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ORIGINAL ARTICLE/ARTICLE ORIGINAL

Epidemiological trends of dermatophytosis in Tehran, Iran: A five-year retrospective study



Tendances épidémiologiques des dermatophytoses à Téhéran, Iran : étude rétrospective sur cinq ans

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Received 26 March 2016; received in revised form 7 June 2016; accepted 21 June 2016
Available online 9 August 2016

KEYWORDS

Dermatophytosis;
Clinical epidemiology;
Trichophyton;
Microsporum;
Epidermophyton;
Iran

Summary

Objective. – Dermatophytosis is the most frequent fungal infection all over the world and its frequency is constantly increasing. The aim of this study was to evaluate clinical features and epidemiological trends of dermatophytosis over the years 2010 to 2014 in Tehran, Iran.

Patients and methods. – A total of 13,312 patients clinically suspected of cutaneous fungal infections were examined. Skin scales, plucked hairs, nail clippings and sub-ungual debris were examined by direct microscopy and culture. Dermatophyte species were identified at the species level by a combination of morphological and physiological criteria.

Results. – Direct microscopy confirmed a contamination rate of 19.7% (2622/13,312 cases) of which 1535 cases (58.5%) were culture positive distributed in male (1022 cases) and female (513 cases). The most commonly infected age group was the 30–39 years old. *Tinea pedis* (30.4%) was the most prevalent type of dermatophytosis followed by *tinea cruris* (29.8%) and *tinea corporis* (15.8%). *Epidermophyton floccosum* (31%) was the most prevalent causative agent, followed by *Trichophyton rubrum* (26.2%) and *Trichophyton mentagrophytes* (20.3%).

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MOTS CLÉS

Dermatophytose ;
Épidémiologie clinique ;
Trichophyton ;
Microsporum ;
Epidermophyton ;
Iran

Conclusion. — Our results showed considerable distribution of dermatophytosis from zoophilic, anthropophilic and geophilic species among population with diverse age groups. Although anthropophilic fungi such as *T. mentagrophytes*, *E. floccosum*, and *T. rubrum* were the main etiologic agents of dermatophytosis, the prevalence of *T. verrucosum* showed a meaningful increase over the years, which highlights the importance of rural dermatophytosis mainly transmitted from large animals. This noticeable information improves our current knowledge about dermatophytosis and assists to establish effective prevention and therapeutic strategies to overcome the disease.

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Résumé

Objectif. — La dermatophytose est l'infection fongique la plus fréquente dans le monde et sa fréquence augmente constamment. Le but de cette étude était d'évaluer les caractéristiques cliniques et les tendances épidémiologiques de la dermatophytose au cours des années 2010 à 2014 à Téhéran, Iran.

Patients et méthodes. — Un total de 13 312 patients cliniquement suspects pour des infections fongiques cutanées ont été examinés. Squames cutanées, poils épilés, fragments d'ongles et de débris sous-unguéaux ont été examinés au microscope et cultivés. Les espèces de dermatophytes ont été identifiées sur des critères morphologiques et physiologiques.

Résultats. — La microscopie directe a confirmé un taux de 19,7 % (2622/13 312 cas), dont 1535 cas (58,5 %) étaient positifs à la culture. Le sex-ratio mâles/femelles était de 1022/513. Le groupe d'âge le plus souvent infecté était de 30–39 ans. Tinea pedis (30,4 %) était le type le plus répandu de la dermatophytose suivie par tinea cruris (29,8 %) et tinea corporis (15,8 %). *Epidermophyton floccosum* (31 %) était l'agent causal le plus répandu, suivi de *Trichophyton rubrum* (26,2 %) et *Trichophyton mentagrophytes* (20,3 %).

