Zafindraibe et al. *Afr. J. Clin. Exper. Microbiol.* 2026; 27 (1): 61 - 70 https://www.afrjcem.org

African Journal of Clinical and Experimental Microbiology. ISSN 1595-689X Jan 2026; Vol.27 No.1
AJCEM/2448. https://www.ajol.info/index.php/ajcem

Original Article **Open Access**

Aetiologic agents of cutaneous mycoses at the parasitology-mycology laboratory of University Center Hospital Joseph Ravoahangy Andrianavalona (CHU JRA), Antananarivo, Madagascar

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Abstract:

Background: Superficial and cutaneous fungal infections are among the most common dermatological conditions worldwide, particularly in tropical and subtropical regions. Caused by a variety of fungi (yeasts, dermatophytes, and molds), they can result in significant morbidity. In resource-limited settings such as Madagascar, their true burden remains underestimated due to limited access to diagnostic facilities and frequent empirical treatment. Local epidemiological data are essential for improving diagnosis and management strategies. The objectives of this study are to determine the prevalence, species distribution, affected anatomical sites and demographic characteristics of patients with superficial and cutaneous mycoses diagnosed at the University Center Hospital Joseph Ravoahangy Andrianavalona (CHU JRA) in Antananarivo, Madagascar.
Methodology: This was a descriptive retrospective review of the register of all patients with cutaneous mycoses at the parasitology-mycology laboratory of CHU JRA over a period of 6 years (January 2015 to December 2020). Data on demographic and clinical characteristics of included patients were collected with designed form and these included age, sex, patient location/department (outpatient or inpatient), year of request for mycological examination, macroscopic examination results according to lesion topography, type of samples (pus, nails, scalp, scales), class of fungi (yeasts, dermatophytes, moulds) and results of mycological culture. Data were analysed on Microsoft Excel and EPI INFO. Chi-squared and Fisher's Exact tests were used to determine the relationship between categorical variables, and $p \leq 0.05$ was considered significant.
Results: Of the samples of 914 patients examined, 287 (31.4%) tested positive for cutaneous fungal infection, giving a prevalence of 31.4%. Yeasts accounted for 57.7% of isolates, dermatophytes for 25.8%, molds for 12.1% and others 4.4%. The most common fungi species involved in cutaneous infections were *Candida* spp (36.9%, n=106), *Trichophyton* spp (21.6%, n=62), and *Aspergillus* spp (5.9%, n=16). The most commonly affected sites were glabrous skin and nails, with *Trichophyton* spp and non-*albicans Candida* species being predominant, respectively. Clinically, the most frequent cutaneous findings were scaly lesions (skin), onycholysis (nails), and tinea capitis (scalp).
Conclusion: Superficial fungal infections are a major health concern in Madagascar. Improved clinical awareness and systematic mycological testing are critical for accurate diagnosis and management.

Keywords: Cutaneous mycoses; *Candida* spp; *Trichophyton* spp; Prevalence; Madagascar

Received Aug 18, 2025; Revised Sep 29, 2025; Accepted Oct 2, 2025

Agents étiologiques des mycoses cutanées au laboratoire de parasitologie-mycologie du Centre Hospitalier Universitaire Joseph Ravoahangy Andrianavalona (CHU JRA), Antananarivo, Madagascar

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Résumé:

Contexte: Les infections fongiques superficielles et cutanées comptent parmi les affections dermatologiques les plus courantes dans le monde, en particulier dans les régions tropicales et subtropicales. Causées par une variété de champignons (levures, dermatophytes et moisissures), elles peuvent entraîner une morbidité importante. Dans les pays à ressources limitées comme Madagascar, leur véritable fardeau reste sous-estimé en raison de l'accès limité aux installations de diagnostic et des traitements empiriques fréquents. Les données épidémiologiques locales sont essentielles pour améliorer le diagnostic et les stratégies de prise en charge. Les objectifs de cette étude sont de déterminer la prévalence, la distribution des espèces, les sites anatomiques affectés et les caractéristiques démographiques des patients atteints de mycoses superficielles et cutanées diagnostiquées au Centre Hospitalier Universitaire Joseph Ravoahangy Andrianavalona (CHU JRA) à Antananarivo, Madagascar.
Méthodologie: Il s'agissait d'une revue rétrospective descriptive du registre de tous les patients atteints de mycoses cutanées au laboratoire de parasitologie-mycologie du CHU JRA sur une période de 6 ans (janvier 2015 à décembre 2020). Les données sur les caractéristiques démographiques et cliniques des patients inclus ont été recueillies à l'aide d'un formulaire conçu et celles-ci comprenaient l'âge, le sexe, la localisation/les services du patient (ambulatoire ou hospitalisé), l'année de la demande d'examen mycologique, les résultats de l'examen macroscopique selon la topographie des lésions, le type d'échantillons (pus, ongles, cuir chevelu, squames), la classe de champignons (levures, dermatophytes, moisissures) et les résultats de la culture mycologique. Les données ont été analysées sur Microsoft Excel et EPI INFO. Les tests du Chi carré et exact de Fisher ont été utilisés pour déterminer la relation entre les variables catégorielles, et $p \leq 0,05$ a été considéré comme significatif.
Résultats: Sur les échantillons de 914 patients examinés, 287 (31,4%) ont été testés positifs pour une infection fongique cutanée, ce qui donne une prévalence de 31,4%. Les levures représentaient 57,7% des isolats, les dermatophytes 25,8%, les moisissures 12,1% et les autres 4,4%. Les espèces fongiques les plus fréquemment impliquées dans les infections cutanées étaient *Candida* spp (36,9%, n=106), *Trichophyton* spp (21,6%, n=62) et *Aspergillus* spp (5,9%, n=16). Les sites les plus fréquemment touchés étaient la peau glabre et les ongles, les espèces *Trichophyton* spp et *Candida* non *albicans* étant respectivement prédominantes. Sur le plan clinique, les signes cutanés les plus fréquents étaient des lésions squameuses (peau), une onycholyse (ongles) et une teigne (cuir chevelu).
Conclusion: Les infections fongiques superficielles constituent un problème de santé majeur à Madagascar. Une meilleure connaissance clinique et des tests mycologiques systématiques sont essentiels pour un diagnostic et une prise en charge précis.

