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The Role of Candida Species in Superficial Mycoses Among Patients in Bauchi State, Nigeria.

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Abstract

Cutaneous candidiasis is a superficial fungal infection predominantly caused by *Candida albicans*. Despite its global burden, data on its prevalence and associated risk factors in Bauchi State, Nigeria, remain limited. This study aimed to assess the prevalence and risk factors of cutaneous candidiasis among patients with superficial mycoses at the Infectious Disease Hospital Bayara, Bauchi State. A cross-sectional study was conducted involving 312 patients with superficial mycoses. Skin scrapings were collected and processed for mycological investigations. Plates containing SDA were inoculated with the sample, and incubated at 35^{0}C for 2 to 7 days. The fungal growths were identified using colony morphology, and microscopically using lactophenol cotton blue preparation. Further identification was done by sub-culturing the organisms on corn meal agar, germ tube test and chromagar Candida. A structured questionnaire was administered to assess potential risk factors. Data were analyzed using descriptive statistics and chi-square tests to determine significant associations. The overall prevalence of cutaneous candidiasis among the patients was 12.5%, with *Candida albicans* (10.9%) being the predominant species. Males (7.05%) had a slightly higher prevalence than females (5.45%). Adults (25–64 years) exhibited the highest prevalence (5.45%), while children and adolescents had the lowest (0.64%). The infection was more prevalent in rural residents (8.0%) and low-income individuals (9.9%). Among the risk factors assessed, only wearing tight or non-breathable clothing (p = 0.036) and a history of prior fungal infections (p < 0.001) were significantly associated with high prevalence of cutaneous candidiasis among the patients. The study identified tight clothing and a history of fungal infections as key risk factors of the infection among the patients, emphasizing the need for public health awareness targeting risk groups.

Keywords
Cutaneous candidiasis, superficial, Mycoses, Bayara, Bauchi State

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INTRODUCTION

The skin serves as a complex and dynamic ecosystem inhabited by various microorganisms, including bacteria, viruses, and fungi. Among the fungal commensals, *Candida* species are commonly found on the skin and mucosal surfaces, including the genitourinary tract, oral cavity, and gastrointestinal system (Henshaw & Olasode, 2019). Although *Candida* species are part of the normal human microbiota, they can become opportunistic pathogens under certain conditions, leading to superficial or systemic infections. Cutaneous candidiasis is a fungal infection of the skin predominantly caused by *Candida albicans* and is commonly associated with warm, moist areas of the body, such as the armpits, groin, and submammary regions (Okechukwu, 2021).

Over 200 species of *Candida* have been identified, but only 15 are known to be pathogenic in humans, with *C. albicans* being the most prevalent (Magaji & Moi, 2022). The condition typically presents with erythema, itching, maceration, and scaling, with lesions often occurring in intertriginous areas (skin folds) (Magaji & Moi, 2022). Other *Candida* species, such as *C. krusei*, *C. glabrata*, *C. kefyr*, *C. parapsilosis*, and *C. tropicalis*, have also been implicated in cutaneous candidiasis, though with lower prevalence (Dufresne *et al.*, 2014; Magaji & Moi, 2022). A study by Magaji and Moi (2022) reported a high prevalence of *C. albicans* among HIV patients in Azare, Bauchi State.

Similarly, Okechukwu (2021) found *C. albicans* to be the most frequently isolated species (48%) from skin scrapings of cutaneous candidiasis patients, followed by *C. krusei* (16.1%), *C. glabrata* (13.5%), *C. kefyr* (7.4%), *C. parapsilosis* (4.8%), *C. tropicalis* (1.7%), and other *Candida* species (8.5%) (Okechukwu, 2021). Consequently, differences in the skin setting, underlying diseases, antibiotic therapy, and alterations in the immune system can persuade the switch of *Candida albicans* from a commensal to a pathogenic form, thus causing significant infections in susceptible individuals (Aragón-Sánchez *et al.*, 2023).

Fungal skin diseases, including cutaneous candidiasis, have a significant burden worldwide. In 2017, the global Disability-Adjusted Life Years (DALYs) for fungal skin diseases peaked between ages 1 and 5 years. The highest burden was observed in sub-Saharan Africa, with a DALY rate of 89.3 per 100,000 males and 78.42 per 100,000 females, while Mali had the highest individual country DALY rate of 122 per 100,000 (Lipner & Scher, 2019).