Conclusion. — Nos résultats ont montré la distribution considérable de dermatophytose des espèces zoophiles, anthropophiles et géophiles parmi la population avec des groupes d'âge divers. Bien que les champignons anthropophiles tels que *T. mentagrophytes*, *E. floccosum* et *T. rubrum* ont été les principaux agents étiologiques de dermatophytose, la prévalence de *T. verrucosum* a montré une augmentation significative au cours des années mettant en évidence l'importance de la dermatophytose rurale principalement transmise par des grands animaux. Cette information notable améliore nos connaissances actuelles sur la dermatophytose et aide à proposer une prévention efficace et des stratégies thérapeutiques pour vaincre la maladie.

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Introduction

Dermatomycoses are considered as one of the most frequent superficial infections affecting public health worldwide [1]. Mycotic dermal infections are caused primarily by keratinophilic fungi of the dermatophyte family, the yeast species of the genera *Candida* and *Malassezia*, and more rarely by other mold and yeast species [29]. Since dermatophytes are the major pathogens causing dermatomycoses, the following article will focus on this group of pathogens.

The dermatophyte family includes over 40 species assigned to 3 genera: *Trichophyton* (skin, nail and hair), *Microsporum* (skin and hair) and *Epidermophyton* (skin and nail) [1,5,7,9,25,31]. They are able to infect the hair, nails and skin and are divided according to the source of infection into anthropophilic, zoophilic and geophilic species [8,25,28]. Members of all three groups can cause human infection. Dermatophytosis includes several distinct clinical manifestations. The severity of the disease depends on the strain or the species of infecting fungus, the sensitivity of the host and the site of infection. The pathogenicity of fungal strains is different; for example, one strain of *M. gypseum* was poorly pathogenic and another produced typical dermatophyte

lesions after local infection [17,41,42]. It is believed that the causative agents of dermatophytoses have affected 20–25% of the world population and the disease is increasing every year [7,23,25,35,38].

A number of factors may contribute to this rise. First, as the population ages, there is a corresponding increase in chronic health problems particularly diabetes and poor peripheral circulation. Second, the number of persons who are immunocompromised (because of infections with human immunodeficiency virus and the use of immunosuppressive therapy, cancer chemotherapy or antibiotics) continue to expand. Third, better antibiotic therapy, leading to increased survival of patients who are predisposed to fungal infections, as well as inappropriate antibiotic therapy disrupting the normal microbial flora on the skin and mucosal surfaces. Fourth, avid sports participation is increasing the use of health clubs, commercial swimming pools and occlusive footweares for exercise [30,40].

The distribution of dermatophyte infections and their causative agents varies depending on geographical region and is influenced by a wide range of factors, such as seasonal migration, international travel, extreme weather, natural disasters, climatic factors and drug therapy [23]. In addition,

other risk factors are changing lifestyle and type of population; for example, in urban life, increased the keeping of pets in home, increased sports participation and showers in fitness studios, changing rooms at public pools, mats in sports facilities, wrestling or martial arts facilities, tropical baths, hotels, mosques and other sources of infection are increased attention to health and medical care [13,30,32]. Personal hygiene (for example skin hygiene) is the primary mechanism to reduce risk of transmission of infectious agents by contact. The use of shoes over long periods of time, lack of hygiene, poor circulation and lack of protection at work are other sources of infection [19,23,32].

Superficial fungal infections are the most prevalent types of mycoses in Iran. Information about the incidence and prevalence of dermatophytosis in Iran has shown that the disease prevalence is around 2.1% to 74% in different parts of Iran [25]. In recent years, efforts at improving the standard of health and increased awareness about the disease have dramatically reduced the disease incidence.

The aim of the present study was to evaluate clinical features and epidemiological trends of dermatophytosis over the years 2010 to 2014 in Tehran, the capital of Iran, with special focus on the changes in the prevalence and distribution of anthropophilic, zoophilic and geophilic species among different age groups of under-studied population.

Patients and methods

Sampling

During January 2010 to December 2014, 13,312 patients from hospitals, clinics and private offices in Tehran urban and rural areas were referred to the Medical Mycology Department of the Pasteur Institute of Iran in Tehran for sampling after completing the questionnaires containing the necessary information including age, sex, marriage, living environment and location, the onset of illness and duration of the complaints, underlying diseases and past medical history. Collection of specimens of skin scales, infected hair or nail in Petri dishes were done according to the procedure manual of Pasteur Institute laboratory, with a scalpel blade for direct microscopic examination and culture.

