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Dermatomycoses in Skin, Hair, and Nails: Prevalence and Fungal Pathogenic Profiling, in Diyala, Iraq

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ABSTRACT

Background: Dermatomycoses refer to fungal infections affecting the skin and its appendages, such as hair and nails, it caused primarily by dermatophytes and yeasts, and occasionally by molds.
Objective: This study aimed to investigate the prevalence of dermatomycosis including the identification of fungal species from infected skin, hair, and nails in Diyala, Iraq.
Methods: Fifty samples of skin, hair and nails were collected from patients with dermal infections in Ba'aqubah teaching hospital and different private clinics in Diyala, Iraq, with different age groups (3-73 years). All samples were identified to detect the pathogenic fungi caused dermatomycosis infections.
Results: This study showed that 78% of samples were positive for dermatomycosis infections. Among samples collected from infected skin, 84% were positive, 57% of infected hair and 75% from infected nails. 89.3% of females included in this study were show positive results for dermatomycosis whereas males were 63.6%. Skin infections were more prevalent among females than males, whereas no significant differences were observed for hair and nail infections between genders. The 21–30 years age group showed the highest prevalence of dermatophycosis. Candida species were the most isolated species that cause dermatomycosis in skin and onychomycosis. Malassezia were isolated from skin and hair scalp, Trichosporon beigelii were isolated from two cases with white piedra, whereas Rhodotorula and Trichophyton mentagrophytes were isolated from one skin case infection for each.
Conclusion: Dermatomycosis can affect hair skin and nails in people with various age groups in both genders, Candida spp. and Malassezia were the most isolated yeasts affecting skin, and Candida was the most yeast caused onychomycosis.

Keywords: Dermatomycosis, Onychomycosis, Malassezia, Trichophyton, Trichosporon.

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INTRODUCTION

One of the most common health disorders over the world are fungal skin infections and dermatophyte infection of skin, hair and nails are the most abundant fungal infections [1]. The term dermatomycoses refer to superficial fungal infections affecting the skin, including its appendages such as hair follicles and nails, these infections, caused primarily by dermatophytes and yeasts, and occasionally by molds [2]. Because a keratinophilic fungi that exhibit an affinity for keratinized tissues structures of the skin, hair, and nails, causing an inflammatory host response and clinical situations identified as tinea [3, 4]. Dermatophytes considered the most pathogens caused dermatophytoses which they responsible for different types of tinea e.g. tinea corporis, tinea capitis and onychomycosis (tinea unguium) [5] dermatophytes also known clinically as ringworm or tinea dermatophytes are divided into three groups based on their preferred habitats: anthropophilic, geophilic [6], zoophilic species of dermatophytes, such as Microsporum canis, Trichophyton verrucosum, and T. mentagrophytes are associated with wild and domestic animals [7] mainly anthropophilic dermatophytes are found as pathogens [5]. Dermatophytoses are produced by species of the fungal genera Trichophyton, Microsporum, and Epidermophyton as a result of their transmissibility from human to human or from animal to human, and these infections are considered public health importance [8]. Cutaneous mycosis describes a wide spectrum of fungal infections caused by dermatophytes (dermatophytosis), Candida (candidiasis), and Malassezia (pityriasis versicolor) species [7]. Superficial infections of the hair shift, scalp, eyebrows, mustache, beard in addition to genital and axilla hairs can be caused by *Trichosporon* spp. which cause white peidra, also common are infections due to the lipophilic yeast fungus Malassezia [9]. Candida albicans, is the most common yeast infection causative agents of skin primarily affect the intertriginous skin areas, such as the groin region, and also the submammary area and the spaces between the fingers and toes [5].

Cutaneous candidiasis predominantly manifests in warm, moist, and occluded regions of the body, such as the inguinal and intergluteal areas, this condition is a relatively prevalent opportunistic infection, frequently resulting from skin maceration and trauma [10]. Intertriginous candidiasis is most commonly observed in the axillary regions, groin, intergluteal folds, and interdigital spaces. In immunocompetent individuals, the principal predisposing factors include moisture, elevated temperature, friction, and maceration of the skin [11]. Despite the high global prevalence of dermatomycoses, regional data, particularly in Iraq, remain limited. This study aimed to investigate the prevalence of dermatomycosis including the identification of fungal species from infected skin, hair, and nails in Diyala, Iraq.

METHODOLOGY

Sample Isolation and Identification

Fifty samples were collected from patients with dermatomycosis in the period from October 2023 to February 2024 from Ba'aqubah Teaching Hospital and some private clinics in Diyala, Iraq, with different age ranged from 3 to 73 years according to samples availability at the clinics.