In Africa, invasive candidiasis has been documented in 21 countries, with higher burdens in Southern and Eastern Africa. South Africa and Zambia report the highest numbers of cases, with *C. albicans* being the predominant cause, despite a growing prevalence of non-*albicans* species (Mehta *et al.*, 2020).

In Nigeria, fungal infections are a common dermatological concern, with skin diseases accounting for approximately one-third of outpatient consultations. However, due to variations in climate, ethnicity, and socioeconomic conditions, the prevalence of cutaneous candidiasis differs across regions. A study in Calabar found a prevalence rate of 0.5% among adolescents (Henshaw & Olasode, 2019), whereas in Owerri, a prevalence of 28.3% was reported among female patients (Okechukwu, 2021).

Despite the global burden of *Candida* infections, epidemiological data on cutaneous candidiasis in Bauchi State remain scarce. However, a study in Bauchi Metropolis evaluated the antifungal and antibacterial activities of *Sabulun salo*, a local traditional medicated soap, against skin infections. The findings highlighted the need for further research to assess the prevalence and risk factors of cutaneous candidiasis in the region (Grover *et al.*, 2020).

Candida infections occur when conditions favor fungal overgrowth or tissue invasion. Key endogenous factors include physiological changes during pregnancy, obesity, endocrinopathies, diabetes mellitus, chronic diseases, immunosuppression, and age-related susceptibility. Exogenous factors include climatic conditions, skin hygiene habits, moisture exposure, and direct contact with infected individuals (Mehta *et al.*, 2020).

Cutaneous candidiasis manifests in two major forms: granulomatous and intertriginous candidiasis. Intertriginous candidiasis typically affects warm, moist areas, including the groin, armpits, intergluteal folds, web spaces of the fingers and toes, submammary folds, umbilicus, and genitalia. The lesions are characterized by well-demarcated, moist, erythematous patches with scaling, satellite pustules, and erosions (Grover *et al.*, 2020). Granulomatous candidiasis is more common in children and presents as reddish papules covered with thick, brownish-yellow crusts, sometimes forming horn-like projections, primarily on the head, face, nails, and legs (Rosani, 2021).

Cutaneous candidiasis is a significant contributor to folliculitis in immunosuppressed and obese patients. It can also present as interdigital candidiasis, diaper dermatitis, or secondary infections associated with other skin diseases such as allergic dermatitis and psoriasis (Grover *et al.*, 2020). The typical clinical features include dry, erosive, erythematous, or scaly skin with pustules and collarette scaling (Lipner & Scher, 2019).

Candidiasis is a global health concern affecting both men and women across all age groups, with increased susceptibility in infants, the elderly, and immunocompromised individuals (Henshaw & Olasode, 2019). A significant proportion of healthy individuals harbor *Candida* species on their skin, oral cavity, and gastrointestinal tract, with oral colonization rates ranging from 25% to 75% (Aragón-Sánchez *et al.*, 2023).

While cutaneous candidiasis is generally not contagious through casual contact, individuals with weakened immune systems are at a higher risk of infection through direct contact with infected persons or contaminated environments (Aragón-Sánchez *et al.*, 2023). Several predisposing factors influence the development of cutaneous candidiasis, including underlying medical conditions, prolonged antibiotic use, immunosuppression, and environmental factors such as high humidity and poor hygiene (Okechukwu, 2021).

Given the high burden of *Candida* infections and the limited epidemiological data in Bauchi State, this study aimed to assess the prevalence and risk factors of cutaneous candidiasis among patients diagnosed with superficial mycoses at the Infectious Disease Hospital, Bayara, Bauchi State. The findings would provide essential data for developing targeted interventions to improve fungal infection management and control strategies in the region.

