
Epidemiology, Causes and Prevention of Skin Diseases

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Science

- Malassezia* and *Trichosporon*: two emerging pathogenic basidiomycetous yeast-like fungi. *Journal of Medical and Veterinarian Mycology*, **32** (Suppl 1), 367–378.
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The Influence of Environmental Factors on Superficial Fungal Infections

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Mycoses, i.e. infections caused by a still growing variety of microfungi, may be subdivided on the basis of aetiological, nosological or epidemiological criteria. In an overview of the influence of factors such as climate, lifestyle and occupation, it may seem appropriate to use a grouping based on the sources of superficial mycoses.

Superficial mycoses may be acquired from propagules of parasitic origin (group 1) shed by infected individuals or of saprobic sources, which may be exogenous/environmental (group 2) but which may also be epi- or endogenous (group 3) since the human body is the normal habitat of certain 'commensal' microfungi.

Group 1: superficial mycoses from parasitic origin

Dermatophytoses (ringworm, tinea) caused by anthropophilic or zoophilic dermatophytes (for a recent review, see Weitzman and Summerbell, 1995) are the only contagious mycoses: the infective particles of parasitic origin are usually transmitted directly, but also indirectly, from one host to another (De Vroey, 1985). Infective propagules are shed by infected individuals; however carriage of pathogenic dermatophytes by healthy animals has been repeatedly demonstrated, and the same carriage, such as agents of tinea capitis on the human scalp, has also been well documented (Mariat *et al.*, 1967).

Tinea capitis, caused by anthropophilic species, is a clear example of a dermatophytosis where socio-economic status and hygiene are probably the most important factors. Isolated cases of tinea capitis in schoolchildren should not be treated solely with orally active antifungal drugs but also with topical agents to prevent further spreading to other individuals.

In Europe, tinea capitis due to imported anthropophilic dermatophytes (such as *Trichophyton violaceum* and *T. soudanense*) is apparently increasing. As noticed, for example, by Badillet (1988) and by Viguié *et al.* (1992), other members of the family including the mothers should be examined to detect other active scalp lesions and to prevent spreading or re-infections (Leeming & Elliott, 1995). The emergence of *Trichophyton tonsurans* tinea capitis in some cities in the UK is a further example of import pathology.

In countries where tinea capitis is still highly prevalent among schoolchildren, prevention could include the use of an azole-containing shampoo. This should be applied to all the children since healthy carriage, mainly when a species such as *Microsporum langeroni* (*M. audouini*) is the main agent in a school, is probably 100%.

Tinea imbricata (tokelau), geographically restricted mainly to the Pacific Islands of Oceania and to some places in Latin America, is caused by one anthropophilic species, *T. concentricum*. It is another example of the role of hygiene and washing facilities in the prevention of certain dermatophytoses caused by anthropophilic species. Evidence for genetic susceptibility to this dermatophytosis has been demonstrated

in Papua New Guinea (Hay *et al.*, 1983).

Skin, particularly tinea pedis, and (toe) nail infections caused by *T. rubrum* or *T. interdigitale* are, by contrast, examples of infections connected with our way of life including well-known factors such as clothing and occupational or recreational activities. Outbreaks of tinea gladiatorum in wrestling teams are examples of direct transmission (Stiller *et al.*, 1992; Beller & Gessner, 1994). The role of swimming baths, showers and other communal life in the indirect transmission has been repeatedly demonstrated. This includes not only recreational but also professional activities (use of protective clothing and footwear in some industries together with the use of common bathing facilities). De Vroey and Meysman (1980) introduced the use of contact plates which not only allow direct sampling from, for example, floors of swimming pools, but also give quantitative results. With this technique, on average, 110 colonies/m² of dermatophytes (*Epidermophyton floccosum*, *Trichophyton interdigitale*, *T. rubrum*) were isolated in various public swimming baths in Belgium (Norland & Detandt, 1988).

Prevention may be achieved by various, often inexpensive means. Individual measures should include thorough drying of feet and application of foot powder (with an antifungal), avoiding the wearing of clothing which favours moisture and the sharing of towels. Infected individuals should also be educated not to put themselves in direct contact with others. Wearing disposable sandals in synthetic fabric could also help to prevent contagion in places where people, for professional or recreational reasons, use common showers.

