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Clinical Manifestations of Dermatophytoses and its Treatment: A Review

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Dermatophytes can invade the keratinized tissue and cause one of the most common fungal infections, dermatophytoses. Dermatophytoses are present worldwide and it is most common in warm climates. It is caused by dermatophytes that belong to the genera *Trichophyton, Epidermophyton* and *Microsporum.* The clinical manifestation and clinical signs of these infections vary according to the infected body part and the specific dermatophytic species. According to the parts of the body that is affected, clinical manifestations of the dermatophytoses are categorized, such as tinea capitis (scalp), tinea barbae (beard area), tinea corporis (skin other than the bearded area, scalp, hands or feet), tinea cruris (groin and perineal areas), tinea pedis (feet), tinea manuum (hands), and tinea unguium (nails). *Trichophyton rubrum, T. mentagrophytes, T. tonsurans, Epidermophyton floccosum* and *Microsporum canis* are the main etiological species for dermatophytoses in all over the world. In this review, we discuss the clinical manifestations of dermatophytoses, etiological agents and their treatment by using oral and topical antifungals.

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Keywords: Dermatophytoses; clinical manifestation; anti-fungal; treatment.

1. INTRODUCTION

The dermatophytes are a collection of keratinophilic fungi that share a great deal with similarity in their morphology and genetic characteristics [1,2]. They are able to invade the keratinized tissue of animals and humans, which can cause fungal infection known as dermatophytoses [3]. *Trichophyton, Epidermophyton, Microsporum, Arthroderma, Nannizzia, Paraphyton* and *Lophophyton* are the names of genera given to the different types of dermatophytes that are categorized under the new system of classification. [4]. In the order Onygenales, the dermatophytes are Ascomycetes that have septate hyphae and they are most closely connected to *Coccidioides immitis* [5,6].

The World Health Organization estimates that dermatophytoses impact 20 to 25 percent of the world's population [7]. In addition, research has shown that the reactions of different species of dermatophytes to antifungal medications are not the same [8]. Fungi that have successfully colonized in the skin will eventually reproduce and spread throughout the superficial layers of skin and cause fungal cutaneous infections.

The broad spectrum of fungal cutaneous infections are caused by organisms that are anthropophilic. Transmission can take place either through direct contact or through exposure to cells that have been desquamated. People who have a compromised cell-mediated immune system are more susceptible to acquire an infection directly through rupture in to the epidermis.

2. TYPES OF DERMATOPHYTIC FUNGI

Fungi that live on the skin are linked to a number of the world's most prevalent diseases, including dandruff and atopic dermatitis/eczema. The natural epidemiological perspective recognises three classes of dermatophytes based on their habitat, which are anthropophilic, zoophillic and geophilic. Anthropophilic dermatophytes are

Table 1. Source of most common dermatophytic species causing dermatophytoses in animals and humans on the basis of their habitats

Source for isolation	Affected organism	Isolated species	Clinical type of drmatophytoses	References
Anthropophilic	Human	*Trichophyton rubrum*	Tinea pedis, Onchomycosis, tinea cruris, tinea faciei, tinea corporis, tinea manuum, tinea barbae	[11-17]
	Human	*T. tonsurans*	Tinea capitis, tinea corporis, tinea faciei	[15,14,16,17]
	Human	*Epidermophyton floccosum*	Tinea cruris	[17]
	Human	*T. digitale*	Tinea pedis	[18,17]
	Human	*T. digitale*	Tinea capitis favosa	[18,17]
Zoophilic	Cats	*Microsporum canis*	Ringworm	[19,20,17]
	Voles, bats	*Arthroderma persicolor*	Ringworm	[21,17]
	Pigs	*M. nanum*	Ringworm	[17]
	Horses	*T. equinum*	Ringworm	[22,17]
	Mice, guinea pigs	*T. mentagrophytes*	Ringworm	[20,17]
	Cattle	*T. verrucosum*	Ringworm	[23,24,17]
	Monkay, Chicken, dogs	*T. simmi*	Ringworm, Tinea capitis (humans)	[25]
Geophilic	Animal and human	*M. gypseum*	Ringworm, tinea capitis/tinea corporis (humans)	[19,26,27,17]

found in humans and zoophilic dermatophytes are found in various animal hosts while geophilic dermatophytes are found in different soil texture. Dermatophytes can be passed from one individual to another without any intermediary (anthropophilic organisms). Other geophilic dermatophytes are found in the soil and can be passed on to humans from there, while still others can be transmitted on to humans from animal hosts (zoophilic organisms) [9]. Transmission of dermatophytes can also take place in an indirect manner through fomites. (e.g., upholstery, hairbrushes, hats). The following Table 1 provides an overview of the most dermatophytic species and the habiat in which they are present [10].