MATERIALS AND METHODS

Study Area

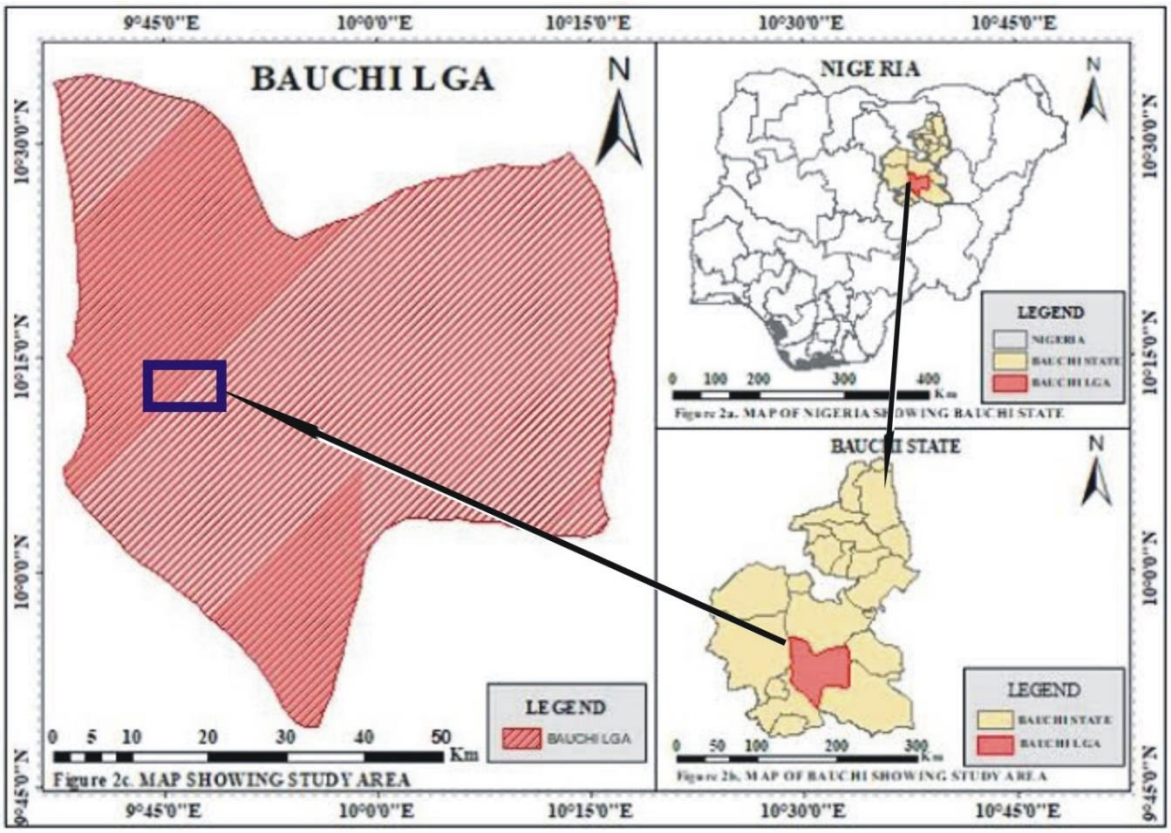

Figure 1: Map of the Study Area

The study was conducted at the Infectious Disease Hospital (IDH) Bayara, located in Birshi, Bauchi Local Government Area (LGA), Bauchi State, Nigeria. The hospital was established on March 11, 1982, and operates 24 hours a day. It is a licensed facility under the Nigerian Ministry of Health, with facility code 05/02/1/2/1/0002, registered as a secondary healthcare center specializing in infectious diseases, especially skin-related conditions. Bauchi LGA spans approximately 3,219 square kilometers and has a total population of 881,600, with 51.1% males and 48.9% females. The geographical coordinates of the study area are 10.2820° N latitude and 9.8120° E longitude (Klein *et al.*, 2017).

Study Design

The study was cross-sectional. Data was collected from a sample of patients attended the Infectious Disease Hospital Bayara, Bauchi State Nigeria. The research involved a multidimensional approach, incorporating both clinical and laboratory aspects. Clinical samples were collected from patients at IDH Bayara and transported to the Microbiology Laboratory of Sa'adu Zungur University Gadau, for laboratory investigation.

Ethical Approval and Study Population

The ethical approval for this study was obtained from Bauchi State Ministry of Health, and the study was conducted in accordance with the ethical guidelines, ensuring that participants' right, privacy and confidentiality were protected. Informed

consent was obtained from the participants before data collection.

The study included patients of all ages and sexes who attended the Infectious Disease Hospital Bayara with clinical signs and symptoms of superficial mycoses. All patients with no signs and symptoms of superficial mycoses, and those not willing to participate in the study were excluded.

