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Original Article

Dermatophytosis: a 16-year retrospective study in a metropolitan area in southern Brazil

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Abstract

Introduction: Dermatophytoses are considered a public health problem. The objectives of this study were to determine the evolution of their prevalence in the metropolitan area of Porto Alegre, Brazil, and to analyze the dermatophyte species distribution according to body site and demographic characteristics of the patients.

Methodology: This work was a retrospective analysis of data from patients attending a tertiary care hospital during 1996–2011.

Results: There were 9,048 cases with cultures positive for dermatophytes. *Trichophyton rubrum* occurred in 59.6% of the cases, followed by *Trichophyton interdigitale* (34%), *Microsporum canis* (2.6%), *Epidermophyton floccosum* (1.5%), *Microsporum gypseum* (1.3%), and *Trichophyton tonsurans* (0.9%). The angular coefficients for *T. interdigitale*, *E. floccosum*, *T. rubrum*, and *M. canis* were +1.119, +0.211, -0.826 and -0.324% per year, respectively. Males presented higher prevalence of infection (79.3% *versus* 53.9%). Tinea unguium occurred in 48.5% of the cases, followed by tinea pedis (33.1%). *T. rubrum* was the predominant species in all regions of the body except the scalp, where *M. canis* was responsible for 75% of the cases.

Conclusion: Monitoring of the evolution of dermatophytosis tracks changes in prevalence over the years and may assist practical measures for the public health control of this disease.

Key words: epidemiology; dermatology; dermatophytes; public health.

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Introduction

Dermatophytoses, also known as ringworm or tineae, are infections caused by dermatophytes, filamentous fungi which attack the skin, hair, and nails in humans [1,2]. Therefore, they are more often seen in dermatological practice [3], and *Trichophyton rubrum* is the most common species of dermatophyte [4].

The prevalence of superficial fungal infections is highly variable, since it depends on climatic parameters such as humidity and temperature, and on each patients' characteristics such as age, gender, predisposition to diseases, anatomical site of lesion, socioeconomic status, and occupation [5]. Dermatophytoses affect approximately 40% of the world's population, and nail infections represent 18%–40% of the onychopathies [6], representing a public health problem. For all these reasons, the objectives of the study were to compare species distribution according to body site and demographic characteristics of the patients and to determine changes in prevalence of dermatophytes in the metropolitan region of Porto Alegre, Brazil, based on data from patients attending a tertiary care regional hospital.

Methodology

A retrospective analysis was performed using the data of culture and mycological examination from all patients who attended the Department of Dermatology of Complexo Hospitalar Santa Casa de Porto Alegre, a tertiary care hospital in southern Brazil, between January 1996 and December 2011. This hospital is the

oldest in the metropolitan area of Porto Alegre, where the population is estimated to be 4,161,237 inhabitants [7], and is one of the hospitals with the most referrals in the dermatology field. The project was approved by the hospital's ethics committee under protocol number 3484/11. Skin and nail samples were collected by means of scraping affected areas with microscope slides and sterile curettes. Hairs were collected with sterile forceps. Part of the clinical material was clarified with potassium hydroxide 20% and examined under the optical microscope for direct mycological examination, and another part was plated on Sabouraud agar with chloramphenicol and cycloheximide and incubated at 25°C for five weeks, during which fungal growth was periodically evaluated. The identification was accomplished through macro- and microscopic observation of the colonies. The urease test was performed to differentiate *T. rubrum* from *T. interdigitale* [8]. Based on current knowledge from molecular analysis, *T. mentagrophytes* var. *mentagrophytes* and *T. mentagrophytes* var. *granulosum* are genetically indistinguishable from *Trichophyton interdigitale*. Thus, they are collectively known as *T. interdigitale* [9,10]; therefore, the nomenclature *T. interdigitale* was used in this study.

Data on diagnosis date, age, gender, ethnicity, anatomical region of lesion, and cultural examination result were tabulated. According to the Brazilian Institute of Geography and Statistics (IBGE) ethnicity classification, white, brown, and black ethnicities were considered. The distribution of ethnic groups was called sample proportion, including all subjects who underwent mycological culture examination during the study period.

