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Original Research Article

# Changing Patterns of Superficial Fungal Infections: Clinical, Resistance and Treatment Insights

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**Abstract:**

**Background:** Superficial fungal infections are highly prevalent worldwide and increasingly complicated by antifungal resistance, leading to chronicity, recurrence, and treatment failure.

**Aim:** To evaluate changing clinical patterns, antifungal resistance profiles, and treatment outcomes of superficial fungal infections in a tertiary care setting.

**Methodology:** This retrospective observational study analyzed 114 patients with superficial fungal infections attending a dermatology outpatient department over one year. Clinical features, infection sites, prior treatment history, mycological findings, antifungal susceptibility (broth microdilution), and treatment outcomes were assessed using descriptive statistics.

**Results:** Infections predominantly affected males (63.2%) and young adults aged 21–40 years (63.1%). Trunk (36.0%) and groin (32.5%) were the most common sites, with pruritus as the leading symptom (88.6%). High resistance was observed to terbinafine (51.8%) and fluconazole (43.0%), while itraconazole showed the highest sensitivity (78.1%). Oral itraconazole achieved superior clinical (82.6%) and mycological cure (76.1%) with the lowest relapse rate (15.2%).

**Conclusion:** The study demonstrates a shift toward increased antifungal resistance, particularly to commonly used agents, underscoring the importance of susceptibility-guided therapy and rational antifungal use.

**Keywords:** Superficial Fungal Infections, Antifungal Resistance, Itraconazole, Dermatophytosis, Treatment Outcomes.



## Introduction

Fungal infections have emerged as an important and often underappreciated global health issue, contributing considerable morbidity and mortality across diverse patient populations. A conservative estimation is that fungal pathogens cause 150 million serious infections and 1.7 million deaths annually worldwide. Infection disproportionately affects the most vulnerable patient groups, primarily the critically ill and immunocompromised, in whom this often leads to devastating clinical outcomes [1, 2]. The burden of fungal diseases is a concern because of issues related to delayed diagnosis and inappropriate antifungal therapy, adding to the growing problem of antifungal resistance, all further contributing to poor patient outcomes.

Management of fungal infections remains limited because of the availability of only a limited number of effective antifungal agents. Currently, only three major chemical classes of antifungal drugs include azoles, echinocandins, and polyenes that are available clinically. Among these, the azole antifungals hold particular clinical importance given their broad-spectrum activity, oral bioavailability, immunomodulatory effects, relatively low toxicity, and overall therapeutic efficacy [3]. Extensive and sometimes indiscriminate use of azoles has contributed to the emergence of resistant fungal strains. Resistance is increasingly a global concern that threatens the long-term effectiveness of existing treatment options.

Superficial fungal infections, or superficial mycoses, are the most common form of fungal disease, usually affecting the skin, hair, and nails. The infective agents are widely distributed throughout the world and are thought to affect 20-25% of the global population, making them an important public health issue. The superficial fungal infections are often judged to be relatively mild; however, their chronicity, recurrence, and resistance to treatment have a major effect on quality of life and healthcare

resources. Of particular note is the finding that approximately 19% of these infections are resistant to azole antifungals, commonly used as first-line treatments [4]. This increasing resistance threatens standards of care and argues for reevaluation of present clinical management.

In addition to superficial infections, fungal pathogens, particularly species of the genus Candida, are capable of inducing a wide spectrum of disease ranging from mild mucocutaneous infections to severe life-threatening invasive infections. Candida albicans remains the most frequently isolated species and accounts for the majority of candidiasis infections. Thankfully, C. albicans has inherently exhibited very low levels of resistance to antifungal therapy, making it relatively easy to treat. However, a notable rise of infections due to nonalbicans Candida species, including Candida auris, Candida glabrata, and Candida parapsilosis, has been observed. These species are associated with higher death rates and are generally more resistant to commonly used antifungal agents.

Invasive fungal infections due to resistant Candida species are more common in high-risk populations such as persons who are immunocompromised, hospitalized for extended periods, diabetic patients, those with recent or prolonged antibiotic use, patients with indwelling catheters, nursing home residents, and those undergoing immunosuppressive treatment following organ transplantation. Such infections are increasingly frequent, with strains that are resistant to polyenes, azoles, and echinocandins, creating a grave danger to public health. The recent emergence and spread of multidrug-resistant fungi, particularly in invasive infections, have thereby heightened the concerns about treatment failure and infection control within the healthcare settings [5].

