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ORIGINAL ARTICLE

Emergence of *Microsporium audouinii* and *Trichophyton tonsurans* as Causative Organisms of Tinea Capitis in the Dominican Republic

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KEYWORDS

Tinea capitis;
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Microsporium canis;
Trichophyton tonsurans

Abstract

Background: Tinea capitis affects mainly children. The frequency and causative organism vary from region to region.

Objectives: To provide epidemiological and mycological data on tinea capitis collected in urban and rural areas of the Dominican Republic.

Methods: Samples were obtained from 118 patients with tinea capitis. Sixty-three of these were from 2 schools in urban areas of the Dominican capital Santo Domingo (53%) and 55 were from rural schools on the border with Haiti (47%).

Results: The study included 84 boys (71.18%) and 34 girls (28.81%). The urban sample comprised mainly boys (84.12%). The most represented age ranges were 6 to 8 years (47.45%), 3 to 5 years (24.59%), and 9 to 11 years (16.94%). *Microsporium audouinii* (39.68%), *Trichophyton tonsurans* (23.80%), *Microsporium canis* (19.04%), and *Trichophyton violaceum* (1.58%) were isolated from children in urban areas, whereas *T. tonsurans* (87%) and *Trichophyton mentagrophytes* (2%) were isolated from those in rural areas. Overall, *T. tonsurans* (61.16%), *M. audouinii* (24.27%), and *M. canis* (11.65%) were the most frequently isolated causative organisms, whereas *T. violaceum* and *T. mentagrophytes* were rarely reported.

Conclusions: In urban areas of the Dominican Republic, tinea capitis was found mainly in boys, but in rural areas it was evenly distributed among boys and girls. The emergence of *M. audouinii* and an increase in *T. tonsurans* were found while *M. canis* continued to be present at lower frequencies. On the rural border with Haiti, there was a significant predominance of *T. tonsurans*.

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PALABRAS CLAVE

Tina del cuero cabelludo;
Microsporum audouinii;
M. canis;
Trichophyton tonsurans

Tinea capitis. Emergencia de *Microsporum audouinii* y *Trichophyton tonsurans* en la República Dominicana

Resumen

Antecedentes: Las tiñas de la cabeza predominan en los niños, con una frecuencia y etiología variables en diferentes partes del mundo.

Objetivos: Comunicar los datos epidemiológicos y micológicos de tiña del cuero cabelludo observados en la zona urbana y rural de la República Dominicana.

Metodología: Se estudiaron 118 muestras de pacientes con diagnóstico de tiña de la cabeza en la República Dominicana, 63 de dos escuelas urbanas en la capital Santo Domingo (53%) y 55 de escuelas rurales en la frontera dominico-haitiana (47%).

Resultados: Se estudiaron 84 varones (71,18%) y 34 mujeres (28,81%). En la zona urbana predominó en los varones (84,12%). La edad con mayores porcentajes fue entre 6 y 8 años (47,45%), de 3 y 5 años (24,59%) y 9 y 11 años (16,94%). En la zona urbana se aislaron *M. audouinii* (39,68%), *T. tonsurans* (23,80%), *M. canis* (19,04%) y *T. violaceum* (1,58%) y en la zona rural *T. tonsurans* (87%) y *T. mentagrophytes* (2%) y globalmente *T. tonsurans* (61,16%), *M. audouinii* (24,27%) y *M. canis* (11,65%) y rara vez *T. violaceum* y *T. mentagrophytes*.

Conclusiones: En la República Dominicana, en la zona urbana, la tiña de la cabeza predomina en los varones y en la zona rural tiene una frecuencia similar en ambos sexos. Se detectó una emergencia por *M. audouinii*, un incremento de *Trichophyton tonsurans*, y una estabilidad con frecuencia más baja de *M. canis*. En la zona rural y la frontera con Haití hay un predominio significativo de *T. tonsurans*.

