

Diversity of fungi as human pathogen

P.N.Chowdhry, Suman Lata Gupta and Nidhi Anand

National Centre of Fungal Taxonomy, E.G.49, III Floor, Inderpuri, New Delhi 110 012, India.

Abstract

Worldwide *human pathogenic fungi* cause *invasive* diseases, pose a serious and growing health problem and are a major cause of death. Superficial mycosis is more prevalent in tropical and subtropical countries including India, where heat and moisture play an important role in promoting of Anthropophilic dermatophytes and tends to get worse during summer, with symptoms alleviating during the winter. Such fungi are known as Dermatophytes and usually colonize the outer layer of the skin, occasionally invade subcutaneous tissues, resulting in kerion development of ringworm symptoms. These symptoms develop by a number of different fungal species e.g. *Trichophyton*, *Microsporum* and *Epidermophyton* are proved most common causative agents. Such fungi attack various parts of the body and lead to Dermatophytosis as *Tinea pedis* (athlete's foot) affects on the feet; *Tinea unguium* on the fingernails and toenails; *Tinea corporis* on the arms, legs and trunk, *Tinea cruris* (jock itch) groin area; *Tinea manuum* hands and palm area, *Tinea capitis* on the scalp, *Tinea barbae* affects facial hair; *Tinea faciei* on the face etc.. The other superficial mycoses (not classic ringworm or dermatophytes) are *Tinea versicolor* caused by *Malassezia furfur* and *Tinea nigra* caused by *Hortaea werneckii*.

Keywords: Human pathogen, Diversity of fungi, invasive diseases

INTRODUCTION

The Mycoses caused by fungal infections of the skin and nails is a widespread and most numerous groups amongst of all mycoses. During the last decades superficial mycotic infections has risen to more than 20–25% of the world's population. Their etiological agents and the predominating anatomical infection patterns vary with geographical location and environmental and cultural factors.[12,13] Such fungi grew most at surface temperatures of 25–28° C and is supported by warm and humid conditions for infection on human skin. Therefore, superficial infections by fungi are relatively common in tropical countries due to wearing of dirty and pungent clothing, low socioeconomic status, crowded living conditions, superficial skin infections, a low tendency to self limitation and poor medical care further help to increase the epidemic spread of skin mycoses. Also booming tourism, international sports activities and increasing migration are also responsible through disseminated of imported group of fungi of dermatomycoses.

The present paper deals with the current epidemiological trends for fungal infections mainly on dermatomycoses of glabrous skin in different locations

ETIOLOGY

The dermatophytes were formerly classified as members of the phylum *Deuteromycota* (Fungi *imperfecti*). Some are known to reproduce sexually and have been reclassified in the phylum

Ascomycota, family Arthrodermataceae. Each of these fungi now has two species names, one for the stage found in vertebrate hosts, and one for the form that grows in the environment (the perfect state).

Dermatophytosis is caused by fungi in the genera *Microsporum*, *Trichophyton* and *Epidermophyton*. These organisms, called dermatophytes, are the pathogenic members of the keratinophilic (keratin digesting) soil fungi. *Microsporum* and *Trichophyton* are human and animal pathogens. *Epidermophyton* is a human pathogen. There are approximately 40 different species of genus *Trichophyton*, *Microsporum* and *Epidermophyton*. Amongst *Trichophyton rubrum* is the most common [4].

Formerly, the perfect states of *Microsporum* species were placed in the genus *Nannizia* and the perfect states of *Trichophyton* in the genus *Arthroderma*. Currently, the perfect states of both *Microsporum* and *Trichophyton* belong to the genus *Arthroderma*.

It is now known that practically all dermatophytes have reservoirs in the soil; however, this classification system is still used to indicate the usual source/ epidemiology of dermatophytes species. Zoonotic species found in animals include:

- *Microsporum canis* (Perfect state – *Arthroderma otae*)
- *Microsporum gallinae*
- *Microsporum gypseum* (A complex containing at least two perfect states – *Arthroderma gypseum* and *Arthroderma incurvatum*)
- *Microsporum equinum*
- *Microsporum nanum* (Perfect state – *Arthroderma obtusum*)
- *Microsporum persicolor* (Perfect state – *Arthroderma persicolor*)
- *Trichophyton equinum*, *Trichophyton mentagrophytes* (A complex containing at least two perfect states –

*Corresponding Author

P.N.Chowdhry
National Centre of Fungal Taxonomy, E.G.49, III Floor, Inderpuri, New Delhi 110 012, India.

