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# Epidemiological characteristics, antifungal susceptibility, and mortality factors of candidemia in adults at a tertiary teaching hospital in Zunyi, China (2016–2023)

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## Abstract

**Background** Candidemia, a common nosocomial bloodstream infection caused by *Candida* species, is associated with a high mortality rate. This study aimed to analyze the epidemiological characteristics, distribution of *Candida* species, antifungal susceptibility, and mortality risk factors of adult patients with candidemia in Zunyi, China. These findings are expected to inform treatment and prevention strategies for candidemia in this region.

**Methods** Clinical data, *Candida* species, antifungal susceptibility profiles, and prognosis of 92 patients with candidemia at the First People's Hospital of Zunyi (the Third Affiliated Hospital of Zunyi Medical University) from January 2016 to December 2023 were retrospectively analyzed. Univariate and multivariate logistic regression analyses were performed to analyze risk factors for patient death.

**Results** Analysis of 92 candidemia cases revealed an average incidence of 0.19% and mortality rate of 35.87%. *Candida albicans* was responsible for 33.70% of the infections, whereas non-*C. albicans* accounted for 66.30% of the total. Non-*C. albicans* was dominated by *C. parapsilosis* (31.52%), *Nakaseomyces glabratus* (18.48%), and *C. tropicalis* (13.04%). The susceptibility of all *Candida* species to amphotericin B exceeded 96%. *C. albicans* and *C. parapsilosis* showed greater than 70% susceptibility to fluconazole, itraconazole, and voriconazole, whereas *C. tropicalis* showed less than 60% susceptibility to these antifungal agents. Among the 33 dead patients, *C. albicans* was associated with a higher mortality rate than non-*C. albicans* ($P=0.007$). Logistic multiple regression analysis showed that cardiovascular disease (OR = 8.913, 95% CI: 1.463–54.289, $P=0.018$), kidney disease (OR = 13.672, 95% CI: 2.025–92.326, $P=0.007$), and antifungal drug treatment duration less than 7 days (OR = 10.694, 95% CI: 1.841–62.112, $P=0.008$) were independent risk factors for mortality in adult patients with candidemia.

**Conclusions** The mortality rate among patients with candidemia remains high with *C. albicans* is the predominant pathogen in Zunyi, China. Cardiovascular disease, kidney disease, and antifungal drug treatment duration less than 7 days were independent risk factors for mortality in adult patients with candidemia. Therefore, greater attention should be paid to adult patients with risk factors for mortality to improve the outcomes of adult candidemia.

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**Keywords** Candidemia, *Candida albicans*, Risk factors, Mortality

## Background

*Candida* species is one of the most important pathogens causing nosocomial bloodstream infections in adults and children worldwide over the past two decades [1, 2, 3]. As opportunistic pathogens, over 200 species of *Candida* have been identified, yet only a subset, approximately 10%, are recognized to cause infections in humans [4]. *Candida* has been ranked as the fourth most prevalent pathogen in bloodstream infections among critically ill patients, posing a substantial threat to patient health [5]. Studies have reported that the incidence of candidemia is approximately 5.72 cases per 100,000 patients in China [6], with mortality rates ranging from 23.4% to 33.13% [7, 8, 9].

Geographical variations exist in the species composition and epidemiological traits of candidemia [10]. Historically, *Candida albicans* being the predominant species, causing over 50% of candidemia cases [11]. However, in recent years, there has been a significant rise in the incidence of non- *C. albicans* species such as *C. parapsilosis*, *Nakaseomyces glabratus*, *C. tropicalis*, *and Pichia kudriavzevii*, which have emerged as major pathogens in infections [12, 13, 14, 15]. Furthermore, the prognosis associated with bloodstream infections caused by different *Candida* species can vary [16]. A study conducted in Shenyang, China, indicates that the 30-day mortality rate of infections caused by *C. albicans* is comparatively higher than those caused by non-*C. albicans* [17]. Conversely, other studies have indicated that mortality rate of bloodstream infections due to non-*C. albicans* was higher than that in *C. albicans* [18]. Given these discrepancies, it is imperative to investigate the local epidemiological characteristics of candidemia in order to develop targeted treatment and prevention strategies.

Common risk factors associated with candidemia include ICU admission, neutrophil deficiency, septic shock, surgical procedures, prior use of broad-spectrum antibiotics, an APACHE II score of ≥ 20, central venous catheterization, and mechanical ventilation [19, 20, 21, 22]. Additionally, studies have identified age, malignant hematologic disorders, urinary catheter placement, hemodialysis, mechanical ventilation, cardiovascular disease, requirement for vasopressor therapy, and concurrent bacterial bloodstream infections as significant predictors of mortality in patients with candidemia [3, 7, 16, 23].

Candidemia is associated with a high mortality rate and presents challenges in early diagnosis and treatment, representing a significant public health concern and a substantial economic burden on healthcare systems [24]. Although numerous studies have analyzed risk factors associated with candidemia [7, 13, 16, 20, 23, 25], there is regional variability in epidemiological characteristics and mortality risk factors in candidemia [26]. It is necessary to understand the *Candida* species distribution, drug susceptibility, and mortality risk factors related to candidemia of adult patients in this region. Enhancing early diagnosis and treatment, proactively managing risk factors associated with mortality, and improving patient outcomes are critical objectives. This study aimed to analyze the *Candida* species distribution, drug susceptibility, and mortality risk factors of candidemia among adult patients in a tertiary teaching hospital in Zunyi, China, with the goal of providing valuable data for the diagnosis and treatment of candidemia.

## Methods

### Study design

This study included adult patients (age ≥ 18 years) diagnosed with candidemia at the First People's Hospital of Zunyi, also known as the Third Affiliated Hospital of Zunyi Medical University, a tertiary teaching hospital with 3,500 beds. The study period spans from January 2016 to December 2023. Candidemia was defined as the isolation of *Candida* from at least one blood culture in a patient presenting with clinical signs and symptoms. Only the initial positive result was considered for analysis in cases of multiple detections of the same *Candida* species in the same patient. Patients with incomplete medical records were excluded.