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Introduction

The overall incidence of fungal infections is known to vary between continents and also within the same continent, particularly in the case of superficial mycoses. The most common causative organisms are *Trichophyton rubrum*, *Trichophyton interdigitale* (*mentagrophytes* var. *interdigitale*), *Microsporum canis*, *Microsporum audouinii*, *Trichophyton tonsurans*, and *Trichophyton verrucosum*.¹ Their frequency is related to socioeconomic level and cultural factors.

The term tinea capitis covers mycoses that are common in areas with high levels of immigration and that usually occur in tropical regions and rural or suburban areas. Cases are almost always reported in children (98%) and are more common in individuals with lower socioeconomic status.^{2,3} Although adults rarely show clinical disease, carriers have been detected in urban areas.

Cases have been reported throughout the world, but with variable frequency. *T. tonsurans* arrived in the Americas with the Spanish conquistadores and, currently, in Mexico, this organism accounts for between 15% and 28% of cases.⁴ In the United States of America, it is the predominant causative organism of tinea capitis (98%), whereas the dermatophyte *M. canis* is more common in some parts of Europe, Arab countries, Iran, Brazil, Mexico, and the Dominican Republic.^{2,5} In poor African countries, the most common causative organisms are *Trichophyton soudanense* and *M. audouinii*.¹ Infection by *M. audouinii* is of historical interest in many parts of the world because it was responsible for epidemics in Europe in the 19th century before arriving in the Americas and then finally almost disappearing 50 years ago.⁶

The dermatophytes isolated from skin lesions have changed greatly in the last 70 years. In Germany, before World War II, *M. audouinii* and *Epidermophyton floccosum* occupied the top of the list of causative organisms by frequency, but from the 1950s onwards *T. rubrum* (80%-90%) has been the predominant dermatophyte at all sites apart from the head.⁷ Whereas in Eastern Europe and Arab countries, zoophilic dermatophytes such as *M. canis* and *T. verrucosum* are more common, in Europe, the incidence of *M. canis* has increased notably in the last few years and is currently the most frequent tinea of the scalp. The countries with the highest incidence are Italy and other Mediterranean countries, although other nearby countries such as Austria, Hungary, Germany, and Poland also have high incidences. The increase in anthropophilic dermatophytes is due to *T. tonsurans*, mainly in the United Kingdom and to *T. soudanense* and *M. audouinii* in France.^{8,9}

In Nigeria, the head is affected in 13.7% of cases and the most common causative organisms are *T. soudanense* (30.6%), *Microsporum ferrugineum* (7.7%), and *M. audouinii* (7.7%), with cases involving *T. tonsurans* occurring less frequently.^{10,11} In Mozambique, the prevalence of tinea capitis is 9.6%, due mainly to *M. audouinii*, *Trichophyton violaceum*, and *T. mentagrophytes*.^{12,13}

Epidemics of tinea capitis due to *T. tonsurans* are often associated with subclinical infection and fomites, while those due to *M. canis* are associated with cats and dogs. *T. tonsurans* gives rise to folded colonies of a white, gray, or yellow coloration, and a dark brown coloration on the underside. Two variants have been identified: *T. tonsurans* var. *tonsurans* and var. *sulfureum*.⁶

The most important species of the *Microsporum* genus is *M. canis*; this species is characterized by rapidly growing

colonies with a villous surface and an orange-yellow coloration at the edges and on the underside. There are 2 variants: *distortum* and *obesum*. The first of these is found in Australia, New Zealand, and the United States.⁶ *M audouinii* produces white-colored colonies with a silky texture and a pink- or peach-colored underside. Two variants are recognized—*Microsporum langeroni* and *Microsporum rivalieri*. Although some consider these distinct species, it has been shown using random amplification of polymorphic DNA techniques that these are morphologic variants of the same species.¹⁴ Recent molecular studies have characterized the *M canis* complex as comprising a group of phylogenetically related anamorphic fungi, such as the anthropophilic taxa *M audouinii* and *M ferrugineum*, and the zoophilic taxon *M canis*. The sexually reproducing species of this complex is *Arthroderma otae*.^{15,16}

The aim of this study was to collect data on outbreaks observed in the Dominican Republic, both in Santo Domingo and a rural area close to the border with Haiti.

