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Updating the epidemiology of dermatophyte infections in Palestine with special reference to concomitant dermatophytosis

Mise à jour de l'épidémiologie des infections à dermatophytes en Palestine avec une référence particulière à la dermatophytose concomitante

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Recurrence

Summary
Objective. — To determine the epidemiology of dermatophytosis in Palestinian patients, detect changes in the etiological agents during the last three decades, and to correlate between concomitant tinea pedis infections, and other cutaneous lesions.
Materials and methods. — 220 suspected dermatophytosis patients were involved in this study. In an additional 38 cases, where consultation was prompted by tinea pedis, the presence of other lesions of concomitant dermatophytosis was studied, to further investigate the diagnosis. Clinical specimens were collected and identification of dermatophyte species was based on gross and microscopic morphology.
Results. — Epidemiology of tinea capitis has gone the most radical changes in Palestine in the last three decades, with the zoophilic dermatophyte *Microsporum canis* replacing *Trichophyton violaceum*, becoming the predominant causative agent. During this study, 21.6% (38/176) patients with tinea pedis and concomitant lesions caused by the same dermatophytes at sites distant from the primary lesions in the foot were prospectively identified. About 63.2% of

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patients with tinea pedis have a concomitant toenail onychomycosis infection.
Conclusions. — The epidemiology of dermatophytosis, especially tinea capitis, has gone the most radical changes in Palestine in the last three decades, with *M. canis* replacing *T. violaceum*, and becoming the predominant causative agent of all cases of infections. The coexistence of tinea pedis with other types of fungal skin infections is a frequent phenomenon; we believe that the infected foot may be a site of primary infection. Thus, the effective therapy for tinea pedis is essential to prevent spreading the infection to other sites of the skin.

MOTS CLÉS
Dermatophytosis ;
Les lésions multiples ;
Onychomycos ;
Dermatophytose concomitante ;
Récurrence

Résumé
Objectif. — Pour déterminer l'épidémiologie des dermatophytoses chez les patients palestiniens, détecter les changements dans les agents étiologiques au cours des trois dernières décennies, et de rechercher une corrélation entre les infections tinea pedis et d'autres lésions cutanées.
Méthodes. — Au total, 220 patients suspectés de dermatophytose ont participé à cette étude. Dans 38 cas supplémentaires, où la consultation serait suscitée par la tinea pedis, la présence d'autres lésions de dermatophytose concomitante a été étudiée afin d'approfondir le diagnostic. Les échantillons cliniques ont été recueillis et l'identification des espèces de dermatophytes a été basée sur la morphologie macroscopique et microscopique.
Résultats. — Épidémiologie de la tinea capitis a connu des changements les plus radicaux en Palestine dans les trois dernières décennies, avec le dermatophyte zoophile *Microsporum canis* remplacant *Trichophyton violaceum* pour devenir l'agent causal prépondérant. Au cours de cette étude, 21,6 % (38/176) des patients avec tinea pedis et des lésions concomitantes, causées par les mêmes dermatophytes à des sites distants des lésions primaires dans le pied, ont été prospectivement identifiés. À peu près 63,2 % des patients atteints de tinea pedis ont une onychomycose concomitante.
Conclusions. — L'épidémiologie des dermatophytes, notamment la tinea capitis, a connu des changements radicaux en Palestine au cours des trois dernières décennies, avec le remplacement de *T. violaceum* par *M. canis* devenant l'agent causal prépondérant de tous les cas d'infections. La coexistence de tinea pedis avec d'autres types d'infections fongiques de la peau est un phénomène fréquent ; nous croyons que le pied infecté peut être un site d'infection primaire. Ainsi, le traitement efficace de tinea pedis est essentiel pour éviter de propager l'infection à d'autres sites de la peau.

Introduction

Dermatophytoses are common worldwide and are believed to affect about 25% the world population [13]. They are typically caused by dermatophytes, which vary with geographic regions. Some species (e.g., *Trichophyton rubrum*, *Trichophyton mentagrophytes*, *Microsporum canis*, and *Epidermophyton floccosum*) are distributed worldwide, whereas others have partial geographic restriction (e.g., *Trichophyton schoenleinii*, *Trichophyton soudanense*, *Trichophyton violaceum*, and *Trichophyton concentricum*) [7].

Most cases of tinea pedis, tinea cruris, onychomycosis, and tinea corporis, are caused by *T. rubrum*, which is the prevailing dermatophyte in most developed countries and in most urban areas of some developing countries and is likely to remain the dominant dermatophyte worldwide [8,11,14].