Direct microscopy

Direct microscopic examination was carried out using 20% KOH for nail and skin and lactophenol cotton blue for hair. Then, the samples were examined under low ($\times 100$) and high ($\times 400$) magnification of light microscope for the presence of arthroconidia, mycelium or spores and their distribution pattern.

Culture

All samples from suspected cases were cultured irrespective of the negative or positive examination result. Each sample was cultured on two tubes of Sabouraud dextrose agar medium (E. Merck, Germany) with chloramphenicol and cycloheximide (SCC) made according to the manufacturer's instructions. Cultures were incubated at 25–30 °C aerobically for 4 weeks. The cultures were checked twice weekly

for evidence of colony growth. Isolated dermatophytes were identified based on their macro- and microscopic features. The macroscopic features were colony morphology, color, texture, growth rate and pigmentation. Microscopic examination of the suspected colonies was carried out in a lactophenol cotton blue mount and slide culture to examine hyphae structure and shape, and presence and arrangement of microconidia and macroconidia. Differential diagnostic methods such as pigment production, hair perforation test, special nutritional requirements, urea hydrolysis, temperature tolerance and temperature enhancement test were also performed if necessary [18].

Statistical analysis

The data were processed using Microsoft Excel 2010. The SPSS version 19 program for Windows was used to perform the statistical analysis. *p*-values less than 0.05 were considered significant.

Results

In this study, 13,312 patients were investigated for dermatomycosis and it was found that 2622 cases were positive during 2010 to 2014. The positive results were obtained in direct microscopic examination of clinical samples. Direct and culture examinations showed 1535 (58.5%) cases of different types of dermatophytosis. During the study period, dermatophytes belonging to *Trichophyton*, *Microsporum* and *Epidermophyton* were isolated. Among them, 1022 were male and 513 were female. During these five years, the most common specimen of dermatophytes was skin scales (1320 cases, 86%), followed by nails (135 cases, 8.8%) and plucked hairs (80 cases, 5.2%) (Table 1). The difference between the prevalence of men and women was statistically significant. The age range was 15 days to 92 years. Table 2 reports the relative frequencies of dermatophytoses and the distribution of patients according to age. The most commonly infected age group was the 20–39 years old. Totally, 1087 cases (41.5%) of positive samples had no growth on culture media.

In Table 1, the results have been grouped according to the location of the dermatophytoses on the patients. *Tinea pedis* (466 cases, 30.4%) was the most common type of cutaneous mycotic infection, followed by *tinea cruris* and *tinea corporis* observed in 457 (29.8%) and 242 patients (15.8%), respectively. *E. floccosum* was most frequently isolated from the groin with the main etiological agents of *tinea cruris* (75.9%). *T. mentagrophytes* and *T. rubrum* were isolated mostly from the foot with the major pathogens of *tinea pedis* (45.3%, 37.2%). *T. tonsurans* was most frequently isolated from the corporal skin with the main etiological agents of *tinea corporis* (39.2%), *tinea capitis* (68.8%) and *tinea manuum* (33.5%). *T. verrucosum* (14.2%) and *M. canis* (10.3%) were isolated mostly from the hand. *M. gypseum* (0.6%) and *T. schoenleinii* (0.6%) were isolated from the foot. *T. violaceum* was isolated only from three cases, two cases from the hand (1.3%) and one case from a foot (0.2%). In general, the frequency rate of the dermatophyte species in males was higher than in females except for finger nail infection (Fig. 1).

Table 1 Isolated dermatophyte species according to the clinical features in Tehran, Iran (2010–2014).
Espèces isolées de dermatophytes selon les caractéristiques cliniques à Téhéran, Iran (2010–2014).