Sample Size Determination

The sample size was obtained using the formula for single population proportion. The prevalence of superficial mycoses was reported to be 28.3% in the study area (Okechukwu, 2021). A 95% confidence level and precision of 5% were taken, as indicated below:

$$n = \frac{(Z\,\alpha/2)^2 \text{ X } P(1-P)}{d^2}$$

By substituting the values in the above formula, approximately three hundred and twelve (312) patients with signs and symptoms of superficial mycoses at the Infectious Disease Hospital Bayara, Bauchi state Nigeria were taken for the study.

Sample Collection

A total of 312 skin scrapping samples were collected from the patients with signs and symptoms of superficial mycoses at the Infectious Disease Hospital Bayara, Bauchi state Nigeria. A cotton swabs containing 70% ethanol, were used in cleaning the infected site. The sample (skin scrapings from the infected area) were collected in to sterile disposable dishes and transported to the Microbiology Laboratory, Sa'adu Zungur University Gadau for mycological investigation. Also, 312 structured questionnaires were administered to the patients at the time of sample collection to gather information on the risk factors and demography of the patients.

Isolation and Identification of Fungal Pathogens

About thirty nine grams (39g) of SDA was dissolved in 1000mL distilled water. This was then sterilized at 121 °C for 15 min. The agar was then allowed to cool after autoclaving. The prepared medium was then inoculated with the test organism and incubated at 35^0C with periodic checking for growth for 30 days before discarding it as negative. Fungal growth was identified macroscopically by the colony morphology, and microscopically using lactophenol cotton blue preparation. Further identification was done by sub-culturing the organisms on corn meal agar, germ tube test and chromagar Candida (Larone, 2011).

Gram Staining

A smear of the organism to be identified was prepared on a glass slide, and heated gently to get it fixed. The slide was flooded with 0.5% crystal violet and left for 30 sec. then rinsed gently with water. The slide was then flooded with Lugol's iodine and allowed to remain for 30sec before washing with water. This was followed by decolourization with 95% ethanol and rinsed with water. The slide was then flooded with 0.1% counterstain safranin and allowed to stand for about 1min. Finally the slide was washed with water and blotted dry. The slide was examined using an oil immersion objective for cell morphology and Gram reaction (Naveena and Joy, 2014).

Corn Meal Agar

About seventeen grams (17g) of Corn Meal Agar (CMA) was Suspended in 1000mL of distilled water and boiled to dissolve the medium completely. Exactly 7mL Tween 80 was added and autoclaved at 121°C for 15 minutes, allowed to cool, poured into plates and left for solidification.

Three consecutive parallel scratches were made into the surface of the Corn Meal Agar plates down to the bottom. Using a steriled inoculating loop, streak was made across the three scratches. A coverslip was flamed and placed over the center of the inoculated scratches. A positive control of a known chlamydospore producing isolate was prepared. The plates were incubated at 25°C and examined microscopically at 24, 48 and 72 hours for production of chlamydospores under a low power objective (Naveena and Joy, 2014).

Germ Tube Test

The germ tube medium (human serum) was inoculated using a needle with a specie of Candida and incubated at 37°C for 2 to 4 hours. After incubation, a drop of serum was withdrawn from the test tube and placed on to a glass slide. The slide was covered with a cover slip, and examined for presence of germ tubes (Naveena and Joy, 2014).

Chromagar Candida

About ten grams (10g) of Chromopeptone, 20.0g of Glucose, 2.0g Chromogen Mix and 15.0g Agar were dissolved in 1000mL of distilled water. The mixture was autoclaved at 121°C for 15 minutes and allowed to cool before pouring it into a plate. The plate was inoculated with the test organism, incubated for 20 to 48 hours at 35°C and observed for the appearance of different colours. Where greenish growth confirmed the presence of *Candida albicans*, blue-*C. tropicalis*, purple-*C. glabrata* and pink-*C. krusei* (Larone, 2011; Naveena and Joy, 2014).

RESULTS

The present study identified *Candida albicans* and *Candida tropicalis* as the causative agents of cutaneous candidiasis. The overall prevalence of the infection among patients with superficial mycoses at the Infectious Disease Hospital, Bayara, was 12.5%. Species-specific prevalence showed that *C. albicans* was more predominant (10.9%), followed by *C. tropicalis* (1.6%) (Figure 2).

