, France) and API *Candida* kits[11]. Isolates from Sabouraud dextrose agar purity plates were inoculated on CHROMagar *Candida* medium following the manufacturer's instructions. The plates were incubated aerobically at 37 °C for 48 to 72 h for species identification by chromogenic changes[12]. Reference strains including *Candida albicans* ATCC 90028, *Candida krusei* ATCC 6258, *Candida glabrata* ATCC 90030 and *Candida tropicalis* ATCC 750 were used periodically to verify the performance of CHROMagar *Candida* and API *Candida* identification systems. *Candida* biofilm detection test was done using the Congo red agar method[13]. Black colonies with a dry crystalline appearance on Congo red agar were interpreted as positive for biofilm production, while pink to red colonies were considered non-biofilm producers. Specimen identifiers were coded before laboratory analysis to minimize observer bias[7,14].

Antifungal susceptibility testing

Antifungal susceptibility testing of *Candida* isolates was performed using the Epsilometer test (E-test) method according to the manufacturer's instructions, and minimum inhibitory concentrations (MICs) were interpreted in accordance with current CLSI guidelines[15,16]. The antifungal agents tested were: Fluconazole (FCZ) (0.016–256 μg/mL), Itraconazole (ICZ) (0.002–32 μg/mL), and Voriconazole (VCZ) (0.002–32 μg/mL). The E-test directly quantifies

antifungal susceptibility, indicating the minimum inhibitory concentration (MIC) values.

Statistical analysis

Data generated from questionnaires and results of the laboratory analysis were analyzed using SPSS software (v.20; IBM Corporation, NY, USA). Frequencies and percentages were used for descriptive analysis. Associations between categorical variables were assessed using Pearson's Chi-square test. Multivariable logistic regression was used to test the association between IUCD use and VVC occurrence. Statistical significance was set at $p \leq 0.05$ with a 95% confidence interval.

Results

Out of the 250 symptomatic subjects recruited for the study, 150 (60.0%) were IUCD users, while 100 (40.0%) were on other forms of contraceptives (non-IUCD group). Most of the IUCD users were within the age range of 26–30 years (45; 30%), while those aged 41–45 years were only 11 (7.3%). Among the non-IUCD group, most of the subjects were aged 21–25 years (31.0%), and the smallest proportion of subjects were aged 41–45 years (12.0%). On the grounds of occupation, most of the women who were on IUCD were housewives (62; 41.3%) compared to the non-IUCD users who were employed (44; 44.0%). There was a significant association between occupation and IUCD use ($\chi^2 = 20.2$; $p = 0.01$) (Table 1). Most of the women using IUCDs were married (62.0%), while the majority of non-IUCD users were single (73.0%). There was a significant association between marital status and IUCD use ($\chi^2 = 29.4$, $p = 0.001$) (Table 1).

A multivariable logistic regression analysis was performed to determine whether IUCD use remained independently associated with vulvovaginal candidiasis after controlling for age, marital status, parity, and occupation. IUCD use was strongly associated with increased odds of VVC after adjustment for age, marital status, occupation, and parity (AOR = 245.56, 95% CI: 72.51–831.56, $p < 0.001$), while acknowledging that the precise magnitude of the association should be interpreted cautiously due to the wide confidence interval. Age ($p = 0.946$), marital status ($p = 0.512$), and parity ($p = 0.260$) were not significantly associated with VVC. Among occupational categories, housewives demonstrated significantly lower odds of VVC compared with women engaged in business activities (AOR = 0.21, 95% CI: 0.05–0.92, $p = 0.038$). This finding demonstrated a strong independent association between IUCD use and VVC rather than establishing a causal relationship (Table 2).

Out of the 150 IUCD users, 115 (76.6%) had vulvovaginal candidiasis, while the infection rate among non-IUCD users was 30 (30%). IUCD use was significantly associated with a higher occurrence of VVC among symptomatic women in this study ($\chi^2 = 53.6$; $p < 0.001$) (Table 3).

The most encountered *Candida* species among both groups was *Candida albicans* 65 (44.8%), followed by *Candida krusei* (34; 23.4%), while the least encountered species was *Candida tropicalis* (19; 13.1%). There was a significant association between *Candida* species distribution among IUCD users and non-IUCD users ($\chi^2 = 55.8$; $p = 0.01$) (Table 4).

