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ISHAM INTERNATIONAL SOCIETY FOR HUMAN AND ANIMAL MYCOLOGY

Medical Mycology, 2018, 56, 145–161
doi: 10.1093/mmy/myx048
Advance Access Publication Date: 28 July 2017
Review Article

Review Article

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Received 19 September 2016; Revised 21 March 2017; Accepted 6 July 2017; Editorial Decision 12 April 2017

Abstract

In this critical literature review, we summarize the epidemiological trends of dermatophytoses reported in Africa. Our findings clearly emphasize the heavy burden of dermatophytosis in Africa. Tinea capitis is the primary clinical presentation of dermatophytosis in African children throughout the entire African continent. The disease affects more than 20% of school-age children in West Africa, while the prevalence ranges from 10% to more than 70% in other regions of Africa. In African adults, the presence of tinea corporis is the most frequent indicator of dermatophytosis. However, epidemiological studies have been primarily conducted on particular patient groups that are not representative of the general population. We examined dermatophyte species distribution patterns. We observed a predominance of anthropophilic dermatophytes, mainly *T. violaceum*, in the North and East of Africa and both *T. soudanense* and *M. audouinii* in the Western and Central regions of the continent. Interestingly, the zoophilic species, *M. canis*, has recently emerged in North and East Africa. Optimization of both mycology diagnosis capacities and epidemiological methodology would provide insight into the role that climate and other global aspects of the human environment play in dermatophyte epidemiology. We advocate that using a multisectoral and collaborative strategy would strengthen such future studies.

Key words: epidemiology, tinea capitis, dermatophytes, dermatophytosis, Africa.

Introduction

Cases of dermatophytosis in humans are chiefly superficial fungal infections, as dermatophytes invade and propagate in keratinized tissues such as hair, skin, and nails. According to Emmons[1] and despite recent significant taxonomy changes, approximately 30 dermatophyte species were classified into three anamorphic genera: *Trichophyton*, *Microsporum*, and *Epidermophyton*.[1] Dermatophytosis is common worldwide and represents a significant veterinary and public health issue.[2] In fact, it was estimated that 20% to 25% of the world population is infected with dermatophytes.[3] Dermatophytes can affect various parts of the body. They tend to grow in an outward pattern on the skin, thereby producing a ring-like lesion—hence the term 'ringworm'. Lesions are clinically classified according to the site of infection as follows: tinea capitis for scalp, tinea manuum

for hands, onychomycosis or tinea unguium for nails, tinea barbae for beard area, and tinea corporis for body including arms and trunk. Tinea capitis affects predominantly, but not exclusively, prepubertal children. Tinea capitis manifests itself by hair loss, which may be associated with more or less severe signs of inflammation. Therefore, clinical signs may either be inconspicuous, with only mild scaling of the scalp, or obvious such as broken hairs, patches of evident alopecia, pustules, and large inflammatory swellings (kerion).[4] Tender occipital lymphadenopathy may also occur in inflammatory tinea capitis forms[4]. A specific tinea capitis presentation is favus, which is caused by *Trichophyton schoenleinii*. This chronic disease is characterized by the presence of "scutula," which are yellowish, cup-shaped crust with a "mice nest" odor, on the scalp causing irreversible scarring-alopecia. Based on their ecology, dermatophytes have been divided into three groups: anthropophilic, zoophilic, and geophilic. Anthropophilic dermatophytes are restricted to human hosts and produce mild chronic inflammation. Zoophilic dermatophytes use an animal reservoir, such as house pets, farm animals, and horses, although they occasionally infect humans who usually develop inflammatory lesions. Geophilic dermatophytes are present in soil containing keratinous materials (i.e., hair, feathers, and horns) and can be transmitted to humans and animals through contact with soil.[2,4]

The distribution of these fungi varies considerably, depending on epidemiological factors (i.e., age, sex, season, and socioeconomic factors) and geographical area.[5] *T. rubrum*, *T. interdigitale*, *M. canis*, *M. gypseum*, and *E. floccosum* are distributed worldwide. Other species have partial geographic restriction, such as *T. schoenleinii*, distributed in Eurasia and Africa; *T. soudanense*, distributed in Africa; and *T. concentricum*, distributed in the Pacific Islands, Far East, and India.[2,6] Overall, *T. rubrum* is the most common dermatophyte in most developed countries. *Tinea capitis* caused by *T. schoenleinii*, or favus, incidence has declined in most countries.[7] *T. tonsurans* emerged in United States, and *M. canis* and *M. audouinii* were the predominant agents of *tinea capitis* in Europe.[8] However, this pattern is not static due to immigration, travel activity, changes in disease surveillance and diagnosis, and the use of antifungals.

In 1964, the first critical reviews of the geographical distribution of dermatophytes in Africa were reported.[9,10] Since that time, many epidemiological reports have focused on the incidence, clinical characteristics, and etiological factors associated with dermatophytosis in different regions of Africa. Therefore, the epidemiology of dermatophytosis has never been analyzed at the scale of the African continent. This systematic literature review aimed to summarize the epidemiological trends of dermatophytosis throughout Africa.

Methods

We defined dermatophyte infections (dermatophytosis or tinea) as a human infection of the hair, skin, or nails caused by dermatophytes, with a mycological confirmation including direct examination, culture, microscopic examination, and/or sequencing of the ITS region of the ribosomal RNA gene.[11] We queried the PubMed (NCBI) database, using the search terms ("Arthrodermataceae" [Mesh] OR "dermatophytes" [Mesh] OR "tinea" [Mesh]) AND "Africa" AND Limits: Humans. No language nor publication date restrictions were used. We also reviewed references listed in the selected papers to collect publications that had been eluded in our search. Studies conducted on the treatment of dermatophytosis in Africa were excluded. Furthermore, studies conducted on histoplasmosis, pityriasis versicolor, fusariosis, nondermatophytes, and other skin disorders in Africa were not included. Two authors examined titles, abstracts, and articles. The articles that passed the initial review process were assessed for inclusion criteria. The articles that passed this second step were reviewed considering data collected on potential explanatory variables.

Dermatophytoses in the main African regions

Dermatophytoses are relatively common and minor conditions, which are apparently evenly neglected over the African continent. To our knowledge, no evidence points to regional discrepancies in the public heath impact and treatment practices. We will further divide the African continent four regions: North, South, West, and East Africa for the purpose of clarification and to be able to highlight potential regional characteristics. The epidemiology of dermatophytosis has been assessed in various contexts: urban or rural areas, adults or children, schoolchildren in primary or junior schools, prison inmates, and inpatients or outpatients in medical institutes, including primary or tertiary health care health institutions, departments of dermatology or dermatology centers, army hospitals, and microbiology departments.[7,12–52] We collected epidemiological data in the literature from studies that had been conducted throughout the entire African continent, in particular: West Africa including Mali, Côte d'Ivoire, Nigeria, Togo, Senegal, Ghana and Guinea;[3,12–28,34,36–47,53,53–60] North Africa including Tunisia, Morocco, Algeria, Egypt and Libya;[30,31,35,48–52,61–82] East Africa including Ethiopia, Kenya, Tanzania and Rwanda;[32,33,83–89] Central Africa including Gabon, Cameroon and Central African

Republic;[7,29,59,90–93] and Southern African countries including Zambia, Botswana, Zimbabwe, Malawi, Republic of South Africa, Mozambique, and Madagascar.[94–105] As dermatophytosis features are distinct in children and adults, we therefore present and analyze the data concerning these two groups separately.

