

Oteseconazole versus fluconazole for the treatment of severe vulvovaginal candidiasis: a multicenter, randomized, double-blinded, phase 3 trial

Xiaoqian Wang,¹ Lihong Chen,² Hongjie Ruan,³ Zhengai Xiong,⁴ Wenyong Wang,⁵ Jin Qiu,⁶ Weihua Song,⁷ Chunlian Zhang,⁸ Fengxia Xue,⁹ Tianhua Qin,¹⁰ Bei Zhang,¹¹ Ruifang An,¹² Xiping Luo,¹³ Wei Wang,¹⁴ Songling Zhang,¹⁵ Yunlang Cai,¹⁶ Jiali Kang,¹⁷ Henan Deng,¹⁸ Shangrong Fan,¹⁹ Manhua Cui,²⁰ Shijin Wang,²¹ Xiaowan Luo,²² Zhiying Su,²³ Jing Shu,²⁴ Quanren Wang,²⁵ Fang Wang,²⁵ Jianling Bai,²⁶ Qinqing Liao¹

AUTHOR AFFILIATIONS See affiliation list on p. 10.

ABSTRACT Vulvovaginal candidiasis (VVC) is a common condition among women. Fluconazole remains the dominant treatment option for VVC. Oteseconazole is a highly selective inhibitor of fungal CYP51. This randomized, double-blinded, phase 3 trial was conducted to evaluate the efficacy and safety of oteseconazole compared with fluconazole in treating severe VVC. Female subjects presenting with vulvovaginal signs and symptoms score of ≥ 7 and positive *Candida* infection determined by potassium hydroxide test or Gram staining were randomly assigned to receive oteseconazole (600 mg on D1 and 450 mg on D2) or fluconazole (150 mg on D1 and D4) in a 1:1 ratio. The primary endpoint was the proportion of subjects achieving therapeutic cure [defined as achieving both clinical cure (absence of signs and symptoms of VVC) and mycological cure (negative culture of *Candida* species)] at D28. A total of 322 subjects were randomized and 321 subjects were treated. At D28, a statistically significantly higher proportion of subjects achieved therapeutic cure in the oteseconazole group than in the fluconazole group (66.88% vs 45.91%; $P = 0.0002$). Oteseconazole treatment resulted in an increased proportion of subjects achieving mycological cure (82.50% vs 59.12%; $P < 0.0001$) and clinical cure (71.25% vs 55.97%; $P = 0.0046$) compared with fluconazole. The incidence of treatment-emergent adverse events was similar between the two groups. No subjects discontinued study treatment or withdrew study due to adverse events. Oteseconazole showed statistically significant and clinically meaningful superiority over fluconazole for the treatment of severe VVC and was generally tolerated.

KEYWORDS oteseconazole, *Candida albicans*, severe vulvovaginal candidiasis, fluconazole, *Candida glabrata*

Vulvovaginal candidiasis (VVC) is a mucosal fungal infectious disease that causes vulvovaginal itching, irritation, burning, soreness, fissuring, redness, vaginal discharge, and dyspareunia (1). Approximately 80% of women experience at least one occurrence of VVC in their lifetime, with a much higher incidence in women of reproductive age than menopausal women, seriously impacting their quality of life (2, 3). Despite that VVC is predominantly caused by *Candida albicans* (*C. albicans*), non-*C. albicans* species, especially *Candida glabrata* (*C. glabrata*), have been increasingly recognized as pathogens associated with VVC (4). Oral fluconazole remains the dominant treatment option for VVC and has achieved great success (5, 6). However, concerns have been raised regarding the development of drug resistance and reduced activity against non-*C. albicans* species (7, 8). In a previous *in vitro* antifungal susceptibility study of *Candida* species, it was observed that the resistance to fluconazole was noticeably higher in *C.*

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Address correspondence to Qinqing Liao, qinqing_liao@163.com.

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glabrata compared to *C. albicans*, with resistance rates of 73.3% and 16.6%, respectively (9). In addition, despite the remarkable therapeutic efficacy observed during fluconazole treatment, approximately 50% of the women experience disease relapse within 6 months of fluconazole cessation (7, 8). Therefore, novel antifungal drugs are still in great need.

Oteseconazole (formerly designated as VT-1161) is a novel, oral, highly selective inhibitor of fungal CYP51. Oteseconazole demonstrated a more than 2,000-fold selectivity for fungal CYP51 over human CYPs, thus potentially reducing the safety concerns caused by off-target toxicities (10). In an antifungal activity test against a panel of clinical isolates of *Candida* species, oteseconazole showed superior activity, with an average potency of a more than 40-fold greater than fluconazole for most species (11). More importantly, for fluconazole-resistant *C. glabrata*, the minimal inhibitory concentration (MIC) of oteseconazole was 64-fold lower than fluconazole (11, 12).

Previous phase 2 and phase 3 global studies with oteseconazole have demonstrated clinically meaningful efficacy in treating recurrent vulvovaginal candidiasis (RVVC), which was defined as ≥ 3 episodes of VVC within ≤ 12 months (13–16). In this phase 3 study, we compared the efficacy and safety of oteseconazole versus fluconazole for the treatment of severe VVC in Chinese women.

MATERIALS AND METHODS

Subject population

Female subjects aged ≥ 18 and ≤ 75 years with vulvovaginal signs and symptoms (VSS) score ≥ 7 were enrolled. The VSS score is determined with a standardized and predefined scoring system in which each sign (congestion and edema, scratches, rhagades and erosions, secretion volume) and symptom (itching, pain) was given a numerical rating based on severity. The severity of each item was graded from 0 to 3 (absent = 0, mild = 1, moderate = 2, and severe = 3), except for the item “scratches, rhagades and erosions” (absent = 0 and present = 3) (17). In addition, positive *Candida* species determined by the microscopic examination of a wet mount of vaginal discharge with potassium hydroxide (KOH) or Gram staining were required. For women of child-bearing potential, a negative pregnancy test at screening was a prerequisite, as well as the usage of contraception throughout the study and 6 months after the last administration of treatments. Subjects with RVVC or a history of RVVC or with concomitant vulvovaginitis caused by other pathogens were excluded. Other major exclusion criteria included the use of antifungal treatments (systemic and/or topical), CYP3A4 substrates, CYP3A4 inducers or inhibitors, and vulvovaginal corticosteroids; estrogen replacement therapy within 7 days before randomization; use of systemic corticosteroid treatments within 30 days before randomization or systemic immunosuppressant treatments within 90 days before randomization; a history of cervical cancer; or moderate to severe hepatic and/or renal disorders.