The highest infection rates 23 (92.0%) occurred among women who had used IUCD for four to five years, followed by those who had used it for more than six years 31 (88.6%), while women who wore IUCD for zero to one year had the lowest infection rates 16 (53.3%). There was a significant association between the duration of IUCD use and the occurrence of VVC ($\chi^2 = 19.2$, $p = 0.004$) (Table 5).

Table 6 shows *Candida* biofilm formation by isolates from IUCD users in the study. *Candida albicans* was the highest biofilm

Table 1. Socio-demographic characteristics of study participants.

Characteristics		No. (%) of subjects using IUCD	No. (%) of non-IUCD users	Statistics
Age	21–25	35 (23.3)	31 (31.0)	
	26–30	45 (30.0)	29 (29.0)	
	31–35	36 (27.0)	13 (13.0)	$\chi^2 = 6.48$
	36–40	23 (15.3)	15 (15.0)	$p = 0.16$
	41–45	11 (7.3)	12 (12.0)	
	Total	150	100	
Occupation	Business	37 (24.7)	41 (41.0)	$\chi^2 = 20.2$
	Employed	51 (34.0)	44 (44.0)	$p = 0.01$
	House wife	62 (41.3)	15 (15.0)	
	Total	150	100	
Parity	1	25 (16.6)	12 (12.0)	
	2	52 (34.7)	53 (53.0)	$\chi^2 = 8.2$
	> 3	73 (48.7)	35 (35.0)	$p = 0.01$
	Total	150	100	
Marital status	Single	57 (38.0)	73 (73.0)	$\chi^2 = 29.4$
	Married	93 (62.0)	27 (27.0)	$p = 0.01$

Table 2. Multivariable logistic regression on vulvovaginal candidiasis (VVC) and IUCD use.

Variables	Adjusted odds ratio (AOR)	95% CI	*p*-value
IUCD use	245.56	72.51–831.56	< 0.001
Age	1.00	0.92–1.09	0.946
Single and married	0.62	0.15–2.60	0.512
Employed and business	0.75	0.23–2.48	0.634
Housewife and business	0.21	0.05–0.92	0.038
Parity	0.74	0.44–1.25	0.260

Table 3. Occurrence of VVC among IUCD and non IUCD users.

IUD usage	No. examined	No. (%) of subjects with VVC	Statistics
IUCD group	150	115 (76.6%)	$\chi^2 = 53.6$
Non-IUCD group	100	30 (30.0%)	$p < 0.001$

Table 4. Distribution of *Candida* species among IUCD and non IUCD users.

Candida species	No. (%) of IUCD users	No. (%) of non-IUCD users	Total	Statistics
Candida albicans	50 (43.5)	15 (50)	65 (44.8)	$\chi^2 = 55.8$
Candida glabrata	22 (19.1)	5 (16.7)	27 (18.6)	$p = 0.01$*
Candida krusei	26 (22.6)	8 (26.7)	34 (23.4)	
Candida tropicalis	17 (14.7)	2 (6.7)	19 (13.1)	
Total	115 (79.3)	30 (20.7)	145	

The symbol * means *p* is statistically significant.

Table 5. Relationship between duration of IUCD use and VVC infection rate.

Duration of use (year)	No. examined	No. (%) of subjects with VVC	Statistics
0–1	30	16 (53.3)	
2–3	60	45 (75.0)	$\chi^2 = 19.2$
4–5	25	23 (92.0)	$p = 0.004$*
> 6	35	31 (88.6)	
Total	150	115 (76.7)	

The symbol * means statistically significant.

https://doi.org/10.48130/sif-0026-0031

Table 6. *Candida* biofilm formation by isolates from IUCD users.

Candida species	No. of isolates tested	No. (%) of biofilm positive isolates	Statistics
Candida albicans	50	30 (60.0)	$\chi^2 = 8.70$
Candida glabrata	22	7 (31.8)	$p = 0.17$
Candida krusei	26	10 (38.5)	
Candida tropicalis	17	8 (47.1)	
Total	115	55 (47.8)	

producer (60.0%), followed by *C. tropicalis* (47.1%). The *Candida* species with the lowest rate of biofilm formation was *C. glabrata* (31.8%). There was no significant variation in the rate of biofilm formation by the different *Candida* species isolated from IUCD users ($\chi^2 = 8.70$; $p = 0.17$).