Dermatophyte species	Number of strains (%)							Total
	Tinea cruris	Tinea unguium		Tinea pedis	Tinea manuum	Tinea corporis	Tinea capitis	
		Toe nail	Finger nail					
<i>Trichophyton rubrum</i>	81 (17.7%)	65 (57%)	7 (33.4%)	173 (37.2%)	18 (11.6%)	52 (21.5%)	6 (7.5%)	402 (26.2%)
<i>Trichophyton mentagrophytes</i>	16 (3.5%)	31 (27.1%)	4 (19%)	211 (45.3%)	18 (11.6%)	22 (9.1%)	10 (12.5%)	312 (20.3%)
<i>Trichophyton verrucosum</i>	3 (0.7%)	2 (1.8%)	1 (4.8%)	8 (1.7%)	22 (14.2%)	12 (5%)	2 (2.5%)	50 (3.3%)
<i>Trichophyton violaceum</i>	0 (0%)	0 (0%)	0 (0%)	1 (0.2%)	2 (1.3%)	0 (0%)	0 (0%)	3 (0.2%)
<i>Trichophyton tonsurans</i>	8 (1.8%)	3 (2.6%)	4 (19%)	15 (3.2%)	52 (33.5%)	95 (39.2%)	55 (68.8%)	232 (15.1%)
<i>Trichophyton schoenleinii</i>	0 (0%)	1 (0.9%)	0 (0%)	3 (0.6%)	0 (0%)	0 (0%)	2 (2.5%)	6 (0.4%)
<i>Epidermophyton floccosum</i>	347 (75.9%)	9 (7.9%)	5 (23.8%)	41 (8.8%)	26 (16.8%)	47 (19.4%)	1 (1.2%)	476 (31%)
<i>Microsporium canis</i>	1 (0.2%)	1 (0.9%)	0 (0%)	11 (2.4%)	16 (10.3%)	12 (5%)	3 (3.8%)	44 (2.9%)
<i>Microsporium gypseum</i>	1 (0.2%)	2 (1.8%)	0 (0%)	3 (0.6%)	1 (0.7%)	2 (0.8%)	1 (1.2%)	10 (0.6%)
Total	457 (100%)	114 (100%)	21 (100%)	466 (100%)	155 (100%)	242 (100%)	80 (100%)	1535 (100%)

Table 2 Distribution of isolated dermatophytes based on patients age groups (year) in Tehran, Iran (2010–2014).
Répartition des dermatophytes isolés basés sur l'âge des groupes de patients (par an) à Téhéran, Iran (2010–2014).

Age group	Tinea cruris	Tinea unguium		Tinea pedis	Tinea manuum	Tinea corporis	Tinea capitis	Total
		Toe nail	Finger nail					
0–9	3 (0.7%)	1 (0.9%)	1 (4.7%)	8 (1.7%)	4 (2.6%)	20 (8.3%)	22 (27.5%)	59 (3.8%)
10–19	40 (8.8%)	4 (3.5%)	1 (4.7%)	7 (1.5%)	43 (27.7%)	73 (30.2%)	55 (68.9%)	223 (14.5%)
20–29	164 (35.9%)	5 (4.5%)	2 (9.5%)	52 (11.2%)	29 (18.7%)	46 (19%)	0 (0%)	298 (19.4%)
30–39	115 (25%)	17 (15%)	3 (14.4%)	110 (23.6%)	32 (20.7%)	38 (15.7%)	1 (1.2%)	316 (20.6%)
40–49	77 (16.9%)	21 (18.4%)	5 (23.8%)	113 (24.2%)	21 (13.5%)	32 (13.2%)	1 (1.2%)	270 (17.6%)
50–59	28 (6%)	23 (20%)	7 (33.5%)	111 (23.8%)	16 (10.3%)	19 (7.8%)	0 (0%)	204 (13.3%)
60–69	18 (4%)	30 (26.3%)	1 (4.7%)	50 (10.7%)	8 (5.2%)	8 (3.3%)	1 (1.2%)	116 (7.6%)
70–79	9 (2%)	13 (11.4%)	1 (4.7%)	12 (2.6%)	2 (1.3%)	6 (2.5%)	0 (0%)	43 (2.8%)
80–89	3 (0.7%)	0 (0%)	0 (0%)	1 (0.2%)	0 (0%)	0 (0%)	0 (0%)	4 (0.3%)
90–99	0 (0%)	0 (0%)	0 (0%)	2 (0.4%)	0 (0%)	0 (0%)	0 (0%)	2 (0.1%)
Total	457 (100%)	114 (100%)	21 (100%)	466 (100%)	155 (100%)	242 (100%)	80 (100%)	1535 (100%)