Mots-clés: Mycoses cutanées; *Candida* spp; *Trichophyton* spp; Prévalence; Madagascar

Introduction:

Fungal infections are widespread globally, causing a diverse range of diseases, including opportunistic and chronic infections, particularly in immunocompromised individuals (1). In recent years, their rising incidence, driven by the indiscriminate use of antibiotics, anticancer therapies, and immunodeficiency conditions such as acquired immune deficiency syndrome (AIDS), has garnered increased attention from clinicians and microbiologists (2).

Superficial mycoses, affecting the skin and its appendages, are caused by keratinophilic fungi and typically elicit minimal inflammatory response (3). Among the most common infections worldwide, their prevalence is estimated at 20–25%, with an increasing trend (4,5). They are particularly prevalent in tropical regions and represent a major cause of dermatological consultations in many African countries (6).

Over the past decade, environmental changes, lifestyle shifts, pet ownership, aging population, and increased use of immunosuppressive therapies have altered the epidemiology and clinical presentation of superficial mycoses (7). Although often benign, these infections cause significant morbidity, recurrence, and cosmetic disfigurement (2,8).

Accurate mycological identification of causative agents is critical to guide appropriate antifungal treatment (9,10). Given their growing clinical importance, potential complications, especially in immunocompromised patients, their recurrent and treatment-resistant nature, and the scarcity of recent epidemiological data, we conducted a retrospective study of superficial cutaneous mycoses at the Parasitology-Mycology Laboratory of Joseph Ravoahangy Andrianavalona University Hospital Centre from 2015 to 2020. This study aimed to determine the prevalence of superficial mycoses among patients referred for mycological examination and to characterize their clinical and biological profiles.

Materials and method:

Study design and setting:

This was a retrospective descriptive analysis of laboratory records of patients at the Parasitology-Mycology Laboratory within

the Paraclinic Unit of Research and Training (UPFR) of the Joseph Ravoahangy Andrianavalona University Hospital Centre (CHU-JRA), 4th Arrondissement of Antananarivo Renivohitra, Analamanga region, Madagascar .

The laboratory, part of the hospital's microbiology department, processes parasitological and mycological samples from medical and surgical departments of Antananarivo's university hospitals, as well as from private clinics and medical practices. The study spanned six years (January 2015 to December 2020)

Ethical consideration:

Consent of the head of the Parasitology-Mycology Laboratory at CHU-JRA and the director of establishment of the University Center Hospital were obtained prior to commencement of the study. The confidentiality of the contents and information obtained were respected and all information received was treated in strict confidentiality. As the study involved retrospective analysis of records, ethical review and approval was not required.

Study population and participants:

The study population included all patients who had mycological examinations and were registered in the results register of the Parasitology–Mycology laboratory. The study participants included all patients with superficial mycoses who were registered in the mycology results register between 2015 and 2020. All patients with negative mycological examination results were excluded.

A mycological examination of patients was considered positive if on direct examination, there is presence of mycelial filaments or spores or yeasts, and on culture, there is presence of various pathogenic fungal colonies on the plate (dermatophytes*, Candida* spp, *Malassezia* spp. etc*...*).

Data collection:

The study variables collected from the laboratory register included patient age, sex, year of request for mycological examination, clinical information according to lesion topography, macroscopic examination results according to lesion topography, prescribing departments (outpatient or inpatient), type of samples (pus, nails, scalp, scales) and their topography, class of responsible species (yeasts, dermatophytes, moulds and others) and mycological culture results.

Sample collection:

Between January 2015 and December 2020, samples from patients with suspected superficial fungal infections (SFIs) were collected at the CHU-JRA Parasitology-Mycology Laboratory. For each patient, demographic data (age, sex), infection site, underlying conditions, and prior medication history were recorded. Infected areas were cleaned before sampling. Scales, hair, and nail samples were collected using sterile scalpels, hair pluggers, or nail clippers and stored in sterile Petri dishes. For suspected pityriasis versicolor, adhesive tape was used to collect samples from affected areas. Samples were divided for direct examination and culture.

Direct microscopic examination of samples:

Samples were processed based on lesion type. Scales, hair, and nail specimens were placed on sterile slides and examined using 10–20% potassium hydroxide (KOH) or lactophenol (for hair) with a compound light microscope. Observations included hyphae, branching hyphae, spores, budding cells, or pseudohyphae. For pityriasis versicolor, adhesive tape samples were examined for short hyphae and round yeasts in grape-like clusters.

Culture of sample:

Samples were inoculated onto two media: Sabouraud's dextrose agar with chloramphenicol (50 mg/L) and cycloheximide (500 mg/L) (SCC), and Sabouraud's glucose agar without cycloheximide (SC). Cultures were incubated at 25–35°C for up to four weeks and monitored daily for colony growth. Mucoid colonies indicated yeast fungi, while filamentous growth suggested moulds.

Fungi identification:

Fungal genera were identified based on macroscopic and microscopic characteristics. Macroscopic features included colony texture, topography, margins, pigmentation (obverse and reverse), and growth rate. Microscopic identification involved tease mounts and slide cultures observed under light microscopy (40×). Microconidia, macroconidia, and accessory structures were assessed. Yeast infections were identified by the presence of budding cells, pseudohyphae, or yeasts, while mold infections were characterized by septate or non-septate, hyaline or dematiaceous hyphae, or arthroconidia.

Statistical analysis:

Demographic and clinical data were entered into Microsoft Excel and analyzed using EPI INFO version 7.2.6. Descriptive statistics were used to summarize patient characteristics and fungal profiles. Associations between fungal genera and demographic variables were assessed using the Chi-square test or Fisher's exact test, with a p-value ≤ 0.05 considered statistically significant.