The epidemiology of dermatophyte infection is likely to alter with changing patterns of migration, growth in tourism, and changes in socioeconomic conditions. Such changes to the epidemiology of causative agents are thought to be a reflection of changing patterns of dermatophytosis. For example, a century ago, tinea capitis was the principal dermatophytosis worldwide, but the last few decades of the 20th century witnessed a global increase in tinea pedis and a spread of one major etiologic agent, *T. rubrum* [7,15]. This phenomenon is likely to be due to increases in urbanization and the use of sports and fitness facilities, the growing prevalence of obesity, and the aging population. Tinea pedis, often transmitted by autoinoculation, is thought to be an important reservoir for dermatophytosis in other parts of the body (e.g., onychomycoses, tinea cruris, tinea corporis) [9]. Szepietowski et al. [20] reported that tinea pedis was the most common concomitant dermatophytosis; about one-third of patients with tinea pedis have a concomitant toenail onychomycosis infection.

Improvements in living conditions have generally been associated with a decline in zoophilic dermatophyte and an increase in anthropolic dermatophyte infections. The epidemiology of tinea capitis and tinea pedis (together with onychomycosis) has gone the most radical changes. Epidemiologic changes in the prevalence of tinea corporis, tinea cruris, tinea manuum, and tinea faciei have been less extensively studied. Their prevalence and the dermatophytes responsible for causing them reflect local trends in tinea capitis and tinea pedis, which are thought to be the source of infection [7].

Table 1 The epidemiology of dermatophyte infections in Palestine (West Bank) (1983—2002).
L'épidémiologie des infections à dermatophytes en Palestine (Cisjordanie) (1983—2002).

Tinea type	Ali-Shtayeh, & Arda (1985)						Ali-Shtayeh, & Arda (1986)	Ali-Shtayeh, Arda, & Abu-Ghdeib (1998)		Ali-Shtayeh, et al. (2002)
	Tinea apitis (n = 165)[a]	Tinea cruris (n = 49)	Tinea corporis (n = 13)	Tinea pedis (n = 13)	Tinea onychomycosis (n = 8)	Total (n = 248)	Tinea capitis (n = 217)	Tinea capitis (school children) (n = 75)	Tinea capitis (clinic patients) (n = 89)	Tinea capitis (n = 23)
Anthropophilc dermatophytes										
Trichophyton violaceum	80 (48.5)	1 (2)	2 (15.4)	1 (7.7)	1 (12.5)	85 (34.3)	108 (49.8)	62 (82.7)	57 (64.1)	19 (82.6)
Trichophyton rubrum	—	15 (30.6)	1 (7.7)	6 (46.2)	3 (37.5)	25 (10.1)	—	—	—	—
Epidermophyton. floccosum	—	12 (15.5)	—	4 (30.8)	—	16 (6.5)	—	—	—	—
Trichophyton schoenleinii	14 (8.5)	—	—	—	1 (12.5)	15 (6)	19 (8.7)	1 (1.3)	1 (1.1)	—
Trichophyton tonsurans	1 (0.6)	9 (18.4)	4 (30.8)	—	1 (12.5)	15 (6)	—	—	—	—
Trichophyton mentagrophytes	8 (4.8)	4 (8.2)	1 (7.7)	1 (7.7)	—	14 (5.6)	8 (3.7)	—	4 (4.4)	—
Zoophilic dermatophytes										
Microsporum canis	52 (31.5)	5 (10.2)	2 (15.4)	1 (7.7)	—	60 (24.2)	69 (31.8)	12 (16)	27 (30.3)	4 (17.4%)
Trichophyton verrucosum	3 (1.8)	1 (2)	2 (15.4)	—	—	06 (2.4)	5 (2.3)	—	—	—
Other species	7 (4.2)	2 (4.1)	1 (7.7)	—	2 (25)	12 (4.8)	8 (3.7)	—	—	—

[a] Number of isolated dermatophytes.