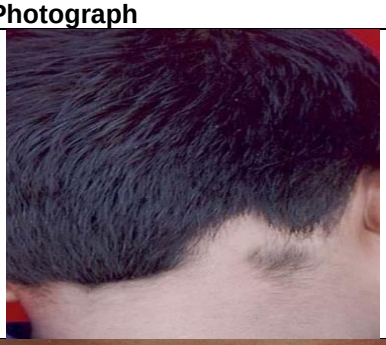
3. MECHANISM OF ACTION OF INVADING DERMATOPHYTIC FUNGI

Dermatophytes are aerobic fungi that secrete proteases enzyme that digest keratin protein, which enables them to invade, colonize and infect the stratum corneum of the epidermis as well as the hair shaft and the nail [28,29]. Dermatophytes are unable to infiltrate in the deeper layers of tissue or organs in the healthy immune-competent host, the infection is typically limited to the cornified layers of the skin and is generally confined to the surface. The infection caused by dermatophytes is also known as "Ringworm" in popular parlance [30,31].

4. CLINICAL TYPES OF DERMATOPHYTOSES

The dermatophytes are responsible for illness in humans and animals including domestic animals. It is often that dermatophyte infections are the most common human infection in all over the world (not just the most common fungal infection). Infections caused by dermatophytes are accountable for the expenditure of at least half a billion dollars in health care [32]. Table 2 shows most common dermatophytic infections and their locations in body.

Table 2. Clinical Manifestations of dermatophytoses/tinea

Tinea infection	Affected Body Part	Photograph
Tinea capitis	Scalp	
Tinea corporis	Abdomen	
Tinea barbae	Beard	

Tinea faciei	Face	
Tinea manuum	Hands	
Tinea cruris	Groin	
Tinea pedis	Feet	
Tinea unguium	Nails	

5. SOME OF THE MOST COMMON CLINICAL MANIFESTATIONS OF DERMATOPHYTOSES

5.1 Tinea Capitis

Tinea capitis is an infection that affects both the scalp and the shafts of the hair. Tinea capitis is characterised by baldness that is either well-defined or not well-defined at all, as well as scaling. The condition known as "black dot" alopecia is caused when enlarged hairs break off just a few millimetres from the scalp. This type of dermatophytoses can also lead to a cell-mediated immune reaction known as a "kerion" which is a mass on the scalp that is sterile, inflammatory and full of muck. Tinea capitis is the most prevalent type of dermatophytoses occurs in children below 12 years of age who had at least three of the following clinical features: scaling on the scalp, itching on the scalp, occipital adenopathy, and diffuse, patchy or discrete alopecia [33,34,35]. Tinea capitis most often caused by any of the dermatophytic species belonging to two genera: *Trichophyton* and *Microsporum* [36,37]. The main causative agents are *T. tonsurans* and *M. canis* [38,39]. Transmission of this infection is can take place through contaminated hats, brushes, pillow and other inanimate objects. Poor sanitation and overcrowding are two factors that contribute to the spread of the disease. Affected hair can continue to harbour viable organisms for longer than one year after they have been released.

5.2 Tinea Corporis

Tinea corporis more commonly known as ringworm, manifests itself as a single or numerous annular, scaly lesions on the trunk, extremities face. These lesions typically have a central clearing, a slightly elevated, reddened border and sharp margination (an abrupt transition from infected to uninfected skin). There is a possibility of pustules or follicular papules forming along the margin of the disease. The level of itching varies [40]. Tinea corporis is most commonly caused by dermatophytes belonging to one of the three genera, namely *Trichophyton*, *Microsporum* and *Epidermophyton* [41]. This type of dermatophytoses is most often caused by *T. rubrum*, *T. tonsurans* and *M. canis* [42]. *T. rubrum* is the most common cause of dermatophytoses around worldwide and it is the most common cause of tinea corporis [43].

