



Fungal infection of the feet in soccer players and non-athlete individuals

Kátia Sheylla Malta Purim, Gisele Pesquero Fernandes Bordignon & Flávio de Queiroz-Telles

Dermatology Section, Infectious Disease Section and Mycology Laboratory of the Federal University of Paraná, Brazil

Summary

This study was conducted to evaluate the occurrence of mycoses affecting the feet of soccer players and to compare this results with those in non-athlete individuals of the same age and sex. Initial evaluation consisted of a dermatological examination of the foot in 22 Chinese athletes, 83 Brazilian athletes and 24 Brazilian non-athletes. Scales of plantar skin, interdigital and subungual areas of the foot were collected for mycological examination (direct and culture). Nail clippings were obtained for histopathologic analysis. *Tinea pedis* was diagnosed more frequently among the non-athlete individuals. None of the Chinese athletes had *tinea pedis* alone. However, in this group onychomycosis was frequently higher when compared to the other groups. The fungal microbiota comprised *Trichophyton rubrum* (40%), *Trichophyton mentagrophytes* (36.4%) and *Candida* spp (20%). *Candida* spp was isolated only from Brazilian athletes. Results obtained with KOH wet mounts agreed with the results obtained in culture and with histopathologic examinations (50.5% vs 40.9%). The frequency of *tinea pedis* among soccer players was lower than the other groups in this study, possibly due to health education and professional foot care.

Key words

Tinea pedis, Onychomycosis, Soccer player

Infección fúngica en pies de jugadores de fútbol y en no atletas

Resumen

Se realizó un estudio para evaluar la ocurrencia de micosis en el pie en jugadores de fútbol en comparación con individuos no atletas de la misma edad y sexo. La evaluación inicial consistió en el examen dermatológico de los pies de 22 atletas chinos, 83 atletas brasileños y 24 individuos sedentarios brasileños. Fueron recogidas para examen micológico escamas de la región plantar, de la interdigital y bajo de las uñas del pie. También se tomaron fragmentos de uñas para análisis histopatológico. Se observó *tinea pedis* más frecuentemente entre los individuos no atletas. Ninguno de los atletas chinos presentó *tinea pedis* de manera aislada, presentando este grupo una mayor frecuencia de onicomicosis que los otros. La microbiota fúngica estaba compuesta por *Trichophyton rubrum* (40%), *Trichophyton mentagrophytes* (36,4%) y *Candida* spp (20%). *Candida* fue aislada solamente de los atletas brasileños. Los resultados micológicos son similares a los obtenidos a través del examen histopatológico. La menor frecuencia de *tinea pedis* en los jugadores de fútbol se debe posiblemente a una mayor educación sanitaria y a los cuidados profesionales de los pies.

Palabras clave

Tinea pedis, Onicomicosis, Futbolista

Dirección para correspondencia:

Kátia Sheylla Malta Purim
Dermatology Section, Hospital de Clínicas – UFPR
Rua General Carneiro, s/n
80060-150 Curitiba, Paraná, Brasil
Tel.: +55 (41) 360 1699
E-mail: kspurim@brturbo.com

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Foot mycoses represent a major problem in dermatology, with increased frequency and potential to influence the quality of life [2]. Foot diseases in males are usually asymptomatic and eventually discovered in routine physical examinations [22]. Athletes have the chance to acquire dermatological lesions including those of fungal etiology. The athlete's synthetic clothing and shoes retain sweat, favoring fungal development. During soccer practice, feet are subjected to intense battering [1,6], that may predispose to the development of mycoses [10].

Tinea pedis has been associated with sports. Indeed, the term "athlete's foot" is used to denote this infection. Tinea pedis and onychomycosis are common fungal infections that may become complicated and serve as chronic foci of further infection. The frequency of tinea pedis and other mycoses among soccer players may be underestimated because the athlete may hide the existence of light peeling or even serious infection of his feet that could ultimately take him out of games and competitions. Furthermore, little is known about the frequency and impact of fungal infections among soccer players. This study evaluates frequency of foot mycoses among soccer players and compares it with general individuals.