Methods

In total, 212 samples from patients with tinea capitis in the Dominican Republic were studied. Sixty-three of those patients were pupils at primary schools in Santo Domingo (33 from Los Alcarrizos and 30 from La Victoria) and 149 were pupils at 2 rural schools in 2 settlements on the border with Haiti (Río Limpio and La Seiba de Bonet) (Table

Table 1 Origin of Patient Samples Studied

| Study of Tinea Capitis in the Dominican Republic | | |
|--|-----------------------------|------------|
| Community | Number of Samples Processed | Percentage |
| Rural border region | 55 | 47% |
| Urban environment | 63 | 53% |



Figure 1 Schoolchildren with tinea capitis included the study.

1). At each school, children with suspected tinea capitis were summoned at the same time. All samples from a given school were therefore taken and processed concurrently (Figure 1). All samples were studied directly by microscopic examination of specimens in 20% potassium hydroxide and cultured on Sabouraud glucose agar with antibiotics. All samples were interpreted by the same mycologist, an author of this study (RA).

Results

In total, 118 samples from Dominican patients with diagnosis of tinea capitis were studied. Sixty-three of these were from 2 schools—one primary and one secondary (Los Alcarrizos [33] and La Victoria [30])—in the capital Santo Domingo (representing 53% of the sample) and 55 were from 2 rural primary schools in 2 settlements (Río Limpio and La Seiba de Bonet) on the border with Haiti (representing 47% of the sample) (Table 1).

In the urban schools of Santo Domingo, 33 samples from Los Alcarrizos were studied (27 from boys and 6 from girls) and 30 from La Victoria (26 from boys and 4 from girls). Thus, of the 63 patients from an urban environment, 53 were boys and 10 were girls. Of the 55 children studied in the rural area, 31 were boys and 24 girls.

Table 2 and Figure 2 show the distribution by sex, environment, and overall.

The age of the patients ranged from 0 to 18 years, with most aged between 6 and 8 years (47.45%), followed by those aged between 3 and 5 years (24.58%), and those aged between 9 and 11 years (16.94%) (Table 3 and Figures 3 and 4).

On examining the samples under a microscope, 91 were found to have directly positive results (77.11%) for fungal structures, with hair parasites in 62.26% of the studies. Spores or filaments were found in the scales of 17.92%. For the remaining samples (22.89%), direct examination was not possible.

Causative organisms were isolated at different rates from samples from urban environments and rural ones. Overall, the following species were found: *T tonsurans* (61.16%), *M audouinii* (Figure 4) (24.27%), and *M canis* (11.65%). The presence of other species was negligible, as illustrated in Figures 5, 6, and 7.

Discussion

Tinea capitis is the most common type of superficial mycosis in children of school age. In a study of 92 medical mycology laboratories in 19 European countries, in which questionnaires mailed to participating centers asking about frequencies of organisms in 1987 and 1997, an increase was found in anthropophilic fungi.¹⁷ Such organisms were the most common cause of scalp infections and this increase was apparent in laboratories that covered urban populations and in children of Afro-Caribbean origin living in Europe. The most common organism was *M canis* and the greatest increase was reported for *T tonsurans*, which was the second most common in 1997.

Table 2 Patients Studied by Origin and Sex

| Tinea Capitis in the Dominican Republic | | | | | |
|---|-------------------|------------|-------------------------------|-------|------------|
| Sex | Rural Environment | Alcarrizos | La Victoria | Total | Percentage |
| Male | 31 (56.36%) | 27 | 26 (total urban, 53 [84.12%]) | 84 | 71.18% |
| Female | 24 (43.63%) | 6 | 4 (total urban, 10 [15.87%]) | 34 | 28.81% |

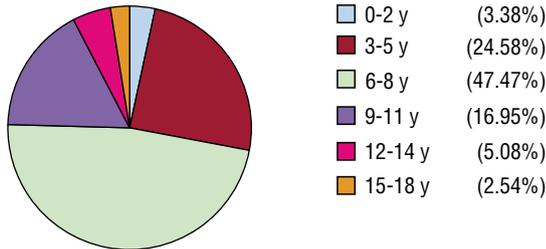


Figure 2 Tinea capitis in the Dominican Republic: distribution by age group.