The use of foot dips with 'wonder' products in communal swimming baths is generally considered of little benefit as an environmental measure: effective water spraying and scrubbing of the floors will eliminate most of the scales and other infective propagules. The use of (wooden) duckboards, e.g. in showers, should be discouraged since fungal propagules remain stuck to these substrates (Martinet, 1988).

Zoophilic dermatophytes are responsible for familial (e.g. *M. canis*), recreational or occupational (e.g. *M. persicolor*, *M. mentagrophytes*, *T. verrucosum*) infections. *M. canis* is transmitted essentially from cats directly, or probably more often indirectly, to individuals. Using our direct isolation procedure, numerous *M. canis* isolates have been obtained not only from infected,

cured or healthy cats, but also from many different sites in the owner's homes, including bedding, furniture, carpets and clothing. Using an air sampler, Symoens *et al.* (1989) isolated >1000 colonies/mm³ of *M. canis* in the rooms of a house in which one infected cat lived! Similar results are recorded with *T. mentagrophytes* in laboratory animals or pet rodents.

Formolization or spray, smoke or dipping with anti-fungals (e.g. enilconazole, Janssen-Cilag) are effective ways to eliminate this inoculum. Enilconazole, the use of which is restricted to veterinary practice, not only disinfects premises, cages and other items but also eliminates or diminishes the carriage, since it may be used in the presence of animals or applied to the animals directly.

Group 2: superficial mycoses from environmental saprobic origin

This group includes dermatophytoses caused by geophilic species and onychomycoses caused by 'moulds'.

Microsporum praecox and *M. gypseum* are examples of dermatophytes which are responsible for recreational or occupational infections of saprobic origin. Transmission from infected individuals probably never occurs.

Dermatophytoses caused by *M. praecox* are commonly seen in patients with a history of horse-riding and are clearly due to exposure to high numbers of spores of saprobic origin in stables (De Vroey *et al.*, 1983; Phelippot *et al.*, 1988; Degeilh *et al.*, 1994). It should be noticed that, thus far, clinical infections by *M. praecox* have only been reported in humans. *M. gypseum* skin infections in gardeners and in cucumber growers have been traced to occupational exposure to soil enriched with powdered bovine keratin which had enhanced the growth of this geophilic dermatophyte (Alsop & Prior, 1961; Klokke, 1962; Bensch & Gemeinhardt, 1966).

Probably no more than 5% of onychomycoses are caused by non-dermatophytic filamentous fungi or moulds, most commonly *Scopulariopsis brevicaulis*. It is widely accepted that 'altered keratin' explains why *Scopulariopsis* onychomycosis (mainly the big toe) is more frequent in elderly people. Although this species is usually considered 'of widespread occurrence' it is not impossible that nail infections result from contact

with a well-defined but still undiscovered source.

Hendersonula toruloidea (*Natrassia mangiferae*) is a plant pathogen in tropical and subtropical countries. Onychomycosis, athlete's foot and palmar infections caused by this exotic species in Western countries are almost exclusively seen in immigrants from certain tropical areas (Hay & Moore, 1984). It is generally accepted that these imported infections have been acquired, sometimes several years before, from soil and plant detritus. Intrahuman transmission seems to not occur. Wearing shoes that are too tight could explain the evolution from a latent to an active infection.

Group 3: superficial mycoses from epi- or endosaprobic origin

Superficial mycoses acquired from the autochthonous human skin flora consist mainly of pityriasis versicolor and other skin disorders (folliculitis, seborrhoeic dermatitis pro parte?) due to one (or more than one?) species (or a variety) of a commensal lipophilic yeast of the genus *Pityrosporum* (*Malassezia*).

Several factors may be responsible for this change from a harmless skin inhabitant to a pathogen, most of them being still putative but clearly patient linked. External factors (sun exposure, warmth and humidity) may be incriminated but still in relation with individual susceptibility. The possible role of body lotions, sun oils and bath oils (Roed-Peterson, 1980; Gründer & Mayer, 1991; Mayer & Gründer, 1991) should be further investigated.