Subjects and methods

An open and comparative study was conducted including male soccer players and non-athletes who had not used anti-fungal medications for the last 30 days. Individuals included in the study gave written consent to participate. Subjects younger than 18 years and older than 38 years old, those with diabetes mellitus, peripheral vascular disease or immunosuppression were excluded from the study. The 129 participants were divided in three groups: 1) Chinese soccer players from the city of Xian, Southwest China (n=22); 2) Brazilian soccer players from different regions of the country playing in Curitiba, Southern Brazil (n=83); 3) Non-athletes from the city of

Curitiba (n=24). Non-athletes were individuals not engaged in regular physical activities that tended to be seated most of the workday.

Initial evaluation was performed in Curitiba, during the Brazilian National Soccer Championship, from August through December 2001, and consisted of physical and dermatological examination. Material was obtained from the nail and the plantar and interdigital areas of the foot for direct mycological examination and culture. To determine if the nail was hosting fungus, nail clippings were obtained for histopathological examination. The definition of those study areas was based on previous studies [3,16]. The material for analysis was taken from the foot with clinical signs of tinea pedis, when there was evidence of infection. If there were no skin or nail lesions the dominant foot (the one most vigorously used in the activities) was chosen. Scales were examined by the potassium hydroxide (KOH) slide method. Cultures were obtained after sampling in Mycosel® agar (Becton-Dickinson, USA, and incubation at 30 °C for at least 40 days. Macro and micro morphological aspects of colonies were observed to determine the fungal genus and species. For the histopathological exam, 3 mm fragments of the nail were taken and stained by the periodic acid-Schiff (PAS) method [19].

Data from the three groups were paired to determine the incidence of fungal infection, using the Fisher's exact test. Correlation coefficient kappa was utilized to evaluate the degree of agreement between direct, culture and histopathological exams. P values less than 0.05 were considered statistically significant.

Results

Demographic characteristics of the studied population are shown in table 1.

The frequency of fungal infections in each group is presented in table 2. Chinese athletes presented tinea pedis only associated with onychomycosis. This group had the

Table 1. Demographic characteristics of the studied population.

| Demographic characteristics | | Chinese athletes n=22 n (%) | Brazilian athletes n=83 n (%) | Brazilian non athletes n=24 n (%) |
|-----------------------------|--------------|-----------------------------------|-------------------------------------|---|
| Age (years) | Mean± | 25.68 ± 3.98 | 24.10 ± 4.14 | 26.27 ± 4.38 |
| Race | Oriental | 22 (100) | 0 (0) | 0 (0) |
| | Caucasian | 0 (0) | 53 (64) | 19 (79) |
| | Mulatto | 0 (0) | 17 (20) | 5 (19) |
| | Black | 0 (0) | 13 (16) | 0 (0) |
| Schooling years | 4 – 8 years | 0 (0) | 18 (22) | 4 (17) |
| | 8 – 11 years | 19 (85) | 51 (62) | 13 (54) |
| | ≥ 12 years | 3 (15) | 13 (17) | 7 (29) |

Table 2. Prevalence of the feet fungal infections.

| Mycosis | Chinese athletes n=22 n (%) | Brazilian athletes n=83 n (%) | Non athletes n=24 n (%) | Total n=129 n (%) |
|------------------------------------|-----------------------------------|-------------------------------------|-------------------------------|-------------------------|
| Absent | 12 (54.5) | 51 (61.4) | 11 (45.8) | 74 (57.4) |
| <i>Tinea pedis</i> | 0 (0) | 13 (15.7) | 5 (20.8) | 18 (13.9) |
| Onychomycosis | 5 (22.7) | 9 (10.8) | 4 (16.7) | 18 (13.9) |
| <i>Tinea pedis</i> + Onychomycosis | 5 (22.7) | 10 (12.0) | 4 (16.7) | 19 (14.7) |

Fisher's exact test, with vs without mycosis
Chinese athletes vs Brazilian athletes: p=0.6276
Chinese athletes vs Non athletes: p=0.7683
Brazilian athletes vs Non athletes: p=0.2404

largest percent of onychomycosis (22.7%) and, also, of tinea pedis associated with onychomycosis. The highest percentage of cases without any mycosis is related to Brazilian athletes (61.4%), followed by Chinese athletes (54.5%). No significant differences were found when the frequency distributions of the groups were compared.