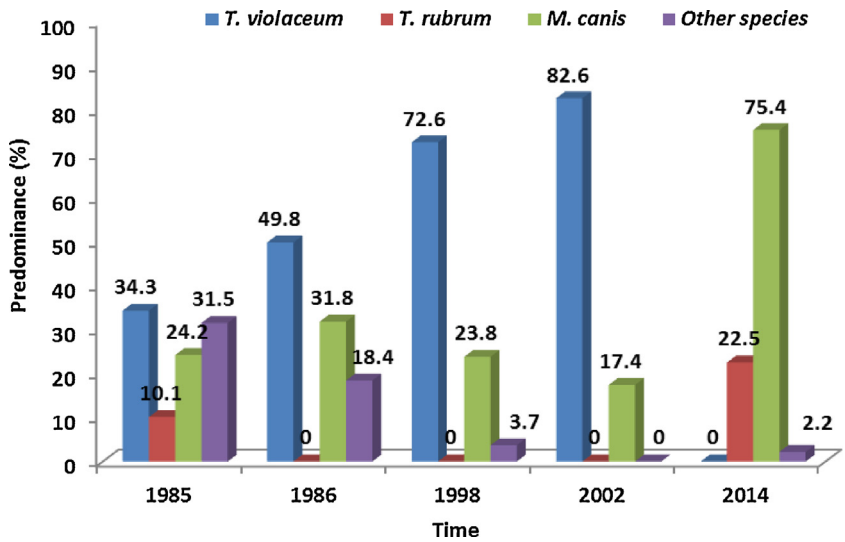

Figure 1 Changes in the epidemiology of dermatophytes in Palestine in the last three decades (1983—2014).
Modifications épidémiologiques des dermatophytes en Palestine durant les trois dernières décennies.

In Western Europe, *T. rubrum* is the most frequently isolated dermatophyte in cases of tinea corporis and tinea cruris [7]; it is also the most common cause of tinea pedis and tinea onychomycosis, which may act as a reservoir of infection predisposing to tinea corporis or cruris through autoinoculation.

Few studies have investigated the etiology of superficial fungal infections in the developing world, and consequently, there is less knowledge of any changes in their epidemiology.

In the Middle East, *T. violaceum* is responsible for most cases of tinea capitis, accounting for 39% in Iraq [2], and 64% in Libya [10]. However, *Microsporum canis* was the predominant dermatophyte isolated in most cases of tinea capitis in Saudi Arabia [1], and Kuwait [17].

In Palestine, *T. violaceum* was responsible for most cases of tinea capitis, accounting for 48.5—82.7% of cases in Palestine in the period 1983—2002, followed by *M. canis* accounting for 16—31.8% of tinea capitis cases [3—6,19] (Table 1, Figs. 1 and 2). On the other hand, *T. rubrum* was responsible for most cases of tinea pedis, onychomycosis, and tinea cruris accounting for 46.2%, 37.5%, and 30.6% of these cases, respectively.

Knowledge of the predominant causative dermatophyte species provides a clearer understanding of risk factors for dermatophytoses and future epidemiologic trends. Such knowledge can lead to the implementation of public health measures to halt the increase in these infections.

This study was therefore aimed at determining the dermatophytes epidemiology including prevalence and

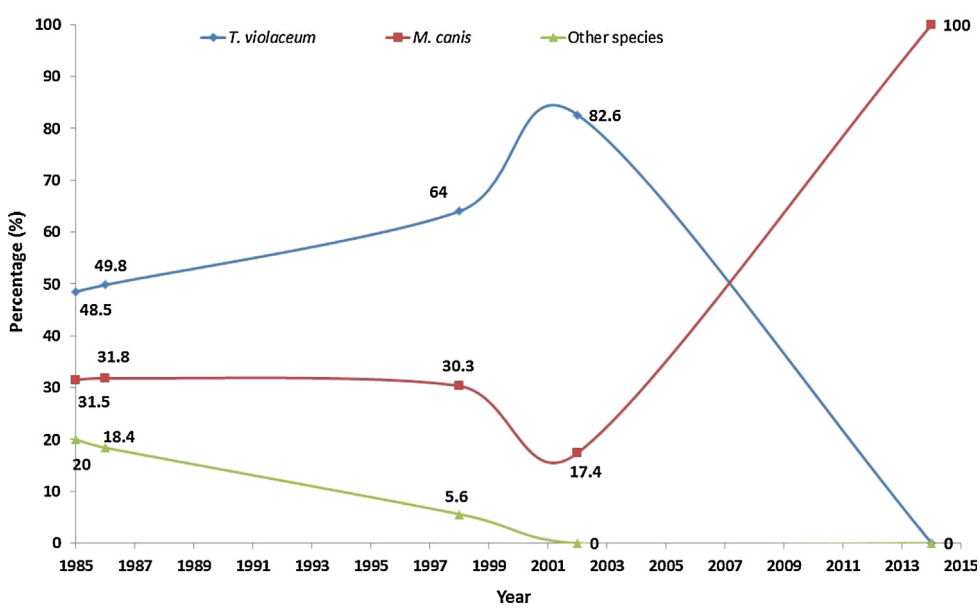

Figure 2 Changes in tinea capitis causative agents populations over three decades (1983—2014) in Palestine.
Modifications dans les agents responsables de teignes durant les trois dernières décennies en Palestine.