This growing problem of antifungal resistance is further reflected in the results of surveillance data. The Centers for Disease Control and Prevention have reported fluconazole resistance in approximately 7% of all Candida isolates obtained from blood samples [6]. These findings emphasize how essential it is to detect antifungal resistance early and correctly to offer appropriate therapy and improve clinical outcomes. This is where antifungal susceptibility testing comes into play, allowing the clinician to ascertain which of the available agents will be effective against a particular pathogen and to outline any emerging pattern of resistance.

Therefore, microdilution techniques are reference procedures and are considered to be the gold standard for antifungal susceptibility testing. These methods offer reliable and standardized results; however, they require labor, they are time-consuming, and special laboratory expertise is needed. Because of these facts, routine use in many clinical laboratories is restricted. Several commercially available methods have been developed to address the challenges. Of them, the Etest is a practical and cost-effective alternative for antifungal susceptibility testing requiring less technical complexity with clinically useful results [7]. The availability of such methods has helped extend testing and improve monitoring of antifungal resistance in clinical settings.

With the increasing prevalence of superficial fungal infections, the shift in the pattern of causative fungal species, and rising resistance rates, there is an urgent need for further elucidation of the epidemiology and clinical characteristics of the changing profile of these infections. For the optimization of patient management and framing the antifungal stewardship strategy, a comprehensive analysis of clinical presentation, distribution of fungal isolates, pattern of resistance, and therapeutic outcome is necessary. In view of this, the present study was undertaken to analyze the changing pattern in superficial fungal infections among patients attending a tertiary care facility, with special emphasis on clinical features, antifungal resistance profiles, and therapeutic outcomes. The insights obtained will be helpful in improving diagnostic strategies, effectively guiding treatment options, and in the formulation of strategies against the growing concern for antifungal resistance both in superficial and invasive fungal infections.

## Methodology

**Study Design:** This study was a retrospective, observational study conducted to evaluate the changing patterns of superficial fungal infections with respect to clinical presentation, antifungal resistance, and treatment outcomes.

**Study Area:** The study was carried out in the Department of Skin, Venereology, and Leprosy, Sheikh Bhikhari Medical College and Hospital, Hazaribagh, Jharkhand, India.

**Study Duration:** The study data were retrieved retrospectively over a one-year period from hospital medical records.

**Sample Size:** A total of 114 patients were included in the final analysis after applying inclusion and exclusion criteria.

**Study Population:** Medical records of patients attending the dermatology outpatient department with a clinical diagnosis of superficial fungal infections were reviewed. Initially, data from 162 patients were retrieved. After excluding cases with incomplete records, loss to follow-up, deep or systemic fungal infections, and insufficient microbiological data, 114 patients with complete clinical, mycological, treatment, and follow-up details were included in the study.

The study population included patients of both sexes and all age groups.

**Data Collection:** Data were collected retrospectively from hospital medical records of patients who attended the dermatology outpatient department with a clinical diagnosis of superficial fungal infections during the study period. A total of 172 patient records were initially retrieved, out of which 114 cases fulfilling the inclusion criteria and having complete clinical, mycological, treatment, and follow-up details were included for final analysis.

Information was systematically extracted using a standardized data collection proforma. The collected data included demographic details such as age and sex, clinical presentation and type of superficial fungal infection, duration of symptoms, history of recurrence, and prior treatment history, particularly the use of topical or systemic antifungal agents and corticosteroids.

Mycological investigation details, including potassium hydroxide (KOH) mount findings, fungal culture results, and antifungal susceptibility patterns, were also documented. In addition, treatment regimens administered at the study center and subsequent clinical outcomes during follow-up visits were recorded to assess treatment response and resistance trends. All data were anonymized prior to analysis to ensure patient confidentiality.

**Inclusion Criteria**

- Patients of any age and sex with a clinical diagnosis of superficial fungal infection
- Patients who underwent mycological investigations (KOH mount and fungal culture)
- Patients with complete treatment and follow-up records
- Patients managed entirely at the study center

**Exclusion Criteria**

- Patients with deep or systemic fungal infections
- Patients lost to follow-up before assessment of treatment outcome
- Patients with incomplete clinical or microbiological records
- Cases with inadequate sample collection or inconclusive laboratory results

**Procedure:** A detailed clinical history was recorded, including duration of illness, prior antifungal or steroid use, and recurrence. Specimens were collected from affected sites using skin scrapings or nail clippings under aseptic precautions. Samples were subjected to potassium hydroxide (KOH) mount and fungal culture. Identification of fungal isolates was done using conventional morphological methods.