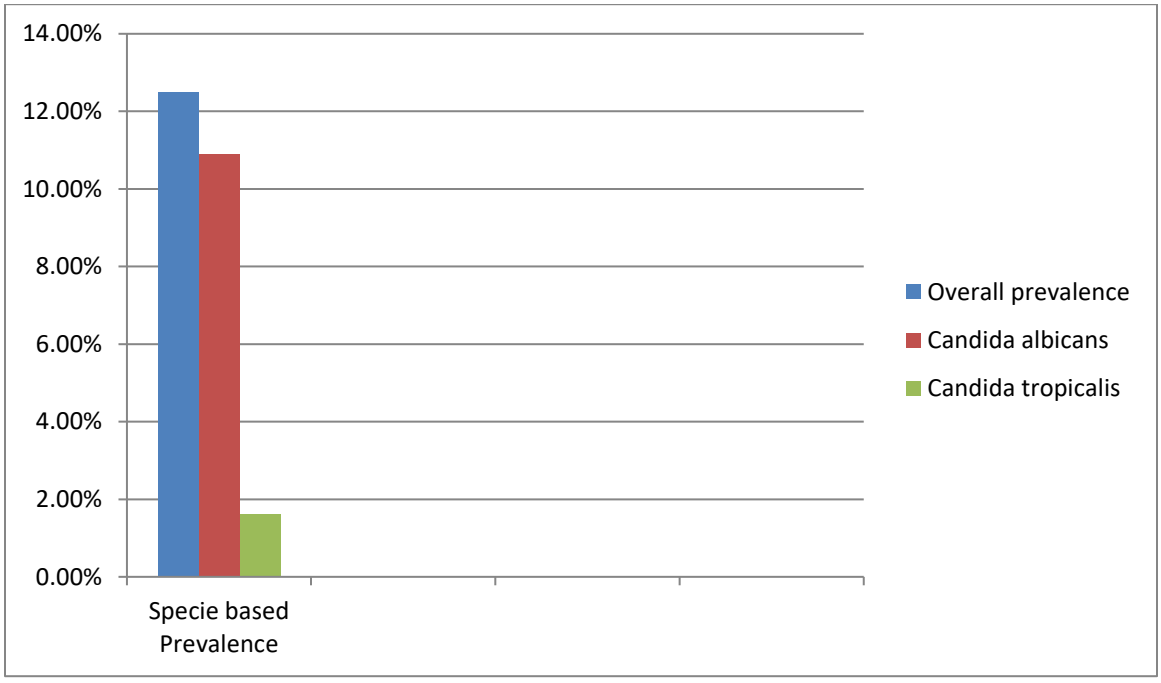

Figure 2: Specie based prevalence of cutaneous candidiasis among the patients

The prevalence of cutaneous candidiasis was higher in males (7.05%) than in females (5.45%). Age-wise distribution revealed the following prevalence rates: children (0–9 years) and adolescents (10–19 years) each had 0.64%, young adults (20–24 years) had 0.96%, adults (25–64 years) had the highest prevalence at 5.45%, and elderly individuals (≥65 years) had a prevalence of 4.81% (Figure 3).