### Clinical data collection

Clinical data were extracted from the medical records of patients treated at the First People's Hospital of Zunyi. Basic demographic data, including sex and age, were collected. Additionally, a detailed compilation of clinical diagnosis and treatment information was performed. The data encompassed patient outcomes and various disease factors, such as hypertension, diabetes, cardiovascular diseases, nervous system diseases, digestive system diseases, respiratory system diseases, urinary system diseases, kidney diseases, solid malignancies, multiple organ dysfunction, shock, bacterial bloodstream infections and *Candida*-related organ involvement. Invasive factors (e.g., tracheal intubation, tracheotomy, mechanical ventilation, bronchoscopic lavage of the respiratory tract, central venous catheterization, arterial catheterization, surgery, surgical drainage tube, urinary tract catheterization) and therapeutic factors (e.g., blood transfusion, use of vasopressors, use of carbapenem antibiotics, use of vancomycin, hemodialysis, ICU admission, hospitalization time, use of hormones, use of antifungal drugs, the

methods of antifungal treatment and duration, as well as the types of corticosteroids used) were also included.

### Microbiological test procedure

Blood samples from patients were collected under aseptic conditions and cultured using the BACT/ALERT 3D automated blood microbial culture system (BioMerieux, Marcy-l 'Etoile, France). Positive cultures were inoculated on blood agar plates (Autobio, Zhengzhou, China) and Sabouraud's agar plates (Autobio, Zhengzhou, China) and incubated at 37°C for 24–48 hours. From 2016 to 2018, strain identification was performed using the VITEK® 2 Compact (BioMérieux, Marcy-l'Étoile, France). From 2019 to 2023, the VITEK® MS mass spectrometer (BioMérieux, Marcy-l'Étoile, France) with the corresponding VITEK® IVD Database 3.2 was used for strain identification. VITEK® MS identification was considered acceptable when the confidence level reached 99.9%. Antifungal susceptibility testing was conducted using the ATB FUNGUS 3 yeast-like fungal susceptibility kit (BioMerieux, Marcy-l 'Etoile, France), which evaluates susceptibility to five antifungal agents: amphotericin B, 5-flucytosine, fluconazole, itraconazole, and voriconazole. *C. albicans* ATCC 90028 and *C. parapsilosis* ATCC22019 were used as quality control strains. Antifungal susceptibility testing was strictly conducted according to the manufacturer's standardized protocols. The minimum inhibitory concentration (MIC) was interpreted using the Clinical and Laboratory Standards Institute (CLSI) M27-A3 microbroth-dilution method [27]. When no breakpoints were available, the breakpoints recommended by the antifungal susceptibility test kit were used for interpretation.

### Statistical analysis

Categorical data were presented as the number of cases and corresponding percentages. Comparisons among categorical variables were performed using the chi-square test or Fisher's exact test, as appropriate. Normally distributed continuous variables are reported as mean ± standard deviation, and differences between groups were assessed using independent t-tests. For continuous variables with non-normal distributions, data were expressed as median (1st quartile, 3rd quartile) [M (P25, P75)], and the Mann-Whitney U test was used to compare the groups. Variables that demonstrated statistical significance ($P<0.05$) in the univariate analysis of mortality risk factors were subsequently included in a multivariate logistic regression model to evaluate the multifactorial associations with death. All statistical analyses were performed using SPSS version 22.0 (SPSS, Inc., Chicago, IL, USA). Statistical significance was set at a two-tailed p-value of less than 0.05.

**Table 1** Prevalence of candidemia from 2016 to 2023

| Year | Total blood culture (*n*) | Candidemia cases detected (*n*, %) [a] | Mortality of candidemia patients (*n*, %) [b] |
|---|---|---|---|
| 2016 | 5094 | 14 (0.27) | 3 (21.43) |
| 2017 | 5479 | 10 (0.18) | 5 (50.00) |
| 2018 | 5903 | 14 (0.24) | 2 (14.29) |
| 2019 | 6841 | 11 (0.16) | 4 (36.36) |
| 2020 | 5501 | 10 (0.18) | 4 (40.00) |
| 2021 | 5641 | 8 (0.14) | 4 (50.00) |
| 2022 | 6337 | 16 (0.25) | 8 (50.00) |
| 2023 | 7579 | 9 (0.12) | 3 (33.33) |
| Total | 48,375 | 92 (0.19) | 33 (35.87) |

[a] Data outside parentheses are the number of patients with candidemia; data in parentheses are the number of patients with candidemia /total blood cultures

[b] Data outside parentheses are the number of dead patients with candidemia; data in parentheses are the number of dead patients with candidemia/number of patients with candidemia

## Results

### Prevalence and mortality rates of candidemia, 2016–2023

From 2016 to 2023, 48,375 blood cultures were analyzed, yielding 92 cases of candidemia, resulting in an overall positive rate of 0.19% (92/48375). The highest annual positive rate was recorded in 2016 at 0.27% (14/5094), whereas the lowest rate was observed in 2023 at 0.12% (9/7579). Among the candidemia cases, the mortality rate was 35.87% (33/92), with the highest mortality rate of 50% in 2017, 2021, and 2022, and the lowest mortality rate of 14.29% in 2018. Comprehensive data for each year are presented in Table 1.

### Distribution of *Candida* species

Among the 92 patients with candidemia, *C. albicans* was the predominant species, accounting for 33.70% (31/92) of the cases, whereas non-*C. albicans* constituted 66.30% (61/92) of patients. Among the non-*C. albicans* isolates, *C. parapsilosis*, *N. glabratus*, and *C. tropicalis* were the most prevalent, representing 31.52% (29/92), 18.48% (17/92), and 13.04% (12/92) of cases, respectively (Fig. 1; Table 2). A comparison between the periods of 2016–2019 and 2020–2023 revealed a statistically significant increase in the isolation rate of *C. albicans* ($P<0.05$) (Table 2).