This study was performed between April 2021 and October 2021 at 26 sites in China. The study was conducted in accordance with the Declaration of Helsinki and the Guidelines for Good Clinical Practice. Each study site obtained independent ethics committee approval before the study initiation, and each subject provided written informed consent before participating in the study. This study was registered in ClinicalTrials.gov (NCT04956419).

Study design and procedures

Subjects were randomly assigned in a 1:1 ratio to the oteseconazole group or the fluconazole group. Subjects, investigators, site personnel, and the sponsor were all blinded to the treatment. To maintain blinding, all randomized subjects received matching oteseconazole or fluconazole placebo based on the treatment regimen, and study treatments had the same appearance.

In the oteseconazole group, subjects were orally administered with oteseconazole 600 mg (150 mg per capsule) and fluconazole matching placebo 150 mg (50 mg per capsule) on D1, oteseconazole 450 mg on D2, and fluconazole matching placebo 150 mg on D4. In the fluconazole group, subjects were orally administered with fluconazole 150 mg and oteseconazole matching placebo 600 mg on D1, oteseconazole matching placebo 450 mg on D2, and fluconazole 150 mg on D4. If clinically meaningful relief was not achieved, symptoms worsened, or signs of intolerance appeared and microscopic examination confirmed positive *Candida* infection 1 week after the initial dose, rescue therapy with clotrimazole vaginal tablet (Canesten, Bayer), 500 mg on D1 and D4, could be provided at the discretion of the investigator. A subject diary was used to record adverse events (AEs), study drug exposure, and concomitant medications from screening till the last visit and was retrieved at each visit.

Assessments and outcome measures

At baseline, D14, and D28, assessments of efficacy were performed in terms of VVC VSS scores (17); vaginal secretion fungal culture, strain identification, and *in vitro* antifungal susceptibility testing conducted by qualified central laboratory per Clinical and Laboratory Standards Institute M59 and M60 guidelines (18, 19) and European Committee on Antimicrobial Susceptibility Testing methods; and microscopic examination of vaginal secretion pathogen by KOH or Gram staining. The baseline was defined as the last measurement before treatment administration.

Safety was assessed by monitoring AEs, physical examinations, laboratory tests (hematology, clinical chemistry, and urinalysis), vital signs, and electrocardiograms (ECGs) from the time of signed consent to the end of the study. For women with child-bearing potential, a blood pregnancy test was performed at screening and at the D28 visit.

Endpoints

The primary efficacy endpoint was the proportion of subjects achieving therapeutic cure at D28, defined as the achievement of both clinical cure (absence of signs and symptoms of VVC) and mycological cure (negative culture of vaginal swabs for growth of *Candida* species). The secondary efficacy endpoints included the proportion of subjects reaching therapeutic cure at D14, the proportion of subjects achieving clinical cure at D14 and D28, the proportion of subjects achieving mycological cure at D14 and D28, and the percentage of subjects taking rescue medication during study treatment.

Statistical analyses

Efficacy analyses were performed in the modified intention-to-treat (mITT) population, which included all randomized subjects with positive mycological culture of *Candida* species at screening. For efficacy analyses, categorical data were summarized as percentages, with 95% confidence intervals (CIs) calculated by the Clopper-Pearson method. Treatment differences between the two groups were detected using Fisher's exact probability test, and the 95% CI of rate difference was calculated by the normal approximate method. For the endpoints of therapeutic cure, clinical cure, and mycological cure rates, analyses in the mITT subpopulation of subjects testing positive for *C. albicans* were also performed. Safety analysis set included all randomized subjects who received at least one dose of study treatment. AEs were coded using the Medical Dictionary for Regulatory Activities (MedDRA) version 24.1 and summarized by preferred term (PT) with a breakdown of treatment groups. All analyses were conducted using SAS software version 9.4 (SAS Institute Inc, Cary, North Carolina).

A sample size of 320 subjects (1:1 randomization) was required to provide 85% power to detect a non-inferiority margin of 12% between the oteseconazole group and the fluconazole group, with a one-sided α of 0.025 of Fisher's exact probability test, a 5% negative rate of vaginal swabs culture, a 10% dropout rate, and assuming therapeutic cure rates of 70% and 65% for the oteseconazole and fluconazole groups at D28 visit, respectively (13).

If the lower limit of the 95% CI for the between group difference was greater than -12% in the primary endpoint analysis, non-inferiority test was met. If non-inferiority was demonstrated, oteseconazole was to be tested for superiority compared with fluconazole for the primary endpoint. All statistical tests for the efficacy endpoints, except for the non-inferiority test in the primary analysis, were tested using a two-sided α of 0.05.

RESULTS

A total of 322 female subjects were randomized, with 161 subjects each in the oteseconazole and fluconazole groups, respectively. A total of 319 subjects had a confirmed positive culture for *Candida* species at screening and were included in the mITT population for efficacy evaluations. All subjects received treatments and were included in the safety analysis set, except for one subject in the oteseconazole group. A total of 316 subjects completed the study, with the reasons for premature study withdrawal being consent withdrawal ($n = 3$), investigator's decisions ($n = 2$), and lost to follow-up ($n = 1$) (Fig. 1).