5.3 Tinea Barbae

Tinea barbae affects both the skin and the coarse hair in the region of the beard and moustache. Adult males are more likely to contract this dermatophytic condition. The most common causative agents for tinea barbae are *T. verrucosum* and *T. mentagrophytes*. These pathogens are contracted through occupational exposure to animals infected with zoophilic dermatophytes. Farm employees are the most likely to become infected because this type of infection is typically caused by a zoophilic organism [44,45].

5.4 Tinea Faciei

Tinea faciei typically appears on the areas of the face that are uncovered by facial hair. It is usually seen in children and women [46]. The patient may report symptoms of itching and burning, both of which are known to become more severe when exposed to sunshine. There are a few crimson spots that are circular or annular in shape. The red areas, on the other hand, may be difficult to distinguish, particularly on skin with a dark pigmentation, and lesions may have very little or no scaling and may not have raised borders. Most common pathogens of tinea faciei are *T. tonsurans, T. verrucosum, T. mentagrophytes, M. canis* and *T. rubrum* [47]. This dermatophytoses is sometimes referred to as "tinea incognito" due to the fact that it has a relatively inconspicuous appearance [48].

5.5 Tinea Manuum

Tinea manuum is a fungal condition that can affect palm, dorsum or interdigital folds of one or both hands. Adolescent and adult males are the more frequently affected [49]. In this type the palms become diffusely dry, scaly and erythematous. The most common agent for this dermatophytoses in worldwide is *T. rubrum* [50]. *T. mentagrophytes*, *T. interdigitale* and *E. floccosum* are the other most etiological agents for tinea manuum [51,52].

5.6 Tinea Cruris

Tinea cruris, also known as "jock itch" caused by dermatophytes that affects the groin area. Tinea cruris is a condition that primarily affects the proximal and medial thighs, but it can also spread to the buttocks and midsection. Patients

who have this type of dermatophytoses frequently report symptoms including itchiness and burning. On a background of red, scaling lesions with raised borders, pustules and vesicles are present at the active edge of the infected region, along with maceration. These lesions are present in addition to the maceration [53,54]. The most important causative dermatophytic agents of tinea cruris are *T. rubrum*, *E. floccosum*, *T. interdigitale*, *T. mentagrophytes* and *T. verrucosum* in Iran and other countries [55,52,56]. This dermatophytoses is more prevalent in males. A suffocating environment, such as that created by damp clothing or clothing that fits too snugly, is ideal condition for the spread of infection.

5.7 Tinea Pedis

Tinea pedis or athlete's foot is an infection of the feet including the soles, interdigital clefts and nails. Fissuring, maceration and scaling in the interdigital spaces of the fourth and fifth digits are the distinguishing features of this condition. Patients suffering from this condition often describe feeling like they have an itchy or burning rash. Mostly tinea pedis is caused by *T. rubrum, T. interdigitale* and *E. floccosum* [57-59]. There are a number of risk factors for acquiring these infections including residing in hot, humid environments, wearing occlusive footwear for prolonged periods of time, excessive sweating, and exposure of the skin to moisture for extended periods [60]. In the general, there has typically been a higher frequency of tinea pedis in males compared to females especially men aged between 20 and 40 years [61-63].

5.8 Tinea Unguium

Tinea unguium or onychomycosis is an infection of the nails. The risk of the risk of this type infection is higher in males compare to females and also increased with the age [64]. Older age, trauma, diabetes, immunosuppression and a history of tinea pedis (athlete's foot) or nail psoriasis are all the predisposing factors for tinea unguium [65]. Exposure to humid environments, unventilated footwear and traveling jobs, handwashing or communal showers facilities increase the risk of developing onychomycosis [66]. Common causative agents include *T. rubrum*, *T. interdigitale*, *E. floccosum* and *T. tonsurans* is commonly associated in infection of children [67,65].

6. DIAGNOSIS OF DERMATOPHYTOSES

According to Barry and Hainer dermatophytic infections can be readily diagnosed based on the history, physical examination and potassium hydroxide (KOH) microscopy [51]. Diagnosis occasionally requires Wood's lamp examination and fungal culture or histologic examination. Molecular sequencing is the new approach of diagnosis. Several molecular techniques are used for the diagnosis of dermatophytoses including PCR, AP-PCR, nested-PCR, amplification of rRNA gene Internal Transcribed Spacer regions etc. By using these molecular techniques for the identification of the species of the dermatophytic fungi is more particular, exact, quick and less likely to be affected by external factor such as temperature variations. It can be useful when the identification of the dermatophytes is not possible with the conventional methods [4].