Dermatophytoses in African children

In this section, we report main epidemiological data on dermatophytosis in African children. In fact, in Africa, more extensive epidemiological data are available on dermatophytosis affecting children compared with adults. Dermatophytosis is a frequent childhood disease, and the fungal species involved varies according to age and clinical presentation.[61] Tinea capitis is the primary clinical presentation of dermatophytosis in African children, as shown in many studies throughout the entire African continent, including West Africa,[13,15–17,20–22,25,37,38,40,42,43] North Africa,[30,61,62,68–71,77] East Africa,[32,33,84,86,88] Central Africa,[7,90,91] and southern Africa.[100,101,105]

Many publications reported a high prevalence of dermatophytosis in West and North African children. In a recent study in Nigeria, tinea capitis occurred in at least 20% of school-age children.[44] However, the epidemiology of dermatophytosis remains particularly heterogeneous in Nigeria, where there are varying reports of dermatophytis in different cities.[43] In Libya, 1,180 (52%) of 2,224 participants in the region of Tripoli presented with superficial mycoses (tinea capitis excluded) primarily (52%) due to dermatophytes. In the study, tinea corporis accounted for 45.9% of the superficial mycoses, and 85% of the tinea corporis cases occurred in children under 15 years of age.[79] In East Africa, a cross-sectional study of dermatophytosis in primary schoolchildren in Kibera (Kenya) showed that the prevalence of dermatophytosis was 11%, with tinea capitis reported as the dominant clinical manifestation.[84] In East African cities, dermatophytosis prevalence among schoolchildren ranged from 10% to 80%.[33,83–87,89] For example, in 1993, a large survey of 5,780 children from 13 schools in the rural Kisumu District (Western Kenya) reported a 10% dermatophytosis prevalence and 8% tinea capitis prevalence.[83] In contrast, in a geographically restricted area in Ethiopia, 80% of children presented with clinical dermatophytosis, among whom tinea capitis was the most common presentation (77%).[87] In the southern African country of Botswana, 81% of children aged 1–15 years presented with tinea capitis.[99] In Dar-Es-Salaam city, Tanzania, 11% of 420 primary schoolchildren presented with dermatophytosis.[85] In Harare, Zimbabwe, 29% of 704 primary schoolchildren presented with clinical symptoms of tinea capitis.[95]

Dermatophytoses in African adults

In this section, we report main epidemiological data on dermatophytosis in African adults. In contrast to studies concerning children, which were primarily conducted on populations of schoolchildren, the epidemiology of dermatophytosis among adults focused on patients of any age attending various healthcare facilities (such as university hospitals, dermatology departments, microbiology departments, dermatology clinics at medical center, or army hospitals) and in inmates. Adult-based studies concerned cases in West Africa,[12,22,23,28,34,36,38,40,45,55,57,58] North Africa,[35,48–52,61,63–65,69–72,75–77,79,106] Central Africa,[29,92] East Africa,[32,102] and southern African countries.[103,104]

Some reports, regarding patients cared for in various healthcare facilities in West Africa, highlighted a higher prevalence of dermatophytosis in adults than in children.[40,45] For example, in a study including patients at a tertiary healthcare institution in the Lagos State (Nigeria), dermatophytes were 6 times more frequently isolated from adults than children under 12 years of age.[40] Numerous dermatophytosis cases have been reported in North African adults attending various health care facilities, particularly dermatology departments.[35,50,51,63,72] In Egypt, a study found a relatively low prevalence (2%) of dermatophytes isolated from skin lesions in Egyptian adults of at least 55 years of age.[77] However, these estimations are impacted by a selection bias, as patients who are referred to tertiary healthcare facilities are unlikely to be representative of the general population. Noticeably, data on tinea pedis and onychomycosis in Africa are relatively scarce compared to other regions of the world. Whether this is mainly due to a relatively lower prevalence or a publication bias regarding these relatively neglected conditions remains to be determined.

Clinical dermatophytes in Africa

In this section, we detail the spectrum of dermatophyte species involved in dermatophytosis in children and adults in Africa. The distribution of dermatophyte species involved in tinea capitis (Fig. 1; Table 1) or tinea corporis (Fig. 2; Table 2) throughout the African continent is illustrated. As stated before, dermatophyte species were identified by direct examination, culture and microscopic examination of the colonies; sequencing of the ITS region of the ribosomal RNA gene was rarely performed.

Dermatophyte species in African children

Studies including both adults and children in West Africa showed tinea corporis to be the most common

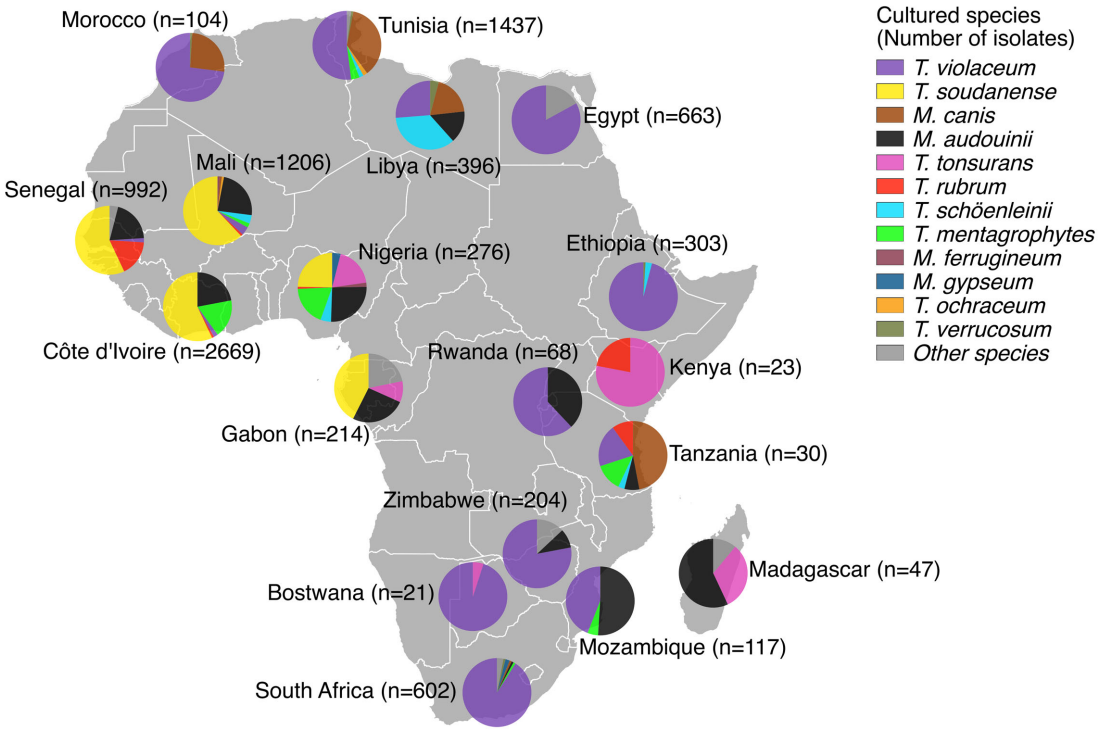

Figure 1. Distribution of dermatophytes species isolated from *tinea capitis* in Africa. *Trichophyton soudanense* and *Microsporum audouinii* are frequently isolated in West and Central Africa, and these species predominant in West Africa. *T. violaceum* is predominant in North, East, and Southern Africa. Dermatophyte species relative frequency are summarized in pie charts for each country, denominators are in parentheses.