During 2010 to 2014, a variable progressive decrease in frequencies of isolation was observed for *T. rubrum*, *E. floccosum* and *M. canis* and a variable progressive increase in frequencies of isolation was observed for *T. mentagrophytes*, *T. tonsurans* and *T. verrucosum*. *T. violaceum* was also found in 2010 and 2011 and *T. schoenleinii* in 2010 and 2012 (Table 3).

Discussion

Dermatophytosis is fungal infection affecting the skin, hair, nail and periungual folds of people and animals, and is caused by various etiologic agents [29]. During the period

2010–2014, mycological positive isolations confirmed by cultures were found in 19.7% of all examined patients suspected of dermatomycoses. In our study, dermatophytes (35.4%) were the most common isolates in total positive cases, followed by *Malassezia* (17.8%), yeasts (15%) and mould infection (3.5%). This indicates that dermatomycoses are still an important public health problem. Dermatophytes are the major pathogens causing dermatomycoses, hence the main reason for choosing dermatophyte for this research. In total, 28.3% cases of all positive samples had no growth on culture media. The most common cases of unsuccessful cultures were isolated from fingernail (85.2%), followed by toenail (70.7%), hand (45.2%) and foot (43.8%). This can be explained by the presence of nonviable fungal

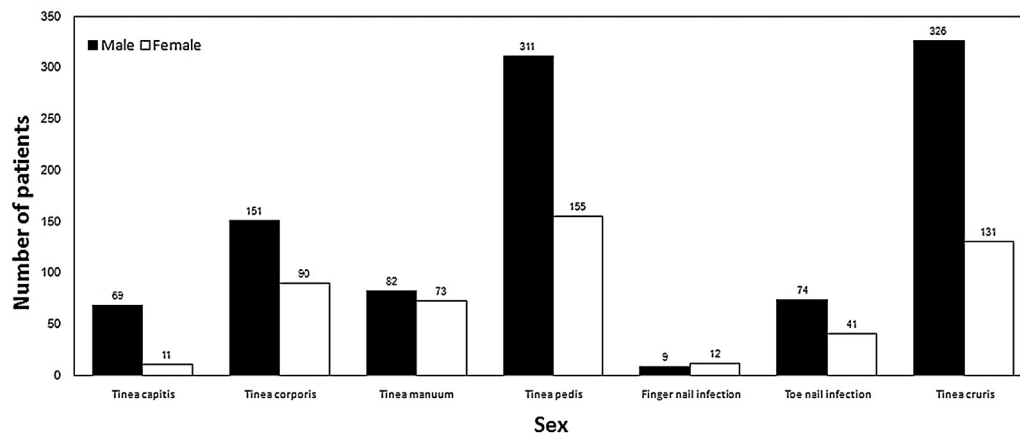


Figure 1 Distribution of dermatophytes by sex and type of tinea during the period 2010–2014 in Tehran, Iran. Values are given as number (n).

Répartition des dermatophytes selon le sexe et le type de teigne au cours de la période 2010–2014 à Téhéran, en Iran. Les valeurs sont données en nombre (n).

Table 3 Number of dermatophyte species and unsuccessful cultures during the period 2010–2014 in Tehran, Iran. Values are given as n (%).

Nombre d'espèces de dermatophytes et des cultures négatives au cours de la période 2010–2014 à Téhéran, en Iran. Les valeurs sont données en n (%).