Following isolation, antifungal susceptibility testing was performed using the broth microdilution method. Treatment was administered based on standard treatment guidelines and anti-fungal sensitivity results. Patients were followed up, and clinical response was assessed and documented.

**Statistical Analysis:** Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Descriptive statistics were used for analysis. Results were expressed as frequencies (n) and percentages (%) and presented in tables and charts where appropriate."

**Result**

Table 1 shows that among the 114 study participants, males predominated (63.2%) compared to females (36.8%). Nearly one-third had a personal history of similar infection (29.8%), while 22.8% reported a family history of dermatophytosis, and 33.3% had a history of topical steroid use. Pruritus was the most common symptom, present in 88.6% of participants, followed by erythema (64.9%) and scaling (57.9%). Other symptoms included burning sensation (25.4%), maceration (14.9%), and secondary infection with oozing or crusting (9.6%), indicating that itching and inflammatory features were the predominant clinical presentations in this cohort.

**Table 1: Baseline Demographics and Clinical Characteristics of Study Participants (N = 114)**

| Parameters | Number of Participants | Percentage (%) |
|---|---|---|
| **Sex Distribution** | | |
| Male | 72 | 63.2 |
| Female | 42 | 36.8 |
| **History of Infection** | | |
| Personal history of similar infection | 34 | 29.8 |
| Family history of dermatophytosis | 26 | 22.8 |
| History of topical steroid use | 38 | 33.3 |
| **Symptoms of Infection** | | |
| Pruritus (itching) | 101 | 88.6 |
| Erythema (redness) | 74 | 64.9 |
| Scaling | 66 | 57.9 |
| Burning sensation | 29 | 25.4 |
| Maceration | 17 | 14.9 |
| Secondary infection (oozing/crusting) | 11 | 9.6 |

Table 2 illustrates the age-wise distribution of the 114 study participants. The majority of participants were young to middle-aged adults. The largest proportion belonged to the 21–30 years age group, accounting for 38 participants (33.3%), followed by the 31–40 years group with 34 participants (29.8%). Participants aged 41–50 years constituted 18 cases (15.8%). Younger individuals aged ≤20 years represented 12 participants (10.5%). Older age groups were less represented, with 8 participants (7.0%) in the 51–60 years group and only 4 participants (3.5%) above 60 years. Overall, the findings indicate that the infection predominantly affected individuals between 21 and 40 years of age.

**Table 2: Distribution of Age Groups among Study Participants (N = 114)**

| Age Group (Years) | Number of Participants | Percentage (%) |
|---|---|---|
| ≤20 | 12 | 10.5 |
| 21–30 | 38 | 33.3 |
| 31–40 | 34 | 29.8 |
| 41–50 | 18 | 15.8 |
| 51–60 | 8 | 7 |
| >60 | 4 | 3.5 |
| **Total** | **114** | **100** |

Table 3 shows the distribution of infection sites among the 114 study participants. The trunk was the most commonly affected site, involving 41 participants (36.0%), followed closely by the groin in 37 participants (32.5%). The neck accounted for 16 cases (14.0%), while the extremities were less frequently involved, seen in 9 participants (7.9%). Multiple site involvement was observed in 11 participants (9.6%). Overall, infections predominantly involved the trunk and groin, indicating a predilection for these anatomical areas in the study population.

**Table 3: Distribution of Infection Sites among Study Participants (N = 114)**

| Site of Infection | Number of Participants | Percentage (%) |
|---|---|---|
| Trunk | 41 | 36 |
| Groin | 37 | 32.5 |
| Neck | 16 | 14 |
| Extremities | 9 | 7.9 |
| Multiple sites | 11 | 9.6 |
| **Total** | **114** | **100** |

Table 4 presents the antifungal susceptibility profile of isolates from 114 study participants. Itraconazole demonstrated the highest sensitivity rate (78.1%) with minimal resistance (8.7%), indicating strong in-vitro effectiveness. Griseofulvin showed moderate activity, with just over half of isolates being sensitive (53.5%) and a resistance rate of 19.3%. In contrast, terbinafine and fluconazole exhibited high resistance rates—51.8% and 43.0%, respectively—along with relatively low sensitivity, suggesting reduced effectiveness against the study isolates. Overall, itraconazole emerged as the most potent antifungal agent, while terbinafine and fluconazole showed limited susceptibility in this population.

