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Original Article

Species Distribution and Antifungal Susceptibility Patterns of Candida Isolates Recovered from Various Clinical Specimens: A Cross-Sectional Study from a Tertiary Care Hospital

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ABSTRACT

Background: *Candidiasis* has emerged as a major cause of healthcare-associated infections, particularly among hospitalized and immunocompromised patients. The increasing prevalence of non-*albicans Candida* species and the growing resistance to commonly used antifungal agents have made accurate species identification and antifungal susceptibility testing essential for effective patient management.

Aim: To determine the species distribution and antifungal susceptibility patterns of *Candida* isolates recovered from various clinical specimens in a tertiary care hospital.

Materials and Methods: This hospital-based cross-sectional study included **105 consecutive *Candida* isolates** recovered from various clinical specimens received in the Department of Microbiology during the study period. Clinical specimens included urine, blood, pus, sputum, vaginal swabs, endotracheal aspirates, and others. Isolates were identified to the species level using standard microbiological methods, and antifungal susceptibility testing was performed according to the Clinical and Laboratory Standards Institute (CLSI) guidelines. Demographic characteristics, clinical risk factors, species distribution, and antifungal susceptibility profiles were analyzed using descriptive statistics.

Results: Among the 105 *Candida* isolates, females accounted for **54.3%** of cases, and the highest proportion of patients belonged to the 41–60-year age group (**38.1%**). Urine was the most common specimen (**40.0%**), followed by blood (**19.0%**) and pus (**15.2%**). *Candida albicans* was the predominant species (**42.9%**), followed by *Candida tropicalis* (**28.6%**) and *Candida glabrata* (**13.3%**). Most isolates were recovered from Intensive Care Unit patients (**36.2%**). Broad-spectrum antibiotic use (**68.6%**) was the most frequent associated risk factor. Antifungal susceptibility testing demonstrated high susceptibility to micafungin (**99.0%**), caspofungin (**98.1%**), and amphotericin B (**97.1%**), whereas fluconazole showed the highest resistance, with susceptibility of **70.5%**.

Conclusion: *Candida albicans* remained the predominant species; however, non-*albicans Candida* species constituted a substantial proportion of isolates. Echinocandins and amphotericin B demonstrated excellent in vitro activity, while fluconazole resistance was relatively common. Routine species identification and antifungal susceptibility testing are important for optimizing antifungal therapy, monitoring resistance trends, and improving patient outcomes in tertiary care hospitals.

***Keywords**: Candida, candidiasis, species distribution, antifungal susceptibility, non-albicans Candida, fluconazole resistance, tertiary care hospital.*

INTRODUCTION

Candida species are opportunistic fungal pathogens that form part of the normal human microbiota of the oral cavity, gastrointestinal tract, genitourinary tract, and skin. Under normal circumstances, these organisms exist as harmless commensals; however, disruption of host immunity or normal microbial flora can result in superficial or invasive candidiasis. In recent decades, *Candida* infections have emerged as a major cause of healthcare-associated infections, particularly among hospitalized patients, critically ill individuals, neonates, elderly patients, transplant recipients, and those receiving immunosuppressive therapy or broad-spectrum antibiotics [1–3]. Invasive candidiasis remains associated with considerable morbidity, prolonged hospital stay, increased healthcare costs, and high mortality despite advances in diagnostic techniques and antifungal therapy.

The epidemiology of candidiasis has undergone significant changes over the past two decades. Although *Candida albicans* continues to be the most frequently isolated species worldwide, there has been a marked increase in infections caused by non-*albicans Candida* species such as *Candida tropicalis, Candida glabrata, Candida parapsilosis,* and *Candida krusei*. The prevalence of these species varies according to geographic region, patient population, underlying disease, and local antifungal prescribing practices. This epidemiological shift is clinically important because several non-*albicans Candida* species exhibit reduced susceptibility or intrinsic resistance to commonly used azole antifungal agents, particularly fluconazole [2,4,5].