dermatophyte infection; the most frequent dermatophyte species involved was *T. mentagrophytes* complex.[37–41] In West African children, the two anthropophilic dermatophytes species, *T. soudanense* and *M. audouinii*, were the main etiological agents isolated from tinea capitis cases (Table 1; Fig. 1).[9,10,13,15–17,19–22,26,27] The most common fungal pathogen in schoolchildren was *T. violaceum* (26%) according to a study in Ghana[60] and *T. schoenleinii* (28.1%) in a Nigerian study.[42] In the Nigeria study, the second and third most frequent dermatophyte species involved were *T. verrucosum* (20.2%) and *M. gallinae* (18.4%), respectively.[42] In Côte d'Ivoire, *T. soudanense* and *M. audouinii* were reported to be the most common etiologic agents of tinea capitis in children.[22] However, the dermatophyte species spectrum was particularly heterogeneous in Nigeria.[43]

In studies investigating both children and adults in North Africa, the most frequent dermatophyte species were *T. violaceum* and *M. canis*.[52,61,63,70,75,78–82,106] In North Africa,[48,49,76,78] *T. violaceum* was reported to be the most common fungal pathogen involved in tinea capitis (Table 1) in Morocco,[70,106] Tunisia,[48,49,61,62,64,65] and Egypt.[75,76] Many other species including *T. verrucosum*, *M. audouinii*, *T. mentagrophytes* complex, *T. schoenleinii*, *T. ochraceum*, *T. rubrum*, *M. gypseum*, *M. ferrugineum*, and *T. tonsurans* have been less frequently isolated from tinea capitis cases in North African children.[49,69,76,80,106] Interestingly, several reports highlighted the emergence of the zoophilic species *M. canis* in North Africa.[52,106] The most common fungal species isolated from cases of tinea capitis was *T. violaceum* followed by *M. canis* (Table 1; Fig. 1).[49,75] Overall, the predominant fungal pathogen isolated from tinea capitis cases was *T. violaceum* (prevalence ranging from 60% to 77%).[49,66,75] One retrospective study showed that *M. canis* (13.4%) was second to *T. mentagrophytes* complex (76.4%) as the predominant species associated with dermatophytosis in Morocco.[70]

Converging observations in children indicate that the anthropophilic dermatophyte species *T. violaceum* was the most common *tinea capitis* agent in East Africa.[32,33,83–85,87,89] One study in Tanzania showed that *M. canis* was the predominant dermatophyte species isolated in a population of primary schoolchildren in Dar-Es-Salaam.[85] Another study in Kenya showed that *T. tonsurans* was the predominant species isolated from tinea capitis cases.[86] Other dermatophyte species including *M. audouinii*, *T. verrucosum*, *T. mentagrophytes*, *T. terrestre*, and *T. schoenleinii* were rarely reported in East Africa.[32,33,83–85,87,89]

Table 1. The frequency of dermatophyte species isolated from *tinea capitis* lesions in African countries and cities. The results correspond to the number of positive cultures for each dermatophyte and the frequency (percentage) considering all dermatophytes isolated in the study is indicated in parentheses; n = number of isolated dermatophytes.

Dermatophytes species N (%)	*T. soudanense*	*T.. rubrum*	*T. violaceum*	*T. mentagrophytes*	*T. verrucosum*	*T. tonusrans*	*T. schöenleinii*	*M. audouinii*	*T. ochraceum*	*M. canis*	*M. ferrugineum*	*M. gypseum*	Other species
Geographical areas, and years													
Western Africa													
Mali													
Bamako, 1973–1977 ($n = 277$)[14]	162 (58)	0	29 (11)	0	0	0	31 (11)	27 (10)	0	14 (5)	14 (5)	0	0
Dire, 1973–1977 ($n = 18$)[14]	12 (67)	0	4 (22)	0	0	0	2 (11)	0	0	0	0	0	0
Gao, 1973–1977 ($n = 94$)[14]	52 (62)	0	18 (16)	0	0	0	16 (19)	0	8 (0)	0	0	0	0
Boulkassobougou, 1998 ($n = 90$)[17]	55 (61)	0	0	0	0	0	0	35 (39)	0	0	0	0	0
Bamako, 2001 ($n = 515$)[18]	341 (66)	12 (2)	0	0		0	0	162 (32)	0	0	0	0	0
Sirakoro, 2009 ($n = 104$)[5]	59 (57)	0	0	24 (23)	0	0	0	21 (20)	0	0	0	0	0
Bandiagara, 2010 ($n = 33$)[5]	22 (67)	0	0	0	0	0	0	11 (33.5)	0	0	0	0	0
Sikasso, 2012 ($n = 75$)[5]	46 (61)	0	0	0	0	0	0	29 (39)	0	0	0	0	0
Côte d'Ivoire													
Abidjan, 1998–1999 ($n = 211$)[13]	138 (65)	0	5 (2)	0	0	0	0	68 (32)	0	0	0	0	0
Abidjan, 2008–2009 ($n = 2{,}458$)[12]	1,394 (57)	20 (1)	34 (1)	484 (20)	0	0	0	526 (21)	0	0	0	0	0
Senegal													
Dakar, 2002 ($n = 158$)[21]	119 (75)	0	0	0	0	0	0	0	0	0	0	0	39 (25)
Dakar, 2005–2007 ($n = 607$)[105]	335 (55)	90 (14.82)	1 (0)	2 (0)	0	0	0	175 (29)	0	4 (1)	0	0	0
Dakar, 2010 ($n = 227$)[55]	107 (47)	76 (33)	18 (8)	0	0	0	0	26 (11)	0	0	0	0	0
Nigeria													
Anambra State, 1984 ($n = 158$)[32]	24 (15)	0	0	38 (24)	0	14 (8.9)	14 (9)	60 (38)	0	0	0	8 (5)	0
Eastern Nigeria, 2007 ($n = 118$)[1]	45 (38)	3 (3)	0	14 (12)	0	37 (32)	0	11 (9)	0	0	6 (5)	2 (1)	0
Northern Africa													
Tunisia													
Central Tunisia,1990–2005 ($n = 1{,}058$)[42]	0	4 (0)	565 (53)	37 (4)	0	1 (0)	26 (3)	2 (0)	24 (2)	395 (37)	0	4 (0)	0
Sfax, 1995–2006 ($n = 245$)[106]	0	0	125 (51)	0	0	0	0	0	0	91 (37)	0	0	29 (12)
Tunis, 1999–2010 ($n = 29$)[107]	0	0	9 (31)	1 (3)	1 (3)	0	0	0	0	18 (62)	0	0	0
Tunis, 1990–2010 ($n = 105$)[51]	0	0	49 (47)	13 (13)	12 (11)	0	0	0	0	31 (30)	0	0	0

Table 1 – Continued.