Sample size culculation

This study was used the following equation for calculating the adequate sample size,

$$n = \frac{z^2\, p(1-p)}{d^2}$$

Where n is the sample size, z for a 95% confidence level is 1.96, P is expected prevalence (50%), and d is precision (corresponding to effect size) [12].

This means 45 or more samples are needed to have a confidence level of 95% that the real value is within ±5% of the samples value.

Laboratory examinations, prepared culture media and microscopic examination

Direct examination

All specimens were direct examinated with 10% KOH to detect fungal infections.

Preparation of Sabouraud's Dextrose Agar Medium (SDA)

It was prepared according to manufacturer instructions, that 65 g SDA was dissolved in 1000 mL distilled water and sterilized by autoclaving. It was cooled down to 45-50 ºC then Ampicillin "500 mg/Liter" and Streptomycin "1 g\ L" was added, then poured in sterile Petri dishes. This medium was used for culturing, isolation and preservation of

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dermatophytes. Microscopic examination was performed by using lactophenol cotton blue stain.

Isolation of specimens from skin, hair and nails

Specimens were collected from infected skin using sterile swabs for wet lesions, then transferred to sterile container. Dry patches were scrapped from skin by sterile medical scalpel, after 10% KOH direct microscopic examination, then the skin specimens were divided into two parts one-part was transferred to sterile petri dish with SDA media, and the other part was cultured on SDA with sterile olive oil to detect Malassezia Spp., M. furfur isolation requires the use of particular media, being a lipophilic yeast that needs mineral oils or long chain fatty acids for growing. The most practical cultivation method consists in using Sabouraud Dextrose Agar added with 1‰ cycloheximide was covered, on the surface, by a thin film of olive oil. In this case the growth is rapid (4-5 days) at 35-37°C. All inoculated media were incubated at 37 ˚C for 7-10 days with daily observation. Infected hair was drawn from scalp by forceps and put them into clean dry container. For nails specimens, deeper part is collected and superficial part is discarded. The specimens were transferred into sterile culture media and incubated at 32 ˚C for 7-10 days with daily observation.

Statistical Analysis

The Statistical Packages of Social Sciences-SPSS (22) program was used to detect the effect of study groups in study parameters. Chi-square test was used to determine the significant differences between percentages. (P ≤0.05) was considered significant.

RESULTS

Laboratory examination shows that 39 (78 %) from 50 sample were positive for pathogenic fungi and 11 (22%) patients were negative with significant differences as appeared in (Table 1). Twenty-six (84%) out of 31 sample collected from infected skin were positive growth for pathogenic fungal species, while 4 (57%) out of seven from infected hair and 9 (75%) out of 12 samples from infected nails (Table 1). Statistical analysis shows there were high significant differences of dermal fungal infections distribution among study groups. It was appeared that skin was the most affected part of body with pathogenic fungi in patients included in this study with high significant differences (Figure 1). The data of this research was collected randomly revealed that 22 (44%) were males and 28 (56%) were female. In addition, 25 (89.3%) out of 28 females were positive results for dermatomycosis, while for males 14 (63.6%) out of 22 were positive. The statistical analysis shows there was no significant differences in distribution of dermatomycosis among gender in study group (Table 2). Skin infections were more prevalence in females with percentage 73% comparing with 27% for males with significant differences, while there was no significant difference in hair and nails infections between the two genders (Table 3).

Table 1: Distribution of Positive and Negative Pathogenic Fungal Infections Results Among the Study Samples

Source of specimens	Positive	Negative	Total	P-value
Skin	26 (84%)	5 (16%)	31 (62%)	0.0002 **
Hair	4 (57%)	3 (43%)	7 (14%)	0.7055 NS
Nails	9 (75%)	3 (25%)	12 (24%)	0.0833 NS
Total	39 (78%)	11 (22%)	50 (100%)	0.0001 **
P-value	0.0001 **	0.781 NS	0.0001 **	---