Several predisposing factors contribute to the development of candidiasis. These include prolonged hospitalization, intensive care unit admission, diabetes mellitus, prolonged use of broad-spectrum antibiotics, indwelling urinary and central venous catheters, mechanical ventilation, total parenteral nutrition, malignancy, neutropenia, organ transplantation, corticosteroid therapy, and HIV infection [6–8]. Colonization of mucosal surfaces often precedes invasive disease, particularly in critically ill patients, emphasizing the importance of early diagnosis and timely therapeutic intervention.

Clinical manifestations of *Candida* infection range from superficial infections such as oral candidiasis, vulvovaginal candidiasis, and cutaneous candidiasis to life-threatening invasive infections including candidemia, endocarditis, meningitis, intra-abdominal candidiasis, osteomyelitis, and disseminated candidiasis. Bloodstream infections caused by *Candida* species represent one of the most common healthcare-associated fungal infections and are associated with substantial mortality if diagnosis and treatment are delayed [1,9].

Rapid and accurate identification of *Candida* species has become increasingly important because different species exhibit distinct virulence characteristics and antifungal susceptibility profiles. Conventional laboratory methods such as Gram staining, germ tube testing, carbohydrate assimilation tests, CHROMagar Candida, and automated identification systems remain widely used in clinical microbiology laboratories. More recently, matrix-assisted laser desorption ionization-time of flight mass spectrometry (MALDI-TOF MS) and molecular diagnostic techniques have improved the speed and accuracy of species identification [10–12].

The emergence of antifungal resistance has become a major public health concern worldwide. Resistance to azole antifungal agents, especially fluconazole, has increased among several *Candida* species, while resistance to echinocandins and polyenes, although less common, has also been reported. The increasing prevalence of multidrug-resistant species such as *Candida auris* further highlights the need for continuous surveillance of antifungal susceptibility patterns [13–15].

Antifungal susceptibility testing performed according to Clinical and Laboratory Standards Institute (CLSI) or European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines plays a crucial role in guiding appropriate antifungal therapy, monitoring emerging resistance, and supporting antimicrobial stewardship programs. Early species identification combined with susceptibility testing enables clinicians to initiate targeted antifungal therapy, thereby improving patient outcomes and reducing unnecessary exposure to broad-spectrum antifungal agents [16,17].

Despite advances in diagnosis and treatment, the epidemiology of candidiasis varies considerably between institutions and geographical regions. Continuous local surveillance of species distribution and antifungal susceptibility is therefore essential for developing institution-specific treatment guidelines and infection control strategies. Information generated from tertiary care hospitals is particularly valuable because these centres manage a large number of critically ill and immunocompromised patients. Therefore, the present study was undertaken to determine the prevalence, species distribution, and antifungal susceptibility patterns of *Candida* isolates recovered from various clinical specimens in a tertiary care hospital, thereby providing useful information for clinicians regarding the changing epidemiology of candidiasis and guiding evidence-based antifungal therapy [18].

MATERIALS AND METHODS

Study Design

This was a hospital-based, cross-sectional observational study conducted in the Department of Microbiology at Sawai Madhopur Medical College, over a period of one year

Study Setting

The study was carried out in the Department of Microbiology of a tertiary care teaching hospital catering to patients from outpatient departments, inpatient wards, intensive care units, emergency services, and specialty departments. The hospital serves as a major referral centre for surrounding urban and rural populations.

Study Population

All consecutive clinical specimens received in the Department of Microbiology during the study period that yielded *Candida* species on culture were included in the study.

Sample Size

A total of **105 non-duplicate Candida isolates** recovered from various clinical specimens were included for analysis.

Clinical Specimens

The specimens included:

- Urine
- Blood
- Pus
- Sputum
- Vaginal swab
- Endotracheal aspirate
- Body fluids and other sterile specimens

Inclusion Criteria

1. Patients of all age groups and both sexes.
2. Clinical specimens showing significant growth of *Candida* species.
3. First isolate obtained from each patient during the study period.
4. Patients admitted to both inpatient and outpatient departments.
5. Samples received with complete demographic and clinical details.

Exclusion Criteria

1. Duplicate isolates from the same patient.
2. Contaminated or improperly collected specimens.
3. Specimens with inadequate clinical information.
4. Mixed fungal cultures where *Candida* could not be identified reliably.
5. Repeat isolates from the same episode of infection.