Considering all the cases, no mycosis was found in more than half of them (57.4%) and equal percent was found for the presence of only *tinea pedis* or onychomycosis (13.9%). The relationship between tinea pedis and onychomycosis was present in few cases (14.7%).

The fungal microbiota was composed of *Trichophyton rubrum* (40%), *Trichophyton mentagrophytes* (36.4%) and *Candida* spp. (20%). *Candida* was isolated only from Brazilian athletes. No other fungus was isolated (Table 3).

Mycological evaluation (direct microscopy and culture) of samples collected from the skin in different areas of the selected foot is shown in table 4, as well as data of the histopathological exams of the nail fragments. Nail clippings and mycological exams of nail scales demonstrated similar results. The degree of agreement between the different nail exams used, a projection of the correlation coefficient kappa, showed a significant agreement of the laboratorial results ($p < 0.0001$), showed in table 5.

Discussion

Foot mycoses are registered with different frequencies in male individuals [13]. Those variations are greatly influenced by social position and behavior more than biological reasons. Men do not frequently look for health care and, when they do, it is because the problem is already advanced [9,13,22].

There is a slight predominance of young individuals playing on Brazilian soccer teams (Table 1). However the age restrictions of entering this research controls this specific data. A greater incidence of *tinea pedis* and onychomycosis is demonstrated after second decade of life [4].

In Brazil, soccer players are a mixed racial group.

The theory of ethnic background influencing the development of fungal infection is still very controversial. Human leukocyte antigens (HLA) were pointed out as one of the features, in some populations, related to chronic dermatophyte infections [18]. Race was also associated with ungueal findings such as *melanonychia striata* found only in black, oriental and mulatto individuals [4].

Sports professionals receive multidisciplinary health services, because they are more exposed to situations that can be harmful to health. Frequent trips expose athletes to inter-human and environmental contagious situations and different epidemic niches. However, the isolated fungi were very similar to those found in other Brazilian studies [13,21]. Soccer players and non-athletes, presented with similar tinea pedis frequency (Table 2); however, the problem was more significant in the non-athletes group due to deficient feet ventilation during the workday. Interdigital maceration by sweating and occlusion caused by stockings and shoes contribute for acquisition of mycosis [20]. Frequent stockings and shoes changes and correct education from health care professionals explained lower incidence of tinea pedis in soccer players.

Onychomycosis alone affected 22.7% of the Chinese, 10.8% of the Brazilian soccer players and 16.7% of the non-athletes. Prevalence (Table 2) of tinea pedis alone was of 20.8% in non-athletes, and absent in Chinese soccer players. However, associated mycosis (nail and skin) was higher in Chinese than in Brazilians (athletes and non-athletes).

T. rubrum was prevalent in the samples (Table 3), while *T. mentagrophytes* was in second place in this study agreeing with previous studies [2,17]. Predominance of *T. mentagrophytes* in the Brazilian groups is explained by a possible natural selection or by an ecological adaptation. Temperature and humidity are very important for development of this dermatophytosis [2,15].

Table 3. Percentual distribution of observed cases according etiological agents.

| Etiological agent | Chinese athletes | Brazilian athletes | Non athletes | Total |
|------------------------------------|------------------|--------------------|--------------|-------|
| <i>Trichophyton rubrum</i> | 70 | 25 | 53.8 | 40 |
| <i>Trichophyton mentagrophytes</i> | 20 | 40.6 | 38.5 | 36.4 |
| <i>Candida</i> spp | 0 | 34.4 | 0 | 20 |
| Bacteria | 10 | 0 | 7.7 | 3.6 |

Table 4. Results of the laboratory exams obtained in the studies.