Figure 4 Tinea capitis due to *Microsporum audouinii*.

Table 3 Patients With Tinea Capitis: Distribution by Age Group

| Tinea Capitis: Origin and Age Distribution | | | | | |
|--|-------------------|------------|-------------|-------|-------------|
| Sex | Rural Environment | Alcarrizos | La Victoria | Total | Percentages |
| 0-2 | 3 | 0 | 1 | 4 | 3.38% |
| 3-5 | 12 | 7 | 10 | 29 | 24.57% |
| 6-8 | 22 | 18 | 16 | 56 | 47.45% |
| 9-11 | 11 | 8 | 1 | 20 | 16.94% |
| 12-14 | 5 | 0 | 1 | 6 | 5.08% |
| 15-18 | 2 | 0 | 1 | 3 | 2.54% |

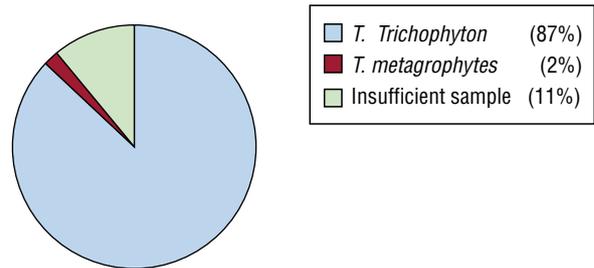


Figure 5 Causative organisms of tinea capitis in a rural environment of the Dominican Republic.



Figure 3 Tinea capitis due to *Trichophyton tonsurans*.

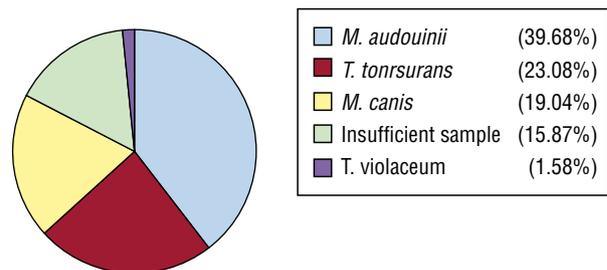


Figure 6 Causative organisms of tinea capitis in an urban environment in the Dominican Republic.

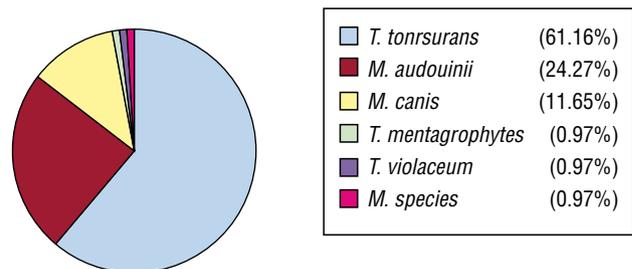


Figure 7 Causative organisms of tinea capitis in the Dominican Republic.

In the Dominican Republic, our data from 2 urban schools revealed a range of causative agents, with a striking change from the previous patterns. There was an increase in *T tonsurans*, but *M audouini* also had a significant presence.

A similar observation was reported on the nearby island of Jamaica, where the dominance of *M audouinii* (61.5% in 1998) had given way to that of *T tonsurans* (85% in 2002).¹⁸ This finding should be studied in greater detail, along with the frequency and type of migrations between these Caribbean islands.

The contrast with other parts of the world is also noteworthy. For example, in Melbourne, Australia, the most common dermatophytes in a primary school were *T soudanense*, *T violaceum*, and *M audouinii* and both individuals with clinical manifestations and carriers were immigrants from African countries, mainly Sudan, and from Arab countries.¹⁹ This suggests that tinea capitis will be a problem in these groups given that immigration is continuing.