The demographics and baseline disease characteristics were generally balanced between the two groups. Baseline mean VSS score was comparable between the oteseconazole (8.7) and fluconazole groups (8.4), with a range of 7–14 in both groups. Most subjects tested positive culture for *C. albicans* (78.1%), followed by *C. glabrata* (15.4%). *In vitro* susceptibility testing demonstrated that 309 and 233 strains were sensitive to oteseconazole and fluconazole, 6 and 32 strains were resistant to oteseconazole and fluconazole, 0 and 53 strains were dose-dependently sensitive to oteseconazole and fluconazole, respectively (Table 1). Oteseconazole yielded a lower MIC value for 90% of the organisms (MIC₉₀) than fluconazole for clinical isolates of *C. albicans* (0.25 vs 4 $\mu\text{g}/\text{mL}$) and *C. glabrata* (4 vs 16 $\mu\text{g}/\text{mL}$) (Table S1).

At D28, a statistically significantly higher proportion of subjects achieved therapeutic cure in the oteseconazole group than in the fluconazole group [66.88% vs 45.91%; difference (95% CI): 20.96% (10.32, 31.60); $P = 0.0002$] (Fig. 2a; Table S2). Consistent results were observed in subjects with a positive culture of *C. albicans*, where therapeutic cure was reported in 76.56% of subjects in the oteseconazole group versus 56.20% in the fluconazole group at D28 [difference (95% CI): 20.36% (8.87, 31.85); $P = 0.0007$] (Fig. 2b; Table S2).

Results of the secondary endpoints were supportive of the primary endpoint. At D28, the proportion of subjects achieving mycological cure was significantly higher in the oteseconazole group than in the fluconazole group [82.50% vs 59.12%; difference (95% CI): 23.38% (13.73, 33.03); $P < 0.0001$], which was also true in the subjects with a positive culture of *C. albicans* [92.19% vs 71.07%; difference (95% CI): 21.11% (11.79, 30.43); $P < 0.0001$]. A significantly higher clinical cure rate at D28 was shown with the treatment of oteseconazole versus fluconazole, in the overall mITT population [71.25% vs 55.97%; difference (95% CI): 15.28% (4.85, 25.70); $P = 0.0046$], as well as in the subpopulation of subjects with positive *C. albicans* [78.13% vs 61.98%; difference (95% CI): 16.14% (4.91, 27.37); $P = 0.0053$] (Fig. 2a and b; Table S2).

At D14, the proportions of subjects experiencing therapeutic cure and mycological cure were significantly higher in the oteseconazole group than in the fluconazole group [therapeutic cure rate: 52.50% vs 38.36%; difference (95% CI): 14.14% (3.32, 24.95); $P = 0.0112$ and mycological cure rate: 81.88% vs 66.67%; difference (95% CI): 15.21% (5.76, 24.66); $P = 0.0019$] (Fig. 2c; Table S3). Consistent results were observed in the subpopulation of subjects with positive *C. albicans* [therapeutic cure rate: 60.94% vs 45.45%; difference (95% CI): 15.48% (3.23, 27.74); $P = 0.0144$ and mycological cure rate: 92.19% vs 79.34%; difference (95% CI): 12.85% (4.27, 21.43); $P = 0.0036$] (Fig. 2d; Table S3). However, the clinical cure rate at D14 was similar between the two groups in the overall mITT population (56.88% in the oteseconazole group vs 50.31% in the fluconazole group, $P = 0.2401$) and in subjects with positive *C. albicans* (63.28% in the oteseconazole group vs 53.72% in the fluconazole group, $P = 0.1257$) (Table S3).