Isolation and Identification

Clinical specimens were processed according to standard microbiological procedures. Specimens were inoculated on Sabouraud Dextrose Agar and incubated at 35–37°C. Isolates were identified based on colony morphology, Gram staining, germ tube test, CHROMagar Candida, and standard biochemical identification methods. Species identification was confirmed according to laboratory protocols.

Antifungal Susceptibility Testing

Antifungal susceptibility testing was performed according to the Clinical and Laboratory Standards Institute (CLSI) guidelines using appropriate quality control strains. The antifungal agents tested included:

- Fluconazole
- Voriconazole
- Itraconazole
- Amphotericin B
- Caspofungin
- Micafungin

Data Collection
The following variables were recorded:

- Age
- Sex
- Hospital ward
- Clinical diagnosis
- Type of specimen
- *Candida* species isolated
- Associated risk factors
- Antifungal susceptibility pattern

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using SPSS software (Version 26.0 or later). Categorical variables were expressed as frequency and percentage. Continuous variables were expressed as mean ± standard deviation. Associations between categorical variables were assessed using the Chi-square or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

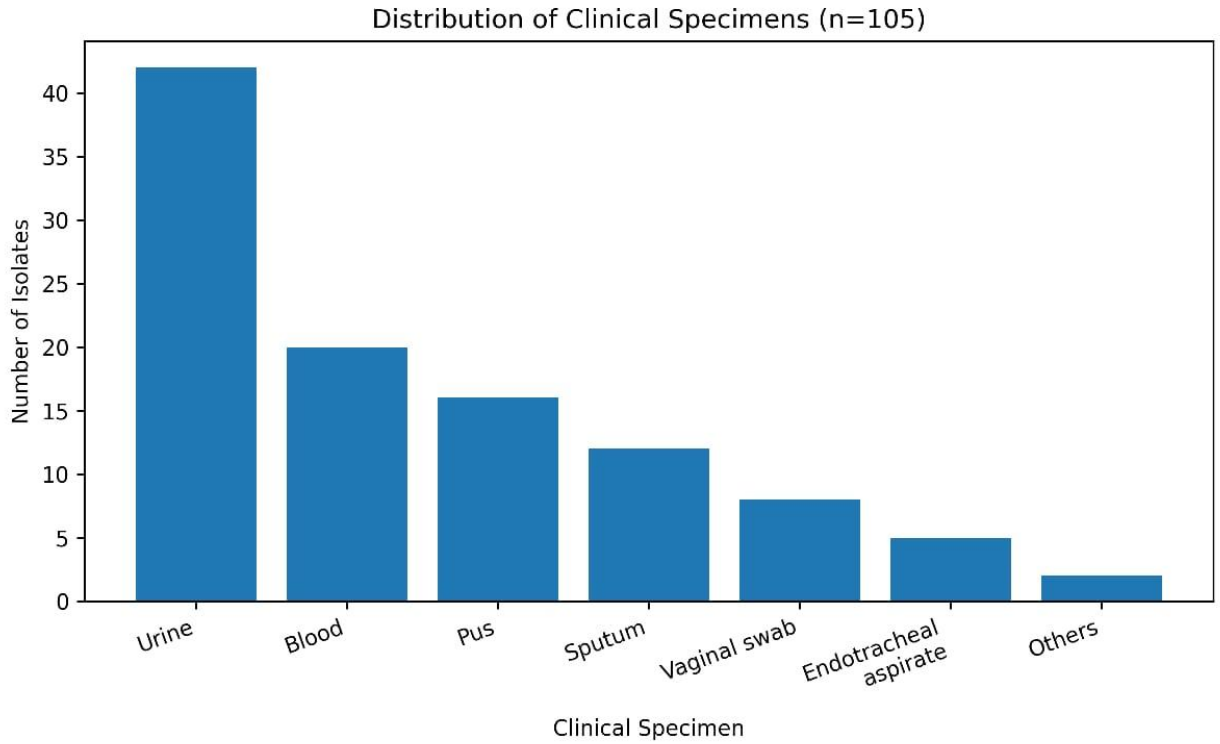
RESULTS
Of the 105 patients with *Candida* isolates, **57 (54.3%) were females** and **48 (45.7%) were males**, indicating a slight female predominance. The highest proportion of cases belonged to the **41–60 years age group (38.1%)**, followed by the **21–40 years age group (34.3%)**. Patients older than 60 years constituted **18.1%**, while those aged 0–20 years accounted for **9.5%** of the total cases. Thus, the majority of *Candida* infections occurred among middle-aged and older adults.