Results:

Prevalence of superficial mycosis:

From January 1, 2015 to December 31, 2020, 914 patients had mycological examinations at the Parasitology-Mycology Laboratory of the Joseph Ravoahangy Andrianavalona University Hospital Centre (CHU-JRA). Of these, 287 (31.4%) had confirmed superficial mycoses, defined by positive direct examination and/or culture results. Direct examination was positive in 97.2% (n=279/287) of cases, while culture was positive in 80.1% (n=230/287), with 77.4% (222/287) of cases positive on both direct examination and cultures, and 2.8% (n=8/230) of culture-positive cases negative on direct examination (Table 1).

A total of 272 fungal species were isolated from 230 culture positive samples with multiple species isolated from some samples. The prevalence of superficial mycoses peaked in 2016, accounting for 30.0% (n=86/287) of cases, with another peak in 2018 (Fig 1).

Table 1: Correlation between direct examination and culture results in mycological examination of superficial mycoses

Direct Microscopic Examination (DME)	**Culture**		**Total (%)**
	Number positive (%)	Number negative (%)	
Number positive (%)	222 (77.4)	57 (19.9)	279 (97.2)
Number negative (%)	8 (2.8)	0	8 (2.8)
Total (%)	**230 (80.1)**	**57 (19.9)**	**287 (100.0)**

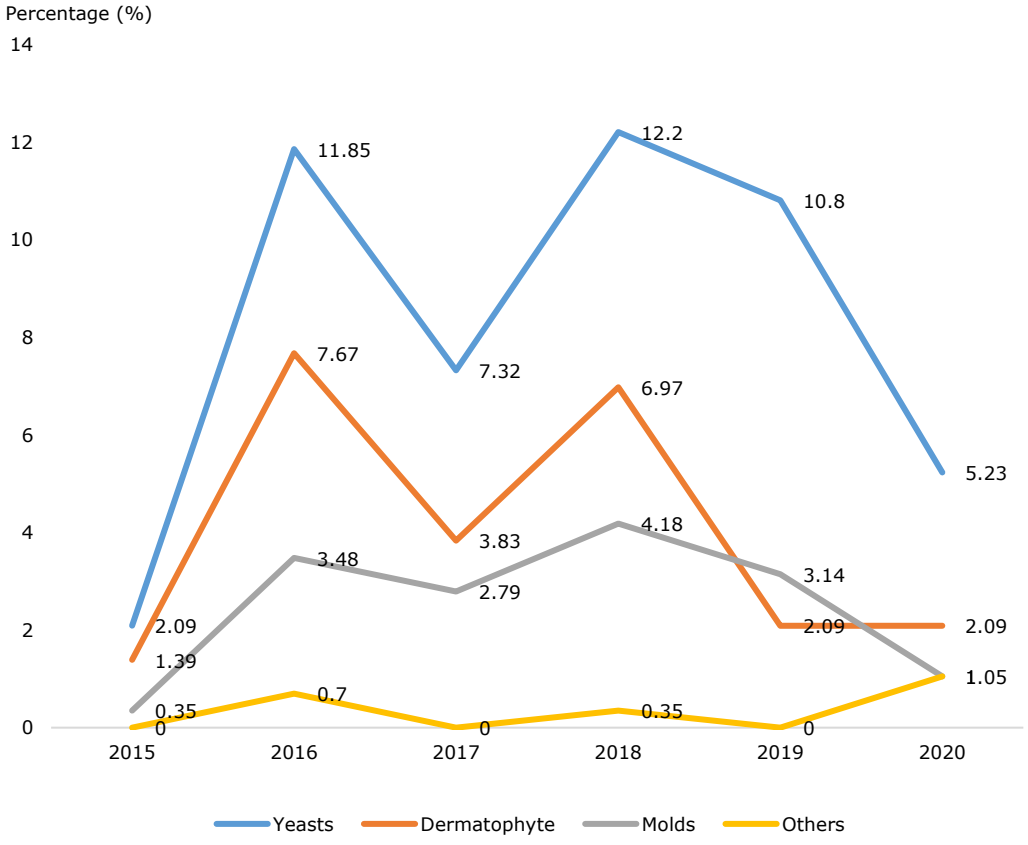


Fig 1: Temporal distribution of superficial mycoses by fungal agent classes over the study period

Socio-demographic characteristics of patients with superficial mycosis:

The age of patients with superficial mycosis ranged from 1 to 78 years (mean age: 31 years). Females predominated (58.9%, n=169/287) compared to males (40.4%, n= 116/287), with a male:female ratio of 2:3. The highest frequency was observed in women aged 31–60 years (24.7%) and men in the same age group (15.0%). Gender data were missing for 0.7% (n=2) of cases (Fig 2).

Mycological examination results:

The most frequently affected site was hairless skin (glabrous, large and small skin folds) (52.4%, n=154/287), followed by nails (29.9%, n=86/287), scalp (12.2%, n=35/ 287), and undetermined (6.4%, n=12/287) (Fig 3), with multiple-site involvement common in the upper limbs, lower limbs, and thorax (Table 2).