** (P≤0.01).
NS: non-significant differences

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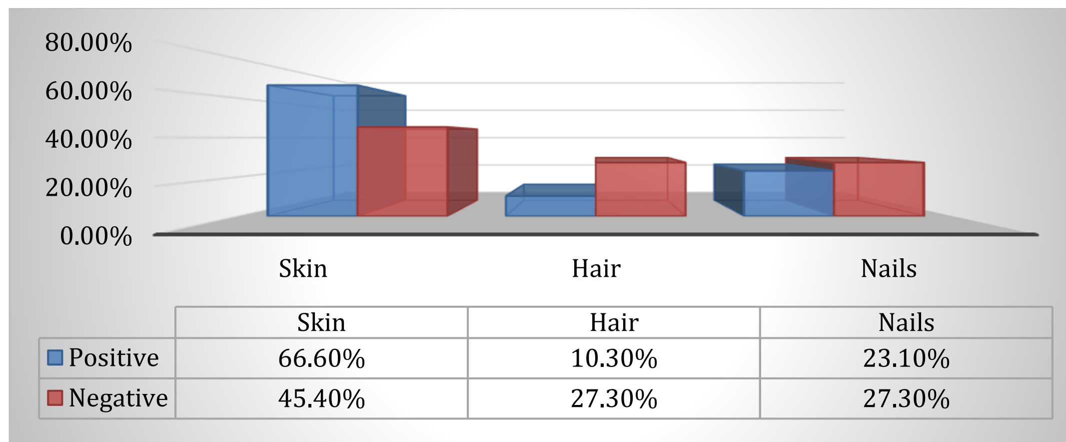

Figure 1: Distribution of pathogenic fungal species among skin, hair and nails

Table 2: Distribution of infections (in general) in study groups according to gender

Gender	Positive	Negative	Total	P-value
Female	25 (89.3%)	3 (10.7%)	28 (56%)	0.0001 **
Male	14 (63.6%)	8 (36.4%)	22 (44%)	0.2008 NS
Total	39 (78%)	11 (22%)	50 (100%)	---
P-value	0.0276 *	0.1794 NS	0.2663 NS	---

* (P≤0.05), ** (P≤0.01).

Table 3: Distribution of the diagnostic infections among Study Samples according to gender

Source of specimens	Female	Male	Total	P-value
Skin	19 (73%)	7 (27%)	26 (66.6%)	0.0186 *
Hair	2 (50%)	2 (50%)	4 (10.3%)	1.00 NS
Nails	4 (44.4%)	5 (55.6%)	9 (23.1%)	0.7389 NS
Total	25 (64.1%)	14 (35.9%)	39 (100%)	0.0497 *
P-value	0.0001 **	0.3717 NS	0.0001 **	---

* (P≤0.05), ** (P≤0.01).

The age groups were divided into seven age groups. Figure 2 shows that the highest percentage of dermatomycosis was 33.3% within the age group (21-30) followed by the age groups (11-20) and (31-40) which gave the same percentage 18%. The least number of infections were in young ≤ 10 and in adults with age period (41-50) which was 5.1%. Furthermore, the age groups (51-60) (≥61) showed 10.25% of dermatomycosis with high significant differences (Figure 2).

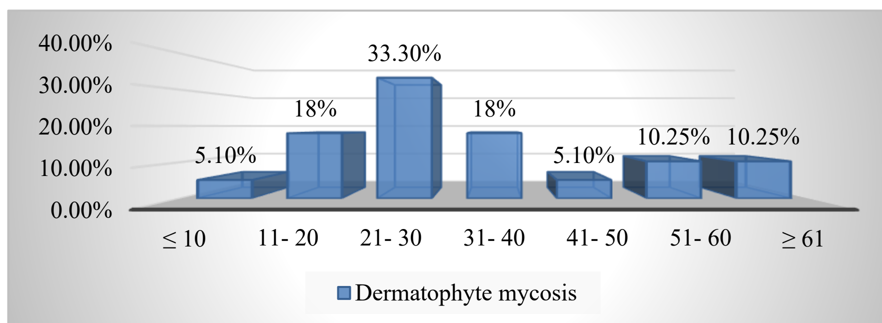

Figure 2: Prevalence of dermatophyte mycosis among age groups

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The laboratory examination showed that *Candida* species were the most isolated species that caused dermatomycosis which were 27 isolate out 39 positive fungal growths. 18 of *Candida* spp. (Figure 3) isolates were isolated from skin infections, whereas nine isolates were from nails infections which term onychomycosis in this case. The other yeast which has isolated from skin (*Tinea versicolor*) and hair scalp was *Malassezia* (Figure 4) with prevalence 6% and 2% respectively. Two cases out of 39 infection cases were white piedra caused by *Trichosporon beigelii* (Figure 5). In addition, *Rhodotorula* was isolated from one skin case infection which caused *Tinea cruris* in young child patient (Figure 6). There was one isolate of *Trichophyton mentagrophytes* (Figure 7) was isolated from 9 years old female suffered from *Tinea corporis* (Table 4).