Dermatophytes species N (%)	*T. soudanense*	*T.. rubrum*	*T. violaceum*	*T. mentagrophytes*	*T. verrucosum*	*T. tonusrans*	*T. schöenleinii*	*M. audouinii*	*T. ochraceum*	*M. canis*	*M. ferrugineum*	*M. gypseum*	Other species
Morocco													
Rabat, 2012 ($n = 104$)[54]	0	0	76 (73)	0	1 (1)	0	0	0	0	27 (26)	0	0	0
Egypt													
Alexandria, 2000 ($n = 276$)[43]	0	0	276 (100)	0	0	0	0	0	0	0	0	0	0
Cairo, 2004–2005 ($n = 387$)[48]	0	0	275 (71)	0	0	0	0	0	0	0	0	0	112 (29)
Libya													
Benghazi, 1979 ($n = 200$)[108]	0	0	0	0	0	0	139 (70)	61 (31)	0	0	0	0	0
Benghazi, 2000 ($n = 196$)[44]	0	0	104 (53)	0	16 (8.2)	0	0	0	0	76 (39)	0	0	0
Central Africa													
Gabon													
Libreville, 1979 ($n = 140$)[74]	69 (49)	0	0	0	0	0	0	36 (26)	0	0	0	0	35 (25)
Libreville, 2011 ($n = 74$)[73]	22 (30)	0	0	0	0	21 (28)	0	19 (26)	0	0	0	0	12 (16)
Eastern Africa													
Kenya													
Eldoret town, 2001 ($n = 23$)[68]	0	5 (22)	0	0	0	18 (78)	0	0	0	0	0	0	0
Tanzania													
Dar es Salaam, 2010 ($n = 30$)[66]	0	3 (10)	6 (20)	4 (13)	0	0	1 (3)	2 (7)	0	14 (47)	0	0	0
Rwanda													
Butare, 1993 ($n = 68$)[71]	0	0	42 (62)	0	0	0	0	26 (38)	0	0	0	0	0
Ethiopia													
Southwestern, 1997 ($n = 96$)[67]	0	0	93 (97)	0	0	0	0	0	0	0	0	0	3 (3)
School BTES, 2005 ($n = 163$)[63]	0	0	161 (99)	0	2 (1)	0	0	0	0	0	0	0	0
School MOA, 2005 ($n = 44$)[63]	0	0	38 (86)	0	0	0	0	0	0	0	0	0	6 (14)

Table 1 – Continued.

Dermatophytes species N (%)	*T. soudanense*	*T.. rubrum*	*T. violaceum*	*T. mentagrophytes*	*T. verrucosum*	*T. tonusrans*	*T. schöenleinii*	*M. audouinii*	*T. ochraceum*	*M. canis*	*M. ferrugineum*	*M. gypseum*	Other species
Southern Africa													
South Africa													
Transvaal, 1976 ($n = 92$)[83]	0	0	84 (91)	0	0	0		2 (2)	0	1 (1)	0	0	5 (5)
Cape, 1987 ($n = 410$)[109]	0	0	371 (91)	6 (2)	8 (2)	2 (1)		6 (2)	0	7 (2)	0	0	10 (2)
Kwa-Zulu Natal, 2004 ($n = 100$)[84]	0	0	90 (90)	0	0	0		0	0	0	0	10 (10)	0
Botswana													
Gaborone, 2009–2010 ($n = 21$)[80]	0	0	20 (95)	0	0	1 (5)	0	0	0	0	0	0	0
Zimbabwe													
Harare, 1990 ($n = 204$)[81]	0	0	159 (78)	0	0	0	0	18 (9)	0	0	0	0	27 (13)
Mozambique													
Maputo, 2001 ($n = 117$)[49]	0	0	51 (44)	6 (5)	0	0	0	60 (51)	0	0	0	0	0
Madagascar													
Antananarivo, 2005 ($n = 27$)[87]	0	0	0	0	0	0	0	27 (100)	0	0	0	0	0
Antsirabe, 2006 ($n = 20$)[110]	0	0	0	0	0	15 (75)	0	0	0	0	0	0	5 (25)

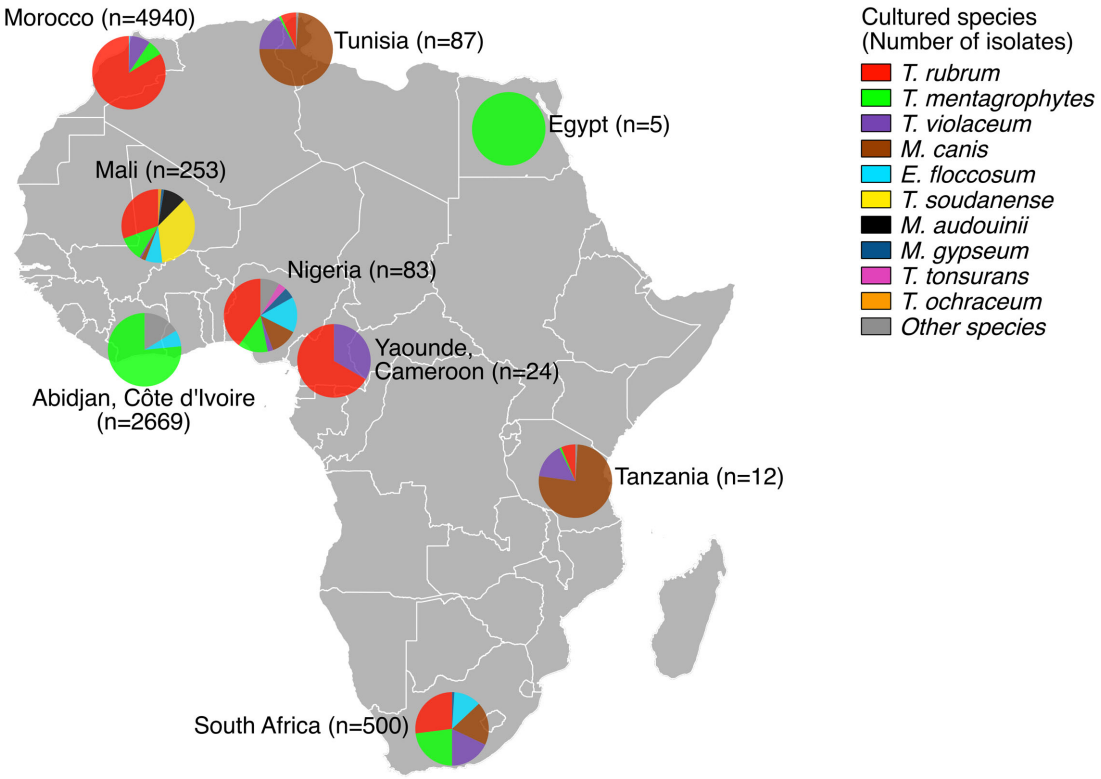

Figure 2. Distribution of dermatophyte species isolated from non–tinea capitis dermatophytosis (encompassing any clinical presentation of dermatophytosis except tinea capitis) cases in Africa. Dermatophyte species relative frequency are summarized in pie charts for each country, denominators are in parenthesis.