Email: pnchowdhry@gmail.com

Arthroderma benhamiae and *Arthroderma vanbreuseghamii*).

Several varieties of *Trichophyton mentagrophytes* exist in nature. Some are important pathogens in both animals and humans; others are mainly human pathogens.

- *Trichophyton simii* (Perfect state – *Arthroderma simii*)
- *Trichophyton verrucosum*

HABIT OF CAUSATIVE FUNGI

These fungi habitat as (i) Anthropophilic: superficial, low inflammatory, dust may act as a reservoir, are mainly found in humans and are very seldom transmitted to animals. (ii) Geophilic (infect children and adolescents, high affinity to the hairy head of a child, high inflammatory and develops highly contagious skin infections, found mainly in soil, where they are associated with decomposing hair, feathers, hooves and other keratin sources. They infect both humans and animals. (iii) Zoophilic (found in animals, sporadically transmitted to humans by cats, dogs)

SYMPTOMOLOGY

Most basic fungal skin infections are caused by dermatophytes and the main clinical manifestations are detailed below [3].

Tinea barbae

Tinea barbae is an infection of the hairs and skin in the beard and mustache area, and is usually seen in men. The lesions may include scaling, follicular pustules and erythema. Tinea barbae can be caused by zoophilic or Anthropophilic dermatophytes. Farm workers are often affected. Most common agents are *Trichophyton verrucosum* while, other agents are *Microsporium canis*, *Trichophyton megninii*, *Trichophyton mentagrophytes*, *Trichophyton rubrum* and *Trichophyton violaceum*.

Tinea capitis (ringworm of the scalp)

Infection develops on the scalp and hair and tends to affect young children worldwide [2]. It can be non-inflammatory, inflammatory or black dot type. The non-inflammatory is caused by *Microsporium audouinii* or *Microsporium ferrugineum* and usually develops as a small papule surrounding a single hair shaft, which spreads centrifugally to other hairs. Scaling occurs and the hair turns grey. The inflammatory type is usually associated with zoophilic or geophilic germs such as *Microsporium canis* and *Microsporium gypseum* respectively. Most common agents are *Trichophyton tonsurans*, *Microsporium audouinii*, and *Microsporium canis*. Other fungi are *Microsporium ferrugineum*, *Microsporium gypseum*, *Microsporium nanum*, *Microsporium versicolor*, *Trichophyton megninii*, *Trichophyton mentagrophytes*, *Trichophyton schoenleinii*, *Trichophyton soudanense*, *Trichophyton verrucosum* and *Trichophyton violaceum* [11].

Tinea corporis (ringworm on the trunk)

This affects the trunk, often in exposed areas like the

abdomen or limbs, causing red patches. It is more common in children than in adults and occurs most frequently in hot climates [26]. Dermatophytes of the genera *Trichophyton* and *Microsporium* are the most common causative agents. *Trichophyton rubrum* can occur as a result of misdiagnosis or mistreatment [15]. Most common fungi are *Trichophyton rubrum*, *Trichophyton canis*, *Trichophyton tonsurans*, and *Trichophyton verrucosum*. Other agents are *Epidermatophyton floccosum*, *Microsporium audouinii*, *Microsporium gypseum*, *Microsporium nanum*, *Microsporium versicolor*, *Trichophyton equinum*, *Trichophyton mentagrophytes*, *Trichophyton raubitschekii*, *Trichophyton schoenleinii* and *Trichophyton violaceum* [16].

Tinea cruris (ringworm of the groin)

This gives an itchy, red rash in the groin and surrounding area and is commonly seen in young men living in a warm climate. [26] and *Trichophyton rubrum*, *Trichophyton mentagrophytes* (var. *interdigitale et granulosum*). Most common fungi are *Epidermatophyton floccosum*, *Trichophyton rubrum*. While, other agents are *Microsporium nanum*, *Trichophyton mentagrophytes* and *Trichophyton raubitschekii*.