Table 2 The epidemiology of dermatophyte infections in Palestine (2014).
L'épidémiologie des infections à dermatophytes en Palestine (2014).

Tinea type[a]	Current study 2013/14					
	Tinea capitis (n = 40)	Tinea cruris (n = 36)	Tinea corporis (n = 9)	Tinea pedis (n = 32)	Tinea onychomycosis (n = 21)	Total (n = 138)
Anthropophilc Dermatophytes						
Trichophyton rubrum	—	11 (30.6)	3 (33.3)	10 (31.3)	7 (21.9)	31 (22.5)
Trichphyton mentagrophytes	—	1 (2.8)	1 (11.1)	1 (3.1)	—	3 (2.2)
Zoophilic Dermatophytes						
Microsporum canis	40 (100)	24 (66.7)	5 (55.6)	21 (65.6)	14 (43.8)	104 (75.4)

[a] Number of isolated dermatophytes.

occurrence of causative agents of dermatophytosis in patients in Palestine, detecting any changes in the etiological agents during the last three decades, and studying the correlation between concomitant dermatophyte infections mainly tinea pedis, toenail onychomycosis and tinea cruris.

Materials and methods

Cases of dermatophytosis included in this study were diagnosed, depending on the clinical picture, at a dermatology clinic in Nablus (Arda Dermatology Clinic), during the period of June 2012 to May 2013.

A total of 220 patients (85 female and 135 male) from six districts in the northern West Bank (Palestine) were involved in the study. The patients were between the age of 2—70 (average 26.5) years.

One portion of each clinical specimen was treated with 30% KOH for microscopic identification of typical hyphae and arthroconidia. A second portion was seeded on Sabouraud-chloramphenicol agar slant and or plate cultures supplemented with cycloheximide (Actidione™) and then incubated at 27 °C for four weeks. Identification of dermatophyte species was mainly based on gross and microscopic morphology and by other in vitro tests, as required [18]. In 38 cases, where consultation was prompted by tinea pedis, we also prospectively studied the presence of other lesions of concomitant dermatophytic fungi, to further investigate the diagnosis.

Data analysis

Data were analyzed using Microsoft Office Excel. Prevalence was expressed as percentages.

Results and discussion

Update on the epidemiology of dermatophyte infections in Palestine

Tables 1 and 2 present an update on the epidemiology of dermatophyte infections in Palestine from 1983 to the current study in 2014. Over two decades (1983—2002), the anthropophilic dermatophyte *T. violaceum* was responsible for most cases of tinea capitis, accounting for up to 83% of all studied cases in Palestine, followed by the zoophilic dermatophyte *M. canis* accounting for up to 32% of the cases [3—6,19] (Table 1, Figs. 1 and 2). On the other hand, *T. rubrum* (anthropophilic) was the predominant causative agent for most cases of tinea pedis, onychomycosis, and tinea cruris accounting for 46.2%, 37.5%, and 30.6% of these cases, respectively. The results of this study have revealed that the zoophilic dermatophyte *M. canis* has emerged as the predominant causative agent, accounting for 43.8%—100% of all dermatophytoses infections studied, followed by *T. rubrum* which was responsible for 21.9—33.3% of dermatophytoses cases except tinea capitis. The only other dermatophyte isolated from some cases of dermatophytoses was *T. mentagrophytes* (detected in one patient of tinea cruris, tinea capitis, and tinea pedis).

The epidemiology of dermatophytoses, especially tinea capitis, has gone the most radical changes in Palestine in the last three decades, with *M. canis* replacing *T. violaceum*, and becoming the predominant causative agent of all cases of infections (Tables 1 and 2, Fig. 2). The emergence of *M. canis* infection and decline in anthropophilic dermatophyte infections in Palestine can be generally associated with degenerating socioeconomic status, crowded living conditions, increase in stray animals, and the sharing of combs [12]. *Microsporum canis* can also exist as an asymptomatic carrier state in children (65.6%) [6], acting as a reservoir of infection, which may explain its rapid increase in prevalence in the recent years.