Regarding the studies concerning children from Central Africa, the most frequently isolated species from tinea capitis lesions was *T. soudanense* (Table 1; Fig. 1).[7,90,91] In one study conducted in the Central African Republic, *M. audouinii* was the common species involved in tinea capitis.[93] Although less frequent, *T. tonsurans*, *T. rubrum*, and *M. audouinii* were also isolated from children from Central Africa.[7,90,91] The two most frequent dermatophyte species involved in tinea capitis among children in southern Africa were *T. violaceum* and *M. audouinii* [94–96,99–101], with some exceptions. Indeed, a study in Mozambique showed that the most common dermatophytes isolated from schoolchildren were *M. audouinii* (88%) and *T. mentagrophytes* (17%).[97] The dermatophyte species spectrum was particularly heterogeneous in Madagascar. One investigation of an outbreak of tinea capitis at a primary school in Antananarivo found only *M. audouinii* (100%).[98] Meanwhile, a study conducted at a primary school in Antsirabe, Madagascar, highlighted the presence of an anthropophilic dermatophyte species (*T. tonsurans*, 88%) and two geophilic dermatophyte species rarely involved in human disease: *M. boullardii* (aka *M. fulvum*, 24%) and *T. terrestre* (6%).[105] Moreover, other dermatophyte species including *T. tonsurans*, *T. mentagrophytes*, *T. yaoundei*, *M. gypseum*, and *M. canis* were occasionally isolated from cases of tinea capitis in southern Africa.[95,96,99,101]

Dermatophyte species affecting African adults

Several dermatophyte species including *T. soudanense*, *T. rubrum*, *T. mentagrophytes*, *T. tonsurans*, *T. verrucosum*, *M. audouinii*, *M. canis*, and *E. floccosum* have been involved in adult cases of tinea corporis in West Africa (Table 1; Fig. 2).[3,12,19,27,34,37,39,45,54]

Overall, *T. violaceum*, *T. rubrum*, and *M. canis* were the three predominant dermatophyte species involved in tinea corporis in North African adults.[74] However, several dermatophyte species, including *T. violaceum*, *T. rubrum*, *M. canis*, *T. verrucosum*, *T. mentagrophytes*, and *E. floccosum*, have been isolated from skin lesions in this population.[63,71,73–75,79] A consistent body of evidence highlights *T. rubrum* as the most frequent species involved foot mycosis in North African adults.[31,35,50,51,63,66,67,72,73,75,77,79] In Egypt, *T. violaceum* was the common fungal species (56.9%) isolated from adult cases of tinea capitis (Table 1; Fig. 2).[76]

Considering East African adults, one study showed that the most common manifestations of dermatophytosis in

Table 2. The frequency of dermatophyte species isolated from *tinea corporis* or onychomycosis lesions in Africa. Data shown are the number of positive cultures for each dermatophyte and the frequency (percentage) considering all dermatophytes isolated in the study is indicated in parentheses.

Dermatophytes species N (%)	*T. soudanense*	*T. violaceum*	*T. rubrum*	*T. mentagrophytes*	*T. tonsurans*	*M. audouinii*	*M. canis*	*M. gypseum*	*E. floccosum*	Other
Geographical areas and years										
Tinea corporis										
Bamako (Mali), 1973–1977 ($n = 138$)[14]	39 (28)	0	38 (28)	28 (20)	0	4 (3)	5 (4)	3 (2)	19 (14)	2 (1) *T. ochraceum*
Bamako (Mali), 2008 ($n = 115$)[16]	52 (45)	2 (1.9)	40 (35)	0	0	21 (18)	0	0	0	0
Bida (Nigeria), 2006–2007 ($n = 22$)[27]	0	0	0	8 (36)	0	0	0	4 (18.2)	3 (14)	7 (31.8)
Abakaliki (Nigeria), 2008 ($n = 61$)[37]	0	2 (3)	33 (54)	3 (5)	3 (5)	0	10 (16)	0	10 (16)	0
Alexandria (Egypt), 1987 ($n = 5$)[46]	0	0	0	5 (100)	0	0	0	0	0	0
Transvaal (South Africa), 1988 ($n = 500$)[85]	0	90 (18)	135 (27)	115 (23)	0	0	95 (19)	5 (1)	60 (12)	0
Der es Salaam (Tanzania), 2010 ($n = 1$)[66]	0	0	0	0	0	0	1 (100)	0	0	0
Onychomycosis										
Abidjan (Côte d'Ivoire), 1997 ($n = 98$)[31]*	0	0	0	75 (77)	0	0	0	0	7 (7)	16 (16.3) *T. spp*
Yaounde (Cameroon), 2012 ($n = 24$)[77]	0	8 (33.3)	16 (67)	0	0	0	0	0	0	0
Rabat (Morocco), 1982–2003 ($n = 4{,}940$)[111]	0	445 (9)	4,130 (84)	341 (7)	1 (0)	0	0	0	15 (0)	8 (0.2)
Alexandria (Egypt), 1987 ($n = 6$)[46]	0	0	0	5 (83)	0	0	0	0	0	1 (17) *T. equinum*
Sfax (Tunisia), 1995–2000 ($n = 80$)[40]	0	15 (18)	0	0	0	0	65 (81)	0	0	1 (1) *T. quinckeanum*
Tunis (Tunisia), 2009 ($n = 6$)[57]	0	0	5 (83)	1 (17)	0	0	0	0	0	0
Tunis (Tunisia), 2009 ($n = 1$)[57]*	0	0	1 (100)	0	0	0	0	0	0	0
Der es Salaam (Tanzania), 2010 ($n = 11$)[66]*	0	0	5 (46)	4 (36)	0	0	0	0	1 (9)	1 (9) *T. schoenleinii*

* *Tinea pedis*

Addis Ababa were tinea capitis in young males and fingernail onychomycosis in females.[32] The most frequent dermatophyte species involved in these infections was *T. violaceum*.[32]

In Cameroon, *T. rubrum* was the major species involved in tinea corporis, tinea pedis, and onychomycosis in adults.[29,92] In this country, a study involving 52 patients with onychomycosis found that fingernails were affected in 12 cases, toenails were infected in 30 cases, and both fingernails and toenails were affected in 10 patients. A dermatophyte was isolated from 58% of patients, in which the most common species was *T. rubrum* (16 cases), followed by *T. violaceum* (8 cases).[29]

Regarding all dermatophyte agents in southern Africa, *T. rubrum* (27%) was the most common fungal pathogen reported from an 8-year survey of patients from hospital clinics and private practices in Pretoria seeking specialist dermatological advice for dermatophytosis in Transvaal.[104] In a population survey conducted between 1987 and 1989 in Northern Malawi, between 1.5% and 2.5% of the population in Karonga District were diagnosed with tinea faciei, tinea corporis, tinea inguinalis, or tinea cruris. Dermatophyte epidemiology was characterized by the predominance of *M. audouinii* (57%) and the relative rarity of *T. rubrum* (approximately 1%). Notably, *E. floccosum* was the most common (56%) dermatophyte species isolated from lesions of the genital area in patients from this region of Africa.[102] In approximately 500 adult dermatology outpatients in Pretoria (South Africa), *T. rubrum* (27%) was the most frequent dermatophyte species, followed by *T. mentagrophytes* (23%), *M. canis* (19%), *T. violaceum* (18%), *E. floccosum* (12%), and *M. gypseum* (1%).[104]

Dermatophytosis risk factors

In this section, we report dermatophytosis risk factors found in some epidemiological studies conducted in Africa. The association between dermatophytosis presentation and various risk factors, including climate, urban or rural environment, socioeconomic level, cultural habits, sex, and age, have been investigated throughout the African continent. The current understanding regarding dermatophyte risk factors in Africa is summarized below.