Table 4: The prevalence of pathogenic fungi isolated from skin, hair and nail

Species	Skin	Hair scalp	Nails	Total
Malassezia	6	2	0	8
Candida spp.	18	0	9	27
Rhodotorula	1	0	0	1
Trichophyton mentagrophytes	1	0	0	1
Trichosporon beigelii	0	2	0	2
Total	26	4	9	39

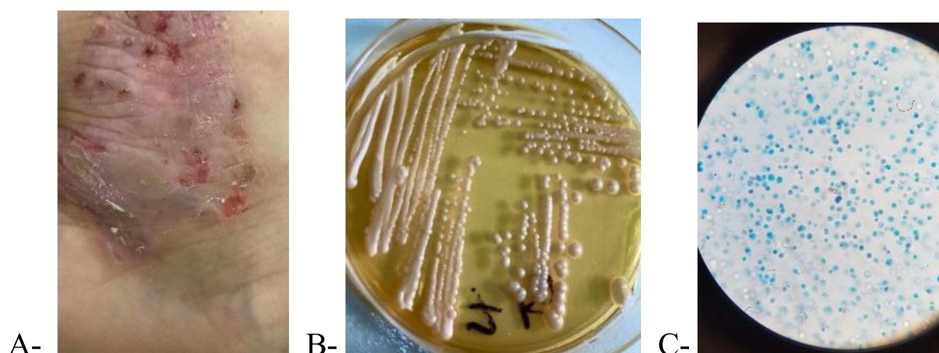

Figure 3: (A) Cutaneous candidiasis with Candida spp. (B) on SDA at 37oC for 2 days (C) microscopic examination with lactophynol cotton blue at 100X

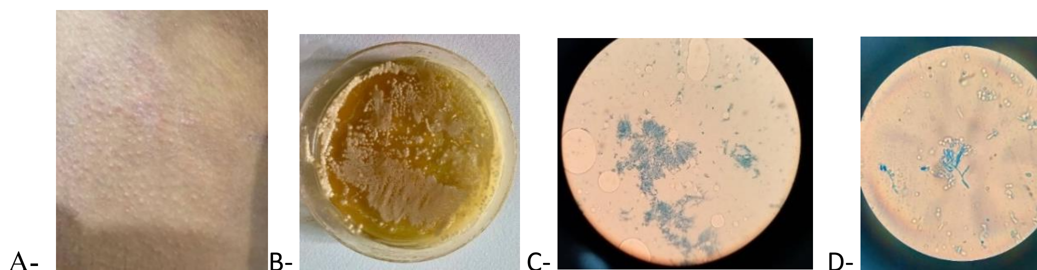

Figure 4: (A) Tinea versicolor by Malassezia spp (B), on SDA with olive oil on 37oC for 2-5 days (C) microscopic examination with lactophynol cotton blue on 40X double-contoured yeast cells, cluster-like arranged and squat hyphae with a “spaghetti and meatballs” like appearance (D) microscopic examination on 100X

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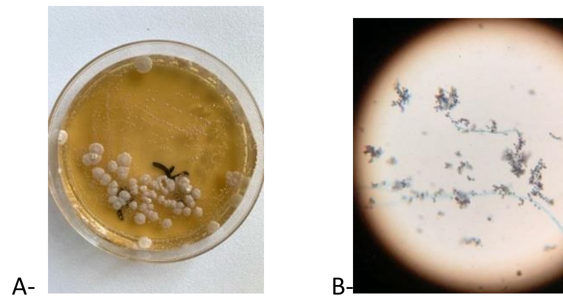
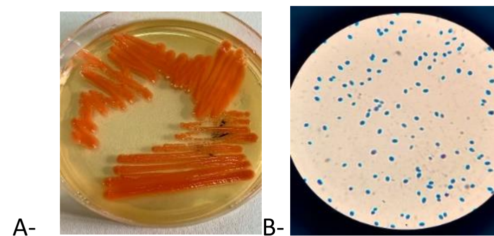