Epidemiologic changes in the prevalence of tinea corporis, tinea cruris, tinea manuum, and tinea faciei have been less extensively studied. Their prevalence and the dermatophytes are thought to be responsible for causing them reflect local trends in tinea capitis and tinea pedis, which are thought to be the source of infection [7].

Recurrence and a lack of treatment response are common in dermatophytosis. In patients with cutaneous and concurrent toenail lesions, often only the former are investigated, which may result in inappropriate treatment due to misdiagnosis.

Concomitant dermatophytosis

During the study period, 38 patients with dermatophytosis and concomitant lesions caused by the same dermatophytes

Table 3 Prevalence pattern of dermatophytic fungi in concomitant dermatophyte infections (*n*[a], %).
Modèle de prévalence de champignons dermatophytes dans les infections concomitantes à dermatophytes (n[a], %).

Dermatophyte	Primary lesions	Concomitant secondary lesions			
	Tinea pedis[a]	Tinea cruris	Tinea onychomycosis	Tinea corporis	Tinea capitis
Microsporum canis	12	12	12	—	—
	3	3	—	—	—
	2	—	2	—	—
	1	1	—	1	—
	2	2	—	—	2
	3	3	—	—	3
Subtotal	23 (100%)	21 (91.3%)	14 (60.9%)	1 (4.3%)	5 (21.7%)
Trichophyton rubrum	1	1	1	—	—
	3	—	3	—	—
	6	6	6	—	—
	4	4	—	—	—
	1	1		1	—
Subtotal	15 (100%)	12 (80%)	10 (66.7%)	1 (6.7%)	0 (0.0%)
Total	38 (100%)	33 (86.8%)	24 (63.2%)	2 (5.3%)	5 (13.2%)

[a] Number of isolated dermatophytes.

at sites distant from the primary lesions were prospectively identified. Concomitant lesions occurred in 21.6% (38/176) of culture-confirmed dermatophyte infections. The concurrent lesions in distant locations of these 38 tinea pedis patients were distributed throughout the body (33 tinea cruris, 24 onychomycosis, 5 tinea capitis, and 2 tinea corporis). All 38 patients (100%) consulted for the primary lesion in the foot.

Our results showed that about two-third (63.2%) of patients with tinea pedis have a concomitant toenail onychomycosis infection. The most frequently identified species was the zoophilic dermatophyte *M. canis* (64/102, 62.75%). The infection may be acquired from infected animals with cutaneous lesions, asymptomatic carriers, contaminated fomites, or from the environment. The transmission can also occur between cohabitants, directly or sharing towels, sheets or seats. Among the fungi isolated in our study, 37.3% (38/102) was *T. rubrum*, an anthropophilic dermatophyte (Table 3). It may be acquired from cohabitants, directly or sharing clothes, towels, sheets or seats, and walking barefoot where there is a high degree of humidity [16]. Since these fungi are the causative agents of the primary infection (tinea pedis), they can spread to other parts of the body (from lower extremities to the scalp) as secondary lesions. These lesions can be concurrent separate or intermittent overtime.

The accurate diagnosis of concurrent chronic dermatophytosis lesions based on an accurate medical history, a complete scan of the patient and appropriate microbiological study including identification of the species isolated in culture is essential. The coexistence of tinea pedis with other types of fungal skin infections is a frequent phenomenon. We hypothesize that infected foot may be a site from which the fungal infections can spread to other body areas. The effective therapy for tinea pedis is therefore essential not only to treat the lesional feet but also to prevent spreading the infection to other sites of the skin.

Conclusions

The results showed a switch from the dominance of *Trichophyton violaceum* (34%—82%) in the years 1983—2002 to the dominance of *Microsporum canis* (75.4%) in 2013/2014. Concomitant fungal skin infections in patients with tinea pedis is a frequent phenomenon. Based on the present results, we can conclude that infected foot may be a site from which the fungal infections can spread to other body areas. The effective therapy for tinea pedi is therefore essential not only to treat the lesional feet but also to prevent spreading the infection to other sites of the skin. Localization of all the lesions, as well as isolation and identification of the causative fungus, are essential to establish the prognosis and choose the most appropriate antifungal agent, route of administration, and duration of treatment in dermatophytosis.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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