Dermatophytes	2010	2011	2012	2013	2014	Total
<i>T. rubrum</i>	151 (28.3%)	70 (14.7%)	75 (12.7%)	48 (10.6%)	59 (10.3%)	403 (15.4%)
<i>T. mentagrophytes</i>	44 (8.3%)	50 (10.5%)	81 (13.7%)	43 (9.5%)	94 (16.4%)	312 (11.9%)
<i>T. tonsurans</i>	33 (6.2%)	28 (6%)	34 (5.8%)	55 (12.2%)	82 (14.4%)	232 (8.8%)
<i>T. violaceum</i>	1 (0.2%)	2 (0.4%)	0 (0%)	0 (0%)	0 (0%)	3 (0.1%)
<i>T. verrucosum</i>	6 (1.1%)	5 (1%)	12 (2%)	7 (1.6%)	20 (3.5%)	50 (1.9%)
<i>T. schoenleinii</i>	3 (0.6%)	0 (0%)	3 (0.5%)	0 (0%)	0 (0%)	6 (0.2%)
<i>M. canis</i>	14 (2.6%)	6 (1.3%)	3 (0.5%)	13 (2.9%)	7 (1.2%)	43 (1.6%)
<i>M. gypseum</i>	0 (0%)	1 (0.2%)	2 (0.3%)	5 (1.1%)	2 (0.4%)	10 (0.4%)
<i>E. floccosum</i>	118 (22.1%)	101 (21.2%)	133 (22.5%)	57 (12.6%)	67 (11.7%)	476 (18.2%)
Unsuccessful cultures	163 (30.6%)	213 (44.7%)	247 (42%)	223 (49.5%)	241 (42.1%)	1087 (41.5%)
Total	533 (100%)	476 (100%)	590 (100%)	451 (100%)	572 (100%)	2622 (100%)

elements (i.e., not cultivable) or by previous antifungal treatment or self-medication by patients before being referred to our laboratory by the physicians, despite the presence of fungal hyphae on direct microscopic examination.

The prevalence of dermatomycosis was found to be different in various gender and age groups. We observed a higher incidence of dermatomycosis on men than women. This result has been reported by other authors in previous studies [14,23]; although it is contradicted in other studies [16].

Age seemed to be an important factor influencing the occurrence of dermatomycosis on the studied group. The significant predominance of cases among patients aged 30–59 years old may be explained by the fact that most adults at this age have jobs and work. In this age group, work plays an important role in infection and exposure to the fungal elements [16].

In our observations, tinea pedis was the predominant (30.4%) type of dermatophyte infection among the other tinea. This is in accordance to previous research by the Pasteur Institute of Iran in Tehran during the period of 2006

to 2009 [43]. Although, compared to the previous article, the prevalence of tinea pedis has decreased (35.4% to 30.4%). Similar results were found in other researches in Tehran [39] and some Asian countries such as Palestine [7], Japan [45], Singapore, Turkey, Mexico and North America [37]. However, our finding is in contrast to others who reported tinea corporis [9], tinea capitis [15] and tinea cruris [3] as the predominant clinical observations in northern and central of Iran. Tinea pedis is the second most common form of tinea in another city of Iran (Ahwaz) [35], and in Egypt [1], the Grenoble area of France [23] and Poland [14]. The frequency rate of tinea pedis was higher in males than females, the most common being the age group 40–49 years old.

In our study, *T. mentagrophytes* was the major dermatophytes causing tinea pedis. Similar results were found in other cities of Iran, including Tehran [39], Esfahan and Qazvin [3], and in other countries such as Egypt [1] and India [12].

Tinea cruris is the second most common form of tinea and accounted for 29.8% of all infections. This result is in accordance with previous research by the Pasteur Institute of Iran in Tehran during the period of 2006 to 2009 [43] (tinea cruris

rate in previous article is 27.7%) and other researches [7,9]. *Tinea cruris* is also the most common form of tinea in other researches done in Iran [3]. Many people with tinea cruris have coincident tinea pedis, and it has been postulated that the tinea cruris is spread by hand from the tinea pedis [48]. The high incidence of tinea cruris is in the age group 20–29 years old and more cases occurred in males than in females.