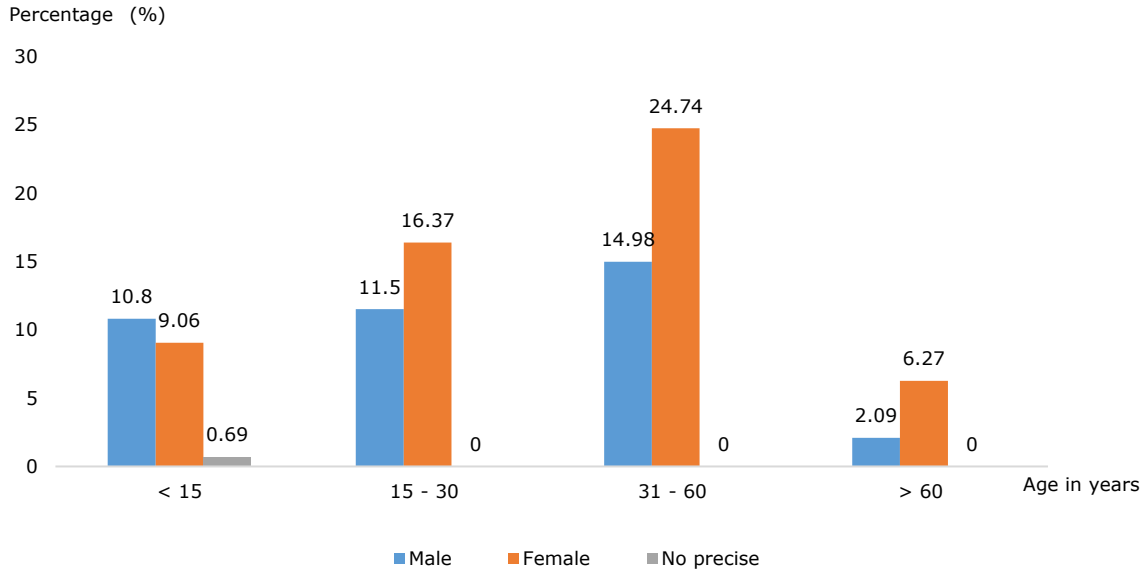
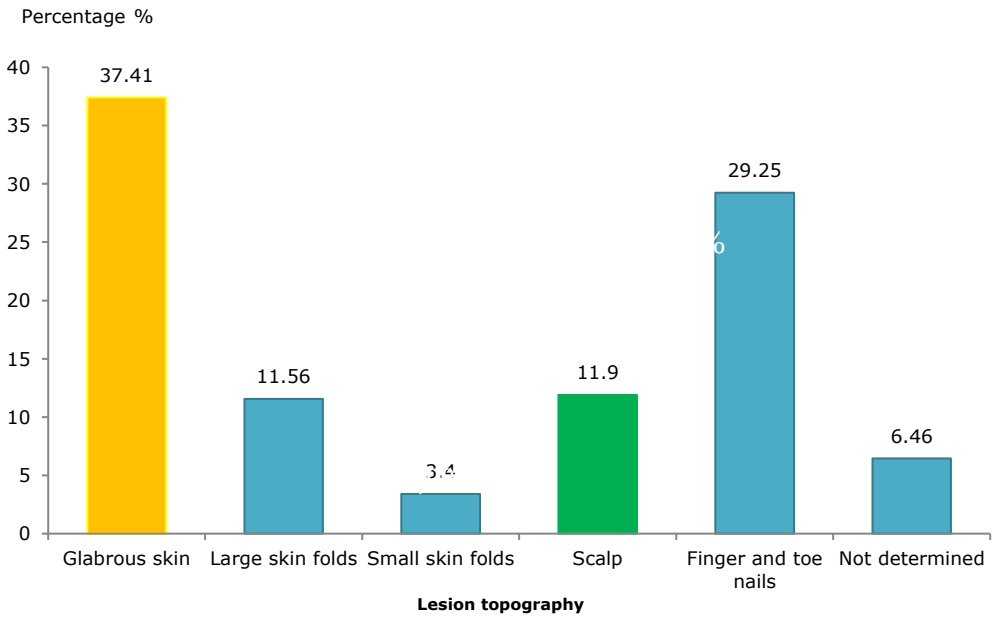


Fig 2: Distribution of superficial and cutaneous fungal infections according to age and gender



Large skin folds (axillary, inguino crural, mammary, intergluteal); Small skin folds (between the fingers, between the toes)

Fig 3: Frequency distribution of superficial mycoses by different body sites of patients

Table 2: Distribution of superficial mycoses based on topography and involvement of multiple body sites

Sampling sites	Frequency (%)	Frequency of involvement of multiple sites (%)
Face	10 (3.4)	7 (7.2)
External auditory canal	20 (6.8)	0
Thorax	16 (5.4)	13 (13.4)
Upper limbs	27 (9.2)	16 (16.5)
Lower limbs	26 (8.8)	13 (13.4)
Axilla	7 (2.4)	4 (4.1)
Inguinal	17 (5.8)	12 (12.4)
Mammary	4 (1.4)	1 (1.0)
Elbows	1 (0.3)	0
Scalp	35 (11.9)	3 (3.1)
Not precise	19 (6.5)	2 (2.1)
Abdomen	9 (3.0)	6 (6.2)
Neck	2 (0.7)	2 (2.1)
Inter gluteal fold	5 (1.7)	1 (1.0)
Finger nail	50 (17.0)	8 (8.2)
Toe nail	36 (12.2)	8 (8.2)
Intertrigo of the small folds	10 (3.4)	1 (1.0)
Total	**294 (100.0)**	**97 (100.0)**

Yeasts were the most commonly isolated fungi pathogens (57.7%; n=157), followed by dermatophytes (25.8%; n=70), moulds (12.1%; n=33), and other fungi (4.4%; n=12) (Fig 4). Among the yeasts, *Candida* spp were predominant (36.9%, n=106/287), with *Candida albicans* and non-*albicans Candida* species contributing significantly, followed by *Rhodotorula* spp (12.5%, n=36/287), *Trichosporon* spp (3.1 %, n=9/287), and *Malassezia* spp (2.1 %, n=6/287).

Among the dermatophytes, *Trichophyton* spp accounted for 21.6% (n=62 /287) of infections, followed by *Microsporum* spp (2.1%, n=6/287). Moulds included *Aspergillus* spp (5.9%, n=17/287), black moulds (3.1%, n=9/287), *Penicillium* spp (1.3%, n=4/287), *Scytalidium* spp (0.7%, n=2/287), and *Cladosporium* spp (0.7%, n=2/287) (Table 3).