**Table 4: Antifungal Susceptibility Profile among Study Participants (N = 114)**

| Antifungal Agent | Sensitive (n, %) | Intermediate (n, %) | Resistant (n, %) |
|---|---|---|---|
| Terbinafine | 22 (19.3%) | 33 (28.9%) | 59 (51.8%) |
| Fluconazole | 27 (23.7%) | 38 (33.3%) | 49 (43.0%) |
| Itraconazole | 89 (78.1%) | 15 (13.2%) | 10 (8.7%) |
| Griseofulvin | 61 (53.5%) | 31 (27.2%) | 22 (19.3%) |

Table 5 summarizes treatment outcomes and relapse rates among 114 study participants receiving different antifungal regimens. Oral itraconazole showed the highest effectiveness, with clinical cure in 82.6% and mycological cure in 76.1% of patients, along with the lowest relapse rate (15.2%). In contrast, terbinafine and fluconazole demonstrated moderate efficacy, with clinical cure rates of 47.1% and 50.0%, respectively, and relatively higher relapse rates (35.3% and 31.8%). Topical clotrimazole achieved clinical cure in 50.0% of cases but was associated with the highest relapse rate (41.7%), and mycological cure could not be assessed. Overall, itraconazole emerged as the most effective treatment with superior cure rates and lower relapses compared to other regimens.

| Table 5: Treatment Outcome and Relapse Rate among Study Participants (N = 114) | | | | |
|---|---|---|---|---|
| **Treatment Regimen** | **Patients (n)** | **Clinical Cure (n, %)** | **Mycological Cure (n, %)** | **Relapse (n, %)** |
| Itraconazole (oral) | 46 | 38 (82.6%) | 35 (76.1%) | 7 (15.2%) |
| Terbinafine (oral) | 34 | 16 (47.1%) | 14 (41.2%) | 12 (35.3%) |
| Fluconazole (oral) | 22 | 11 (50.0%) | 9 (40.9%) | 7 (31.8%) |
| Clotrimazole (topical) | 12 | 6 (50.0%) | NA | 5 (41.7%) |

## Discussion

This study illustrates the changing clinical and therapeutic scenario of superficial fungal infections, in tune with the emerging evidence that dermatophytosis in India is facing significant epidemiological and resistance-related changes. In our series of 114 patients, males formed a higher proportion, 63.2%, which is in accordance with previous Indian literature, where male preponderance has been consistently reported and attributed to increased outdoors exposure, sweating, occlusive clothing, and occupation-related factors (Verma & Madhu, 2017) [8]. Younger adulthood, especially in the 21–40-year age group, was predominant, 63.1% in our series, similar to that reported by Mukherjee et al. (2020) [9], who proposed that the most productive age groups are getting affected, possibly due to the increased physical activity and life style-related factors."

A significant number of our patients reported a past history of similar fungal infection (29.8%) and family history of dermatophytosis (22.8%), indicating chronicity and recurrence in the current patterns of dermatophytosis. Indeed, Indian studies have documented similar trends, attributing chronicity and recurrence to shared living environments, poor hygiene practices, and incomplete courses of treatment (Verma & Madhu, 2017) [8]. The widespread previous history of topical steroids in our patients (33.3%) supports strongly the concern raised by Panda and Verma (2017) [10] regarding unbridled misuse of over-the-counter steroid–antifungal combinations. Misuse is known to produce transient suppression of inflammation, loss of classical morphology, and persistent or extensive disease, which may explain the diverse clinical presentations observed in our study.

Clinically, pruritus was the predominant symptom in our patients, 88.6%, followed by erythema, 64.9%, and scaling, 57.9%. These symptoms agree with the conventional descriptions of dermatophytosis. However, the relatively high prevalence of burning sensation, 25.4%, and secondary infection, 9.6%, suggests that the lesions may be more inflamed and complicated, which often characterizes steroid-modified tinea. Indeed, such symptom profiles have been described by previous studies, especially in cases with chronic or incompletely treated infection, in which altered immune response and disruption of barrier function predispose to secondary bacterial colonization (Panda & Verma, 2017) [10].