Age-associated risk factors

Throughout the entire African continent, the prevalence of dermatophytosis, regardless of clinical presentation, peaks among children aged between 4 and 11 years. In particular, this feature of the disease has been evidenced in many studies conducted in West Africa.[20–22,37,39,42,46,47,53,54] Tinea capitis is uncommon among infants,[68] as shown in Tunisia, where a 12-year retrospective study showed that only 4% of infants were diagnosed with tinea capitis.[68] The clinical presentation of dermatophytosis has been shown to vary according to age in North African children; tinea capitis was most frequent before 10 years of age, while tinea corporis and onychomycosis were more frequent in older children.[30,61,62,68,70,77–80] Similarly, many studies found that dermatophytosis prevalence peaked among children 6 to 11 years of age in East African,[32,84–86] Central African,[91] and southern African countries.[94,99] In contrast to tinea capitis, the risk of non–tinea capitis dermatophytosis (encompassing any clinical presentation of dermatophytosis except tinea capitis) increases with age. For instance, older age and family history of mycosis were associated with an increased risk of foot mycosis in a retrospective study of 148 patients in Sfax, Tunisia.[50] Likewise, in Cameroon, a study was conducted including 590 patients aged 16 to 83 years in a dermatological unit in Yaoundé and a volunteer service in Douala, of which the majority of the 9% patients diagnosed with onychomycosis were over 50 years of age.[29]

While tinea capitis is the most frequent clinical presentation of dermatophytosis in children, tinea corporis is most frequent in West African adults. In West African cities, tinea corporis prevalence in adults ranged from 2% to 41%[12,27,36,38,40,45,55,57]. Recently, tinea corporis prevalence was estimated at 21% among schoolchildren in Mali.[17] In North African cities, tinea corporis was the most frequently reported dermatophytosis presentation among adults, with prevalence ranging from 2% to 46%.[63,71,73,75,79] Tinea pedis and onychomycosis are also among the most common fungal diseases in North African adults.[50,63,66] A retrospective study conducted between 1998 and 2007, showed that dermatophytosis was diagnosed in 9,960 (39%) of 25,432 subjects suspected to have superficial mycoses. The most common clinical presentation was onychomycosis (30%), followed by tinea pedis (25%), tinea cruris (22%), tinea corporis (11%), and tinea capitis (10%).[63] Furthermore, in Sfax, the most frequent clinical presentations were tinea pedis and onychomycosis.[66] In Tunis, among 100 outpatients with suspected fungal foot disease attending the dermatology department of a tertiary hospital, a fungal foot infection was confirmed via positive microscopy or culture in 45% of cases, and dermatophytes were involved in 57% of confirmed cases.[50] At the dermatology clinic at Tripoli Medical Centre in Libya, tinea pedis was diagnosed in 8% of 2,224 patients with suspected clinical symptoms of superficial mycosis.[79] An initial study was conducted including military staff attending the dermatology department at the Army's Central Hospital in Algiers. The investigation showed that in 650 males, fungal foot infection (including tinea pedis and superficial candidiasis) was clinically suspected in 147 patients and confirmed via

positive culture in 119 patients, thereby yielding a total prevalence of 18%.[35] In a second study concerning 1,300 male outpatients in the same department, the clinical diagnosis of tinea pedis and onychomycosis was suspected in 249 and 72 patients, respectively, and confirmed via positive dermatophyte culture in 197 (79%) and 60 (83%) of cases, respectively, thus yielding a global prevalence of 15% for tinea pedis and 5% for toenail onychomycosis in this population.[72]

Notably, tinea capitis also occurs in adults. A tinea capitis prevalence of 5% and 4% has been reported in adults in Tunisia[48] and Egypt,[76] respectively. However, even when considering the dermatology department outpatient population, tinea capitis is relatively uncommon in adults.[48,69,76] In Addis Ababa, a study in a reference center for dermatological diseases for the entire country of Ethiopia showed that tinea capitis was diagnosed in only 10% of 165 adults with a clinical dermatophytosis presentation. Overall, tinea capitis in young adult males and fingernail onychomycosis in females were the most common manifestations of dermatophytosis in Addis Ababa.[32]

Hormone-related risk factors

As stated before, tinea capitis prevalence generally peaks in children between 4 and 11 years of age.[22,47,94] Children of this age group display a higher exposure to dermatophyte sources. Although we found no studies that addressed the pathophysiology of dermatophytoses specifically in African setting, it has been shown that these children are also more susceptible to dermatophyte infection of the scalp and hair due to the lower fungistatic properties of fatty acids in the sebum, which is due to pre-pubertal hormone characteristics.[99,107–109] Clearly, tinea capitis is an uncommon disease in adults.[76] Compared with children, scalp hair in adults exhibits increased resistance against dermatophyte colonization due to the fungistatic properties of post-pubertal sebum, which mainly consists of long-chain fatty acids.[110] A reduction in sebum triglycerides may predispose postmenopausal women to the development of tinea capitis.[99] We found no data in the literature indicating that hormonal changes occurring during pregnancy could be associated with an increased risk of dermatophytosis.

Sex effect

Many studies reported a higher infection rate among male children compared with girls.[20,22,37,39,46,47] However, one study in Alexandria did report that girls predominantly affected by the disease.[78] In general, male children were more affected than female children in West African children.[13,15,20–22,27,37,39,47] In particular, prevalence of tinea capitis was 3 to 5 times higher in boys than in girls in Central Nigeria.[22,47] Similar findings came out of studies conducted in North Africa.[52,69,70,106] For example, in Morocco, the male to female ratio was 1.4 in children under 10 years of age with tinea capitis.[70] In East Africa, a 2:1 male to female ratio was found in private primary schoolchildren with tinea capitis in Kenya.[86] Furthermore, male gender was significantly associated with an increased risk of tinea capitis amongst schoolchildren in Addis Ababa (Ethiopia).[87] In Central Africa,[7,91,93] a statistically significant higher prevalence of tinea capitis in boys (21% boys vs. 10% girls) was observed in schoolchildren in Gabon[91] and (63.7% vs. 36.3%) Cameroon.[7] In southern African countries, studies concerning schoolchildren in Lusaka, Zambia,[94] and the Maputo Province, Mozambique,[97] also showed a higher prevalence of *tinea capitis* among boys compared with their girl counterparts. In contrast to these trends in children, dermatophytosis prevalence was significantly higher in adult females than in adult males.[38,40,45] This was confirmed in Tunisia, where a study showed that 64% of 255 patients with suspected onychomycosis were females,[67] and in Egypt, where 85% of the adult outpatients consulting at five dermatology centers were females.[76]