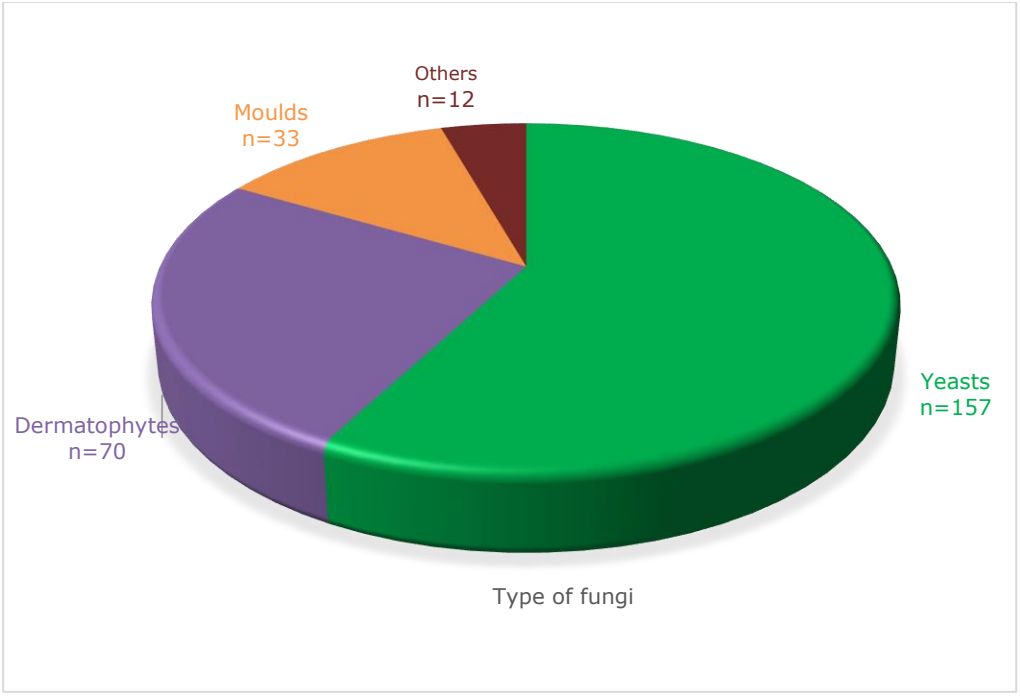


Fig 4: Frequency of fungi class isolated from patients with superficial mycoses

Table 3: Distribution of fungal species identified by mycological cultures according to body sites affected by superficial mycoses in CHUJRA, Antananarivo, Madagascar

Class of fungi	**Fungi species**	**Number of fungi isolated from affected superficial sites (%)**						**Total (%)**
		Glabrous skin	**Scalp**	**Nails**	**Large Folds**	**Small Folds**	**External canal auditory**	
Yeast	*Malassezia* spp	1 (1.3)	1 (4.6)	-	-	-	-	2
	Malassezia furfur	4 (5.3)	-	-	-	-	-	4
	Candida spp	1 (1.3)	-	8 (5.9)	-	-	-	9
	Non albicans Candida	12 (15.8)	6 (27.2)	34 (25.0)	2 (11.2)	1 (14.3)	2 (14.3)	57
	Candida albicans	9 (11.8)	1 (4.6)	29 (21.3)	1 (5.9)	-	-	40
	Rhodotorula spp	14 (18.4)	4 (18.2)	10 (7.6)	5 (29.4)	1 (14.3)	2 (14.3)	36
	Trichosporon spp	4 (5.3)		4 (2.9)	-	1 (14.3)	-	9
	Subtotal	**45 (59.2)**	**12 (54.5)**	**85 (62.5)**	**8 (47.1)**	**3 (42.9)**	**4 (28.6)**	**157 (57.7)**
Dermatophytes	*Microsporum* spp	2 (2.6)	-	1 (0.7)	-	-	-	3
	Trichophyton rubrum	1 (1.3)	-	1 (0.7)	1 (5.9)	-	1 (7.1)	4
	Trichophyton mentagrophytes	3 (4.0)	-	1 (0.7)	1 (5.9)	2 (28.6)	-	7
	Trichophyton tonsurans	1 (1.3)	2 (9.1)	-	1 (5.9)	-	-	4
	Trichophyton violaceum	-	1 (4.6)	2 (1.5)	-	-	-	3
	Trichophyton verrucosum	-	-	-	1 (5.9)	-	-	1
	Trichophyton spp	15 (19.7)	2 (9.1)	20 (14.7)	3 (17.7)	2 (28.6)	1 (7.1)	43
	Epidermophyton floccosum	-	-	-	1 (5.9)	-	-	1
	Microsporum persicolor	-	-	-	1 (5.9)	-	-	1
	Microsporum langeronii	-	3 (13.6)	-	-			3
	Subtotal	**22 (28.9)**	**8 (36.4)**	**25 (18.4)**	**9 (52.9)**	**4 (57.1)**	**2 (14.3)**	**70 (25.8)**
Molds	*Aspergillus* spp	-	-	7 (5,2)	-	-	3 (21,4)	10
	Aspergillus fumigatus	-	-	2 (1,5)	-	-	3 (21,4)	5
	Aspergillus flavus	-	-	-	-	-	-	-
	Aspergillus niger	-	-	-	-	-	1 (7,1)	1
	Black molds	2 (2.6)	-	6 (4,4)	-	-	1 (7,1)	9
	Scytalidium dimidiatum	1 (1.3)	-	1 (0,7)	-	-	-	2
	Penicillium spp	-	-	4 (2,9)	-	-	-	4
	Cladosporium spp	1 (1.3)	-	1 (0,7)	-	-	-	2
	Subtotal	**4 (5.3)**	**0**	**21 (15.4)**	**0**	**0**	**8 (57.1)**	**33 (12.1)**
Others	Not determined	4 (5.3)	2 (9.1)	3 (2.2)	-	-	-	9
	Prototheca zopfii	-	-	1 (0.7)	-	-	-	1
	Prototheca spp	1 (1.3)	-	1(0.7)	-	-	-	1
	Subtotal	**5 (6.6)**	**2 (9.1)**	**5 (3.7)**	**0**	**0**	**0**	**12 (4.4)**
Total (%)		**76 (27.9)**	**22 (8.1)**	**136 (50.0)**	**17 (6.3)**	**7 (2.6)**	**14 (5.2)**	**272 (100.0)**