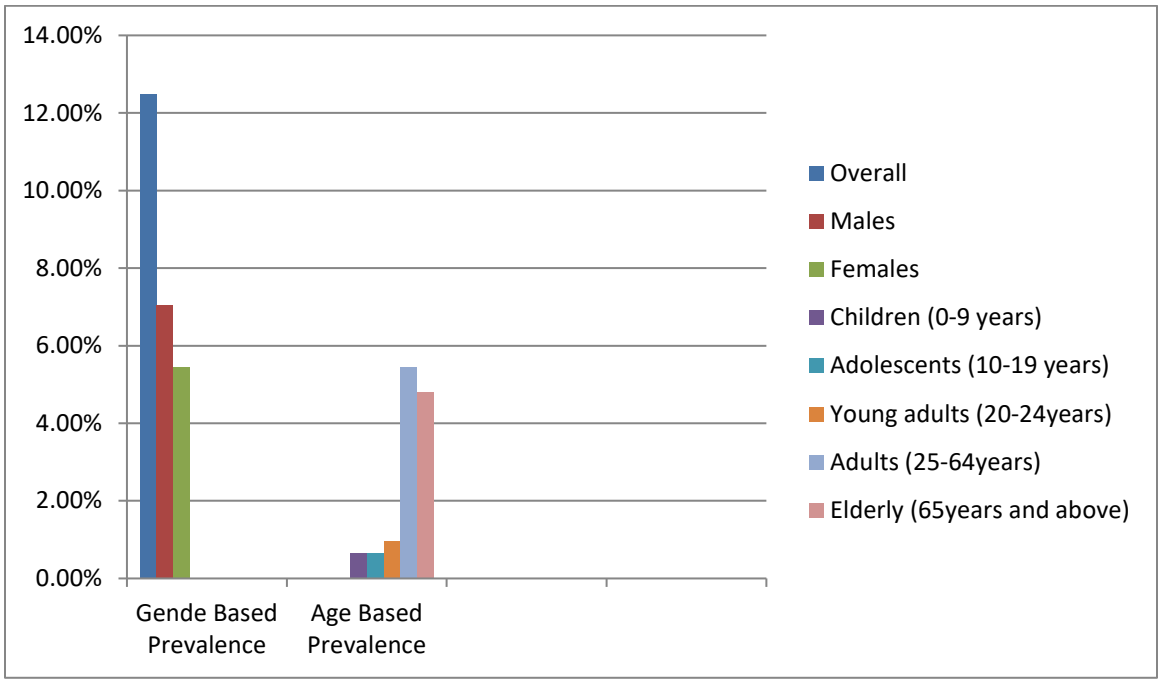

Figure 3: Prevalence of Cutaneous Candidiasis According to the Gender and Age of the Patients

Several risk factors were examined in relation to the prevalence of cutaneous candidiasis (Table 1). Patients from rural areas had a higher prevalence (8.0%) compared to their urban counterparts (4.5%). Socioeconomic status also played a role, with low-income individuals showing the highest prevalence (9.9%), followed by those with moderate income (1.6%) and high income (1.0%).

Interestingly, diabetic patients exhibited a lower prevalence (1.9%) compared to non-diabetic individuals (10.6%). Similarly, patients with chronic illnesses or those on medications such as antibiotics, corticosteroids, or immunosuppressants had a significantly lower prevalence (0.6%) than those without chronic conditions or medication use (11.9%).

Individuals with a history of recent skin infections (7.1%) had a higher prevalence than those without (5.4%). Personal hygiene and clothing choices also influenced prevalence rates, with those using soap or antiseptics while bathing showing a lower prevalence (5.4%) compared to those who did not (7.1%). Conversely, individuals who frequently wore tight or non-breathable clothing had a significantly higher prevalence (8.0%) than those who did not (4.5%) ($p = 0.036$).

Excessive sweating appeared to be protective, as those who reported excessive sweating had a lower prevalence (3.2%) compared to those who did not (9.3%). Additionally, individuals exposed to humid environments (4.8%) had a lower prevalence than those who were not (7.7%). Similarly, frequent contact with water, such as swimming or manual laundry washing, was associated with a lower prevalence (4.8%) than those without such exposure (7.7%).

The use of shared public facilities (e.g., public bathrooms, gyms) was associated with a higher prevalence (7.1%) compared to those who did not use them (5.4%). A notable finding was that individuals with a previous history of fungal infections had a significantly higher prevalence (10.6%) compared to those without (1.9%) ($p < 0.001$). Similarly, those with a family history of fungal infections had a higher prevalence (7.1%) than those without (5.4%).

Table 1: Prevalence of Cutaneous Candidiasis Based on the Risk Factors of the Infection

Variables	Positive	Prevalence (%)	χ^2	p-value
Residence				
Urban	14	4.5	0.100	0.751
Rural	25	8.0		
Monthly income				
Low	31	9.9	2.790	0.248
Moderate	5	1.6		
High	3	1.0		
Do you have diabetes?				
Yes	6	1.9	2.901	0.089
No	33	10.6		
Do you have any other chronic illnesses?				
Yes	2	0.6	0.701	0.402
No	37	11.9		
Are you currently on any medication (e.g., antibiotics, corticosteroids, immunosuppressants)?				
Yes	2	0.6	0.701	0.402
No	37	11.9		
Have you had any recent skin infections?				
Yes	22	7.1	1.440	0.230
No	17	5.4		
Do you use soap or antiseptic while bathing?				
Yes	17	5.4	0.090	0.764
No	22	7.1		
Do you frequently wear tight or non-breathable clothing?				
Yes	25	8.0	4.402	0.036*
No	14	4.5		
Do you sweat excessively?				
Yes	10	3.2	0.002	0.961
No	29	9.3		
Do you work or live in a humid environment?				
Yes	15	4.8	3.210	0.073
No	24	7.7		
Do you have frequent contact with water (e.g., swimming, washing clothes manually)				
Yes	15	4.8	3.210	0.073
No	24	7.7		
Do you use shared public facilities (e.g., public bathrooms, gyms)?				
Yes	22	7.1	3.462	0.063
No	17	5.4		
Have you had a fungal infection before?				
Yes	33	10.6	144.56	0.001*
No	6	1.9		
Do you have family members with a history of fungal infections?		0.0		
Yes	22	7.1	3.462	0.063
No	17	5.4		