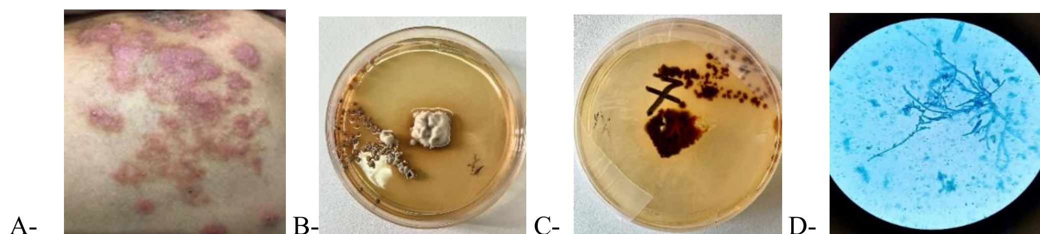
A- B-

Figure 5: Trichosporon beigelii (A) on SDA at 32oC for 2 days (B) microscopic examination with lactophynol cotton blue at 100X



A- B-

Figure 6: Rhodotorula Spp. (A) on SDA at 32oC for 2 days (B) microscopic examination with lactophynol cotton blue at 100X



A- B- C- D-

Figure 7: (A) Tinea corporis infection with Trichophton mentagrophytes (B) on SDA at 32oC for 5-8 days (C) reverse of colony (D) microscopic examination with lactophynol cotton blue at 100X showed the macro and microconidia with hypha

DISCUSSION

Dermatomycosis are common and widespread in humans and animals. Individuals of all ages are infected with fungal skin infections, whether they are young or adult men or women. These infections depend on several factors, including the site of infection, the immune response of the host and the type of causative agent in addition to many other factors such as the rate of movement, travel and lifestyle in general may be affected by the epidemiology of dermatomycoses [13]. The current study was in line with Khodadadi et al. [14] and consistent with earlier research [15], dermatophytosis was the second most dominant kind of superficial infections (34.8%). However, 82%, 74%, and 83.2% of dermatophytosis were found in epidemiologic investigations conducted in China, Turkey, and Germany, respectively [16]. Gender has some effects on dermatomycosis distribution as the house duties are the accountability of most women in our society, so it's not surprising to find higher frequency of tinea unguium in females (75%) than males (25%). In addition, cosmetic manicuring practices undertaken by women can be considered as another explanation for this findings [17].

Some dermatophytoses are more frequently associated with male sex (tinea cruris, tinea barbae), while tinea capitis is associated with the adult female sex, they occur in particular in the postmenopausal

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period, due to the reduction of a significant part of saturated fatty acids inhibiting the development of dermatophytes, caused by the hormonal modifications typical of this stage of life [18].

Rashidian et al. [19] revealed that men were mostly affected, regardless of the fact that there was a statistically negligible differences between the two genders. The current study indicated that age has an effect on the predisposition to infection with various fungal diseases as a result of the different physiological factors and the different nature of the body, in addition to the methods of body care and observance of hygiene.

Different activity and frequent exposure to pathogens, these results are reliable with the outcomes of Urban et al. [20] that the burden of fungal skin disease was the highest among younger patients, while the prevalence rate was the highest in the elderly one. The current results also agreed with what was stated by Khodadadi et al. [14], where the study established that group 20-41 is the most frequent fungal infection. These results are much resample with Gupta, et al. [21], that demonstrated that the age group 21-30 had the highest frequency, followed by the group 31-40 with a ratio of (24.37 and 23.55%) correspondingly.

The reason for this is due to the fact that people of these ages engage in various types of activities, which exposes them to infectious factors, these results are agreeing with our previous study in the same field that Dermatophyte infections were the most common, accounting for 44.1% and Tinea versicolor was the most predominant in younger ages [22].

Despite the fact that dermatophytes initiate universally, the incidence rate may vary in different geographic areas reliant on environmental conditions or life routine, hot and humid weather, sun exposure, low socioeconomic rank, overcrowding with sharing of clothes and footwear, poor hygiene and sanitary circumstances, and migration of population are important influential factors for the increasing chronic and recurrent forms of dermatophytosis [23].

As dermatophytes thrive in hot, humid environments, many tropical and developing countries are facing an increase in dermatophyte infections [24]. This study found that Candidiasis is caused by Candida spp. They vary from superficial infections of the skin and mucous membranes and working outdoors under moist and temperate conditions is favorable for the development of pityriasis versicolor. Malassezia furfur is recognized as the main causative agent of Pityriasis versicolor, a chronic infection (colonization) of the stratum corneum, usually asymptomatic, distributed all over the world, mainly affecting young adults of both sexes [18].