The anatomical areas of the lesions were scalp, hair, face, beard, trunk, arms, legs, groin, feet, hands, toenails, fingernails, and non-specified skin and nail. Statistical tests were performed, and the programs used for each specific objective of the study are described in Table 1. For each statistical analysis, cases with missing values in the variables to be analyzed were excluded.

Results

Of the 36,446 mycological culture examination tests requested, 39% (14,214) were positive for fungi, of which 9,048 were dermatophytes. Table 2 shows the prevalence of the species and the results of the simple linear regressions conducted to determine the tendencies in prevalence over the years.

Table 1. Statistical tests performed and programs used for each objective

Objectives	Tests (α = 0.05)	Programs*
Determine the behavior of the prevalence over the years	Simple linear regression	SPSS
Compare the prevalence of fungi between the genders	Pearson's Chi-square	R
Compare the patients ages between the genders	Mann-Whitney U	SPSS
Compare the patients ages among species of dermatophytes	Kruskal-Wallis	SPSS
Compare ethnic proportion of cases affected by each species with the sample proportion and determine which ethnic groups are responsible for the statistical difference	Chi-square /Chi-square corrected by Bonferroni	WinPEPI
Determine differences between anatomical sites affected by fungi	Fisher's exact test / adjusted residuals	SPSS

*SPSS version 18, R version 13.2e, WinPEPI version 11.25

Table 2. Prevalence of infections by dermatophytes and simple linear regressions of prevalence over 16 years (1996–2011) in Complexo Hospitalar Santa Casa, a metropolitan area of Porto Alegre, Brazil

Species	Cases (n)	%	B (95% CI) %/year	P
Trichophyton rubrum	5,396	59.64	-0.826 (-0.597 / -1.055)	< 0.001
Trichophyton interdigitale	3,074	33.97	1.119 (0.835 / 1.403)	< 0.001
Microsporum canis	237	2.62	-0.324 (-0.197 / -0.451)	< 0.001
Epidermophyton floccosum	134	1.48	0.211 (0.144 / 0.278)	< 0.001
Microsporum gypseum	122	1.35	-0.048 (0 / -0.118)	0.197
Trichophyton tonsurans	84	0.93	-0.059 (0 / -0.131)	0.131
Trichophyton violaceum	1	0.01	-	-
Total	**9048**	**100**	**-**	**-**

B: slope coefficient of simple linear regression (SPSS version 18 / α = 0.05); CI: confidence interval

Table 3. Prevalence of dermatophyte infections and distribution of species according to age and gender, in Complexo Hospitalar Santa Casa, a metropolitan area of Porto Alegre, Brazil (1996–2011)

	Distribution of dermatophyte species according to age (years)				Prevalence of dermatophyte infections among patients with superficial mycoses (%)**		
	Median (quartiles 25 / 75)						
		Gender			Gender		
	Total	Male	Female	P[1]	Male	Female	P[2]
Species	(n = 8,616)*	(n = 3,842)	(n = 4,774)		(n = 5,117)	(n = 9,067)	
T. rubrum	40 (29 / 53)	38.5 (28 / 52)	41 (29 / 54)	< 0.01	51.5	30.4	< 0.01
T. interdigitale	43 (30 / 55)	40 (28 / 50)	45 (31 / 56)	< 0.01	23.0	19.9	< 0.01
T. tonsurans	40.5 (24 / 52)	38 (24 / 54)	45 (26 / 52)	0.594	0.6	0.6	0.785
M. canis	11 (6 / 33)	7 (4 / 13)	20 (8 / 37)	< 0.01	1.6	1.7	0.495
M. gypseum	23 (6 / 46)	7 (3 / 26)	32.5 (15 / 48)	< 0.01	0.9	0.8	0.637
E. flocossum	37 (28 / 50)	34 (27 / 42)	45.5 (34 / 62)	< 0.01	1.7	0.5	< 0.01
Total					**79.3**	**53.9**	**< 0.01**

*Due to missing age data, only 8,616 of the 9,048 patients with dermatophytosis were taken into account for these calculations; **Expressed as percentage of all positive cases (with dermatophyte and non-dermatophyte superficial fungal infections); P[1] Significance of age differences between genders; P[2] Significance of prevalence differences between genders.