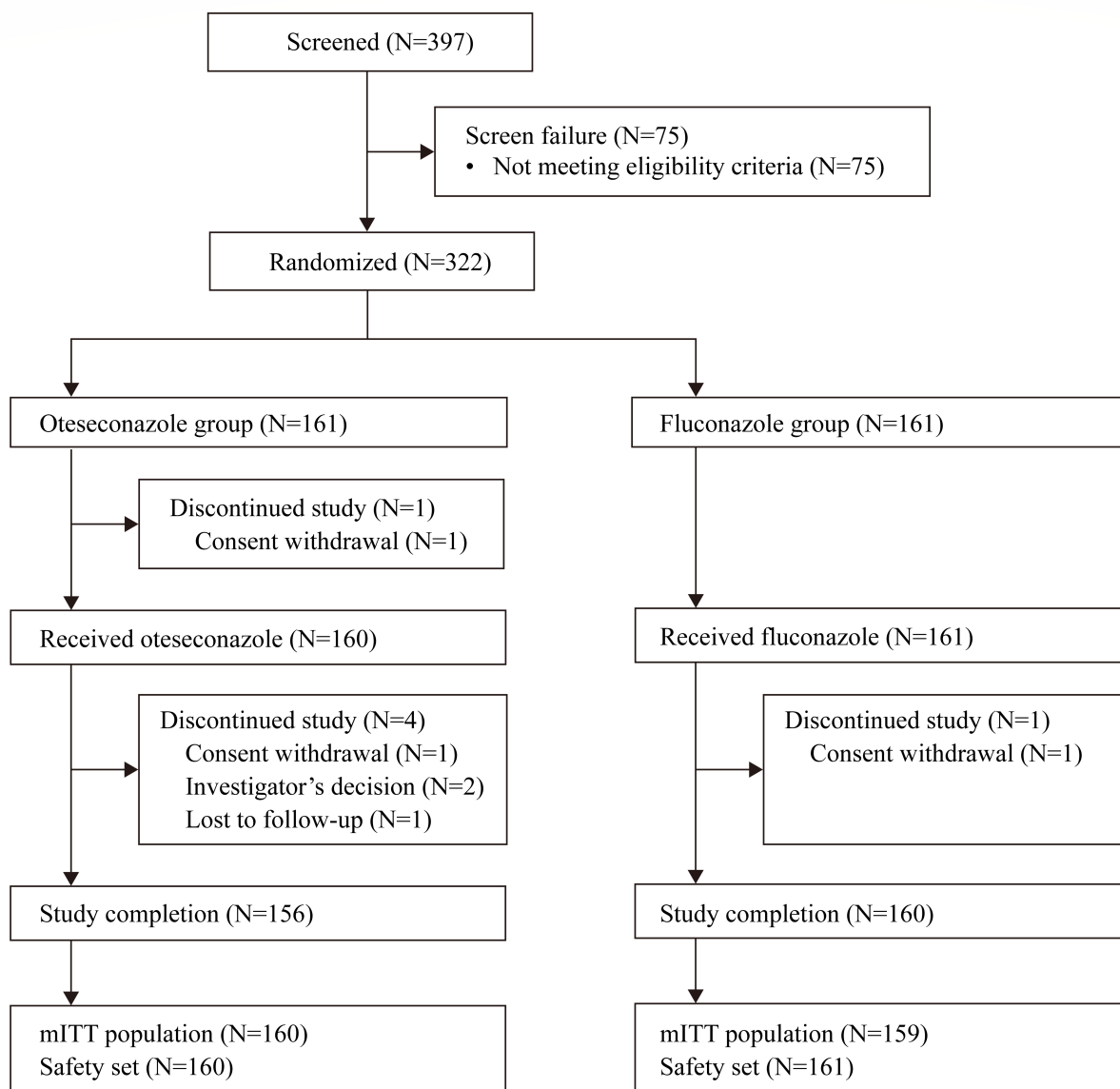


FIG 1 Subject disposition. Abbreviations: N, number of subjects; mITT, modified intention-to-treat.

Antifungal rescue medication usage was reported in 3.75% of subjects receiving oteseconazole versus 14.47% of subjects receiving fluconazole, and such difference was statistically significant ($P = 0.0009$).

In the oteseconazole group, one subject missed one capsule of oteseconazole on D1 and another subject missed one capsule of fluconazole matching placebo on D4, and all the other subjects administered treatments per the protocol, indicating a high compliance. There were 51.3% and 42.9% of subjects in the oteseconazole group and the fluconazole group, respectively, reporting at least one treatment-emergent adverse event (TEAE), among whom 21.9% and 19.9% of subjects experienced at least one treatment-related adverse event (TRAE), respectively. All TEAEs were mild or moderate in severity. In the oteseconazole group, the most commonly reported TEAEs by PT were urinary tract infection (8.1%), bacterial vulvovaginitis (4.4%), dizziness (3.8%), and headache (3.8%); while in the fluconazole group, the most commonly reported TEAEs by PT were bacterial vulvovaginitis (7.5%), bacterial vaginosis (6.2%), urinary tract infection (4.3%), and nausea (3.1%) (Table 2). No subjects discontinued treatments or study due to TEAEs. No deaths occurred in this study. One subject in the fluconazole group reported

TABLE 1 Demographics and baseline disease characteristics (mITT)^c

	Oteseconazole (N = 160)	Fluconazole (N = 159)
Age (year)		
Mean (SD)	29.9 (8.0)	31.2 (7.5)
Median (min, max)	29 (18, 70)	31 (18, 50)
Ethnicity		
Han	152 (95.0)	149 (93.7)
Other	8 (5.0)	10 (6.3)
Weight (kg)		
Mean (SD)	56.6 (9.2)	55.6 (8.7)
Median (min, max)	55.0 (42.0, 95.0)	55.0 (40.0, 90.0)
BMI (kg/m ²)		
Mean (SD)	21.4 (3.5)	21.5 (3.2)
Median (min, max)	20.8 (15.6, 37.1)	20.8 (16.4, 32.9)
Composite VSS score		
Mean (SD)	8.7 (1.8)	8.4 (1.8)
Median (min, max)	8.0 (7, 14)	8.0 (7, 14)
<i>Candida</i> species ^a		
<i>Candida albicans</i>	128 (80.0)	121 (76.1)
<i>Candida glabrata</i>	22 (13.8)	27 (17.0)
<i>Candida tropicalis</i>	5 (3.1)	3 (1.9)
<i>Candida krusei</i>	1 (0.6)	2 (1.3)
<i>Candida spherical</i>	2 (1.3)	2 (1.3)
<i>Candida parapsilosis</i>	1 (0.6)	2 (1.3)
<i>Kodamaea ohmeri</i>	0	1 (0.6)
<i>Candida dubliniensis</i>	1 (0.6)	0
<i>Saccharomyces cerevisiae</i>	0	1 (0.6)
<i>Candida lusitanae</i>	0	1 (0.6)
Susceptibility testing ^b		
Sensitive	309 (96.6)	233 (72.8)
Resistant	6 (1.9)	32 (10.0)
Dose-dependently sensitive	0	53 (16.6)
Wild strain	2 (0.6)	2 (0.6)
Unknown	3 (0.9)	0

^aDetermined by mycological culture of vaginal secretion.

^bA total of 320 fungal strains were isolated from 319 subjects and 320 was set as the denominator. One subject in the fluconazole group presented with two strains (*Candida parapsilosis* and *Kodamaea ohmeri*).

^cData are n (%) unless otherwise indicated. Abbreviations: BMI, body mass index; max, maximum; min, minimum; mITT, modified intention-to-treat; N, number of subjects in the mITT population; SD, standard deviation; VSS, vulvovaginal signs and symptoms.

a serious TEAE of threatened abortion, which was deemed as unrelated to the treatment by the investigator. During the study, there were no clinically significant changes in the vital signs, physical examination findings, ECGs, or laboratory parameters in either group.

DISCUSSION

Primarily based on the global pivotal phase 3 studies of VIOLET (NCT03562156 and NCT03561701) and ultraVIOLET (NCT03840616), oteseconazole (Vivjoa) was approved by the Food and Drug Administration (FDA) to reduce the incidence of RVVC in April 2022. This randomized, double-blinded, positive-controlled, phase 3 study was conducted to evaluate the efficacy and safety of oteseconazole versus fluconazole in treating severe VVC in Chinese women.