Superficial candidoses are also mostly caused by our own mucosal or skin yeast flora. Infections due to *Candida albicans* or other *Candida* species are quick to develop when there is any imbalance in the host-commensal relationship. Increased moisture leading to maceration may be considered as an environmental factor predisposing to *Candida* intertrigos. However, the several well-known factors are not really environmental but patient linked or iatrogenic and concern mainly invasive candidosis.

Conclusion

Environmental factors are clearly involved in the transmission of some superficial mycoses such as tinea

Table 15.7 List of fungi discussed and some of their epidemiological characteristics.

Agent	Genus and species	Main pathological implication
<i>Dermatophytes</i>		
Anthropophilic species	<i>Epidermophyton floccosum</i>	Tinea cruris
	<i>Microsporum langeroni</i>	Tinea capitis
	<i>Trichophyton concentricum</i>	Tinea imbricata
	<i>Trichophyton interdigitale</i>	Tinea pedis/onychomycosis
	<i>Trichophyton rubrum</i>	Tinea pedis/onychomycosis
	<i>Trichophyton soudanense</i>	Tinea capitis/onychomycosis
	<i>Trichophyton tonsurans</i>	Tinea capitis/corporis
	<i>Trichophyton violaceum</i>	Tinea capitis
Zoophilic species	<i>Microsporum canis</i>	Tinea corporis/capitis
	<i>Microsporum persicolor</i>	Tinea corporis
	<i>Trichophyton mentagrophytes</i>	Tinea corporis/kerion
	<i>Trichophyton verrucosum</i>	Kerion/sycosis
Geophilic species	<i>Microsporum gypseum</i>	Tinea corporis
	<i>Microsporum praecox</i>	Tinea corporis
<i>Moulds</i>		
Environmental/saprobic	<i>Hendersonula toruloidea</i>	Onychomycosis
	(<i>Natrassia mangiferae</i>)	
	<i>Scopulariopsis brevicaulis</i>	Onychomycosis
<i>Yeasts</i>		
Episaprobic	<i>Pityrosporum/Malassezia</i> spp.	Pityriasis versicolor
Endosaprobic	<i>Candida albicans</i>	Candidiasis

capitis, tinea pedis and tinea unguium. However, the role of patient-linked factors is more important in most superficial mycoses.

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which is a normal inhabitant of the skin and the yeast, *Candida albicans*, the most frequent cause of superficial candidosis, is resident in the gastrointestinal tract of healthy subjects. These infections are therefore endogenous, almost always arising from organisms present in the normal flora. The filamentous dermatophytes which infect man and cause dermatophytosis belong to three genera, *Microsporum*, *Trichophyton* and *Epidermophyton*, and may be divided into those which are spread from man to man (anthropophilic), from animal to man (zoophilic) and from soil to man (geophilic). In contrast to the yeasts, dermatophytes are not part of the normal human flora and infections are acquired by transfer of fungal elements in keratin shed from lesions on infected humans or animals. These differences are relevant to the consideration of the influence of internal factors on these infections.

Age

Pityriasis versicolor

The incidence of the yeast phase of *M. furfur* on the chest and back of healthy adults has been reported to be 92% (Roberts, 1969). However, in a study of clinically normal skin from the backs of newborn infants and those aged 6 months to 15 years old, *M. furfur* was not found in children under 1 year old; the highest prevalence (93%) was in the 15-year-old children (Faergemann & Fredriksson, 1980). This study reflects the comparative rarity with which this infection, resulting from the conversion of the yeast to a mycelial phase, occurs in children under 10 years of age, and suggests that physiological changes in skin lipids during puberty could enhance fungal pathogenicity. The disease itself is most commonly seen in young adults with a lower incidence in the elderly.

Superficial candidosis

Since the most important source of *Candida* in human disease is endogenous, many studies have been carried out on the yeast flora of the mouth, rectum and vagina of healthy subjects. Odds (1988) has calculated from published data that carriage rates of *C. albicans* in the mouths of healthy subjects ranged from 2 to 41%.

The Influence of Internal Factors on Superficial Fungal Infections

Y.M. CLAYTON

The superficial fungal infections are the commonest of human mycoses and include pityriasis versicolor, candidosis and dermatophytosis. Pityriasis versicolor is caused by the lipophilic yeast, *Malassezia furfur*,