Table 4. Prevalence and distribution of dermatophyte species according to anatomical sites of lesions in Complexo Hospitalar Santa Casa, a metropolitan area of Porto Alegre, Brazil (1996–2011)

Site	Species												Total*
	T. rubrum		*T. interdigitale*		*T. tonsurans*		*M. canis*		*M. gypseum*		*E. floccosum*		
	n	%	n	%	n	%	n	%	n	%	n	%	n
Scalp	4 -	2.9	2 -	1.5	11 +	8.0	104 +	75.9	16 +	11.7	0	0	137
Face	69 -	51.1	19 -	14.1	6 +	4.4	14 +	10.4	26 +	19.3	1	0.7	135
Beard	2	33.3	1	16.7	1 +	16.7	1 +	16.7	1 +	16.7	0	0	6
Trunk	144 +	70.6	8 -	3.9	2	1.0	39 +	19.1	10 +	4.9	1	0.5	204
Arm	142	62	22 -	9.6	4	1.7	36 +	15.7	23 +	10.0	2	0.9	229
Leg	125 +	67.9	18 -	9.8	3	1.6	16 +	8.7	19 +	10.3	3	1.6	184
Inguinal	435 +	81.6	61 -	11.4	5	0.9	9	1.7	9	1.7	14 +	2.6	533
Foot	1,595 -	53.3	1,296 +	43.3	10 -	0.3	2 -	0.07	6 -	0.2	84 +	2.8	2,993
Toenails	2501	60.5	1560 +	37.7	34	0.8	11 -	0.3	5 -	0.1	25 -	0.6	4,136
Hand	171 +	77.0	37 -	16.7	3	1.3	3	1.3	4	1.8	4	1.8	222
Fingernails	143 +	79.4	31 -	17.2	3	1.7	0 -	0	3	1.7	0	0	180
Nail uns.	51 +	77.3	15	22.8	0	0	0	0	0	0	0	0	66
Skin uns.	1	33.3	0	0	1 +	33.3	1 +	33.3	0	0	0	0	3

*Cases with complete data; uns: unspecified; + / - : Higher/lower than expected associations between species and lesion site ($p < 0.05$, Fisher's exact test); Underlined: values with higher degree of significance ($p < 0.001$) calculated from the adjusted residuals

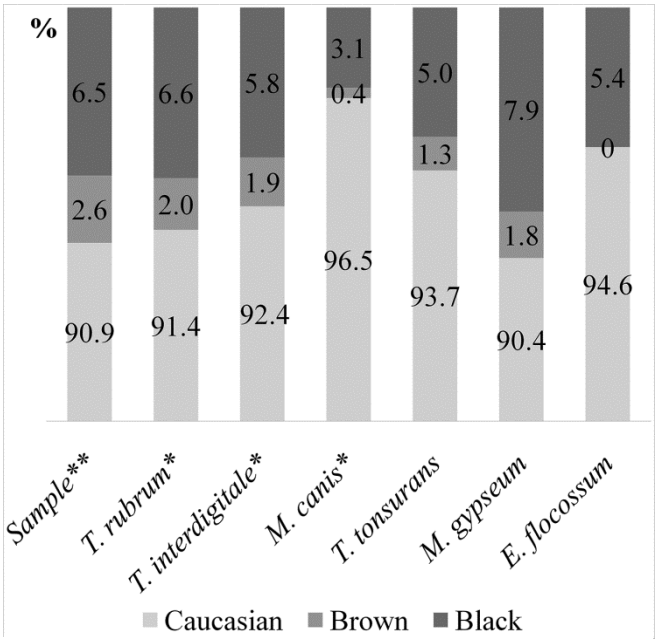
The p values, the slope coefficients (B), and 95% confidence interval for B are also shown. The coefficients indicate increase or decrease of cases per year (%).