After adequate discussion with and agreed upon by the investigators and health authority, we used a locally standardized VSS scoring system for screening and efficacy evaluations according to the current VVC diagnosis and treatment guidance in China (17). This scoring system is modified based on the global standard and is rendered to

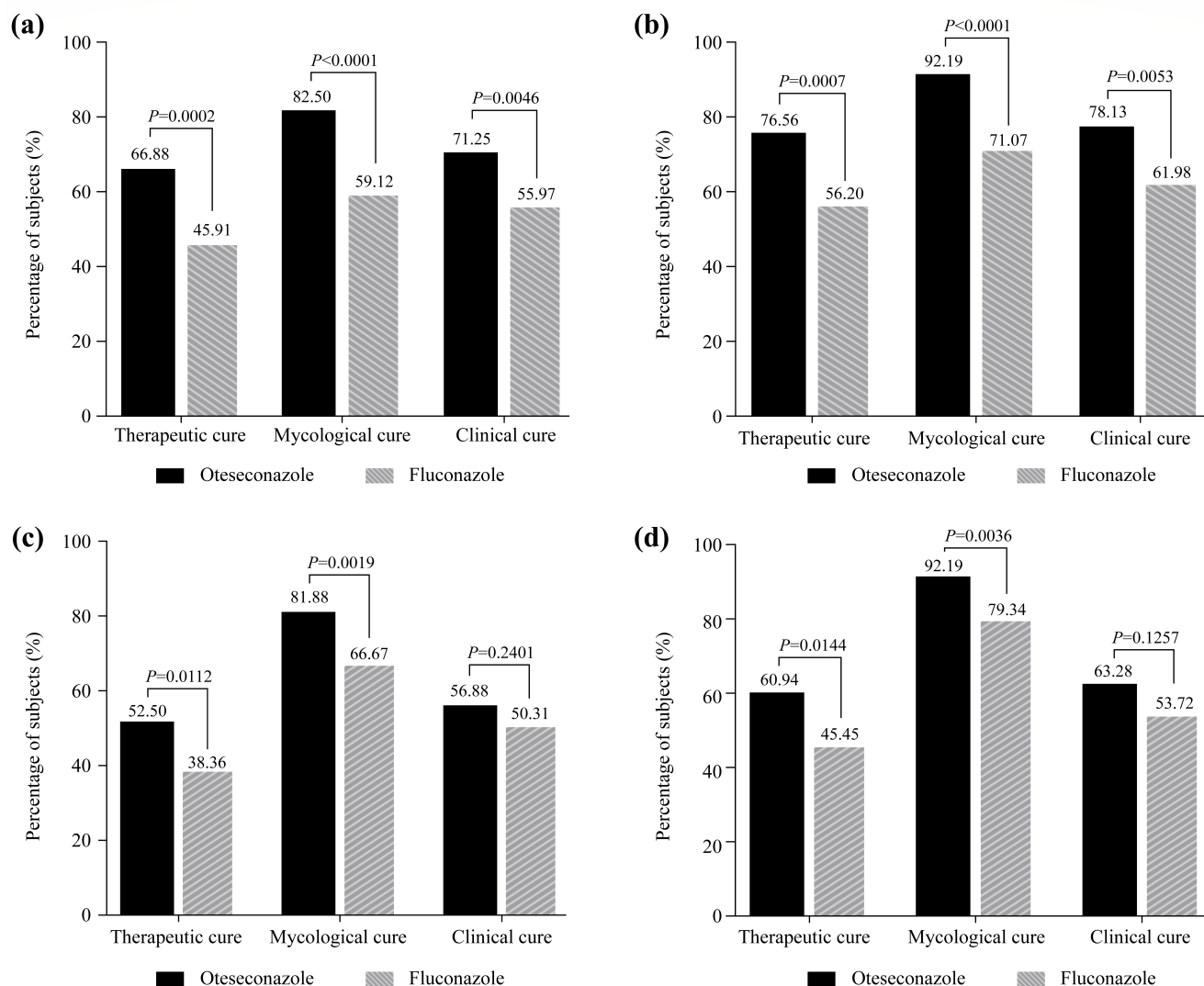


FIG 2 Efficacy results at D28 in the mITT population (a), at D28 in the mITT subpopulation with positive culture for *Candida albicans* (b), at D14 in the mITT population (c), and at D14 in the mITT subpopulation with positive culture for *Candida albicans* (d). Abbreviation: mITT, modified intention-to-treat.

better suit the Chinese women suffering from VVC and reflect their conditions more accurately. The decision of choosing the time point of Day 28 to assess the efficacy primarily was in accordance with the FDA guidance on drug development for VVC treatments issued in 2019 (20), in which the primary endpoint for the efficacy evaluations of systemic drugs with long half-time was recommended to be assessed at D21 to D30.

The results of MICs for clinical isolates of *Candida* species and *in vitro* susceptibility test favored oteseconazole over fluconazole. At D28, oteseconazole demonstrated statistically significant and clinically meaningful superiority over fluconazole (66.88% vs 45.91%; $P = 0.0002$) in the primary endpoint of therapeutic cure rate, and consistent results were observed in the secondary endpoints of clinical cure and mycological cure rates at D28. In line with the reported epidemiology in VVC, *C. albicans* was the causative agent for the majority of subjects (78.1%) in this study (1). As expected, the results of therapeutic cure, clinical cure, and mycological cure rates at D28 in subjects tested positive for *C. albicans* were consistent with those in the overall mITT population. In addition to potent antifungal clinical activity in the treatment of VVC, oteseconazole treatment was potentially associated with reduced VVC recurrence and sustained treatment effect (13). In a phase 2 study in VVC subjects, subjects in the

TABLE 2 Treatment-emergent adverse events with an incidence >1% in either group by preferred term (safety set)^a