Table 7 shows the distribution of VVC among the non-IUCD group on other contraceptives. Most of the participants on other forms of contraception used oral contraceptives (70; 70.0%). The least used method of contraception in the study was injectables (8; 8.0%). Subjects on the Norplant implant suffered a higher rate of candidiasis (5; 41.7%), followed by subjects on emergency contraceptives (4; 40.0%), while those on oral contraceptives had the lowest rate of VVC (18; 25.7%). There was no statistically significant variation in the distribution of VVC among non-IUCD users.

The most common presenting symptom in women using IUCD was genital pruritus (45; 30.0%), followed by vaginal discharge (30; 20.0%). The least common presenting symptoms were dysmenorrhoea (9; 6.0%) and increased menstrual flow (9; 6.0%), respectively (Table 8).

The resistance pattern of different *Candida* species to antifungal agents among women who used intrauterine contraceptive devices (IUCDs) is shown in Table 9. *Candida albicans* and *Candida glabrata* exhibited high levels of *in vitro* resistance to Fluconazole and Itraconazole, with 50% or more of the isolates classified as resistant. Voriconazole demonstrated the highest *in vitro* activity against most *Candida* species tested, although some isolates of *Candida krusei* (6; 23.1%) and *Candida tropicalis* (5; 29.4%) were categorized as susceptible dose-dependent. The results represent *in vitro* antifungal susceptibility testing and should not be interpreted as direct evidence of clinical treatment failure.

Table 7. Distribution of VVC among non IUCD group on other methods of contraceptives.

Contraceptives	No. of subjects	No. of subjects with VVC (%)	Statistics
Oral contraceptives	70	18 (25.7)	$\chi^2 = 1.85$
Injectables	8	3 (37.5)	$p = 0.60$
Emergency contraceptives	10	4 (40.0)	
Norplant implant	12	5 (41.7)	
Total	100	30 (30.0)	

Table 8. Symptoms of vaginitis among subjects using IUCD.

Symptoms	No. (%) of subjects
Dysmenorrhoea	9 (6.0)
Dyspareunia	11 (7.3)
Erosion around the cervix	20 (13.3)
Increased menstrual flow	9 (6.0)
Decreased menstrual flow	10 (6.7)
Genital pruritus	45 (30.0)
Vaginal discharge	30 (20.0)
Redness of the vulva	16 (10.7)

Table 9. Resistance profile of *Candida* species isolated from IUCD users with VVC in Calabar.

Candida species	No. of isolates	Antifungal agents tested	SDD' (%)	No. (%) of isolates resistant (R)
Candida albicans	50	Fluconazole	25 (50.0)	25 (50.0)
		Itraconazole	15 (30.0)	35 (70.0)
		Voriconazole	0 (0.0)	0 (0.0)
Candida glabrata	22	Fluconazole	10 (45.5)	12 (54.5)
		Itraconazole	8 (36.4)	14 (63.6)
		Voriconazole	0 (0.0)	0 (0.0)
Candida krusei	26	Fluconazole	10 (38.5)	16 (61.5)
		Itraconazole	8 (30.8)	18 (69.2)
		Voriconazole	6 (23.1)	0 (0.0)
Candida tropicalis	17	Fluconazole	7(41.2)	10(58.8)
		Itraconazole	6 (35.3)	11 (64.7)
		Voriconazole	5 (29.4)	0 (0.0)

KEY: R (%): Percentage of isolates that were resistant to the antifungal. SDD (%): Percentage of isolates with susceptible dose-dependence (SDD), meaning they require higher doses of the antifungal to be effective.

Discussion

This study recorded a significantly higher prevalence of vulvovaginal candidiasis (VVC) among IUCD users compared with non-IUCD users. Although IUCD use remained significantly associated with VVC after adjustment for age, marital status, occupation, and parity, the very large adjusted odds ratio and wide confidence interval suggest that the estimated effect size should be interpreted with caution. Furthermore, important VVC risk factors, including diabetes mellitus, recent antibiotic exposure, pregnancy status, immunosuppression, hormonal influences, and other behavioural factors, were not included in the regression model. Therefore, residual confounding cannot be excluded. Similar findings have been reported in several studies that observed increased *Candida* colonization and a higher frequency of vaginal infections among women using intrauterine contraceptive devices[17,18]. However, other investigators have suggested that factors such as antibiotic exposure, diabetes mellitus, sexual behaviour, hormonal status, personal hygiene practices, and host susceptibility may exert a greater influence on VVC occurrence than contraceptive method alone[19]. The discrepancies among studies may reflect differences in study design, participant characteristics, diagnostic criteria, and methods used for *Candida* identification. While our findings demonstrate a strong association between IUCD use and VVC, the unmeasured confounders limit causal inference. Future studies incorporating a broader range of clinical and behavioural risk factors are needed to better quantify the independent effect of IUCD use on VVC risk.