Table 1. Demographic profile of patients (n = 105)

Variable	**Number (%)**
Male	48 (45.7)
Female	57 (54.3)
Age 0–20 years	10 (9.5)
21–40 years	36 (34.3)
41–60 years	40 (38.1)
>60 years	19 (18.1)

Table 2. Distribution of clinical specimens

Specimen	**Number (%)**
Urine	42 (40.0)
Blood	20 (19.0)
Pus	16 (15.2)
Sputum	12 (11.4)
Vaginal swab	8 (7.6)
Endotracheal aspirate	5 (4.8)
Others	2 (1.9)
Total	**105 (100)**



Graph 1: Distribution of clinical specimens

Table 2: Distribution of clinical specimens

Urine was the **most common clinical specimen**, contributing **42 (40.0%)** of all *Candida* isolates. Blood samples accounted for **20 (19.0%)** isolates, followed by pus (**16; 15.2%**), sputum (**12; 11.4%**), vaginal swabs (**8; 7.6%**), and endotracheal aspirates (**5; 4.8%**). Two isolates (**1.9%**) were recovered from other specimen types. These findings indicate that urinary tract specimens were the predominant source of *Candida* isolation in this study.

Table 3. Species distribution of *Candida*

Species	**Number (%)**
Candida albicans	45 (42.9)
Candida tropicalis	30 (28.6)
Candida glabrata	14 (13.3)
Candida parapsilosis	8 (7.6)
Candida krusei	5 (4.8)
Candida kefyr	3 (2.9)
Total	**105 (100)**

Table 3: Species distribution of *Candida*

Species identification showed that ***Candida albicans*** was the **most frequently isolated species**, accounting for **45 (42.9%)** isolates. This was followed by ***Candida tropicalis*** with **30 (28.6%)** isolates and ***Candida glabrata*** with **14 (13.3%)** isolates. ***Candida parapsilosis***, ***Candida krusei***, and ***Candida kefyr*** accounted for **7.6%**, **4.8%**, and **2.9%** of isolates, respectively. Although *C. albicans* remained the predominant species, non-*albicans Candida* collectively represented a substantial proportion of isolates.

Table 4. Ward-wise distribution

Ward	**Number (%)**
ICU	38 (36.2)
Medicine	25 (23.8)
Surgery	18 (17.1)
Obstetrics & Gynaecology	10 (9.5)
Pediatrics	8 (7.6)
Others	6 (5.7)

Table 4: Ward-wise distribution

The highest number of *Candida* isolates was obtained from patients admitted to the **Intensive Care Unit (ICU)**, where **38 (36.2%)** isolates were recovered. The Medicine ward contributed **25 (23.8%)** isolates, followed by the Surgery ward (**18; 17.1%**). Obstetrics and Gynaecology accounted for **10 (9.5%)** isolates, Pediatrics for **8 (7.6%)**, and other hospital departments for **6 (5.7%)**. These findings suggest that critically ill hospitalized patients represented the largest group affected by candidiasis.

Table 5. Risk factors

Risk factor	Number (%)
Broad-spectrum antibiotic use	72 (68.6)
Diabetes mellitus	36 (34.3)
Urinary catheter	32 (30.5)
ICU admission	38 (36.2)
Central venous catheter	18 (17.1)
Immunosuppression	14 (13.3)

Table 5: Risk factors associated with candidiasis

Broad-spectrum antibiotic use was the **most common associated risk factor**, observed in **72 (68.6%)** patients. ICU admission was noted in **38 (36.2%)**, diabetes mellitus in **36 (34.3%)**, and urinary catheterization in **32 (30.5%)** patients. Central venous catheterization was present in **18 (17.1%)**, while **14 (13.3%)** patients were immunosuppressed. These findings indicate that multiple clinical risk factors commonly coexisted among patients with *Candida* infection.