### Antimicrobial susceptibility of *Candida* species

In the antimicrobial susceptibility profiling of *Candida* species, all strains exhibited excellent susceptibility to amphotericin B. *C. albicans* demonstrated susceptibility to the azole antifungals fluconazole, itraconazole, and voriconazole, with susceptibility ratios of 90.32%, 80.65%, and 74.19%, respectively. The susceptibility of both *N. glabratus* and *P. kudriavzevii* to itraconazole was 100%. *C. tropicalis* displayed a significant level of resistance to azole agents, with a susceptibility ratio of 58.33% for

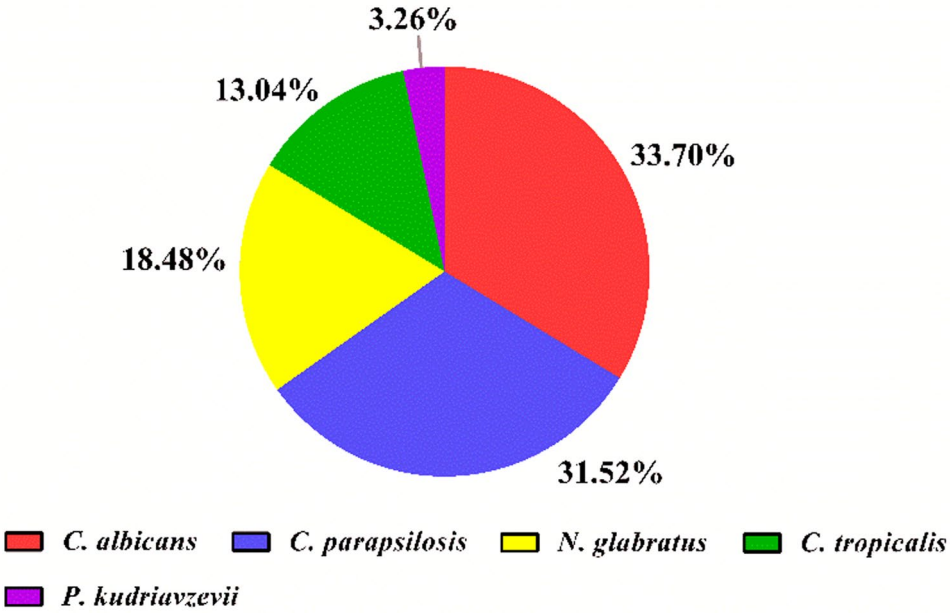


**Fig. 1** Proportional distribution of *Candida* species among 92 candidemia cases

**Table 2** Comparative distribution of *Candida* species between 2016–2019 and 2020–2023

| | Total 2016–2023 *N* (%) | 2016–2019 *N* (%) | 2020–2023 *N* (%) | $\chi^2$ | *P* |
|---|---|---|---|---|---|
| ***C. albicans*vs. non-*C. albicans*** | | | | 3.977 | 0.046* |
| *C. albicans* | 31/92 (33.70) | 12 (24.49) | 19 (44.19) | | |
| Non-*C. albicans* | 61/92 (66.30) | 37 (75.51) | 24 (55.81) | | |
| Total | 92 (100) | 49 (100) | 43 (100) | | |
| ***Candida* species** | | | | | |
| *C. albicans* | 31 (33.70) | 12 (24.49) | 19 (44.19) | 3.977 | 0.046* |
| *C. parapsilosis* | 29 (31.52) | 19 (38.78) | 10 (23.26) | 2.556 | 0.110 |
| *N. glabratus* | 17 (18.48) | 12 (24.49) | 5 (11.63) | 2.515 | 0.113 |
| *C. tropicalis* | 12 (13.04) | 5 (10.20) | 7 (16.28) | 0.745 | 0.388 |
| *P. kudriavzevii* | 3 (3.26) | 1 (2.04) | 2 (4.65) | 0.013 | 0.908 |

*Significant statistical difference ($P < 0.05$)

$\chi^2$: chi-square value

fluconazole, itraconazole, and 33.33% for voriconazole (Table 3).

### Univariate analysis of factors associated with *C. albicans* and non-*C. albicans* infection

Among 92 patients with candidemia, 59.78% (55/92) were male, with a median age of 69.50 (53, 79) years. A significant proportion (70.65%, 65/92) were elderly patients aged ≥ 60 years. Most patients had underlying diseases, with the most prevalent being respiratory system disease (65.22%, 60/92), digestive system disease (48.91%, 45/92), hypertension (41.30%, 38/92), kidney disease (30.43%, 28/92), shock (28.26%, 26/92), and cardiovascular diseases (27.17%, 25/92).

Among the invasive factors, 64 cases (69.57%) had central venous catheters, 47 cases (51.09%) had mechanical ventilation, 45 cases (48.91%) underwent surgery, 43 cases (46.74%) had tracheal intubation, and 37 cases (40.22%) had surgical drainage tubes. Regarding treatment factors, 71 cases (77.17%) involved the use of hormones, 66 cases (71.74%) received antifungal drugs,

**Table 3** Antifungal susceptibility profiles of five *Candida* species

| Candida Species | Number of strains (*n*) | Antifungal susceptibility results (*n*, %) [a] | | | | |
|---|---|---|---|---|---|---|
| | | Amphotericin B | 5-Flucytosine | Fluconazole | Itraconazole | Voriconazole |
| *C. albicans* | 31 | 30 (96.77%) | 30 (96.77%) | 28 (90.32%) | 25 (80.65%) | 23 (74.19%) |
| *C. parapsilosis* | 29 | 29 (100%) | 24 (82.76%) | 23 (79.31%) | 26 (89.66%) | 24 (82.76%) |
| *N. glabratus* | 17 | 17 (100.00%) | 17 (100.00%) | 15 (88.24%) | 17 (100.00%) | 14 (82.35%) |
| *C. tropicalis* | 12 | 12 (100.00%) | 12 (100.00%) | 7 (58.33%) | 7 (58.33%) | 4 (33.33%) |
| *P. kudriavzevii* | 3 | 3 (100.00%) | 2 (66.67 %) | N/A | 3 (100.00%) | 2 (66.67%) |

a, The values in parentheses represent the percentage of strains that were susceptible to each antifungal agent

N/A, Not Applicable, *P. kudriavzevii* is assumed to be intrinsically resistant to fluconazole

60 cases (65.22%) were admitted to the ICU, 57 cases (61.96%) received blood transfusions, and 55 cases (59.78%) involved the use of carbapenem antibiotics. The mortality rate in this study was 35.87% (33 cases). Comparative analysis of the clinical characteristics of patients with *C. albicans* and non-*C. albicans* candidemia showed significant differences in the incidence of tracheal intubation, mechanical ventilation, surgery, surgical drainage tubes, hemodialysis, and mortality ($P < 0.05$, Table 4).

#### Distribution of *Candida* in dead patients

Among the patients who died, *C. albicans* was the predominant species, representing 51.52% (17/33) of the cases, which was significantly higher than that in the survival group (23.73%, 14/59) ($P = 0.007$). Conversely, *C. parapsilosis* was more prevalent in the survival group, with 40.68% (24/59) of cases, as opposed to 15.15% (5/33) in the death group, indicating a significant difference ($P = 0.011$) (Fig. 2).