The anatomical distribution in our study showed trunk involvement as the most common site (36.0%), followed closely by groin involvement (32.5%). This pattern is comparable to reports from Eastern and Northern India showing the predominance of tinea corporis and tinea cruris, representing the role of humidity, sweating, and tight clothing in the same (Mukherjee et al., 2020) [9]. Multisite involvement in nearly 10% of our patients further supports the presence of extensive disease, which, indeed, has been increasingly reported in the post-steroid era of dermatophytosis (Verma & Madhu, 2017) [8].

One of the most critical findings of our study is the high level of antifungal resistance, particularly to terbinafine. More than half of the isolates in our study (51.8%) were resistant to terbinafine, closely paralleling the alarmingly high terbinafine resistance rates reported by Singh et al. (2018) [11] in association with mutations in the squalene epoxidase gene. Identical resistance patterns have been observed throughout India and even internationally, suggesting this is no longer a locally isolated issue (Nenoff et al., 2020) [12]. Fluconazole resistance was also quite significant in our study at 43.0%, supporting earlier observations that fluconazole has limited utility in dermatophytosis due to its fungistatic nature and suboptimal keratin penetration (Bangia et al., 2019) [13].

By contrast, itraconazole showed the highest sensitivity in our isolates (78.1%) with relatively low resistance of 8.7%, which again points to its current role as the most effective systemic agent for dermatophytosis. This corresponds well with previous studies on its superior efficacy in vitro and clinically, particularly in chronic or recalcitrant diseases (Jaiswal et al., 2021) [14]. Griseofulvin manifested moderate effectiveness in our study, showing sensitivity in 53.5% of the isolates. That echoes the decline in its efficacy but also the relevance it retains in selected cases and especially where the use of newer azoles is contraindicated.

The treatment outcomes in our study strongly reflect the susceptibility data. Patients treated with oral itraconazole showed high clinical and mycological cure rates, 82.6% and 76.1%, respectively, at a relatively low relapse rate of 15.2%. These closely resemble the results of Jaiswal et al. 2021 [14], which demonstrated superior cure rates with itraconazole compared to terbinafine. On the other hand, terbinafine-treated patients in the present study had markedly

lower clinical and mycological cure rates-47.1% and 41.2%, respectively-and a high relapse rate of 35.3%-which certainly underlines the clinical relevance of resistance emerging. Fluconazole outcomes were equally suboptimal, and topical clotrimazole given alone proved not very effective and with high relapse, reinforcing the consensus that the use of topical agents as monotherapy in extensive or chronic disease is inadequate. Bangia et al., 2019 [13].

Besides microbiological resistance, the impacts of chronic dermatophytosis spill over psychosocial and economic domains. Continuous pruritus, visible lesions, and frequent recurrences significantly disable quality of life and work productivity, as reported in earlier Indian studies too (Verma & Madhu, 2017) [8]. Our observation underscores the urgent requirement for a comprehensive response involving rational antifungal use, strict regulation of topical steroid combinations, education of patients, and regular monitoring of resistance patterns. In the absence of such a policy, the gap between current clinical practice and the changing behavior of pathogens is likely to further widen, making management of superficial fungal infection increasingly complex in the future.

## Conclusion

This study delineates that the clinical and therapeutic scenario of superficial fungal infections is unequivocally shifting, with predominance in young to middle-aged adults, frequent involvement of the trunk and groin, and a high symptomatic burden with itching and erythema as leading features. The notable association with infection history, family history, and topical steroid abuse underlines the issue of chronicity and recurrence due to changing host and behavioral factors. The susceptibility patterns indicate an overall disturbing trend toward lower effectiveness of commonly used agents, such as terbinafine and fluconazole, pointing to the emergence of resistance and possible treatment failure. On the other hand, itraconazole showed better sensitivity and more favorable clinical and mycological outcomes with a low rate of relapse, thus standing out as a systemic therapy of choice. The findings highlight the imperative need for rational use of antifungals, avoidance of inappropriate steroid combinations, and susceptibility-based treatment to contain resistance and improve long-term outcomes in superficial fungal infections.

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