Frequency distribution of isolated fungi species by anatomical sites:

The distribution of the identified fungal species is detailed in Table 3. On the hairless skin, *Trichophyton* spp (19.7%), *Rhodotorula* spp (18.4%), non-*albicans Candida* (15.8%), and *Candida albicans* (11.8%) were the most frequent isolates. On the scalp, non-*albicans Candida* (27.3%), *Rhodotorula* spp (18.2%), and *Microsporum langeronii* (13.6%) predominated. On the nails (onychomycosis), non-*albicans Candida* (25.0%), *Candida albicans* (21.3%), *Trichophyton* spp (14.7%), and *Rhodotorula* spp (7.4%) were most common.

On large folds (axillary, inguinal, mammary, elbow, intergluteal), *Rhodotorula* spp (n=5), *Trichophyton* spp. (n=3), and non-*albicans Candida* (n=2) were frequently isolated. On the interdigital and intertriginous spaces, *Trichophyton* spp (n=2) and *Trichophyton mentagrophytes* (n=2) were the primary isolates. On the external auditory canal, *Aspergillus fumigatus* (n=3) and *Aspergillus* spp (n=3) were the most common (Table 3).

Discussion:

Superficial mycoses are a significant yet underrecognized public health issue in Madagascar, particularly in tropical climates conducive to fungal proliferation (10,11). In this study, 31.4% (n=287/914) of patients undergoing mycological examination at the CHU-JRA Parasitology-Mycology Laboratory had confirmed superficial mycoses, consistent with global prevalence estimates of 20–25% (5). However, prevalence varies widely across studies (14.3–52.2%), influenced by sample size, diagnostic techniques, and regional factors (1,7). Madagascar's tropical environment, coupled with socioeconomic challenges such as poor hygiene and limited access to healthcare, likely exacerbates the burden of these infections (11,13).

In our study, direct examination was more sensitive (97.2%, n=279/287) than culture (80.1%, n=230/287) in detecting the causative fungal agents in patients with superficial mycosis, with 77.6% (n=222/287) concordance between the two methods. Notably, 19.9% of samples were positive by direct microscopy but culture-negative, possibly due to low fungal load or prior antifungal treatment (14,15). Similar findings were reported in Turkey with 97% positivity rate with combined microscopy and culture (14) and in France (41.6% vs. 36.3% for microscopy vs. culture) (15). Direct examination detects non-viable fungal structures, complementing culture results, but its accuracy depends on proper sample collection and meticulous analysis (16). The use of conventional phenotypic identification in this study limited species-level differentiation, highlighting the need for advanced diagnostic tools.

Among the patients with superficial mycoses, females (58.9%, n=169/287) were more frequently affected than males (40.4%, n=116/287), particularly in the 31–60-year age group (39.8%: females 24.7% vs males 15.0%), and the 15–30-year group (27.9%: females 16.4% vs males 11.5%). This aligns with studies in Senegal (29.5% prevalence in women aged 31–60 years) (12), China (17), Saudi Arabia (18), Brazil (19), India (20), and Nigeria (21). Female predominance may be attributed to household activities involving prolonged water exposure, increasing maceration risk, and greater dermatological consultation rates due to aesthetic concerns (12,21). The high prevalence in active age groups (15–60 years) likely reflects increased environmental exposure, hormonal influences, and hygiene practices (21–23).

Hairless skin (37.4%) and nails (29.3%) were the most affected sites, with multiple-site involvement common in the upper limbs, lower limbs, and thorax. Similar patterns were observed in Nigeria (24), India (2,25), Nepal (26), and Brazil (16). Exposed body parts are prone to environmental contamination, trauma, and chemical exposure, while poor hygiene and socioeconomic conditions in Madagascar amplify these risks (13, 16). Yeasts dominated (57.7%), followed by dermatophytes (25.8%) and moulds (12.1%). This contrasts with global trends where dermatophytes are typically predominant (12, 24,29), but aligns with studies in Brazil (59.9–82.9% yeasts) (23,27) and Egypt (46.0%) (28). Among the yeasts, *Candida* spp (36.9%) were most common, followed by *Rhodotorula* spp (11.2%). *Trichophyton* spp (21.6%) led among dermatophytes, consistent with their anthropophilic nature (29–31), while *Aspergillus* spp (5.9%) were the primary moulds (28). The high yeast prevalence may reflect Madagascar's humid climate and frequent water exposure, favoring opportunistic *Candida* spp (32).

Fungal species varied by site. Hairless skin infections were primarily caused by *Trichophyton* spp (14.6%), *Rhodotorula* spp (12.7%), and *C. albicans* (8.2%), while scalp infections were caused by non-*albicans Candida* (17.1%), *Rhodotorula* spp (11.4%), and *Microsporum langeronii* (8.6%). Onychomycosis was dominated by non-*albicans Candida* (27.0%), *Candida albicans* (20.0%), and *Trichophyton* spp (15.9%), consistent with studies in Côte d'Ivoire (32,33,34), Serbia (35), and Lithuania (36). Otomycoses were primarily caused by *Aspergillus fumigatus* and other *Aspergillus* species. The site-specific distribution reflects environmental, occupational, and hygiene-related risk factors, with *Candida* spp thriving in moist conditions and *Trichophyton* spp spreading through direct contact (4,25).