#### Univariate analysis of 33 dead patients with candidemia

Univariate analysis revealed that age, cardiovascular disease, kidney disease, multiple organ dysfunction, shock, tracheal intubation, mechanical ventilation, central venous catheterization, blood transfusion, use of vasopressors, use of carbapenem antibiotics, hemodialysis, ICU admission, monotherapy with voriconazole, and antifungal treatment duration less than 7 days were associated with mortality in patients with candidemia ($P < 0.05$, Table 5).

Multifactorial logistic regression analyses revealed that cardiovascular disease (OR = 8.913, 95% CI: 1.463–54.289, $P = 0.018$), kidney disease (OR = 13.672, 95% CI: 2.025–92.326, $P = 0.007$), and antifungal drug treatment duration less than 7 days (OR = 10.694, 95% CI: 1.841–62.112, $P = 0.008$) were independent risk factors for mortality in patients with candidemia. (Table 6).

## Discussions

Candidemia is a deep mycosis that is difficult to diagnose at an early stage and has poor prognosis. In recent years, with the widespread use of antifungal drugs and immunosuppressants, the development of transplantation techniques, and the increase of invasive procedures, the incidence of candidemia has gradually increased, and the prevalence of candidemia has regional differences [28]. Candidemia has been reported to be the fourth most common nosocomial infection, and more than 90% of candidemia is caused by *Candida* spp [29]. Among specific patient populations, such as those with cancer and systemic autoimmune diseases, the mortality rates due to candidemia are notably high, reaching 51% and 27.8%, respectively [30, 31]. A global study, encompassing data from over 120 countries, estimated that 1,565,000 individuals develop invasive candidiasis or candidemia annually, with 995,000 fatalities, suggesting a mortality rate of 66.30% [32]. This study, observing candidemia cases from 2016 to 2023, noted a persistently low incidence of 0.19%, yet an average mortality rate of 35.87%, peaking at 50% in the years 2017, 2021, and 2022. The mortality rate of candidemia in our study was higher than that reported in Luzhou, China, while the incidence rate was similar [33]. The reported mortality rate of adult candidemia in Luzhou was 22.3%, with an incidence rate of 0.24% [33]. It is noteworthy that a candidemia epidemiology study in Iran reported a mortality rate of 59% for non-*C. albicans* candidemia, compared to a relatively lower mortality rate of 39% for *C. albicans* candidemia [34]. A study of adult candidemia in Canada from 2010 to 2018 showed no differences in mortality rates among different *Candida* species [35]. However, in our study, the mortality rate for *C. albicans* candidemia was 54.84%, which is significantly higher than the mortality rate of 26.23% for non-*C. albicans* candidemia. This finding further indicates that there are regional differences in the mortality rates between *C. albicans* and non-*C. albicans* candidemia. Therefore, investigating the epidemiology and mortality of candidemia in our region holds significant importance.

Consistent with global trends [25, 36, 37, 38, 39], this study found that *C. albicans* was the predominant strain associated with candidemia, accounting for 33.70%. Notably, the incidence of candidemia due to non-*C. albicans* species in this study was 66.30%, aligning with findings from other research [25, 39]. Some studies have shown that *C. tropicalis* is the most common species causing bloodstream infections caused by non-*C. albicans* [39, 40]. This study identified *C. parapsilosis* as the predominant non-*C. albicans*, accounting for 31.52% of the cases, followed by *N. glabratus* (18.48%), *C. tropicalis* (13.04%), and *P. kudriavzevii* (3.26%). *C. parapsilosis* was the leading non-*C. albicans* species in candidemia is consistent with reports from tertiary hospitals in Beijing and Guangzhou, China [25, 38], and its propensity to infect pediatric populations [41, 42]. The high rate of *C. parapsilosis* infections may be linked to its frequent carriage by healthcare workers and its ability to form biofilms on medical equipment surfaces, which could explain its elevated incidence in certain regions [24, 43].

Variations in *Candida* species distribution are influenced by geographical factors and patient-specific elements, such as age, presence of malignancies, surgical procedures, and use of central venous catheters [44]. In the United States, a striking 99% of candidemia cases in patients with acute leukemia are attributed to non-*C. albicans* species, a phenomenon likely due to compromised immune systems and extensive antifungal usage [45]. The choice of antifungal agent also influences