In the developed countries of the Americas, *M audouinii* and *M canis*—considered as the most common causative organisms for tinea capitis over the past 100 years—have been surpassed by *T tonsurans*; already in 1950 this dermatophyte was spreading from Mexico and the Caribbean to North America.²⁰ Thus, in the past 60 years it has become the primary causative organism of tinea capitis in the United States of America, while in Europe, there has been a shift from *M audouinii* to *T tonsurans*. A similar shift has occurred in Canada, with an increase from 9% to 78% between 1985 and 1996.^{21,22}

Ten years ago, *M canis* was the most prevalent organism in certain regions such as Spain and the Dominican Republic itself.²³ Now, in Spain, *T tonsurans*, *T verrucosum*, and *M audouinii* have been isolated in African immigrants.²⁴⁻²⁶

In Kuwait, *Trichophyton violaceum* (41.5%), *M canis* (27.4%), *M audouinii* (14.8%), and *T mentagrophytes* var. *mentagrophytes* (9.5%) predominate whereas *T verrucosum*, *T tonsurans*, and *Microsporum gypseum* are uncommon.²⁷

Tinea capitis is a clear example of changes in the geographical patterns of dermatophytoses, with a very heterogeneous distribution in the Americas, but also on other continents. In a study conducted in China in 2004, *M canis* was identified as being responsible for a school epidemic.²⁸ In a study in Nigeria, tinea capitis was predominant in boys (78.2%) and the children were mainly aged 10 to 14 years (42.7%) and 5 to 9 years (40.3%).¹¹ These data on age distribution are very similar to ours—both for the urban environment and the rural one. In terms of sex distribution, a similar predominance in boys was observed in the capital of the Republic.

In a study in Nepal, 68.1% of the infections occurred in children under 11 years of age, with a predominance in girls (male:female ratio, 1:1.9); gray patches were the most common clinical form (52.2%), followed by the black dot form (17.4%), seborrheic presentation (13%), and alopecia areata (11.6%).²⁹ Inflammatory lesions were rare (4.3%). In that country, the tineaes were largely trichophytic—*T violaceum* (48.71%), *T mentagrophytes* (15.38%), and *T tonsurans* (12.82%)—whereas fewer than 10% were caused by *M canis*, *T rubrum*, *M gypseum*, *M audouinii*, or *Microsporum nanum*. In most of our patients, there was a predominance of the dry forms, and the clinical patterns were so varied that we were unable to establish a clear relationship between clinical appearance and causative organism. In our study, the distribution was very similar for both sexes in the rural environment, with

a slight predominance in boys, whereas in urban areas, the predominance was noteworthy in boys (84.12%). We do not fully understand this observation. It is likely that it is related to visits to the barbers, because given that most individuals have curly hair, boys have their heads almost shaved and go to the barbers often whereas girls prefer to let their hair grow, wear it pulled straight, and wash it less often. We took random samples from 3 schools close to the those studied, but we could not isolate any causative organisms.

As indicated previously, *T tonsurans* is the most common causative organism for tinea capitis in several developed countries, particularly in the United States of America, and its increase there has occurred in parallel with a worldwide increase in recent years. This spread has been observed in daily clinical practice in Santo Domingo in the Dominican Republic, but the actual frequency has not been investigated and there are no reports about whether these infections are found in immigrants. This anthropophilic dermatophyte was not found in Haiti before 1988, and it started to be isolated from scalp lesions of patients in the capital Port au Prince from 2005 onwards.³⁰ We think it is significant that this agent was isolated as almost the only causative organism in these 2 Caribbean communities on the border with Haiti (87%). This surely is related to migration patterns in the region. In a study by Raccurt et al³⁰ in Haiti, *T tonsurans* was present in 63.6% while less common were *T mentagrophytes* (14.5%), *M audouinii* (12.7%), *T rubrum* (7.3%), and *M gypseum* (1.8%). The authors speculated that the recent emergence of *T tonsurans* in Haiti is linked to the dramatic increase in morbidity among Haitian migrants. All isolates of *T tonsurans* var. *sulfureum* came from patients in the border region. So it would be interesting if, in the near future, clinical and epidemiological studies were complemented with molecular epidemiological techniques.

Conflicts of Interest

The authors declare no conflicts of interest.

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