Table 6. Antifungal susceptibility pattern

Antifungal	Sensitive n (%)	Resistant n (%)
Fluconazole	74 (70.5)	31 (29.5)
Voriconazole	94 (89.5)	11 (10.5)
Itraconazole	80 (76.2)	25 (23.8)
Amphotericin B	102 (97.1)	3 (2.9)
Caspofungin	103 (98.1)	2 (1.9)
Micafungin	104 (99.0)	1 (1.0)

Table 6: Antifungal susceptibility pattern

Antifungal susceptibility testing demonstrated excellent activity of echinocandins and amphotericin B. **Micafungin** showed the highest susceptibility rate (**99.0%**), followed by **caspofungin (98.1%)** and **amphotericin B (97.1%)**. Susceptibility to **voriconazole** was **89.5%**, while **itraconazole** showed **76.2%** susceptibility. **Fluconazole** exhibited the lowest susceptibility (**70.5%**) and the highest resistance (**29.5%**) among the antifungal agents tested, indicating reduced effectiveness compared with the other antifungal drugs evaluated.

During the study period, 105 *Candida* isolates were recovered from various clinical specimens. Females constituted a slightly higher proportion of cases than males. The majority of patients belonged to the 41–60-year age group. Urine was the most common specimen yielding *Candida*, followed by blood and pus. *Candida albicans* was the predominant species isolated; however, non-*albicans Candida* species collectively represented more than half of the isolates. The highest number of isolates originated from patients admitted to the intensive care unit. Broad-spectrum antibiotic therapy, diabetes mellitus, prolonged hospitalization, urinary catheterization, and ICU admission were the most frequent associated risk factors. Antifungal susceptibility testing demonstrated excellent activity of echinocandins and amphotericin B, whereas fluconazole showed comparatively lower susceptibility, highlighting the importance of routine species identification and susceptibility testing.

DISCUSSION

The present study evaluated the species distribution and antifungal susceptibility patterns of *Candida* isolates recovered from various clinical specimens in a tertiary care hospital. A total of 105 *Candida* isolates were analyzed. The findings demonstrated that *Candida albicans* remained the predominant isolate, although non-*albicans Candida* (NAC) species collectively constituted a substantial proportion of isolates. These observations are consistent with the changing epidemiology of candidiasis reported from tertiary care hospitals worldwide [1–18].

In the present study, females constituted a slightly higher proportion of patients than males. This finding is comparable with earlier Indian studies that reported a female predominance, mainly due to the higher frequency of urinary and vulvovaginal candidiasis among women [3,6]. Similar demographic patterns have also been observed in recent tertiary care hospital studies from India.

Urine was the commonest specimen yielding *Candida* isolates, followed by blood and pus. The predominance of urine specimens has been documented in several previous studies and reflects the increasing incidence of candiduria among hospitalized patients, particularly those with diabetes mellitus, prolonged catheterization, and broad-spectrum antibiotic exposure [4,7,10]. Recent Indian studies have reported similar specimen distributions, with urine contributing the largest proportion of isolates.

Species identification revealed that *Candida albicans* was the most frequently isolated species. However, non-*albicans Candida* species together accounted for a significant proportion of isolates, with *Candida tropicalis* being the predominant non-*albicans* species. This finding correlates well with earlier Indian studies [5,8,11] and reflects the epidemiological shift towards non-*albicans Candida* species reported over the past decade. The increasing isolation of NAC species is clinically important because these organisms often exhibit reduced susceptibility to azole antifungal agents.

The majority of isolates in our study were recovered from Intensive Care Unit patients. ICU admission is a well-recognized risk factor for invasive candidiasis because critically ill patients are frequently exposed to invasive procedures, prolonged hospitalization, mechanical ventilation, broad-spectrum antibiotics, and indwelling catheters. Similar observations have been reported by several investigators [9,12,15]. Recent surveillance studies continue to identify ICUs as the major source of invasive *Candida* infections.