**Table 4** Clinical characteristics of 92 patients with candidemia

| Variable | Total ($n=92$) | *C. albicans* ($n=31$) | Non-*C. albicans* ($n=61$) | $\chi^2$/U (*C. albicans* vs. Non-*C. albicans*) | *P* |
|---|---|---|---|---|---|
| Sex, male/female | 55/37 | 15/16 | 40/21 | 2.525 | 0.112 |
| Age (years) | 69.50 (53, 79) | 71(65.50, 78.50) | 68 (52, 79) | -0.781 | 0.435 |
| **Disease factor** | | | | | |
| Hypertension | 38 (41.30) | 10 (32.26) | 28 (45.90) | 1.578 | 0.209 |
| Diabetes | 17 (18.48) | 5 (16.13) | 12 (19.67) | 0.171 | 0.679 |
| Cardiovascular disease | 25 (27.17) | 10 (32.26) | 15 (24.59) | 0.611 | 0.435 |
| Nervous system disease | 24 (26.09) | 5 (16.13) | 19 (31.15) | 2.404 | 0.121 |
| Digestive system disease | 45 (48.91) | 18 (58.06) | 27 (44.26) | 1.567 | 0.211 |
| Respiratory system disease | 60 (65.22) | 18 (58.06) | 42 (68.85) | 1.055 | 0.304 |
| Urinary system disease | 21 (22.83) | 8 (25.81) | 13 (21.31) | 0.236 | 0.627 |
| Kidney disease | 28 (30.43) | 11 (35.48) | 17 (27.87) | 0.563 | 0.453 |
| Solid malignancy | 10 (10.87) | 3 (9.68) | 7 (11.48) | 0.000 | 1.000 |
| Multiple organ dysfunction | 11 (11.96) | 7 (22.58) | 4 (6.56) | 3.606 | 0.058 |
| Shock | 26 (28.26) | 9 (29.03) | 17 (27.87) | 0.014 | 0.907 |
| Bacterial bloodstream infection | 20 (21.74) | 6 (19.35) | 14 (22.95) | 0.156 | 0.693 |
| *Candida*-related organ involvement | 9 (9.78) | 5 (16.13) | 4 (6.56) | 1.187 | 0.276 |
| **Invasive factors** | | | | | |
| Tracheal intubation | 43 (46.74) | 20 (64.52) | 23 (37.70) | 5.935 | 0.015* |
| Tracheotomy | 12 (13.04) | 2 (6.45) | 10 (16.39) | 1.022 | 0.312 |
| Mechanical ventilation | 47 (51.09) | 21 (67.74) | 26 (42.62) | 5.190 | 0.023* |
| Bronchoscopic lavage of respiratory tract | 9 (9.78) | 4 (12.90) | 5 (8.20) | 0.120 | 0.729 |
| Central venous catheterization | 64 (69.57) | 24 (77.42) | 40 (65.57) | 1.362 | 0.243 |
| Arterial catheterization | 33 (35.87) | 12 (38.71) | 21 (34.43) | 0.164 | 0.686 |
| Surgery | 45 (48.91) | 21 (67.74) | 24 (39.34) | 6.633 | 0.010* |
| Surgical drainage tube | 37 (40.22) | 18 (58.06) | 19 (31.15) | 6.194 | 0.013* |
| Urinary tract catheterization | 14 (15.22) | 6 (19.35) | 8 (13.11) | 0.231 | 0.631 |
| **Therapeutic factor** | | | | | |
| Blood transfusion | 57 (61.96) | 20 (64.52) | 37 (60.66) | 0.130 | 0.718 |
| Use of vasopressors | 34 (36.96) | 13 (41.94) | 21 (34.43) | 0.497 | 0.481 |
| Use of carbapenem antibiotics | 55 (59.78) | 20 (64.52) | 35 (57.38) | 0.436 | 0.509 |
| Use of vancomycin | 22 (23.91) | 6 (19.35) | 16 (26.23) | 0.534 | 0.465 |
| Hemodialysis | 21 (22.83) | 11 (35.48) | 10 (16.39) | 4.252 | 0.039* |
| ICU admission | 60 (65.22) | 19 (61.29) | 41 (67.21) | 0.318 | 0.573 |
| Hospitalization time | 25 (12.50, 49) | 29 (15, 48) | 23 (12, 49) | -0.678 | 0.498 |
| Use of hormones | 71 (77.17) | 26 (83.87) | 45 (73.77) | 1.190 | 0.275 |
| Use of antifungal drugs | 66 (71.74) | 23 (74.19) | 43 (70.49) | 0.139 | 0.709 |
| **Antifungal drug treatment methods** | | | | | |
| Caspofungin | 2 (2.17) | 0 (0.00) | 2 (3.28) | N/A | 0.548 |
| Micafungin | 2 (2.17) | 0 (0.00) | 2 (3.28) | N/A | 0.548 |
| Fluconazole | 25 (27.17) | 10 (32.26) | 15 (24.59) | 0.611 | 0.435 |
| Voriconazole | 35 (38.04) | 12 (38.71) | 23 (37.70) | 0.009 | 0.925 |
| Voriconazole + Amphotericin B | 2 (2.17) | 1 (3.23) | 1 (1.64) | N/A | 1.000 |
| Prophylactic antifungal therapy | 17 (18.48) | 7 (22.58) | 10 (16.39) | 0.522 | 0.470 |
| Targeted antifungal therapy | 49 (53.26) | 16 (51.61) | 33 (54.10) | 0.051 | 0.821 |
| Oral administration | 4 (4.35) | 2 (6.45) | 2 (3.28) | 0.027 | 0.869 |
| Intravenous infusion | 62 (67.39) | 21 (67.74) | 41 (67.21) | 0.003 | 0.959 |
| **Duration of antifungal drug use** | | | | | |
| Less than 7 days | 27 (29.35) | 11 (35.48) | 16 (26.23) | 0.849 | 0.357 |
| 7–14 days | 21 (22.83) | 7 (22.58) | 14 (22.95) | 0.002 | 0.968 |
| 15–21 days | 8 (8.70) | 1 (3.23) | 7 (11.48) | 0.876 | 0.349 |
| 22–28 days | 4 (4.35) | 2 (6.45) | 2 (3.28) | 0.027 | 0.869 |
| More than 28 days | 6 (6.52) | 2 (6.45) | 4 (6.56) | 0.000 | 1.000 |

**Table 4** (continued)

| Variable | Total ($n=92$) | *C. albicans* ($n=31$) | Non-*C. albicans* ($n=61$) | $\chi^2$/U (*C. albicans* vs. Non-*C. albicans*) | *P* |
|---|---|---|---|---|---|
| **Types of hormones** | | | | | |
| Dexamethasone | 64 (69.57) | 24 (77.42) | 40 (65.57) | 1.362 | 0.243 |
| Methylprednisolone | 5 (5.43) | 1 (3.23) | 4 (6.56) | 0.032 | 0.857 |
| Prednisone | 1 (1.09) | 0 (0.00) | 1 (1.64) | N/A | 1.000 |
| Hydrocortisone | 1 (1.09) | 1 (3.23) | 0 (0.00) | N/A | 0.337 |
| **Outcome** | | | | | |
| Mortality | 33 (35.87) | 17 (54.84) | 16 (26.23) | 7.313 | 0.007* |

*Significant statistical difference ($P<0.05$)