Underlying chronic conditions

Predisposing host factors play an important role in the occurrence of dermatophytosis of the skin and nails. Chronic venous insufficiency, diabetes mellitus, cellular immunity disorders, and genetic predisposition are risk factors for onychomycosis.[111] Epidemiological studies concerning diabetes mellitus patients found that a clinical suspicion of foot mycosis occurred in 61% of cases and was confirmed in 30% of 307 hospitalized patients in Tunisia.[51] In this population, foot mycosis occurred in 38% of patients, which was primarily due to dermatophytes (94%); the most common site of dermatophyte infection was the interdigital (toe web) spaces (60%) followed by toenail onychomycosis (30%). The main risk factors associated with superficial fungal infections were patient age and duration of diabetes. Dermatophytes were more frequently isolated from patient toenails in type 2 diabetes cases compared with type 1 diabetes patients; however, the relatively young age of the type 1 diabetes patients might be a confounding factor.[51] Protracted immunosuppressive therapy, long-term topical or systemic corticosteroid treatment, and chronic hepatitis C virus infection have each been associated with an increased risk of tinea capitis in adults.[76] Regarding human immunodeficiency virus (HIV) infection, a study in Cameroon found that 53% of cases had at least one superficial mycosis; e.g., oral candidiasis in 77%, tinea corporis in 21%, tinea versicolor in 15%, tinea pedis in 13%, and tinea unguium in

12% of patients.[92] Another study found a 4 times higher prevalence of dermatophytosis in patients infected with human immunodeficiency virus (HIV). This may be because manifestations may be atypical and more severe, resulting in extensive lesions, when dermatophytes infect immunocompromised patients.[99]

Socioeconomic level

According to a few studies, the low socioeconomic level was associated with an increased risk of tinea capitis, which is likely linked to poor hygiene conditions. Population-based studies concerning 4,839 schoolchildren in Ghana, Gabon, and Rwanda found the highest prevalence of dermatophytosis in schools in which the children came from lower socioeconomic-level households.[59] Moreover, prevalence of tinea capitis was higher in schools serving populations of low socioeconomic level.[24,59] For example, in Ghana, 10% of the pupils of low socioeconomic level and 5% of middle or high socioeconomic-level students presented with tinea capitis.[59] In Lusaka (Zambia), tinea capitis was significantly more frequent amongst children from squatter and low socioeconomic-level areas compared with those from wealthy areas.[94] In Algeria, tinea capitis affecting children from urban and rural areas was associated with low socioeconomic level.[52] Similarly in Cameroon, onychomycosis in adults was associated with a low socioeconomic class.[29]

Hair dressing and cosmetic practices

In some studies, hairdressing practices and cultural habits were highlighted as dermatophytosis risk factors in West Africa.[47,59] In Mali, public hairdressing practices, home hairdressing practices, traditional braiding customs, and head shaving practices were associated with tinea capitis.[17,18] In East Africa, head shaving at the barber shop was also found as a significant dermatophytosis risk factor.[84] A study highlighted the association between severe dermatophytosis and the use of bleaching products (mainly topical glucocorticoids) in dark-skinned women from Dakar, Senegal.[112]

Cultural and religious practices

Traditional lifestyles and religious practices such as communal living and the performance of ritual ablution may influence dermatophyte infections prevalence.[113] A study concerning a Muslim adult male population regularly attending mosques in Durban, South Africa, found a high (85%) prevalence of tinea pedis and tinea unguium.[103] Yenişehirli et al.[114] investigated potential causative agents of dermatophytosis in mosques in Tokat, Turkey. They reported that contaminated carpets and slippers may act as anthropogenic dermatophyte reservoir and that shared slippers were likely an important transmission source.[114]

Environmental risk factors of dermatophytoses in Africa

Although dermatophytes are disseminated throughout Africa, the most prevalent species and most common sites of infection vary by ecogeographical region. Hot and humid climates as well as overcrowding are risk factors of skin diseases such as dermatophytosis. We will further analyze the impact or various factors on the epidemiology of dermatophytoses in Africa.

Urban and rural environments

Cross-sectional population-based studies performed in Ghana, Gabon, and Rwanda showed that among 4,839 schoolchildren, the highest prevalence of tinea capitis was observed in rural areas.[59] Moreover, a significant difference in dermatophytosis prevalence among children in urban and rural areas was observed in West Africa.[7,26,42,47,53,59,94] A higher prevalence was observed in rural versus urban areas, respectively, in Anambra State (Southeastern Nigeria) (8% vs. 4%),[53] Ghana (11% vs. 7%),[60] Togo (20% vs. 11%),[26] and Gabon (26% vs. 20%).[90] In contrast, some studies found a higher prevalence among primary schoolchildren from relatively more urbanized areas of Mali (55% vs. 17%),[16] Illubabor district in Southwestern Ethiopia (58% vs. 29%),[89] and two distinct states in Central Nigeria (45% vs. 23%).[47] In North Africa, two studies were conducted on select populations. The mycology laboratory of a large tertiary health center in Sfax, Tunisia, showed that 82% of patients diagnosed with dermatophytosis originated from urban areas.[63] Moreover, a retrospective study concerning children with inflammatory tinea capitis found that 50% of cases came from a rural area, 35% originated from Tunis City, and 16% came from an urban area surrounding Tunis City.[69]

Climate

In Africa, hot and humid climate favors the growth and spread of dermatophytes.[3] The distribution of dermatophyte species varies from continent to continent, country to country and also over time within a region.[43] Based on the literature, the predominance of *M. audouinii* in West Africa, Central Africa, and Madagascar (Fig. 1) was related to the moderate and above average levels of precipitation each year. In Nigeria, epidemiological studies showed

geographical heterogeneity in dermatophytosis prevalence rates in schoolchildren originating from the center, east, northeast or southeast of the country, which ranged from 3% to 17%.[44–46,50,71] Similarly, in Togo, dermatophytosis prevalence was 11% in a dry region of the north and 20% in a humid locale in the south.[66] *T. soudanense* is widely disseminated throughout tropical Africa.[10] In Mali (West Africa), all studies reported the predominance of the two anthropophilic dermatophytes species, *T. soudanense* and *M. audouinii*, in all dermatophytosis presentations. Along a gradient from the Sudano-Guinean to Sahelian climate in Mali, *T. soudanense* was clearly predominant in cases of tinea capitis and tinea corporis in both children and adults.[17] In contrast to North African studies, tinea pedis and onychomycosis were rarely reported in studies set in tropical African regions. Although tropical and subtropical climates were associated with an increased prevalence of skin mycoses, tinea pedis and onychomycosis were rare in rural Africa as well as India.[115]

Dermatophytosis transmission

According to one study, the dermatophytosis transmission was reported to be mainly associated with contact with animals in rural areas or with other family members in urban areas.[76] In Egypt, a multicenter study showed that 17% of 1,380 adult outpatients with tinea capitis reported a history of close contact with animals.[76] In a primary school in Antananarivo, Madagascar, 27 children with tinea capitis caused by *M. audouinii* reported contact with infected classmates, while 19 (70%) of the cases reported that their brothers or sisters at home were also infected.[98] The importance of asymptomatic anthropophilic dermatophyte carriers, which probably act as a reservoir in endemic populations, was highlighted in a study of 510 primary schoolchildren in Alexandria (Egypt). Dermatophytes were isolated in 7% of the children, clinical dermatophytosis was diagnosed in 3%, and asymptomatic carriers accounted for 5% of the pupils.[78] Recently, a study concerning 256 adopted children found that asymptomatic anthropophilic dermatophyte carriers contaminated a family member in 29% of cases.[116]

On the African continent, *M. canis* was predominantly observed in North Africa (Figs. 1 and 2). This zoophilic species, which is adapted to cats and dogs, can infect humans, particularly children, who are regularly in contact with house pets. In the early 2000 s, the emergence of *M. canis*, which had never been isolated in Tunisia before 1950, was documented as an tinea capitis agent by Belhadj *et al.*[117] One can hypothesize that the proximity between humans and their house pets is greater in the more urbanized North African region than in relatively rural areas elsewhere in Africa.