Tinea faciei

Tinea faciei is seen on the no bearded parts of the face. The lesions are usually pruritic; itching and burning may become worse after exposure to sunlight. Some lesions may resemble those of tinea corporis; others may have little or no scaling or raised edges. In some cases, the areas of erythema are indistinct. Due to the atypical presentation, tinea faciei is often confused with other skin diseases that affect the face. Most common species are *Trichophyton tonsurans* in North America. *Trichophyton mentagrophytes* and *Trichophyton rubrum* in Asia are commonly recorded.

Tinea manuum

Tinea manuum is a dermatophytes infection of one or, occasionally, both hands. In this form, the palms become diffusely dry, scaly and erythematous. It is most often caused by anthropophilic dermatophytes (cases may be an extension of Athlete's foot) but is occasionally caused by zoophilic organisms. Most common species are *T. rubrum* while, other species are *Epidermatophyton floccosum*, *Microsporium canis* and *Microsporium gypseum*, [17].

Tinea pedis (athlete's foot)

A very common infection occurs in 5% adults and increases with age from adolescence [23]. It occurs more frequently in people who wear occlusive shoes. [26], and is caused by *Trichophyton rubrum* and *Trichophyton interdigitale* (formerly *Trichophyton mentagrophytes* var. *interdigitale*). The incidence of Tinea pedis is around 10% and increasing further during the last 40 years [14]. While most common species are *T. rubrum*, *T. mentagrophytes* var *interdigitale*, *E. floccosum* while other species *M. persicolor*, *T. raubitschekii*, *T. violaceum*. [18]

Tinea unguium (Onychomycosis, nail infections)

The causative include *Candida* species and non-dermatophytes moulds. Dermatophytes are most commonly responsible for Onychomycosis in temperate western countries, whereas *Candida* and non-dermatophytes moulds are more frequently recorded from countries with a hot and humid climate.[4]. *Trichophyton rubrum* is the most common dermatophytes associated with Onychomycosis, others include *Trichophyton interdigitale*, *Epidermophyton floccosum*, *Trichophyton violaceum*, *Microsporium gypseum*, *Trichophyton tonsurans*, *Trichophyton soudanense* [6]. *Candida* spp.[26] and non-dermatophytes moulds, like *Scytalidium* (now *Neoscytalidium*), *Scopulariopsis* and *Aspergillus*. *Scytalidium* mainly affects people in the tropics, although it can persist if they move to more temperate areas[21].

Tinea versicolor (*Pityriasis versicolor*)

A common skin disease develops by the overgrowth of *Pityrosporum orbiculare*, also named *Malassezia furfur*. Most adults harbor *Pityrosporum orbiculare* on their skin; few people develops infection as a harmless skin disease characterized by hyper pigmented patches with fine scales on the upper trunk, occurs frequently on neck, face and upper arms.[22].

Table 1. Dominant species of dermatophytes

Locations	Dominant Fungal species
Tinea capitis	<i>Trichophyton violaceum</i> , <i>Trichophyton tonsurans</i> , <i>Trichophyton soudanense</i> , <i>Microsporium canis</i> , and <i>Microsporium audouinii</i>
Tinea pedis	<i>Trichophyton rubrum</i> , <i>Trichophyton mentagrophytes</i> (var. <i>interdigitale</i>), and <i>Epidermophyton floccosum</i>
Tinea cruris	<i>Trichophyton rubrum</i> and <i>Trichophyton mentagrophytes</i> (var. <i>interdigitale et granulatum</i>)
Tinea corporis	<i>Trichophyton rubrum</i> , <i>Microsporium canis</i> , and <i>Trichophyton tonsurans</i>
Tinea unguium	<i>Trichophyton rubrum</i> and <i>Trichophyton mentagrophytes</i> (var. <i>interdigitale</i>)

SUPERFICIAL FUNGAL INFECTION IN INDIA

India. In northern India, anthropophilic dermatophytes are the predominant pathogens causing tinea capitis. In a study of 153 consecutive patients with tinea capitis, 90% of the patients were aged less than 15 years; 75% belonged to poor socio-economic groups and 19% had a family history of tinea capitis. *Trichophyton violaceum* (38%), *M. audouinii* (34%), *T. schoenleinii* (10%) and *T. tonsurans* (10%) were the most commonly isolated pathogens [3]. Tinea capitis caused by *T. violaceum* is endemic in south India. A study conducted in 1978 suggested that trauma to the scalp caused by ritual shaving may be one explanation for this. Twenty one cases of tinea capitis were found in boys aged 10–17 years in Purasawalkam, Madras, who were shaved consecutively by the same barber. The razors were cleaned only in soap and water [19]. While, tinea pedis was found comparatively rare in Indian subcontinent, especially in the poorer areas [20].