N/A: Not Applicable, the method used was Fisher's exact test

ICU, intensive care unit; $\chi^2$, chi-square value

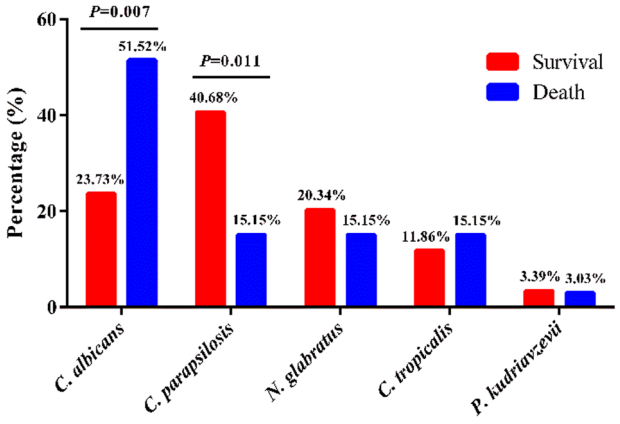


**Fig. 2** Mortality rates among different *Candida* species

species distribution, for instance, fluconazole use has been linked to an increased incidence of *N. glabratus* and *P. kudriavzevii* infections, whereas caspofungin use has been associated with a rise in *C. parapsilosis*, *N. glabratus*, and *P. kudriavzevii* infections [46]. In a six-year multicenter study on adult candidemia in China, the proportion of fluconazole use was 36.3%, while the proportions of *N. glabratus* and *P. kudriavzevii* were 20.2% and 2.3%, respectively [47]. Our study shows similar results, with fluconazole use at 27.17%, *N. glabratus* at 18.48%, and *P. kudriavzevii* at 3.26%. However, in the multicenter study, the proportion of caspofungin use was 25.3%, and *C. parapsilosis* accounted for 15.6% [47], whereas in our study, caspofungin use was only 2.17%, but *C. parapsilosis* reached 31.52%. This discrepancy suggests that the distribution of *Candida* species is influenced not only by antifungal drug usage but also by other factors. The escalating resistance to antifungal drugs, particularly among non-*C. albicans* species, has become a global concern [48]. Identification of *Candida* isolates at the species level is important for empiric treatment of early suspected candidemia infections [49].

Polyenes, echinocandins, azoles, and flucytosine constitute the primary antifungal agents for the treatment of candidemia [50]. Clinical guidelines predominantly endorse echinocandins for managing fungal infections [29]. Biofilm formation is one of the main drug resistance mechanisms of *Candida* [51]. Notably, azoles such as fluconazole, voriconazole, and itraconazole are ineffective against *Candida* biofilms, whereas amphotericin B demonstrates the capacity to inhibit biofilm development effectively [51]. Due to the unavailability of echinocandin antibiotic testing kits at the initial stage of this study, and considering that fluconazole and voriconazole are commonly used antifungal agents by clinicians at our hospital, with significantly lower treatment costs compared to echinocandin drugs such as micafungin. Therefore, we selected the ATB FUNGUS 3 kit to perform antifungal susceptibility testing. In this study, the susceptibility of *C. albicans* to amphotericin B was 96.77%, and the susceptibility of other *Candida* species to amphotericin B was 100%. Despite the high mortality associated with its use to treat candidemia, fluconazole remains the most commonly used antifungal drug in developing countries [52]. The literature indicates that the susceptibility rate of *C. tropicalis* to fluconazole varies from 71.8 to 88.8% [7, 23, 53], however, in this study, it was alarmingly low at only 58.33%. The increased resistance to *C. tropicalis* may be attributed to the favorable safety profile, cost-effectiveness, and excellent tissue penetration of fluconazole, which has led to its broad application by clinicians for both empirical and prophylactic treatment, potentially fostering resistance [54]. In our study, the susceptibility of *Candida* spp. to fluconazole was higher than that to voriconazole, which is consistent with findings from Luzhou, China [33]. This may similarly be attributed to the higher frequency of voriconazole use by clinicians in the region, leading to increased resistance to voriconazole.

Previous studies have identified renal insufficiency, neutropenia, diabetes, and malignancies as significant risk factors for candidemia [55, 56]. In addition, solid organ transplantation, recent history of surgery, hemodialysis, mechanical ventilation, prolonged ICU stay (≥7 days), and the use of central venous catheters are recognized as important contributors to the risk of such

**Table 5** Univariate analysis of clinical characteristics of 33 patients died of candidemia

| Variable | Survival ($n=59$) | Death ($n=33$) | $\chi^2$/Z | *P* |
|---|---|---|---|---|
| Sex, male/female | 34/25 | 21/12 | 0.318 | 0.573 |
| Age (years) | 66 (51.5, 76) | 73 (68, 83) | -3.063 | 0.002* |
| **Disease factor** | | | | |
| Hypertension | 22 (37.29) | 16 (48.48) | 1.094 | 0.296 |
| Diabetes | 12 (20.34) | 5 (15.15) | 0.378 | 0.539 |
| Cardiovascular disease | 9 (15.25) | 16 (48.48) | 11.809 | 0.001* |
| Nervous system disease | 16 (27.12) | 8 (24.24) | 0.091 | 0.763 |
| Digestive system disease | 25 (42.37) | 20 (60.61) | 2.816 | 0.093 |
| Respiratory system disease | 35 (59.32) | 25 (75.76) | 2.520 | 0.112 |
| Urinary system disease | 15 (25.42) | 6 (18.18) | 0.630 | 0.427 |
| Kidney disease | 11 (18.64) | 17 (51.52) | 10.800 | 0.001* |
| Solid malignancy | 5 (8.47) | 5 (15.15) | 0.407 | 0.524 |
| Multiple organ dysfunction | 3 (5.08) | 8 (24.24) | 5.671 | 0.017* |
| Shock | 11 (18.64) | 15 (45.45) | 7.503 | 0.006* |
| Bacterial bloodstream infection | 12 (20.34) | 8 (24.24) | 0.190 | 0.663 |
| *Candida*-related organ involvement | 4 (6.78) | 5 (15.15) | 0.866 | 0.352 |
| **Invasive factors** | | | | |
| Tracheal intubation | 19 (32.20) | 24 (72.73) | 13.961 | 0.000* |
| Tracheotomy | 8 (13.56) | 4 (12.12) | 0.000 | 1.000 |
| Mechanical ventilation | 21 (35.59) | 26 (78.79) | 15.802 | 0.000* |
| Bronchoscopic lavage of respiratory tract | 4 (6.78) | 5 (15.15) | 0.866 | 0.352 |
| Central venous catheterization | 35 (59.32) | 29 (87.88) | 8.151 | 0.004* |
| Arterial catheterization | 17 (28.81) | 16 (48.48) | 3.560 | 0.059 |
| Surgery | 30 (50.85) | 15 (45.45) | 0.246 | 0.620 |
| Surgical drainage tube | 26 (44.07) | 11 (33.33) | 1.014 | 0.314 |
| Urinary tract catheterization | 10 (16.95) | 4 (12.12) | 0.382 | 0.536 |
| **Therapeutic factor** | | | | |
| Blood transfusion | 32 (54.24) | 25 (75.76) | 4.158 | 0.041* |
| Use of vasopressors | 12 (20.34) | 22 (66.67) | 19.495 | 0.000* |
| Use of carbapenem antibiotics | 28 (47.46) | 27 (81.82) | 10.392 | 0.001* |
| Use of vancomycin | 13 (22.03) | 9 (27.27) | 0.319 | 0.572 |
| Hemodialysis | 7 (11.86) | 14 (42.42) | 11.220 | 0.001* |
| ICU admission | 33 (55.93) | 27 (81.82) | 6.251 | 0.012* |
| Hospitalization time | 25 (13, 49) | 21 (8, 47) | -1.095 | 0.273 |
| Use of hormones | 42 (71.19) | 29 (87.88) | 3.347 | 0.067 |
| Use of antifungal drugs | 39 (66.10) | 27 (81.82) | 2.578 | 0.108 |
| **Antifungal drug treatment methods** | | | | |
| Caspofungin | 1 (1.69) | 1 (3.03) | N/A | 1.000 |
| Micafungin | 0 (0.00) | 2 (6.06) | N/A | 0.126 |
| Fluconazole | 19 (32.20) | 6 (18.18) | 2.102 | 0.147 |
| Voriconazole | 17 (28.81) | 18 (54.55) | 5.945 | 0.015* |
| Voriconazole + Amphotericin B | 2 (3.39) | 0 (0.00) | N/A | 0.535 |
| Prophylactic antifungal therapy | 11 (18.64) | 6 (18.18) | 0.003 | 0.956 |
| Targeted antifungal therapy | 28 (47.46) | 21 (63.64) | 2.225 | 0.136 |
| Oral administration | 3 (5.08) | 1 (3.03) | 0.000 | 1.000 |
| Intravenous infusion | 36 (61.02) | 26 (78.79) | 3.041 | 0.081 |
| **Duration of antifungal drug use** | | | | |
| Less than 7 days | 10 (16.95) | 17 (51.52) | 12.195 | 0.000* |
| 7–14 days | 17 (28.81) | 4 (12.12) | 3.347 | 0.067 |
| 15–21 days | 7 (11.86) | 1 (3.03) | 1.116 | 0.291 |
| 22–28 days | 3 (5.08) | 1 (3.03) | 0.000 | 1.000 |
| More than 28 days | 2 (3.39) | 4 (12.12) | 1.408 | 0.235 |
| **Types of hormones** | | | | |