Candida albicans was the predominant species isolated from both IUCD and non-IUCD groups, consistent with numerous studies identifying *C. albicans* as the principal aetiologic agent of vulvovaginal candidiasis worldwide[19]. Nevertheless, non-*albicans Candida* species, particularly *Candida krusei* and *Candida tropicalis*, were also recovered from participants in both groups. The presence of these species is clinically relevant because non-*albicans Candida* species have increasingly been reported among women with VVC and are often associated with recurrent infections and reduced susceptibility to commonly used antifungal agents[2,19]. The recovery of these species in the present study highlights the changing epidemiology of vulvovaginal candidiasis and points to the importance of species-level identification in the management of VVC.

Biofilm production was observed among *Candida* isolates recovered from IUCD users, with *Candida albicans* demonstrating the highest proportion of biofilm-producing isolates. However, the

differences in biofilm formation among *Candida* species were not statistically significant. Consequently, the present findings suggest that biofilm formation may be common among vaginal *Candida* isolates, but the study does not provide sufficient evidence to conclude that any particular species possesses a significantly greater biofilm-forming capacity than others. Biofilm formation is recognized as an important virulence factor in *Candida* infections because it enhances microbial persistence and tolerance to antifungal agents[20]. Additional studies employing quantitative biofilm assays and larger sample sizes are needed to clarify species-specific differences in biofilm production.

In vitro antifungal susceptibility testing revealed high resistance among *Candida* isolates recovered from IUCD users with vulvovaginal candidiasis. Resistance to itraconazole was particularly high across all *Candida* species, ranging from 63.6% in *Candida glabrata* to 70.0% in *Candida albicans*. Similarly, considerable resistance to fluconazole was observed, with resistance rates of 50.0%, 54.5%, 61.5%, and 58.8% among *Candida albicans*, *Candida glabrata, Candida krusei,* and *Candida tropicalis*, respectively. These findings suggest that azole resistance may represent a significant therapeutic challenge in the study population.

The high prevalence of fluconazole resistance observed in this study is consistent with reports from several developing countries where extensive empirical use of azole antifungals has been associated with the emergence of resistant *Candida* strains[21,22]. The highest fluconazole resistance was observed among *Candida krusei* (61.5%), followed by *Candida tropicalis* (58.8%) and *Candida glabrata* (54.5%). These findings are clinically important because infections caused by resistant isolates may result in treatment failure and recurrent vulvovaginal candidiasis. Previous studies have also reported increasing resistance among non-*albicans Candida* species, particularly *Candida glabrata* and *Candida krusei*, which are increasingly recognized as important causes of recurrent and difficult-to-treat VVC[19,23].

In contrast, all *Candida albicans* and *Candida glabrata* isolates were susceptible to voriconazole, while no resistance was detected among *Candida krusei* and *Candida tropicalis* isolates despite the presence of susceptible dose-dependent isolates. This finding suggests that voriconazole may retain good *in vitro* activity against *Candida* species circulating in the study population. Similar observations have been reported in studies demonstrating superior activity of second-generation triazoles against *Candida* species exhibiting reduced susceptibility to fluconazole and itraconazole[24,25].

A substantial proportion of isolates also demonstrated susceptible dose-dependent (SDD) responses to the tested azoles. For fluconazole, SDD rates ranged from 38.5% to 50.0%, while itraconazole SDD rates ranged from 30.0% to 36.4%. The presence of SDD isolates suggests that therapeutic success may depend on achieving adequate drug concentrations and highlights the importance of susceptibility-guided therapy[16]. Collectively, these findings underscore the need for routine antifungal susceptibility testing to guide treatment decisions and support antifungal stewardship programmes aimed at limiting the further emergence of resistant *Candida* strains.