Our study provides critical epidemiological data on superficial mycoses in Madagascar, highlighting a high prevalence (31.4%) and a unique predominance of yeasts, particularly *Candida* spp compared to global dermatophyte-driven trends. These findings underscore the need for enhanced diagnostic capacity, including molecular techniques, to improve species identification and guide targeted antifungal therapy. The high burden among females and active age groups suggests that public health interventions should focus on improving hygiene education, particularly for women engaged in water-intensive household tasks. Strengthening healthcare access and training clinicians in mycological diagnostics could reduce recurrence and morbidity. Additionally, this study contributes to the limited literature on fungal infections in Madagascar, providing a baseline for future research and regional comparisons in Africa (10,12,13).

There are some limitations to our study. Selection bias may arise as the sample was drawn from the laboratory register, which may not fully represent the Malagasy population. Information bias due to missing or incomplete data in the register may have influenced the results.

Conclusion:

Superficial mycoses are prevalent in Madagascar, with a crude prevalence of 31.4% in this study, driven by yeasts (57.6%), dermatophytes (25.5%), and moulds (15.9%). The high burden, particularly in females and active age groups, underscores the influence of tropical climate, socioeconomic challenges, and limited healthcare access.

To address this public health issue, we recommend increasing public awareness of dermatological consultations, enhancing physician training on mycological diagnostics, and improving access to rapid, effective care. Future studies should incorporate molecular diagnostics to improve species identification and guide targeted antifungal therapy.

Acknowledgements:

We express our gratitude to the head and staff of the Bacteriology-Parasitology-Mycology Laboratory at the Joseph Ravoahangy Andrianavalona University Hospital Centre (CHU-JRA), Antananarivo, Madagascar, for their support in facilitating data collection and laboratory analyses.

Contributions of authors:

All authors contributed to the study conception, design, and manuscript preparation. NJZ and RHA performed data collection and laboratory analyses. RHA performed statistical analysis. All authors interpreted the data, drafted the manuscript, and approved the final version for submission.

Source of funding:

Authors received no external funding.

Conflicts of interest:

Authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References :

1. Cai, W., Lu, C., Li, X., et al. Epidemiology of superficial fungal infections in Guangdong, Southern China: a retrospective study from 2004 to 2014. Mycopathologia. 2016; 181 (5-6): 387-395.doi:10.1007/s11046-016-9986-2.
2. Hazarika, D., Jahan, N., and Sharma, A. Changing trend of superficial mycoses with increasing non-dermatophyte mold infection: A clinicomycological study at a tertiary referral center in Assam. Indian J Dermatol. 2019; 64 (4): 261-265. doi:10.4103/ijd.IJD_579_18.
3. Dismukes, W., Pappas, P., and Sobel, J. Clinical Mycology. Oxford: Oxford University Press; 2003.
4. Havlickova, B., Czaika, V. A., and Friedrich, M. Epidemiological Trends in skin mycoses worldwide. Mycoses. 2008; 51 S4(4): 2-15. doi:10.1111/j.14390507.2008.01606.x
5. Ameen, M. Epidemiology of superficial fungal infections. Clin Dermatol 2010; 28 (2): 197-201. doi:10.1016/j.clindermatol.2009.12.005.
6. Degboé, B., Atadokpede, F., Adégbidi, H., et al. Mycoses superficielles: apects épidémiologiques et cliniques en milieu hospitalier à Cotonou de 2005 à 2014. Ann Dermatol Vener. 2016; 143 (4): S24. doi:10.1016/S0151-9638(16)30137-5
7. Vena, G. A., Chieco, P., Posa, F., Garofalo, A., Bosco, A., and Cassano, N. Epidemiology of dermatophytoses: retrospective analysis from 2005 to 2010 and comparison with previous data from 1975. New Microbiol. 2012; 35 (2): 207-213.
8. Issouani, J., Meftah, A., Garboub, A., et al. Les Mycoses cutanées chez les diabétiques. Ann Endocrinol. 2015; 76 (4): 527. doi: 10.1016/j.ando.2015.07.762
9. Hochedez, P., Datry, A., and Caumes, É. Mycoses superficielles. EMC – AKOS Traité de Médecine. 2007: 1-6 [article 4-1380]. doi: 10.1016/S1634-6939(07)45411-4
10. Gnat, S., Łagowski, D., Nowakiewicz, A., and Dyląg, M. A global view on fungal infections in humans and animals: infections caused by dimorphic fungi and dermatophytoses. J Appl Microbiol.2021;doi:10.1111/jam.15084.
11. Sharma, B., and Nonzom, S. Superficial mycoses, a matter of concern: Global and Indian scenario-an updated analysis. Mycoses. 2021. doi: 10.1111/myc.13264.
12. Diongue, K., Diallo, M. A., Ndiaye, M., et al. Champignons agents de mycoses superficielles isolés à Dakar (Sénégal) : une étude rétrospective de 2011 à 2015. J Mycol Med. 2016; 26 (4): 368-376. https://doi.org/10.1016/j.mycmed.2016.08.003
13. Zida, A., Barro-Traoré, F., Dera, M., Bazié, Z., Niamba, P., and Guiguemdé, T. R. Aspects épidémiologiques des mycoses cutanéo-phanériennes chez les détenus de la maison