"χ^2": chi-square, "*": Significant at $p < 0.05$

DISCUSSION

This study investigated the prevalence and risk factors of cutaneous candidiasis among patients with superficial mycoses at the Infectious Disease Hospital Bayara. The overall prevalence was found to be 12.5%, with *Candida albicans* being the predominant species (10.90%) followed by *Candida tropicalis* (1.6%). These findings are consistent with previous studies reporting *C. albicans* as the most frequent causative agent of cutaneous candidiasis (Dufresne *et al.*, 2014; Sei, 2015). A study by Dufresne *et al.* (2014) found *C. albicans* responsible for 48% of cases, with *C. tropicalis* accounting for a lower proportion (1.7%), which aligns with our findings.

Henshaw & Olasode (2019) reported a 0.5% prevalence among adolescents in Calabar, which is significantly lower than that of the current study (12.5%), whereas Okechukwu (2021) found a 28.3% prevalence among female patients in Owerri (higher, compared to the findings of the current study). These discrepancies highlighted the influence of regional climate, socioeconomic factors, and healthcare access on the cutaneous candidiasis burden.

The gender-based prevalence of cutaneous candidiasis in our study was 7.05% among males and 5.45% among females, which slightly contradicts reports suggesting an equal distribution between men and women (Ahronowitz *et al.*, 2019). The highest prevalence was observed among adults aged 25–64 years (5.45%), followed by the elderly (4.81%). This pattern aligns with Ahronowitz *et al.* (2019), who stated that candidiasis risk increases in infants and the elderly due to weaker immune defenses.

Several risk factors were assessed, but only two were found to be statistically significant: frequent wearing of tight or non-breathable clothing (χ^2 = 4.402, p = 0.036) and a history of prior fungal infection (χ^2 = 144.559, p = 0.000). The association between tight clothing and cutaneous candidiasis is well-documented, as occlusion and humidity create an ideal environment for fungal growth (Campois *et al.*, 2015). Similarly, patients with prior fungal infections had a significantly higher prevalence (10.6%) compared to those without (1.9%), suggesting a predisposition to recurrent infections, possibly due to genetic or environmental factors (Brown *et al.*, 2007).

While other risk factors did not reach statistical significance, trends were observed. Patients from rural areas exhibited a higher prevalence (8.0%) compared to urban dwellers (4.5%), likely due to lower access to healthcare and hygiene resources. Low-income patients showed the highest prevalence (9.9%), which supported previous findings linking socioeconomic status to fungal infections (Mehta *et al.*, 2020). The protective effect of good hygiene was also evident, as those who used soap or antiseptic while bathing had a lower prevalence (5.4%) than those who did not (7.1%), reinforcing the role of hygiene in fungal infection prevention (Coppola *et al.*, 2015).

Patients with diabetes and other chronic diseases exhibited a lower prevalence (1.9% and 0.6%, respectively) compared to non-diabetics (10.6%) and those without chronic diseases (11.9%). This contradicted studies that suggest diabetics and immunocompromised individuals are at greater risk (Neofytos *et al.*, 2010). One possible explanation is that diabetic and chronically ill patients may be on antifungal or immunomodulatory treatments that suppress infection. Also, their populations might be negligible compared to those of their counterparts.

CONCLUSION

This study highlighted the significant burden of cutaneous candidiasis in Bauchi State, Nigeria, with an overall prevalence of 12.5%. The findings reinforced the predominance of *Candida albicans* and the association of tight clothing and a prior history of fungal infections as significant risk factors. Although other factors such as residence, socioeconomic status, diabetes, and hygiene practices showed notable trends, though, they did not reach statistical significance. The relatively

higher prevalence in males, adults, and rural residents suggested the need for enhanced public health awareness, especially in at-risk populations. The results also highlighted the importance of preventive strategies, including proper clothing choices, improved hygiene, and early diagnosis and treatment to reduce recurrent infections.

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