Preferred term	Oteseconazole (N = 160)	Fluconazole (N = 161)
Urinary tract infection	13 (8.1)	7 (4.3)
Bacterial vulvovaginitis	7 (4.4)	12 (7.5)
Dizziness	6 (3.8)	3 (1.9)
Headache	6 (3.8)	1 (0.6)
Nausea	5 (3.1)	5 (3.1)
Upper respiratory tract infection	5 (3.1)	4 (2.5)
Abdominal discomfort	4 (2.5)	1 (0.6)
Abdominal pain	3 (1.9)	1 (0.6)
Blood creatine phosphokinase increased	3 (1.9)	2 (1.2)
Diarrhoea	3 (1.9)	2 (1.2)
Lethargy	3 (1.9)	2 (1.2)
Abnormal uterine bleeding	2 (1.3)	0
Aspartate aminotransferase increased	2 (1.3)	1 (0.6)
Atrial escape rhythm	2 (1.3)	0
Bacterial vaginosis	2 (1.3)	10 (6.2)
Bilirubin conjugated increased	2 (1.3)	2 (1.2)
Blood cholesterol increased	2 (1.3)	1 (0.6)
Blood triglycerides increased	2 (1.3)	1 (0.6)
Blood uric acid increased	2 (1.3)	3 (1.9)
Dry mouth	2 (1.3)	0
Lipids increased	2 (1.3)	0
Menstrual disorder	2 (1.3)	0
Mycoplasma infection	2 (1.3)	1 (0.6)
Nasopharyngitis	2 (1.3)	0
Proteinuria	2 (1.3)	0
Rash	2 (1.3)	3 (1.9)
Urine ketone body present	2 (1.3)	0
White blood cells urine positive	2 (1.3)	0
Anaemia	1 (0.6)	4 (2.5)
Asthenia	1 (0.6)	3 (1.9)
Back pain	1 (0.6)	2 (1.2)
White blood cell count decreased	1 (0.6)	2 (1.2)
Abdominal pain upper	0	2 (1.2)
Decreased appetite	0	2 (1.2)
Neutrophil count decreased	0	2 (1.2)
QRS axis abnormal	0	2 (1.2)

^aData are n (%). Abbreviations: N, number of subjects in the safety set.

oteseconazole group showed no evidence of mycological recurrence whereas 28.6% and 46.1% of subjects in the fluconazole group had mycological recurrence at D84 and D168, respectively (13).

Oteseconazole was generally tolerated in subjects with severe VVC. The incidence of TEAEs was similar between the oteseconazole and the fluconazole groups. In the oteseconazole group, the most commonly reported TEAEs were urinary tract infection and bacterial vulvovaginitis, which were expected symptoms in subjects with severe VVC. Other commonly reported TEAEs in the oteseconazole group were mainly in the infection and infestations, gastrointestinal disorders, nervous system disorders, and system organ classes, which were also typical events of azole antifungal agents. In the fluconazole group, the most frequently observed TEAEs were bacterial vulvovaginitis, bacterial vaginosis, and urinary tract infection, which were similar to that reported in the previous study (15).

The potential pregnancy risk in the use of azole agents is an important concern for patients with VVC. The FDA has alerted the public that the use of chronic, high doses of fluconazole during the first trimester of pregnancy may be associated with birth defects (21). Based on the previous rat studies, oteseconazole is contraindicated in females of reproductive potential and in pregnant or lactating women (22). In the present study, nine subjects (two in the oteseconazole group and seven in the fluconazole group) reported pregnancy during the study, all chose elective termination. No treatment-related pregnancy risks were reported in this study or previous studies. At the time being, there are limited data on pregnant women who were exposed to oteseconazole during clinical trials, and these data are insufficient to exclude potential risks to human infants. Further studies are warranted to investigate the impact of oteseconazole on reproductivity and fertility and inform the optimal usage and relative precautions for women of reproductive potential.

This study had several limitations. Firstly, we did not perform long-term follow-up to evaluate the effect of oteseconazole on reducing VVC recurrence. However, in the three completed phase 3 studies (NCT03562156, NCT03561701, and NCT03840616) where subjects with RVVC were treated and followed up for more than 1 year, oteseconazole significantly reduced VVC recurrence rate. In addition, long-term follow-up did not result in any increase in toxicity, with no serious TRAEs or deaths reported. There were only few severe TEAEs leading to treatment discontinuations observed (15, 22, 23). Another limitation was that this study did not assess the antifungal effect of oteseconazole and fluconazole against non-*C. albicans* species due to the very small number of isolates. However, it is worth noting that preclinical studies of oteseconazole showed potent antifungal activity against non-*C. albicans* species both *in vitro* and *in vivo* (11, 12). Nonetheless, additional clinical data demonstrating such efficacy would be very insightful, especially considering that infections caused by non-*C. albicans* species are on the rise (24, 25). In the future, a global, multicenter trial to investigate the efficacy and safety of oteseconazole among a diverse population of patients presenting with various *Candida* species from diverse ethnic backgrounds is substantial.

In conclusion, this phase 3 study demonstrated statistically significant and clinically meaningful superiority of oteseconazole over fluconazole in the treatment of severe VVC. Additionally, oteseconazole was generally tolerated. The totality of evidence suggested that oteseconazole could serve as a treatment option in women suffering from severe VVC, with improved efficacy and a desirable safety profile.

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X.Q.W. was the coordinating investigator and was involved in the study execution, data analysis and interpretation, and manuscript writing. Q.P.L. was the principal investigator, and she was involved in the study conception, protocol development and review, data analysis, and manuscript review. Q.R.W. and F.W. were involved in the study design, study oversight, data analysis and interpretation, and manuscript writing and review. J.L.B. was involved in the statistical analyses plan development, outputs programming, data analysis, and manuscript review. All the other authors were the investigators, and they were involved in protocol review, study execution, data analysis, and manuscript review. All authors contributed substantially to the work. All authors had

full access to the data and were responsible for the integrity and accuracy of the data. All authors approved the final version of the manuscript to be published.