Temporal trends in African dermatophytosis epidemiology

An increase in dermatophytosis prevalence has been noted worldwide, especially in developing countries.[2,43,118] Prevalence of tinea capitis varies depending on many factors such as the age and economic status of individuals as well as location climate.[10,119] Children are generally more susceptible to tinea capitis compared with adults.[3]

In Mali, Joyeux reported the anthropophilic dermatophyte species *T. soudanense* in 1912,[120] whereas the zoophilic species *T. verrucosum* and *M. canis* were reported for the first time in 1973.[19] Since that time, the disappearance of *T. schoenleinii*, *T. violaceum*, *M. canis*, and *M. ferrugineum* represents the most important change in the spectrum of dermatophytes isolated from *tinea capitis* cases in Mali. In Nigeria, the epidemiological pattern of dermatophytosis remains highly heterogeneous, which varied depending on the time-period, community, and geographical area. Various dermatophyte species have been observed in different parts of Nigeria;[10,43] in particular, the species *T. mentagrophytes* was predominantly reported in this country.[37–39,41] The recent emergence of *M. canis* and the disappearance of *T. schoenleinii* are the most dramatic changes in the profile of dermatophyte species involved in tinea capitis in North Africa (Fig. 1).[52,106] Overall, the most common dermatophyte species involved in tinea corporis in Africa were *T. violaceum* and *T. rubrum*, while *M. canis* was the predominant etiological agent of *tinea corporis* in North Africa (Fig. 2).[63,71,73,75,79] Many epidemiological studies reported higher incidence of tinea pedis and onychomycosis in Northern Africa than in other regions of the continent. This epidemiological trend has been explained by increased urbanization, use of community showers, collective sports practices, and the use of occlusive footwear. Indeed, these factors were associated with a high prevalence of tinea pedis among certain groups, including marathon runners, miners, and soldiers.[2,4,6,34,35,111,115,119,121,122] In Northern African cities, *T. rubrum* (which is the most frequent anthropophilic dermatophyte worldwide) was the most frequent etiological agent isolated from tinea pedis and onychomycosis cases.[31,35,50,51,63,64,66,67,73]

Particularities of African dermatophytosis epidemiology

The epidemiology of dermatophytosis in developing countries is characterized by the predominance of tinea capitis, while developed countries are characterized by the

predominance of tinea pedis and onychomycosis.[115] Our review confirms the high prevalence of tinea capitis in Africa, especially among children. In fact, highly communicable tinea capitis is a significant public health issue, primarily affecting schoolchildren in tropical regions.[22,60,130] The etiological agents are heterogeneously distributed across geographical regions.[99]

Spreading of African dermatophytes to other continents

The pattern of dermatophyte distribution throughout the African continent also influences the distribution of the etiological agents of dermatophytosis to other continents via African immigrants. For instance, *T. soudanense*, an anthropophilic dermatophyte species originating from West Africa[123] has been reported occasionally in countries that had colonial relationships with the African endemic area. In France, a retrospective study of tinea capitis over a period of 10 years showed that 95% of cases of *T. soudanense*, the predominant species in the West African sub-region, occurred in patients of African origin.[124] Similarly, between 1986 and 1995 in Germany, most *T. soudanense* samples were isolated from African immigrants.[125] *T. violaceum*, a dermatophyte species endemic to the North and East African sub-regions, was also imported to various countries via North and East African emigration routes, including Sweden[126] and Italy.[127] The species has also been traced far from Africa, in New Zealand[128] and Australia.[129]

Limitations in the current literature

The current insight into the epidemiology of dermatophyte infections and epidemiological trends of dermatophytes in Africa is limited by varied study designs and especially the heterogeneous denominators that have been used to estimate prevalence in the analyzed studies. Most of the studies simply reported prevalence of dermatophytosis that had been diagnosed in health structures equipped with diagnostic laboratory facilities. Such estimations are inevitably prone to selection bias depending on access to health care and quality of health care. Furthermore, the study population is hardly representative of the general population. Results from studies concerning schoolchildren can hardly be extrapolated to children who are not in the school system. The heterogeneous characteristics of the reporting mycology diagnostic facilities and the changes in species denomination over time render it very challenging to obtain a comprehensive view of dermatophyte species epidemiology and geographic distribution throughout Africa.

Another limitation is the reproducibility and accuracy of dermatophyte identification data. The identification methods used in the analyzed studies were conventional, based on morphological criteria that are often not specific. Moreover, the constantly evolving dermatophyte taxonomy and nomenclature is a serious limitation. As highlighted in **Figure 1**, there is little overlap between the geographical distribution of *T. violaceum* and *T. soudanense* associated with *tinea capitis* in Africa. However, based on an analysis of the ITS region of the rRNA gene, Gräser et al. consider *T. soudanense* a synonym of *T. violaceum*.[131] If this assumption is correct, this disparity in geographical distribution of species results from biases due to local dermatophyte species identification or nomenclature habits.

Finally, a limitation of our report is that, for simplicity, the effect of risk factors was generalized to the whole African continent even though no data were available for each region. This should be interpreted with caution because the underlying assumption that the risk factors effect is homogeneous over the whole continent is probably wrong.

Perspectives

Despite significant gaps in reported data, this literature review clearly emphasizes the heavy burden of dermatophytosis in Africa. *Tinea capitis* affects between 10% and 80% of children, depending on the study site. In contrast, dermatophytosis burden in adults is less understood, primarily because published studies focused on specific populations and cannot be extrapolated to the general population. Nevertheless, several steps can be taken to obtain a more comprehensive vision of dermatophytosis burden in Africa. Mycology diagnosis capacities in Africa should be reinforced to enhance both patient care and data quality. The design of further dermatophytosis epidemiology studies conducted throughout the African continent should be strengthened by using standardized and representative population-based approaches. Finally, in line with the recently popularized "one health" concept, further studies should promote a multisectoral and collaborative approach to investigate the role that other factors play in dermatophytosis epidemiology such as climate and other aspects of the human environment, including changes in grooming habits, contact with domestic animals, and other changes in behaviors and practices triggered by the massive rural to urban migration in Africa over the past 50 years.

Acknowledgments

We thank Stanislas Rebaudet for creating the maps and Sandra Moore for English editing.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and the writing of the paper.

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