The ages of the patients affected by dermatophytes (range, 1 to 98 years) expressed as median and 25th and 75th quartiles and separated by gender, are presented in Table 3. The prevalence of the different species of dermatophyte in relation to gender is also shown in Table 3. The prevalence of each species is expressed as percentage calculated on all cases with a superficial fungal infection (dermatophyte or non-dermatophyte). According to these calculations, there was a higher prevalence of *T. rubrum*, *T. interdigitale*, and *Epidermophyton floccosum* in men. When comparing the different species in relation to ages of the patients without taking into account gender, pairwise comparisons between the species (Kruskal-Wallis test, two-by-two species) showed that patients with *Microsporum canis* and *M. gypseum* were significantly younger than patients with other dermatophytes, and patients with *T. rubrum* were significantly younger than patients infected with *T. interdigitale* ($p < 0.001$). When gender was also taken into account (Mann-Whitney test), males were, in general, younger than females, except in cases with *T. tonsurans*. Even though the median ages may appear different for this species (38 *versus* 45 for males and females, respectively) (Table 3), these differences were not statistically significant, but the number of patients affected by this species was much smaller than by other species (*e.g.*, 84 cases *versus* 5,396 or 3,074 for *T. rubrum* and *T. intergigitale*, respectively).

Regarding ethnicity, *T. interdigitale* and *M. canis* affected a larger number of white people, while *T. rubrum* affected fewer brown people. For other species, there was no statistically significant difference (Figure 1).

There were differences in the anatomical sites affected by each species of dermatophyte. Table 4 shows the number of cases, the percentage of species in the anatomical regions of the lesions, and the association between the species and the lesion site. The calculation of the adjusted residuals after application of Fisher's exact test showed a higher (+) or lower (-) association between certain species and a lesion site than the calculated expected values in the contingency tables. The values with a higher ($p<0.001$) degree of significance (positive or negative) are underlined. For example, in Table 4, although foot skin was the most frequent infection site for *T. rubrum*, the body sites with which this species shared

Figure 1. Ethnic proportion found in comparison with the sample proportion (%)



Statistical analysis: Chi-square corrected by Bonferroni (WinPEPI version 11.25) *P value < 0.05; **ethnic sample proportion, considering all subjects submitted to mycological culture examination (n = 36446); Total numbers: *T. rubrum* (5,165); *T. interdigitale* (2,962); *T. tonsurans* (80); *M. canis* (225); *M. gypseum* (114); *E. floccosum* (130)

increased affinity were the trunk, legs, hands, and fingernails, the inguinal region being the preferred site with the highest positive association (underlined in Table 4). In contrast, *T. interdigitale* showed increased affinity for the feet and toenails and a decreased affinity for the groin. *M. canis* and *M. gypseum* showed low propensity for the feet (negative association).

In general, tinea unguium was the most prevalent dermatophytosis (48.5%), with the toenails being affected more frequently than the fingernails (94.4% *versus* 4.1% of nail infections, respectively). Tinea pedis, the second most prevalent dermatophytosis (33.1%), was followed by tinea corporis (6.8%), tinea cruris (5.9%), tinea manuum (2.4%), tinea capitis (1.5%), tinea faciei (1.5%), and tinea barbae (0.07%).

Discussion

Our study included 9,048 cases of dermatophytosis, making it the largest epidemiological study of these diseases in Brazil and, to our knowledge, of the worldwide literature. *T. interdigitale* and *E. floccosum* increased their prevalence in our hospital, unlike what was found in a recent study in Italy in 2012, where the prevalence of

E. floccosum declined [11]. *T. rubrum* remains the most frequent all over America and Europe [12], and an increase has been shown in some studies [11,13]. However, according to our study, its prevalence among the other dermatophytes decreased about 0.8% per year.

The prevalence of *M. canis* was also reduced in our study. In Porto Alegre, Aquino *et al*. [14] also found a decrease of *M. canis*, unlike what was reported by Mezzari *et al*. [15]. Aquino *et al*. considered this decrease a reflex of systematic and effective veterinary control in pets.

Trichophyton was the predominant genus among the three genera of dermatophytes, as observed in previous studies performed worldwide [12,16]. Based on the data compiled in the review by Havlickova *et al*. [12], the lowest *Trichophyton* genus percentage was in Africa, with about 50% of the cases of dermatophytosis. In America, about 90% of dermatophytosis was caused by this genus, which agrees with the 94.5% found in our study.