**Table 5** (continued)

| Variable | Survival ($n=59$) | Death ($n=33$) | $\chi^2$/Z | *P* |
|---|---|---|---|---|
| Dexamethasone | 40 (67.80) | 24 (72.73) | 0.243 | 0.622 |
| Methylprednisolone | 2 (3.39) | 3 (9.09) | 0.459 | 0.498 |
| Prednisone | 0 (0.00) | 1 (3.03) | N/A | 0.359 |
| Hydrocortisone | 0 (0.00) | 1 (3.03) | N/A | 0.359 |

*Significant statistical difference ($P<0.05$)

N/A: Not Applicable, the method used was Fisher's exact test

ICU: intensive care unit; $\chi^2$: chi-square value

**Table 6** Logistic multiple regression analysis of risk factors for death in candidemia patients

| Risk Factors | β | SE | Wald | OR | 95% CI | *P* |
|---|---|---|---|---|---|---|
| Age | 0.057 | 0.032 | 3.235 | 1.059 | 0.995–1.127 | 0.072 |
| Cardiovascular disease | 2.187 | 0.922 | 5.630 | 8.913 | 1.463–54.289 | 0.018* |
| Kidney disease | 2.615 | 0.974 | 7.203 | 13.672 | 2.025–92.326 | 0.007* |
| Multiple organ dysfunction | 1.116 | 1.195 | 0.873 | 3.054 | 0.294–31.738 | 0.350 |
| Shock | -0.481 | 1.139 | 0.178 | 0.618 | 0.066–5.768 | 0.673 |
| Tracheal intubation | 1.506 | 2.574 | 0.342 | 4.508 | 0.029–700.107 | 0.559 |
| Mechanical ventilation | 0.810 | 2.604 | 0.097 | 2.247 | 0.014–370.072 | 0.756 |
| Central venous catheterization | 0.755 | 1.09 | 0.480 | 2.128 | 0.251–18.009 | 0.488 |
| Blood transfusion | -0.858 | 0.890 | 0.930 | 0.424 | 0.074–2.427 | 0.335 |
| Use of vasopressors | 1.835 | 1.112 | 2.722 | 6.265 | 0.708–55.412 | 0.099 |
| Use of carbapenem antibiotics | -0.034 | 1.078 | 0.001 | 0.967 | 0.117–7.990 | 0.975 |
| Hemodialysis | -0.715 | 1.053 | 0.461 | 0.489 | 0.062–3.854 | 0.497 |
| ICU admission | -1.873 | 1.349 | 1.928 | 0.154 | 0.011–2.161 | 0.165 |
| Monotherapy with voriconazole | 1.625 | 0.991 | 2.690 | 5.078 | 0.728–35.391 | 0.101 |
| Antifungal drug treatment duration less than 7 days | 2.370 | 0.898 | 6.969 | 10.694 | 1.841–62.112 | 0.008* |

*Significant statistical difference ($P<0.05$)

β: regression coefficient; SE: standard deviation; OR: odds ratio; CI: confidence interval

infections [47, 57]. The results of the univariate analysis of the death and survival groups in this study revealed that cardiovascular disease, kidney disease, multiple organ dysfunction, and shock were associated with mortality in patients with candidemia; invasive procedures, including tracheal intubation, mechanical ventilation, and central venous catheterization were identified as major invasive factors associated with mortality. Other significant factors associated with mortality include blood transfusions, vasopressor use, carbapenem antibiotics, hemodialysis, ICU admission, monotherapy with voriconazole, and antifungal treatment duration less than 7 days. Some studies have indicated that age, shock, central venous catheterization, ICU admission, and cardiovascular disease were associated with mortality in patients with candidemia [58, 59], which is consistent with this study. One study has demonstrated that there is no significant difference in the use of caspofungin between the survival and deceased groups among patients with candidemia [58]. Additionally, no significant differences were observed in the use of prophylactic antifungal therapy between survival and deceased groups [47]. These findings were consistent with the results of this study. It is imperative to minimize invasive procedures for clinically high-risk patients. Timely evaluation of the invasive device removal in patients who have undergone procedures such as tracheal intubation and central venous catheterization is essential. The prompt removal of these invasive elements can significantly affect patient prognosis. Observational studies on the treatment of candidemia have demonstrated that removal of central venous catheters is associated with improved patient outcomes [60].