Broad-spectrum antibiotic therapy was the most frequent associated risk factor in the present study, followed by diabetes mellitus, urinary catheterization, and prolonged ICU stay. These factors disrupt the normal microbial flora and impair host defenses, facilitating colonization and infection by *Candida* species. Comparable findings have been reported by numerous investigators [6,13–15], highlighting the importance of antimicrobial stewardship and infection prevention measures.

Antifungal susceptibility testing demonstrated excellent in vitro activity of echinocandins and amphotericin B, whereas fluconazole exhibited comparatively lower susceptibility. Similar findings have been reported in several Indian and international studies, where increasing fluconazole resistance among non-*albicans Candida* species has emerged as a major therapeutic concern [14–18]. Recent surveillance also confirms that echinocandins remain highly effective against most *Candida* isolates.

A recently published study by **Aruna and Jahappriya (2025)** [19] from a tertiary care hospital in South India similarly reported that *Candida albicans* remained the commonest isolate, while non-*albicans Candida* species were increasingly encountered. Their study also demonstrated high susceptibility to echinocandins and amphotericin B, with comparatively lower susceptibility to fluconazole, findings that are in agreement with the present study.

Recent global evidence published in **2024** has further highlighted the changing epidemiology of candidiasis, demonstrating increasing recovery of non-*albicans Candida* species and emphasizing the importance of continuous surveillance of antifungal susceptibility because resistance patterns vary across geographical regions and healthcare settings.

Kumar A, Singh N, Das A, Agarwal J, et al. conducted a retrospective study in 2025 at a tertiary care hospital in North India and analyzed 1,641 *Candida* isolates recovered from various clinical specimens. The authors reported that non-*albicans Candida* species (72.6%) predominated over *Candida albicans* (27.4%), with *Candida tropicalis* being the most common non-*albicans* species. Urine was the commonest specimen, and fluconazole showed the highest resistance among the antifungal agents tested. These findings support the increasing prevalence of non-*albicans Candida* species and emphasize the importance of routine species identification and antifungal susceptibility testing in tertiary care hospitals. [20]

A 2025 study from a tertiary care center in Central India evaluated candidemia and antifungal susceptibility among bloodstream isolates. *Candida tropicalis* was the predominant species, followed by *Candida albicans* and *Candida parapsilosis*. The study observed high resistance to azole antifungal agents, particularly among non-*albicans Candida* species, while echinocandins remained effective against most isolates. The authors emphasized that routine species identification and antifungal susceptibility testing are essential for appropriate antifungal therapy and antimicrobial stewardship [21].

Overall, the findings of the present study support previous national and international observations that *Candida albicans* continues to be the leading pathogen, although non-*albicans Candida* species are increasing steadily. The high activity of echinocandins and amphotericin B and the comparatively lower susceptibility to fluconazole underscore the need for routine species identification and antifungal susceptibility testing to optimize antifungal therapy and improve patient outcomes in tertiary care hospitals.

CONCLUSION

The present study demonstrated that *Candida albicans* remained the predominant species isolated from various clinical specimens; however, non-*albicans Candida* species constituted a significant proportion of isolates, indicating a changing epidemiological trend. Urine was the most common clinical specimen, and intensive care unit patients represented the largest group affected by candidiasis. Broad-spectrum antibiotic therapy, diabetes mellitus, urinary catheterization, and prolonged hospitalization were the major associated risk factors. Antifungal susceptibility testing showed excellent activity of echinocandins and amphotericin B, whereas comparatively lower susceptibility was observed with fluconazole. Routine species-level identification together with antifungal susceptibility testing is essential for early diagnosis, appropriate antifungal selection, antimicrobial stewardship, and improved patient outcomes in tertiary care hospitals.

Limitations

- The study was conducted at a **single tertiary care center**, which may limit the generalizability of the findings to other healthcare settings.
- The **sample size was relatively small (105 isolates)** and may not fully represent the epidemiology of candidiasis in the broader population.
- **Molecular identification and antifungal resistance gene analysis** were not performed; therefore, resistance mechanisms could not be characterized.

DECLARATIONS:
Conflicts of interest: The authors declare that there are no conflicts of interest.
Consent to participate: Written informed consent was obtained from all participants.
Consent for publication: Consent for publication was obtained.
Authors' contributions: All authors contributed equally to the study and approved the final manuscript.

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