Dermatophytosis is the most common skin disease in the rural population and around Sitapura and Sanganer area of Jaipur (Raj).

Amongst, the 200 suspected patients with clinical symptoms of dermatophytosis, 170 samples (85%) found to be positive by KOH examination and 120 (60%) confirmed in culture. *Tinea corporis* (infection of the glabrous skin) was the most common dermatophytosis reported followed by *Tinea cruris*, *Tinea capitis*, *Tinea pedis* and *Tinea manuum*. *Tinea barbae* and *Tinea faciei* reported least among all the cases of Dermatophytosis [1, 2, and 23].

Incidence of dermatophytosis from other localities constitutes 6.09% among the patients attending the outpatient department of skin and STD. Dermatophytosis was common among the age group of 21-30 years (24%) with a male to female ratio of 1.94: 1, which was similar to other studies [5, 7, 20] A majority of the patients were manual laborers (30.6%) from a rural background (54.6%) and belonged to the lower socio economic status (65.4%). *Tinea corporis* was the most common clinical type with 33.3%, and *Tinea capitis* was more common in the age group of less than 10 years (94.1%).

Trichophyton rubrum was the most common isolate (58.9%) followed by *Trichophyton mentagrophytes* (24.6%), which was comparable [27]. The highest culture isolate was seen in *Tinea corporis*, (43.8%) of the total recorded cases. These culture results were almost comparable [2, 8, and 9]. However, the percentage of *M. gypseum* was higher, which could be due to the patients' interaction with soil and domestic animals.

Dermatophytosis in Tamil Nadu was manifested clinically more in the age group of 11-20 and 21-30 years. Among various clinical conditions, tinea capitis was common in children below 12 years. Microbiological investigation revealed the presence of dermatophytic fungi in 78% of the samples. *Trichophyton rubrum* was the predominant pathogen followed by *Trichophyton mentagrophytes* [10].

Out of 260 patients, 157 (60.38%) tested positive by direct microscopy and 116 (44.62%) by culture. Ten patients were negative for dermatophytes by direct microscopy but yielded growth on culture; 51 were positive on direct microscopy but negative on culture. Ninety three cases were negative by both techniques. Culture positivity was highest with tinea manuum (56.25%) and lowest with tinea barbae (0%). Being the most common clinical type, tinea corporis contributed the highest number of culture positive cases (71/153). The isolation rate of dermatophytes was 44.6% (116/260), with four species of dermatophytes being isolated: *T. rubrum* (isolation rate 73.27%), *T. mentagrophytes* (17.24%), *T. violaceum* (1.72%) and *E. floccosum* (7.75%)[22].

A total of 112 soil samples collected from various areas of Jammu, India, were screened for the prevalence of keratinophilic fungi and related dermatophytes. From 65 positive samples (58.1%), a total of six genera with 13 species were isolated [5]

REFERENCES

- [1] Bhavsar, H; Modi, D. J ; Sood, N ; Shah, H 2012. A study of superficial mycoses with clinical mycological profile in tertiary care hospital in Ahmadabad, Gujarat, *National Journal of Medical Research* ,2(2):150-164
- [2] Bindu V, Pavithran K. 2002. Clinicomycological study of dermatophytosis in Calicut. *Indian J Dermatol Venereol Leprol*. 68: 259-261
- [3] Blanka, H; Viktor A. C. and Markus, F. 2008. Epidemiological trends in skin mycoses worldwide. *Mycoses*. 51 (4): 2–15