In our study, *E. floccosum*, *T. rubrum* and *T. mentagrophytes* were the major dermatophytes causing tinea cruris. This result confirms the results of other researchers in Iran [3,43].

In the current study, tinea corporis ranked third in prevalence and accounted for 15.8% of all tinea. Similar results were found in another city of Iran (Ahwaz) [35] and in Egypt [1], Japan [45] and Poland [14]. Whereas, Ansari et al. [9] and Naseri et al. [35] and Bhatia and Sharma [12] all reported that tinea corporis was the most common form of dermatophytosis. The most common being the age group 10–19 years old.

The prevalence of tinea corporis compared to the previous article of the Pasteur Institute of Iran in Tehran, has increased (13.7% to 15.8%). *T. tonsurans* (39.2%) was the main etiological agent of tinea corporis in this study, followed by *T. rubrum* (21.5%) and *E. floccosum* (19.4%). *T. mentagrophytes* was the main etiological agent of tinea corporis in the northeast of Iran (Mashhad) [35]. *T. verrucosum* was the main etiological agent of tinea corporis in Qazvin city in Iran [3], *T. rubrum* was the main etiological agent in Poland [14] and India [10] and *M. canis* was the main etiological agent in Lithuania [38] and Italy [47]. The high incidence of tinea capitis was in the age group 10–19 years and more cases occurred in males than in females.

Tinea manuum constituted 10% of all infections. The prevalence of tinea manuum was almost the same as the previous article of Pasteur Institute of Iran in Tehran. Similar to tinea corporis, it mostly occurred in the age group 10–19 years old. *T. tonsurans* was the main etiological agent in tinea manuum. The frequency rate of tinea manuum was higher in males than females.

Tinea unguium constituted 8.8% of all infections, the most common being the age group 60–69 years old. *T. rubrum* was the main etiological agent of tinea unguium followed by *T. mentagrophytes*. Similar results were found in Qazvin city of Iran [3], in some European countries such as Poland [14], Italy [47], Greece [34], and in Algeria [3] in Africa, and in French Guiana [46] in south America.

The high occurrence of fungal infection on toenails and the importance of this site concerning dermatomycosis are mentioned in several publications [16,23].

These studies attribute the infection at this site to the use of shoes over long periods of time, lack of hygiene, poor circulation, and lack of protection at work among other factors. The fingernail infection is considered of occupational nature, especially in professions that require frequent contact with water. In addition, the maceration of periungual tissue caused by the use of manicure tools (which are not always disinfected properly) can promote cross-infection among people who use this service [16].

In general, the frequency rate of the dermatophyte species in males was higher than in females except for finger nail infection.

Tinea capitis was the least frequent fungal lesion in our observations. This result is similar to previous researches by the Pasteur Institute of Iran in Tehran during the period of 2006 to 2009 [43]. Although, compared to the previous article, the prevalence of tinea capitis has increased (3.6% to 5.2%). The highest incidence of tinea capitis was in the age group 10–19 years old of which 89.2% belonged to the ages of 10 to 13 years including 27.3% in 10 years old, 25.5% in 11 years old, 21.8% in 12 years old and 14.6% in 13 years old patients. Similar results were reported by Ali-Shtayeh et al. and Sarabi and Khachemoune [6,44].

In the present study, *T. tonsurans* was the most causative agent of tinea capitis. Similar results were reported from northeast and center of Iran [43] and in France [23]. Whereas, *T. verrucosum* in Isfahan [15], and *T. violaceum* and *T. schoenleinii* in Mashhad, two other cities of Iran, were the main etiological agents of tinea capitis [35]. In other countries, *T. violaceum* in Iraq [3], Palestine [7], Libya, Tunisia, Egypt [21] and southeastern and northwestern of China [49], *T. tonsurans* in Canada [26], North America [27], South and Central America [26], and several parts of Europe [27], *T. rubrum* in Poland [14], *M. canis* in Saudi Arabia and Kuwait [7,11], modernized cities in China [49], Korea [33], Italy [47] and Lithuania [38], and *M. gypseum* in India [10] was the main etiological agent of tinea capitis.