Skin microflora is home to Malassezia spp., which are responsible for conditions like seborrheic dermatitis, Malassezia folliculitis, and pityriasis versicolor (PV) [25]. *Trichosporon beigelii* is recognized as the causative agent of White piedra, infection of the hair, beard hair, pubis and armpits. White piedra is characterized by the formation of whitish nodules (1-1.5 mm) on the hair shaft, mainly in the distal part; the nodules are particularly adherent and, in some cases, can form sheaths around the hair extremity. It may happen that the hair breaks near the follicular exit. Shaving generally solves the infection. The surrounding skin is not affected [26].

Onychomycosis is a frequent nail disorder, accounting for up to 50% of all nail problems. Treatment of onychomycosis is expensive and requires a long time of antifungal medications it was appeared that onychomycosis are more prevalence in diabetic patients [27].

Trichophyton spp., is the primary pathogenic agent responsible for skin, hair, and nail infections worldwide [28]. Iraq is consecutively major epidemic of dermatophyte infections that have unusual clinical pictures and reproducing many skin diseases and Trichophyton mentagrophytes represented the most frequent dermatophyte that has been isolated [29].

Despite of the few references about Rhodotorula spp. pathogenicity, there are several reports of an outbreak of skin infections in humans including meningeal, skin, ocular, peritoneal, and prosthetic joint infections most of Rhodotorula infections are related with immunosuppression, corticosteroids receiving and cytotoxic drugs [30].

Recently it was proved that Rhodotorula is a widely distributed fungus that has evolved as an important pathogen, especially in immunocompromised individuals and *Rhodotorula glutinis* was isolated from pus of the skin ulcer in 63 years old female with well controlled type 2 diabetes mellitus [31]. In the current study Rhodotorula was isolated from one skin case infection which cause Tinea cruris in young child. Over the past decade, there has been a

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noticeable increase in the prevalence of cutaneous dermatophytosis in India, with rates ranging from 6.0% to 61.5% depending on the specific region [32], this study was find that the Primary identification of dermatophytosis, mostly in lesions affecting hairy regions, is crucial for dermatologists to confirm timely and appropriate treatment, thereby justifying the risk of scarring in this otherwise treatable disorder. The atypical laboratory manifestations of cutaneous fungal infections observed in this study may contribute to the expanding spectrum of dermatological conditions that mimic other diseases. The proposed classification framework offers a systematic approach that can aid clinicians in considering dermatophyte infections, particularly in cases of non-responsive or recalcitrant lesions within common dermatologic disorders.

One of the reasons of dermatomycosis infections that increase in last years in Diyala is due to the increase of cosmetics and beauty salons that use extra hygiene and different products may affect the skin defense and normal flora that provide balance in skin and hair environments which prevent overgrowth of yeasts that could invade the cutaneous layer and cause dermal infection, factors such as age, gender, and geographical location play an important role in the prevalence of these infections. In recent years, an increase in the number of fungal skin infections has been observed in the governorate [22]. This may be attributed to the environmental change resulting from the clearing of agricultural lands and population density, which led to an increase in temperatures and humidity, providing a suitable environment for the growth and spread of fungi. In addition, there is a large number of foreign workers, which have spread widely in recent years, and frequent travel and movement. All of these factors may contribute to the spread of fungal skin diseases more than before. The limitations of this study were the small size of the study samples.

The current study reveals a particularly high prevalence of dermatomycosis, with skin infections particularly dominant among females and individuals aged 21–30, suggesting possible gender- and age-related susceptibility influenced by environmental or behavioral factors. The predominance of Candida spp. over traditional dermatophytes points to a shifting etiological landscape that may reflect local climatic conditions, host factors, or antifungal exposure patterns. The isolation of emerging opportunistic fungi such as *Malassezia*, *Trichosporon beigelii*, and *Rhodotorula* underscores the evolving complexity of fungal pathogens and the need for precise mycological diagnosis. These findings highlight the importance of ongoing epidemiological monitoring and the development of context-specific diagnostic and treatment protocols.

CONCLUSION

This study concluded that dermatomycosis can affect hair skin and nails in people with different age groups in both genders, Candida spp. and Malassezia were the most isolated yeasts affecting skin, and Candida was the most yeast caused onychomycosis.

Recommendations

This study is recommending to conduct further tests and statistics on the prevalence of fungal skin infections by including larger number of infections, investigating disease cases in different regions of Iraq, and conducting a comprehensive survey over successive years to determine the prevalence rate of dermatomycosis.

Source of funding

This research is self-funded and has not received any funding from any organization.

Ethical approval

The study was approved by the ethical committee for research and higher studies of the Iraqi Ministry of Health. Informed consent was obtained from each participant.

Conflict of interest

The author declare that there is no conflict of interest.

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