- [4] Chi, C.C; Wang, S.H; Chou, M.C. 2005. The causative pathogens of Onychomycosis in southern Taiwan. *Mycoses*. 48: 413–20.
- [5] Deshmukh, S. K. and Agrawal, S. C. 2003. Isolation of dermatophytes and other keratinophilic fungi from soils of Jammu, India. *Mycoses* 46(6): 226–228.
- [6] Garg, A.P; Muller, J(1992) Inhibition of growth of dermatophytes by Indian hair oils. *Mycosis*. 35 : 363-369.
- [7] Hanumanthappa, H; Sarojini, P; Muddapur, S.B 2012. Clinicomycological study of 150 cases of dermatophytes in a tertiary care hospital in South India. *Indian J. Dermatol* .57: 322-323
- [8] Havlickova, B; Czaika, V. A. and Friedrich, M 2008. Epidemiological trends in skin mycoses worldwide *Mycoses*, 51 (4): 2–15
- [9] Jain, N; Sharma, M and Saxena, V.N 2008. Clinico-mycological profile of dermatophytosis in Jaipur Rajasthan. *Indian J Dermatol Leprol Venereol*. 74(3): 274-275.
- [10] Kamalam A and Thambiah, A.S. 1979. Tinea capitis in a Moslem school. *Indian J Med Res*. 70: 40–3.
- [11] Kanwar, A.J and Mamta, C. J. 2001 Superficial fungal infections In : Valia RG Valia AR editors IADVL textbook and atlas of dermatology 2nd ed Mumbai, Bhalani Publishing House pp 215-258.
- [12] Male O. 1990, The significance of mycology in medicine. In: Hawks worth, DL (ed.), *frontiers in Mycology*. Wallingford: CAB International.1: 131–56.
- [13] Macura, A.B 1993. Dermatophyte infections. *Int. J Dermatol*, 32: 313–23
- [14] Nelson, M.M; Martin, A.G and Hefferman, M.P 2003, Superficial fungal infections: dermatophytosis, Onychomycosis, tinea nigra, piedra. In: Fitzpatrick TB (ed.), *Dermatology in General Medicine*, 6th edn. Vol 2. New York: McGraw-Hill, : 1989–2005.
- [15] Nenoff, P; Herrmann J and Graßer, Y. 2007. *Trichophyton mentagrophytes* sive interdigitale? Dermatophytes in the course of time. *JDDG*. 5: 198–202.
- [16] Singh, S and Beena, P.M. 2003. Comparative study of different microscopic techniques and culture media for the isolation of dermatophytes. *Indian J Med Microbiol*. 21: 21-24.
- [17] Shah, H.S; Amin, A.G and Kavinde, M.S 1975. Analysis of 2000 cases of dermatomycoses. *Indian J Pathol Bacteriol*. 18 : 32-37.
- [18] Sharma M. 1983. Taxonomical physiological and Para-clinical studies of fungi causing skin and other infections in human beings PhD .Thesis Botany Department *University of Rajasthan*.; Jaipur, India.
- [19] Singal, A; Rawat, S and Bhattacharya, S.N. 2001. Clinicomycological profile of tinea capitis in North India and response to griseofulvin. *J.Dermatol*. 28: 22–6.
- [20] Singh, A.K; Srivastava, K.S 1994. A Clinico-mycological study on tinea pedis at Ranchi. *Indian. J. Dermatol Venereol Leprol*. 60: 68–71.
- [21] Singh, S and Beena, P.M 2003. Profile of dermatophytes infections in Baroda. *Indian J Dermatol Venereol Leprol* .69:281-3.
- [22] Srinivasan, B; Suyambu, R; Thiyagarajan, T and Solomon, J 2012. Epidemiology of dermatophytosis in and around Tiruchirapalli (Tamilnadu), India. *Asian Pac J Trop. Dis*. 2(4): 286-289
- [23] Sharma, R; Jasuja, N.A and Sharma, S. 2012 Clinical and Mycological study of Dermatophytesosis in Jaipur (India). *International Journal of Pharmacy and Pharmaceutical Sciences*, 4(3): 215-217
- [24] Valdigem, G.L; Pereira, T ; Macedo, C; Duarte, M.L; Oliveira, P and Ludovico P, 2006. A twenty year survey of dermatophytosis in Braga, Portugal. *Int J Dermatol* 45:822-826
- [25] Venkatesan, G; Singh, R; Murugessan, A.G; Janaki, C and Shankar, G.S 2007. *Trichophyton rubrum*-the predominant etiological agent in human dermatophytosis in Chennai, India. *Afr J Microbiol Res* 1: 9-12.