AUTHOR AFFILIATIONS

¹Department of Obstetrics and Gynecology, Beijing Tsinghua Changgung Hospital, Tsinghua University School of Clinical Medicine, Beijing, China

²Department of Gynecology, Shaanxi Provincial People's Hospital, Shaanxi, China

³Department of Gynecology, Women's Hospital of Nanjing Medical University, Nanjing Maternity and Child Health Care Hospital, Jiangsu, China

⁴Department of Obstetrics and Gynecology, The Second Affiliated Hospital of Chongqing Medical University, Chongqing, China

⁵Department of Gynecology, The First Affiliated Hospital of Xi'an Medical University, Shaanxi, China

⁶Department of Obstetrics and Gynecology, Shanghai Tong Ren Hospital, Shanghai Jiaotong University School of Medicine, Shanghai, China

⁷Department of Gynecology, Obstetrics Women & Children's Health Care Hospital of Linyi, Shandong, China

⁸Department of Gynecology, Taihe Hospital Affiliated Hospital of Hubei University of Medicine, Hubei, China

⁹Department of Gynecology, Tianjin Medical University General Hospital, Tianjin, China

¹⁰Department of Gynecology, Urumqi Maternal and Child Health Hospital of Xinjiang Uygur Autonomous Region, Xinjiang, China

¹¹Department of Gynecology, Xuzhou Central Hospital, Jiangsu, China

¹²Department of Obstetrics and Gynecology, The First Affiliated Hospital of Xi'an Jiaotong University, Shaanxi, China

¹³Department of Gynecology, Guangdong Women and Children Hospital, Guangdong, China

¹⁴Department of Obstetrics and Gynecology, Peking University Third Hospital, Beijing, China

¹⁵Department of Obstetrics and Gynecology, The First Hospital of Jilin University, Jilin, China

¹⁶Department of Obstetrics and Gynecology, Zhongda Hospital Southeast University, Jiangsu, China

¹⁷Department of Gynecology, Guangzhou First People's Hospital, Guangdong, China

¹⁸Department of Gynecology, The First People's Hospital of Chenzhou, Hunan, China

¹⁹Department of Obstetrics and Gynecology, Peking University Shenzhen Hospital, Guangdong, China

²⁰Department of Obstetrics and Gynecology, The Second Hospital of Jilin University, Jilin, China

²¹Department of Gynecology, The First Affiliated Hospital of Xinxiang Medical University, Henan, China

²²Department of Gynecology, Boai Hospital of Zhongshan, Guangdong, China

²³Department of Gynecology, Women and Children's Hospital of Xiamen University, Fujian, China

²⁴Department of Reproductive Endocrinology and Gynecology, Zhejiang Provincial People's Hospital, Zhejiang, China

²⁵Clinical Research and Development, Jiangsu Hengrui Pharmaceuticals Co., Ltd., Shanghai, China

²⁶Department of Biostatistics, School of Public Health, Nanjing Medical University, Jiangsu, China

AUTHOR ORCIDs

Xiaoqian Wang  <http://orcid.org/0009-0006-3288-544X>

Qinping Liao  <http://orcid.org/0000-0001-9175-1560>

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AUTHOR CONTRIBUTIONS

Xiaoqian Wang, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Lihong Chen, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Hongjie Ruan, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Zhengai Xiong, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Wenying Wang, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Jin Qiu, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Weihua Song, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Chunlian Zhang, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Fengxia Xue, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Tianhua Qin, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Bei Zhang, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Ruifang An, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Xiping Luo, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Wei Wang, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Songling Zhang, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Yunlang Cai, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Jiali Kang, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Henan Deng, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Shangrong Fan, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Manhua Cui, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Shijin Wang, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Xiaowan Luo, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Zhiying Su, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Jing Shu, Data curation, Formal analysis, Investigation, Supervision, Validation, Writing – review and editing | Quanren Wang, Conceptualization, Methodology, Project administration, Writing – review and editing | Fang Wang, Conceptualization, Methodology, Project administration, Writing – review and editing | Jianling Bai, Conceptualization, Formal analysis, Methodology, Visualization, Writing – review and editing | Qinping Liao, Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Validation, Writing – review and editing

DATA AVAILABILITY

All the data underlying the findings of this manuscript are available from the corresponding author. Qualified scientific and medical researchers may request access to the data by sending an email to the corresponding author (qinping_liao@163.com); the corresponding author and sponsor will grant access to the data if the request is deemed appropriate.

ADDITIONAL FILES

The following material is available [online](#).

Supplemental Material

Tables S1 to S3 (AAC00778-23-s0001.docx). Susceptibility analysis and summary of efficacy results.