7. TREATMENT OF DERMATOPHYTOSES

Dermatophytic infections can be treated with antifungal medications that are either taken orally or applied topically or with a combination of the two [68]. All of these strategies are targeted at destroying the fungal cell wall in order to stop the infection mechanism that the fungus uses and to kill the cells. It is standard practise to consider topical antifungals to be the first-line treatment for dermatomycoses. The technique of administration that topical antifungals use gives them the advantage of curing skin diseases by their direct application at the site of infection, making them more effective than systemic treatments, which are typically used to treat fungal infections [69]. Dermatophytoses that can be treated with both first and second-line topical antifungal drugs, depending on the severity of the infection [70,71].

Allopathic treatment time-duration is long, expensive and not in approach of every class of the community. These chemical drugs may have various side effects such as headache, vomiting, pain, rashes, anaemia, decreased renal functions and jaundice etc. So, there is need for effective and safe antifungal treatments. In order to this, a wide variety of plant products, including flavonoids, alkaloids, saponins, oils and phytosterols are currently undergoing clinical testing as potential treatments for dermatophytic infections [87]. The ability of essential oil of plants to prevent and treat fungal infections is due to the presence of phytochemical

Table 3. Oral and topical anti-dermatophytic agents

S.No	Antifungal agent	Clinical manifestations of dermatophytoses	Duration of tretment	References
1	Griseofulvin	Tinea corporis Tinea pedis Tinea cruris Tinea barbae	6-8 weeks	[72]
2	Clotrimazole	Tinea corporis Tinea cruris Tinea pedis	4-6 weeks	[73]
3	Terbinafine	Tinea pedis	4 weeks	[74]
		Tinea unguium	12 weeks	
		Tinea manuum	2-4 weeks	[75]
		Tinea barbae	4 weeks	[55]
		Tinea faciei	2 weeks	[76]
		Tinea capitis	4-6 weeks	[77]
4	Butenafine (1%)	Tinea corporis Tinea cruris Tinea pedis	2-4 weeks	[72]
5	Econzole nitrate (1%)	Tinea pedis	2 weeks	[78]
6	Setacozazole (2%)	Tinea corporis Tinea cruris	4 weeks	[79,80]
7	Amorofine (0.25%)	Tinea corporis	4 weeks	[81]
8	Effinaconazole (10%)	Tinea pedis	12 months	[82]
		Tinea unguium	12 months	[83]
9	Amphotericin B (0.1%)	Tinea corporis Tinea cruris	4 weeks	[84]
10	Eberconazole (1%)	Tinea corporis Tinea cruris Tinea pedis	2-4 weeks	[73]
11	Naftifine (2%)	Tinea cruris	2 weeks	[85]
12	Luliconazole (1%)	Tinea corporis	1 week	[86]
		Tinea cruris	1 week	
		Tinea pedis	2 weeks	

substances. There are numerous ways to assess the essential oils in vitro antidermatophytic activity. The most common tests are the agar-based disc diffusion, broth dilution and vapour phase tests. Despite the fact that essential oils extracted form plants is widely used by humans and that there is strong evidence from recent research that they may be complimentary or alternative options for preventing and treating dermatophytoses [88].

8. CONCLUSION AND FUTURE PERSPECTIVE

From the present review of dermatophytic infections, it can be concluded that such kind of fungal infections might be painful and lethal if untreated. Dermatophytoses may become more prevalent under certain circumstances, including crowded living conditions, wearing tight or suffocating clothing, heightened urban living, low socio-economic status, close contact with animals and inadequate personal hygiene. The contagious nature of dermatophytic infections facilitates easy transmission to healthy individuals, with a high likelihood of spreading from animals to humans. It is noteworthy that these fungi can also spread within the same individual's body, migrating from one location to another due to their high level of contagiousness. Clinic-practitioner and researchers face significant challenges in treating dermatophytoses or tinea. These include the rising occurrence and evolving identification of dermatophytes, prolonged treatment durations, a restricted array of antifungal agents, numerous side effects associated with available

medications and the emergence of drug resistance. Treatment of dermatophytic infections is possible using plant-based products and antifungal drugs. However, identification of specific compounds responsible for antifungal potential is required to enhance plant-based therapy of dermatophytic infections.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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