Some authors have concluded that the mechanism of spread and reasons for the emergence of *T. tonsurans* in tinea capitis are still unclear and remain speculative. In addition, *T. tonsurans* can exist as an asymptomatic carrier state in children, acting as a reservoir of infection, which may explain its rapid increase in prevalence in several populations [26,27].

As an interesting result in the case of tinea capitis in our study, one sample was reported to be caused by *E. floccosum*. Tinea capitis caused by *E. floccosum* is interesting because it further stressed the possibility of the occurrence of unusual cases of dermatophytosis. Sporadic reports of the infection of the scalp and hair by this dermatophyte have been reported from different parts of the world [2,6,24].

Increased use of sports clubs and swimming pools, and living in crowded places and conditions may contribute to the increased incidence of tinea capitis, tinea cruris and tinea corporis in Tehran and some urban populations.

In our study *E. floccosum* (31%) was the most prevalent causative agent, followed by *T. rubrum* (26.2%) and *T. mentagrophytes* (20.3%). Similar results in Iran were found in reports by Falahati et al. [22] and Sadeghi et al. [43]. In other researches in Iran, *E. floccosum* [25], *T. mentagrophytes* [9,11,39], *T. tonsurans* [4] and *T. verrucosum* [35] were the most common isolated dermatophytes.

Naseri et al. [35] reported *T. verrucosum*, *T. mentagrophytes* and *E. floccosum* as the most commonly isolated dermatophytes in Mashhad, Hamadan, Tabriz and Isfahan cities of Iran.

The most common isolated dermatophytes in other countries were *T. rubrum* in European countries such as the Grenoble area of France [23], Lithuania [38], Poland [14], Italy [47] and Greece [34,36], in African countries such as Brazil [16] and Tunisia [20], in Asian countries such as Turkey [5], India [10] and Japan [45], *T. tonsurans* in Egypt [1] and

M. canis in Palestine [7], Kuwait and United Arab Emirates [11].

During 2010 to 2014, a variable progressive decrease in frequencies of isolation was observed for *T. rubrum*, *E. floccosum* and *M. canis* and a variable progressive increase in frequencies of isolation was observed for *T. mentagrophytes*, *T. tonsurans* and *T. verrucosum*. *T. violaceum* was also found in 2010 and 2011 and *T. schoenleinii* was also found in 2010 and 2012.

In 2010, *T. rubrum* was the most frequent species followed by *E. floccosum* and *T. mentagrophytes*, while the order changed to *T. mentagrophytes*, *T. tonsurans* and *E. floccosum* in 2014. In previous researches by the Pasteur Institute of Iran in Tehran during the period of 2006 to 2009, *E. floccosum* was the most frequent species followed by *T. rubrum* and *T. mentagrophytes* in 2006, while the order changed to *T. rubrum*, *T. mentagrophytes* and *E. floccosum* in 2009.

The epidemiology of dermatophytosis in Iran has shown significant changes in various regions of the country over the last decades. According to religious beliefs in Iran, not keeping dogs as pets, the number of contamination with zoophilic fungi such as *M. canis* is fewer than other countries. In addition, improvement in living conditions has generally been associated with a decline in zoophilic dermatophytes and an increase in anthropophilic dermatophyte infections. Although *M. canis* infection is becoming a serious epidemiologic problem in Europe, South America, Australia and New Zealand [26,27], it has descended as reported in the present study. Among the zoophilic fungi, prevalence of *T. verrucosum* has increased over the years. Overall, anthropophilic dermatophytes such as *T. mentagrophytes*, *E. floccosum*, and *T. rubrum* are the main etiologic agents of dermatophytosis in Tehran, the capital of Iran.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgements

This work was supported financially by the Pasteur Institute of Iran (Project/Grant numbers 586 & 766). Authors are grateful to the personnel of Mycology Department of the Pasteur Institute of Iran for helpful assistance in sample preparation.

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