The high rates of azole resistance observed in this study may also be considered alongside the biofilm-producing ability of the *Candida* isolates. Although species-specific differences in biofilm formation were not statistically significant, biofilm production was common among isolates, particularly *Candida albicans*. Biofilms are known to provide a protective environment that reduces antifungal penetration and enhances microbial persistence[20]. The coexistence of biofilm production and elevated azole resistance among isolates recovered from IUCD users may contribute to persistent or recurrent infections. However, because the present study did not evaluate the direct association between biofilm production and antifungal resistance, this relationship should be interpreted cautiously and warrants further investigation.

Limitations of study

This study was limited by its clinic-based design, unequal group sizes, and lack of molecular confirmation of *Candida* species. Intravaginal cleansing practices may influence vaginal microbiota and vulvovaginal candidiasis occurrence; unfortunately, this study did not collect information on douching practices, intravaginal cleansing agents, or intimate hygiene products. This study also did not collect data on risk factors such as diabetes status, HIV infection, recent antibiotic use, sexual activity, and duration of replacement of the IUCD and therefore could not be evaluated. We recognize that molecular confirmation of *Candida* species using ITS sequencing would provide more robust identification, particularly for non-albicans *Candida* species, but this was beyond the scope of this study.

Conclusions

The study revealed IUCD use was significantly associated with a higher occurrence of VVC, as participants with IUCD experienced higher infection rates compared to non-users. Although *Candida albicans* is the leading cause of VVC, in this study, non-*albicans* species were more prevalent 65 (56.5%) among IUCD users, raising concerns about antifungal resistance. Family planning and VVC infection management strategies should be tailored to address the specific needs of women, especially those using IUCDs, to mitigate the risk of VVC and improve reproductive health outcomes.

Ethical statements

Ethical approval for this study was obtained from the Ethics Research Committee of UCTH with reference number: NHREC/07/10/2012/UCTH/HREC/33/570. Informed consent was obtained from all participants before enrolment into the study. All the participants signed a written informed consent.

Author contributions

The authors confirm their contributions to the paper as follows: study conception and design: Ogba OM, Ibe H; data collection: Ogba OM, Ibe H, Inah IO, Obongha EE; analysis and interpretation of results: Ogba OM, Ibe H, Akpan NG; draft manuscript preparation: Ogba OM, Ibe H, Nyambi ES. All authors reviewed the results and approved the final version of the manuscript.

Data availability

The datasets generated and/or analyzed in the current study are available from the corresponding author upon reasonable request.

Acknowledgments

We are grateful to the management and staff of the Microbiology Laboratory, UCTH Calabar, for their support and provision of facilities used in this research.

https://doi.org/10.48130/sif-0026-0031

Conflict of interest

The authors declare that they have no conflict of interest.

Dates

Received 29 December 2025; Revised 25 July 2026; Accepted 27 July 2026; Published online 2 November 2026

References

[1] San Juan Galán J, Poliquin V, Gerstein AC. 2023. Insights and advances in recurrent vulvovaginal candidiasis. *PLoS Pathogens* 19(11):e1011684

[2] Willems HME, Ahmed SS, Liu J, Xu Z, Peters BM. 2020. Vulvovaginal candidiasis: a current understanding and burning questions. *Journal of Fungi* 6(1):27

[3] Workowski KA, Bachmann LH, Chan PA, Johnston CM, Muzny CA, et al. 2021. Sexually transmitted infections treatment guidelines, 2021. *MMWR Recommendations and Reports* 70(4):1−187

[4] Pappas PG, Kauffman CA, Andes DR, Clancy CJ, Marr KA, et al. 2016. Executive summary: clinical practice guideline for the management of candidiasis: 2016 update by the infectious diseases society of America. *Clinical Infectious Diseases* 62(4):409−417

[5] Intra J, Sala MR, Brambilla P, Carcione D, Leoni V. 2022. Prevalence and species distribution of microorganisms isolated among non-pregnant women affected by vulvovaginal candidiasis: a retrospective study over a 20 year-period. *Journal of Medical Mycology* 32(3):101278

[6] Donders G, Sziller IO, Paavonen J, Hay P, de Seta F, et al. 2022. Management of recurrent vulvovaginal candidosis: narrative review of the literature and European expert panel opinion. *Frontiers in Cellular and Infection Microbiology* 12:934353