REFERENCES

- Sobel JD. 2007. Vulvovaginal candidosis. *Lancet* 369:1961–1971. [https://doi.org/10.1016/S0140-6736\(07\)60917-9](https://doi.org/10.1016/S0140-6736(07)60917-9)
- Yano J, Sobel JD, Nyirjesy P, Sobel R, Williams VL, Yu Q, Noverr MC, Fidel PL. 2019. Current patient perspectives of vulvovaginal candidiasis: Incidence, symptoms, management and post-treatment outcomes. *BMC Womens Health* 19:48. <https://doi.org/10.1186/s12905-019-0748-8>
- Gonçalves B, Ferreira C, Alves CT, Henriques M, Azeredo J, Silva S. 2016. Vulvovaginal candidiasis: epidemiology, microbiology and risk factors. *Crit Rev Microbiol* 42:905–927. <https://doi.org/10.3109/1040841X.2015.1091805>
- Denning DW, Kneale M, Sobel JD, Rautemaa-Richardson R. 2018. Global burden of recurrent vulvovaginal candidiasis: a systematic review. *Lancet Infect Dis* 18:e339–e347. [https://doi.org/10.1016/S1473-3099\(18\)30103-8](https://doi.org/10.1016/S1473-3099(18)30103-8)
- Sherrard J, Wilson J, Donders G, Mendling W, Jensen JS. 2018. European (IUSTI/WHO) International Union against Sexually Transmitted Infections (IUSTI) World Health Organisation (WHO) guideline on the management of vaginal discharge. *Int J STD AIDS* 29:1258–1272. <https://doi.org/10.1177/0956462418785451>
- Workowski KA, Bachmann LH, Chan PA, Johnston CM, Muzny CA, Park I, Reno H, Zenilman JM, Bolan GA. 2021. Sexually transmitted infections treatment guidelines, 2021. *MMWR Recomm Rep* 70:1–187. <https://doi.org/10.15585/mmwr.rr7004a1>
- Sobel JD, Wiesenfeld HC, Martens M, Danna P, Hooton TM, Rompalo A, Sperling M, Livengood C III, Horowitz B, Von Thron J, Edwards L, Panzer H, Chu T-C. 2004. Maintenance fluconazole therapy for recurrent vulvovaginal candidiasis. *N Engl J Med* 351:876–883. <https://doi.org/10.1056/NEJMoa033114>
- Collins LM, Moore R, Sobel JD. 2020. Prognosis and long-term outcome of women with idiopathic recurrent vulvovaginal candidiasis caused by *Candida albicans*. *J Low Genit Tract Dis* 24:48–52. <https://doi.org/10.1097/LGT.0000000000000496>
- Wang F-J, Zhang D, Liu Z-H, Wu W-X, Bai H-H, Dong H-Y. 2016. Species distribution and in vitro antifungal susceptibility of vulvovaginal *Candida* isolates in China. *Chin Med J (Engl)* 129:1161–1165. <https://doi.org/10.4103/0366-6999.181964>
- Warrilow AGS, Hull CM, Parker JE, Garvey EP, Hoekstra WJ, Moore WR, Schotzinger RJ, Kelly DE, Kelly SL. 2014. The clinical candidate VT-1161 is a highly potent inhibitor of *Candida albicans* CYP51 but fails to bind the human enzyme. *Antimicrob Agents Chemother* 58:7121–7127. <https://doi.org/10.1128/AAC.03707-14>
- Sobel JD, Nyirjesy P. 2021. Oteseconazole: an advance in treatment of recurrent vulvovaginal candidiasis. *Future Microbiol* 16:1453–1461. <https://doi.org/10.2217/fmb-2021-0173>
- Schell WA, Jones AM, Garvey EP, Hoekstra WJ, Schotzinger RJ, Alexander BD. 2017. Fungal CYP51 inhibitors VT-1161 and VT-1129 exhibit strong *in vitro* activity against *Candida glabrata* and *C. krusei* isolates clinically resistant to azole and echinocandin antifungal compounds. *Antimicrob Agents Chemother* 61:e01817-16. <https://doi.org/10.1128/AAC.01817-16>
- Brand SR, Sobel JD, Nyirjesy P, Ghannoum MA, Schotzinger RJ, Degenhardt TP. 2021. A randomized phase 2 study of VT-1161 for the treatment of acute vulvovaginal candidiasis. *Clin Infect Dis* 73:e1518–e1524. <https://doi.org/10.1093/cid/ciaa1204>
- Brand SR, Degenhardt TP, Person K, Sobel JD, Nyirjesy P, Schotzinger RJ, Tavakkol A. 2018. A phase 2, randomized, double-blind, placebo-controlled, dose-ranging study to evaluate the efficacy and safety of orally administered VT-1161 in the treatment of recurrent vulvovaginal candidiasis. *Am J Obstet Gynecol* 218:624. <https://doi.org/10.1016/j.jog.2018.03.001>
- Martens MG, Maximos B, Degenhardt T, Person K, Curelop S, Ghannoum M, Flynt A, Brand SR. 2022. Phase 3 study evaluating the safety and efficacy of oteseconazole in the treatment of recurrent vulvovaginal candidiasis and acute vulvovaginal candidiasis infections. *Am J Obstet Gynecol* 227:880. <https://doi.org/10.1016/j.jog.2022.07.023>
- de Cássia Orlandi Sardi J, Silva DR, Anibal PC, de Campos Baldin JJCM, Ramalho SR, Rosalen PL, Macedo MLR, Hofling JF. 2021. Vulvovaginal candidiasis: epidemiology and risk factors, pathogenesis resistance, and new therapeutic options. *Curr Fungal Infect Rep* 15:32–40. <https://doi.org/10.1007/s12281-021-00415-9>
- Liu Z, Liao Q. 2012. Amendment of the standards for the diagnosis and treatment of vulvovaginal candidiasis (VVC). *Chin Med J* 28:401–402.
- CLSI. 2018. CLSI supplement M59. In *Epidemiological cutoff values for antifungal susceptibility testing*, 2nd ed. Clinical and Laboratory Standards Institute, Wayne, PA. https://clsi.org/media/1934/m59ed2_sample-updated.pdf.
- CLSI. 2017. CLSI supplement M60. In *Performance standards for antifungal susceptibility testing of yeasts*, 1st ed. Clinical and Laboratory Standards Institute, Wayne, PA. https://clsi.org/media/1895/m60ed1_sample.pdf.
- US Food and Drug Administration. Guidance for industry. Vulvovaginal candidiasis: developing drugs for treatment. Available from: <https://www.fda.gov/>. Accessed April 09, 2023
- US Food and Drug Administration. 2011. FDA Drug Safety Communication: Use of long-term, high-dose Diflucan (fluconazole) during pregnancy may be associated with birth defects in infants. Available from: <https://www.fda.gov/drugs/drug-safety-and-availability/fda-drug-safety-communication-use-long-term-high-dose-diflucan-fluconazole-during-pregnancy-may-be>. Accessed 07 Aug 2023.
- US Food and Drug Administration. 2022. Vivjoa (oteseconazole capsules). Available from: https://www.accessdata.fda.gov/drugsatfda_docs/label/2022/215888s000lbl.pdf. Accessed 09 Apr 2023.
- Sobel JD, Donders G, Degenhardt T, Person K, Curelop S, Ghannoum M, Brand SR. 2022. Efficacy and safety of oteseconazole in recurrent vulvovaginal candidiasis. *NEJM Evidence* 1. <https://doi.org/10.1056/EVIDoa2100055>
- Makanjuola O, Bongomin F, Fayemiwo SA. 2018. An update on the roles of non-albicans *Candida* species in vulvovaginitis. *J Fungi (Basel)* 4:121. <https://doi.org/10.3390/jof4040121>
- Mintz JD, Martens MG. 2013. Prevalence of non-albicans *Candida* infections in women with recurrent vulvovaginal symptomatology. *Adv Infect Dis* 03:238–242. <https://doi.org/10.4236/aid.2013.34035>