In our study, the median age of patients with candidemia was 69.50 years, which is significantly higher than that reported in a study conducted in Egypt, where the median age of adults was 47 years [61]. However, no difference was observed in the median ages between patients with *C. albicans* candidemia and those with non-*C. albicans* candidemia in our study. Age is an important risk factor for candidemia [49, 62], and the risk of death associated with candidemia escalates with increasing age [23], likely due to diminished immunity, reduced organ function, and the prevalence of chronic diseases in the elderly population. Consequently, there is a heightened need for vigilance when diagnosing candidemia in elderly patients. In this study, deceased patients predominantly exhibited infections caused by *C. albicans*, constituting 51.52% of all cases. This finding is consistent with the results of a study from China, where *C. albicans* was responsible for 54.5% of candidemia-related fatalities

[33]. However, this rate is higher than that reported in a study from Fujian, China, which found that *C. albicans* accounted for 25.00% of candidemia-related deaths [58].

Candidemia is associated with high rates of morbidity and mortality, particularly among critically ill or immunocompromised patients [63]. Multiple logistic regression analysis revealed significant factors associated with mortality in cases of candidemia, including cardiovascular disease, kidney disease, and antifungal treatment duration less than 7 days. In a study of candidemia in Brazil, inadequate treatment was identified as a significant risk factor for mortality in patients with candidemia [64]. Our finding that antifungal drug treatment duration of less than 7 days is a significant factor for mortality in candidemia supports this notion. Clinicians should focus on patients with candidemia who have cardiovascular disease and kidney disease, ensuring prompt management of these underlying conditions. Additionally, it is crucial to ensure that the duration of antifungal drug treatment is adequate. In a 9-year retrospective study conducted in Brazil and Spain, age was identified as a significant factor associated with mortality [65]. In a 10-year retrospective study of adult candidemia in Finland, admission to the ICU and age greater than 65 years were identified as independent risk factors for mortality [66]. Similarly, a study on candidemia in Chongqing and Shenyang, China, also indicated that admission to the ICU is an independent predictor of mortality in candidemia [13, 53]. This study findings differ from the aforementioned reports, indicating that age and ICU admission were not independent risk factors for mortality in patients with candidemia. Notably, in this study, only 55.93% of the survival group had a history of ICU admission, compared to 81.82% in the death group. Patients who required ICU admission tended to be older, immunocompromised, and frequently suffered from severe illnesses such as cardiovascular disease and renal insufficiency. Consequently, heightened vigilance is warranted in clinical practice to reduce the risk of candidemia in elderly ICU patients. A study in South Korea identified hematologic disease, the use of immunosuppressants, total parenteral nutrition, mechanical ventilation, and septic shock as independent risk factors for mortality in patients with candidemia [67]. The differences in mortality risk factors among patients with candidemia in our region compared to those reported by other researchers may be partly attributed to variations in medical conditions across different regions. Factors such as the prevalence of underlying diseases among patients, differences in disposable income available for treatment, and variations in treatment plans devised by clinicians can all contribute to the differences in mortality risk factors in patients with candidemia.

This study presents an 8-year retrospective statistical analysis of clinical data from patients diagnosed with candidemia at the First People's Hospital of Zunyi, spanning the period from 2016 to 2023. Given that 51.52% of fatal cases of candidemia are caused by *C. albicans*, clinicians should remain vigilant for candidemia caused by this species. Additionally, particular attention should be paid to older patients, who often have comorbid cardiovascular and renal diseases and are at a higher risk of mortality. It is crucial to ensure the appropriate and full-course use of antifungal agents, as inadequate duration of antifungal therapy can increase the risk of patient mortality. In accordance with the global guidelines for the diagnosis and management of candidiasis, for candidemia without deep-seated or metastatic foci, the recommended duration of antifungal therapy is 14 days from the first day of persistently negative blood cultures [68]. This study provides important references for the epidemiological surveillance of candidemia in the Zunyi region and globally, as well as for antifungal stewardship and clinical management strategies.

This study had some limitations. First, as this was a single-center study with a modest sample size of 92 patients, the generalizability of our findings may be limited. A limited number of patients could have introduced variability bias in the study. A multicenter approach in future studies could accurately represent the epidemiology of candidemia in this region. Second, the study did not include drug susceptibility experiments for echinocandins, which are agents of significant clinical interest owing to their potent antifungal profile, especially amid rising resistance to azole antifungal drugs. Incorporating these assays would provide a comprehensive understanding of the antifungal resistance patterns. Finally, the study did not perform a statistical analysis of laboratory indicators related to candidemia, which could be critical for early detection and therapeutic decision-making.

## Conclusion

This study analyzed the prevalence of candidemia in in Zunyi, China, highlighting the high mortality rate of *C. albicans* as the primary pathogen. The primary risk factors for increased mortality in patients with candidemia include cardiovascular disease, kidney disease, and antifungal drug treatment duration less than 7 days. These findings underscore the importance of early recognition and targeted management of high-risk patients, particularly those with cardiovascular and kidney disease. Ensuring appropriate and full-course antifungal therapy is critical to improving outcomes in patients with candidemia. This study enhances the understanding of candidemia epidemiology and management in Zunyi, China, supporting local efforts to optimize antifungal stewardship and refine clinical practice guidelines. Additionally, this

study provides valuable reference data for global surveillance, treatment strategies, and clinical management of candidemia.

**Abbreviations**

| | |
|---|---|
| ICU | Intensive care unit |
| χ2 | Chi-square value |
| β | Regression coefficient |
| SE | Standard deviation |
| OR | Odds ratio |
| CI | Confidence interval |

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**Author contributions**
Conception and design: XHC. Acquisition of data: XHC, MJS, QF, GWY and RGT. Analysis and interpretation of data: XHC and SFY. Drafting of the article: XHC. Critical revision of the article: XHC and HZ. Writing—review & editing: XHC. Study supervision: XHC. and HZ. All authors have read and agreed to the published version of the manuscript.

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**Data availability**
The datasets used or analysed during this study available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate**
This study was approved by the Ethics Review Committee of the First People's Hospital of Zunyi (Approval No. 2023-1-192). The Ethics Review Committee of the First People's Hospital of Zunyi has waived the requirement for informed consent because this is a retrospective analysis, all patient information was anonymized, and there were no additional interventions or risks to participants in this study. This study was conducted in full accordance with the Declaration of Helsinki.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

**Clinical trial number**
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