d'arrêt et de correction de Ouagadougou (Burkina Faso). J Mycol Med. 2015; 25 (2): e73-e79. https://doi.org/10.1016/j.mycmed.2015.03.006
14. Koksal, F., Er, E., and Samasti, M. Causative agents of superficial mycoses in Istanbul, Turkey: retrospective study. Mycopathologia. 2009; 168 (3): 117-123. doi: 10.1007/s11046-009-9210-z.
15. Kayman, T., Sarigüzel, F. M., Koç, A. N., and Tekinşen, F. K. Etiological agents of superficial mycoses in Kayseri, Turkey. J Eur Acad Dermatol Venereol. 2013; 27(7): 842-845. doi:10.1111/j.1468-3083.2012.04589.x
16. Silva-Rocha, Azevedo, M. F., and Chaves, G. M. Epidemiology and fungal species distribution of superficial mycoses in Northeast Brazil. J Mycol Med. 2017; 27 (1): 57-64. doi: 10.1016/j.mycmed.2016.08.009.
17. Wang, X., Ding, C., Xu, Y., Yu, H., Zhang, S., and Yang, C. Analysis on the pathogenic fungi in patients with superficial mycosis in the Northeastern China during 10 years. Exp Ther Med. 2020; 20 (6): 281. doi: 10.3892/etm.2020.9411.
18. Abanmi, A., Bakheshwain, S., El Khizzi, N., et al. Characteristics of superficial infections in the Riyadh region of Saudi Arabia. Int J Dermatol. 2008; 47 (3): 229-235. doi:10.1111/j.1365-4632.2008.03563.x
19. Di Chiacchio, N., Madeira, C. L., Humaire, C. R., Silva, C. S., Fernandes, L. H., and Dos Reis, A. L. Superficial mycoses at the Hospital do Servidor Público de São Paulo between 2005 and 2011. An Bras Dermatol. 2014; 89 (1): 67-71. doi:10.1590/abd1806-4841.20141783.
20. Dulla, S., Kumari, P. S., and Kumari, R. L. Prevalence of non-dermatophytes in clinically diagnosed Tineasis. Int J Curr Microbiol App Sci. 2015; 4: 541-549.
21. Nwafia, I. N., Ohanu, M. E., Ebede, S. O., et al. Changing Epidemiology of Superficial Fungal Infections in Enugu, South East Nigeria. Arch Clin Microbiol. 2020; 11 (6): 132.
22. Vasudha, C. I., Anuradha, B., and Faizan, M. A. A Study on Prevalence and Clinico-Micological Profile of Superficial Fungal Infections in a Tertiary Care Hospital. Int J Curr Microbiol Appl Sci. 2019; 8: 2553-2563.
23. de Albuquerque Maranhão, F. C., Oliveira-Júnior, J. B., Dos Santos Araújo, M. A., and Silva, D. M. W. Mycoses in northeastern Brazil: epidemiology and prevalence of fungal species in 8 years of retrospective analysis in Alagoas. Braz J Microbiol. 2019; 50 (4): 969-978. doi: 10.1007/s42770-019-00096-0.
24. Adefemi, S. A., Abayomi, M. A., and Abu, J. M. Superficial fungal infections seen at a tertiary health centre: clinical and mycological studies. West Afr J Med. 2010; 29 (4): 267-270.
25. Lakshmanan, A., Ganeshkumar, P., Mohan, S. R., Hemamalini, M., and Madhavan, R. Epidemiological and clinical pattern of dermatomycoses in rural India. Indian J Med Microbiol. 2015; 33 S: 134-136.doi:10.4103/0255-0857.150922.
26. Khadka, S., Sherchand, J. B., Pokharel, D. B., et al. Clinicomycological Characterization of Superficial Mycoses from a Tertiary Care Hospital in Nepal. Dermatol Res Pract. 2016. 9509705. doi: 10.1155/2016/9509705.
27. Calado, N. B., de Sousa Júnior, F. C., Diniz, M. G., et al. A 7-year survey of superficial and cutaneous mycoses in a public hospital in Natal, Northeast Brazil. Braz J Microbiol. 2011; 42 (4): 1296-1299. doi:10.1590/S1517-83822011000400008.
28. Moubasher, A. H., Abdel-Sater, M. A., and Soliman, Z. Incidence and biodiversity of yeasts, dermatophytes and non-dermatophytes in superficial skin infections in Assiut, Egypt. J Mycol Med. 2017; 27 (2): 166-179. doi: 10.1016/j.mycmed.2017.01.005.
29. Faure-Cognet, O., Fricker-Hidalgo, H., Pelloux, H., and Leccia, M. T. Superficial Fungal Infections in a French Teaching Hospital in Grenoble Area: Retrospective Study on 5470 Samples from 2001 to 2011. Mycopathologia. 2016; 181 (1-2): 59-66.doi:10.1007/s11046-015-9953-7.
30. Gamage, H., Sivanesan, P., Hipler, U. C., Elsner, P., and Wiegand, C. Superficial fungal infections in the department of dermatology, University Hospital Jena: A 7-year retrospective study on 4556 samples from 2007 to 2013. Mycoses. 2020; 63 (6): 558-565. doi: 10.1111/myc.13077.
31. Wu, T., Wu, S. D., Zhang, L. Y., et al. Pathogen Analysis of Superficial Mucocutaneous Mycosis in a Tertiary A-level Hospital from 2007 to 2018. Curr Med Sci. 2022 Apr;42(2):434-438. doi: 10.1007/s11596-022-2576-7.
32. Konate, A., Yavo, W., Kassi, K. F., et al. Profil mycologique de l'onychomycose à Abidjan (Côte d'Ivoire). J Mycol Med. 2014; 24 (3): 205-210. https://doi.org/10.1016/j.mycmed.2014.03.001
33. Kiki-Barro, P. C. M., Konaté, A., Kassi, F. K., et al. Profil mycologique des onychomycoses des mains chez les vendeurs de « Garba » à Abidjan (Côte d'Ivoire). J Mycol Med. 2017; 27 (4): 543-548. https://doi.org/10.1016/j.mycmed.2017.08.004
34. Angora, K. E., Ira-Bonouman, A., Vanga-Bosson, A. H., et al. Caractéristiques cliniques et mycologiques des onychomycoses à *Candida* à l'Institut Pasteur de Côte d'Ivoire. J Mycol Med. 2018; 28 (1): 167-172. https://doi.org/10.1016/j.mycmed.2017.10.003
35. Otašević, S., Barac, A., Pekmezovic, M., et al. The prevalence of *Candida* onychomycosis in Southeastern Serbia from 2011 to 2015. Mycoses. 2016; 59 (3): 167-172. doi: 10.1111/myc.12448.
36. Paškevičius, A., Švedienė, J., Kiverytė, S., et al. *Candida* Distribution in Onychomycosis in vitro Susceptibility to Antifungal Agents. Acta Dermatovenerol Croat. 2020; 28 (7): 204-209.