The species distribution is consistent with the findings of previous studies conducted in the metropolitan area of Porto Alegre, with *T. rubrum* being the most prevalent, followed by *T. interdigitale* [14,15]. Only *T. tonsurans* changed in ranking; its prevalence was reduced, making it the sixth most common dermatophyte. This is an important finding because in other studies in Brazilian states [13,17,18], this species was among the first ones in ranking, while *T. interdigitale* ranked fourth place in those states.

Regarding the differences between the genders, there was a higher prevalence of *T. rubrum*, *T. interdigitale*, and *E. floccosum* in men. As those fungi are the most prevalent among dermatophytes, a greater propensity for dermatophyte infections in men is suggested, since 79.3% of the examined male population was infected by some species of dermatophytes, compared to only 53.9% of the female population. The higher prevalence in males has already been mentioned in other studies [17,19,20], and may be explained by the frequent practice of sports, use of tight-fitting footwear, and lack of foot hygiene [21].

Another difference observed between the genders was that women's age was higher than men's age, except with regard to *T. tonsurans*, which showed no significant difference. This may be related to sudden hormonal changes; decrease of triglycerides in sebum (substances that would have antifungal action) during menopause [22]; and the fact that women are more concerned with their aesthetic appearance, regardless of age, and seek more dermatological assistance than men. This may have increased the median women's age.

The southern Brazilian population has a strong European descent, so our sample population comprised about 90% Caucasians. So far, to our knowledge, no study had analyzed ethnicity of patients infected by dermatophytes. There is no clear explanation for the statistical differences found in this study. However, we believe that this might be related to a protective role of melanin against these infections.

In studies that relate dermatophytosis to hormone action, it was observed that steroid hormones inhibit the growth of dermatophytes *in vitro*, especially *T. rubrum* and *E. floccosum*. In the hair follicles of the scalp and face, an autonomous control over the androgenic steroid hormones metabolism occurs, and this fact could affect colonization with these species [23,24]. This would explain why these fungi do not easily attack the scalp and face, in agreement with our study, which showed a negative association of *T. rubrum* with these locations and only one case of face infection with *E. floccosum*. This might also be one of the reasons that *M. canis* and *M. gypseum* attack more children than adults, since children do not have these hormones in high concentration. Another already known reason why children are more frequently affected by these two species is their contact with cats and dogs. *M. canis* is a zoophilic dermatophyte most commonly found in cats and dogs, either infected or not. *M. gypseum* is the most frequently found geophilic dermatophyte in these animals, usually causing no infection to them, but is carried on their coats after contact with soil. Thus, children usually acquire infection through these animals [2,25]. It has been observed that the inflammatory type of tinea capitis is caused mainly by *M. canis* and *M. gypseum*, and tends to affect children all over the world [26]. *T. tonsurans* also showed greater association with the scalp, but the age of the patients was higher than in infections with *M. canis* and *M. gypseum*. This can be related to the type of lesion caused by *T. tonsurans*, which mimics seborrheic dermatitis and, consequently, the dermatophytosis could not be properly treated and thus continued into adulthood [27].

T. rubrum was the most frequent agent of dermatophytosis, which corroborates the literature [16]. It is commonly found in all regions of the body, except on the scalp, where *M. canis* predominates. It was observed that toenails were more affected by dermatophytes than fingernails, also in agreement with the literature [28,29]. Toenails were more affected by

the genus *Trichophyton* than was the foot skin, unlike *E. floccosum*, which was more prevalent in the skin than in the nails, corroborating the literature data [19,30].

Conclusions

This study, although it has the limitations of being retrospective, from a single center, and not population based, corroborates other studies in the region in relation to the distribution of dermatophytes, with *T. rubrum* being the most common species, followed by *T. interdigitale*. However, the results of this study showed gender differences in relation to age and prevalence of dermatophyte infection , females having higher age and males showing higher prevalence of dermatophytosis. Furthermore, we observed a decrease in prevalence of *T. rubrum* and *M. canis*, and an increase of *T. interdigitale* and *E. floccosum* during the long period of this study. In this sense, the continuation of epidemiological studies in the region is necessary for monitoring and controlling the evolution of dermatophytosis. Finally, our study provides statistical support for epidemiological inferences concerning this infection, and may assist practical measures for the public health control of this disease.

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