[7] Pan Y, Sun Y, Chen L, Cheng Y, Jin P, et al. 2023. *Candida* causes recurrent vulvovaginal candidiasis by forming morphologically disparate biofilms on the human vaginal epithelium. *Biofilm* 6:100162

[8] Fleiss JL, Levin B, Paik MC. 2003. *Statistical Methods for Rates and Proportions*. Hoboken, N.J.: John Wiley & Sons Inc. pp. 760 doi: 10.1002/0471445428

[9] Okungbowa FI, Isikhuemhen OS, Dede AP. 2003. The distribution frequency of *Candida* species in the genitourinary tract among symptomatic individuals in Nigerian cities. *Revista Iberoamericana de Micologia* 20(2):60−63

[10] Enweani IB, Gugnani HC, Okobia R, Ojo SB. 2001. Effect of contraceptives on the prevalence of vaginal colonization with Candida species in Edo State, Nigeria. *Revista Iberoamericana de Micologia* 18(4):171−173

[11] de Souza CM, Dos Santos MM, Furlaneto-Maia L, Furlaneto MC. 2023. Adhesion and biofilm formation by the opportunistic pathogen *Candida tropicalis*: what do we know? *Canadian Journal of Microbiology* 69(6):207−218

[12] Ogba OM, Chidinma BD, Inah IO, Ogba RO, Akpan NG, et al. 2024. Catheter associated *Candiduria* among in-patients accessing care in a Tertiary Health Institution in Calabar, Nigeria. *Sokoto Journal of Medical Laboratory Science* 9(3):227−236

[13] Coignard C, Hurst SF, Benjamin LE, Brandt ME, Warnock DW, et al. 2004. Resolution of discrepant results for *Candida* species identification by using DNA probes. *Journal of Clinical Microbiology* 42:858−861

[14] Harriott MM, Lilly EA, Rodriguez TE, Fidel PL, Noverr MC. 2010. *Candida albicans* forms biofilms on the vaginal mucosa. *Microbiology* 156:3635−3644

[15] Espinel-Ingroff A. 2022. Commercial methods for antifungal susceptibility testing of yeasts: strengths and limitations as predictors of resistance. *Journal of Fungi* 8(3):309

[16] Clinical and Laboratory Standards Institute (CLSI). 2022. *Performance standards for antifungal susceptibility testing of yeasts* (3rd ed., CLSI supplement M27M44S)

[17] Farr A, Effendy I, Frey Tirri B, Hof H, Mayser P, et al. 2021. Guideline: vulvovaginal candidosis (AWMF 015/072, level S2k). *Mycoses* 64(6):583−602

[18] Sherrard J, Donders G, White D, Jensen JS. 2011. European (IUSTI/WHO) guideline on the management of vaginal discharge. *International Journal of STD & AIDS* 22(8):421−429

[19] Gaziano R, Sabbatini S, Monari C. 2023. The interplay between *Candida albicans*, vaginal mucosa, host immunity and resident microbiota in health and disease: an overview and future perspectives. *Microorganisms* 11(5):1211

[20] Cavalheiro M, Teixeira MC. 2018. *Candida* biofilms: threats, challenges, and promising strategies. *Frontiers in Medicine* 5:28

[21] Bitew A, Abebaw Y. 2018. Vulvovaginal candidiasis: species distribution of Candida and their antifungal susceptibility pattern. *BMC Women's Health* 18:94

[22] Bhattacharya S, Sae-Tia S, Fries BC. 2020. Candidiasis and mechanisms of antifungal resistance. *Antibiotics* 9(6):312

[23] Cornely OA, Sprute R, Bassetti M, Chen SCA, Groll AH, et al. 2025. Global guideline for the diagnosis and management of candidiasis: an initiative of the ECMM in cooperation with ISHAM and ASM. *The Lancet Infectious Diseases* 25(5):e280−e293

[24] Donders GGG, Bellen G, Ruban K, Van Bulck B. 2018. Short- and long-term influence of the levonorgestrel-releasing intrauterine system (Mirena®) on vaginal microbiota and *Candida*. *Journal of Medical Microbiology* 67(3):308−313

[25] Pfaller MA, Diekema DJ, Turnidge JD, Castanheira M, Jones RN. 2019. Twenty years of the SENTRY antifungal surveillance program: results for *Candida* species from 1997−2016. *Open Forum Infectious Diseases* 6(1):S79−S94

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