| Area / Material | Laboratory exam | Groups (n=129) | | | p-values* | | |
|-------------------|-----------------|-------------------------------|---------------------------------|---------------------------|--|----------------------------------|------------------------------------|
| | | Chinese athletes (n=22) n (%) | Brazilian athletes (n=83) n (%) | Non athletes (n=24) n (%) | Chinese athletes vs Brazilian athletes | Chinese athletes vs non athletes | Brazilian athletes vs non athletes |
| Plantar area | Direct exam | 2 (9.1) | 5 (6.0) | 6 (25.0) | 0.6310 | 0.2470 | 0.0149** |
| | Culture | 0 (0) | 3 (3.6) | 5 (20.8) | 1 | 0.0502 | 0.0135** |
| Interdigital area | Direct exam | 2 (9.1) | 15 (18.1) | 9 (37.5) | 0.5155 | 0.0376** | 0.0551 |
| | Culture | 4 (18.2) | 19 (22.9) | 7 (29.2) | 0.7764 | 0.4966 | 0.5913 |
| Nail | Direct exam | 1 (4.6) | 12 (14.5) | 6 (25.0) | 0.2924 | 0.0984 | 0.2289 |
| | Culture | 2 (9.1) | 9 (10.8) | 5 (20.8) | 1 | 0.4177 | 0.2991 |
| Nail clipping | Histopathologic | 2 (9.1) | 12 (14.5) | 3 (12.5) | 0.7291 | 1 | 1 |

* Fisher's exact test

** Statistically significant differences ($p < 0.05$)

Table 5. Comparative between mycological and histopathological analysis of the nail.

| Compared data | Kappa's correlation coefficient | Value of p |
|---|---------------------------------|------------|
| Direct mycological exam vs culture | 0.5047 | < 0.0001 |
| Direct mycological exam vs histopathological exam | 0.4837 | < 0.0001 |
| Culture vs histopathological exam | 0.4094 | < 0.0001 |

Candida spp can be found as an infectious agent or as a member of the normal microbiota of the interdigital foot areas. It can be acquired from direct contact between individuals or from indirect contamination of personal items. It is necessary to differentiate *Candida* infection from the ones of normal microbiota. Besides the clinical manifestations, the observation of hyphae or pseudo-hyphae in direct exam of skin or nail scales, and presence of PAS positive structures in histopathological exam of nail clipping or biopsy are necessary for the diagnosis of candidiasis.

In the Brazilian soccer players *Candida* spp as an etiological agent was attributed to possible skin pH changes and maceration and sweating. The usage of broad-spectrum antibiotics to eradicate foci of bacterial infections, as well as frequent joint infiltration of corticosteroids, were reported as contributing factors for the development of this yeast. Emotional stress from the play-offs soccer championship and world cup could also have contributed to reduced organic defenses and immunity problems [11].

Fungus presence does not necessarily unchain mycosis, if the necessary environment for its development does not exist. Therefore infection agent and host relation depends on a variety of features linked to the fungus and to the individual [21]. In the three groups nail traumas (due to sport or/and shoes) and the humidity on the feet contributed significantly for fungal infection.

The education on prophylaxis was the way to interrupt the emergence of tinea pedis in Chinese soccer players. The risk of onychomycosis could be avoided with reorientation and special vigilance of nails. Its repercussions in several dermatosis and usual sports mycosis will then be minimized [4,7,12].

It has been reported the importance of bacteria participating primarily and secondarily on the pathogenesis of tinea pedis [3] but we have not found a significant bacterial population on the studied specimens.

Feet fungal processes, in general, were better prevented in Brazilian athlete group. Looking for the best performance, Brazilian athletes are submitted constantly to clinical and laboratory exams, allowing a medical vigilance and healthier habits. This constant supervision helps prevention, leading to a diagnose in a sub-clinical phase of the disease. Non-athletes were not educated to feet care. Health attention regarding feet condition was not a priority for regular workers.

Mycological exams, direct and culture, from plantar area revealed a higher percentage of positive results in non-athletes. Feet protection demanded in soccer games reduce impact to plantar area. Interdigital area, had positive exams in the non-athletes group more often than in the athletes group. Permanent humidity between digital areas contributed for the development of mycosis (Table 4).

Nail mycosis can be quite hard to recognize. One may not realize the changes or not recognize them as a problem. Once enough health information is supplied, nail care may become a priority. Moreover, it is esthetically unpleasant and constitutes itself an infectious focus; the onychomycosis can cause more problems, such as lock landing of the nail, pain, discomfort, risk of secondary infection, surgery and removal of the activities [8,14].

In athletes, repetitive trauma can cause onycholysis and dystrophy with or without onychomycosis. In this group trauma and onychomycosis can be associated, not only one can be the cause of the other but also they can be connected to a common factor, in this case, physical activity. Secondary contamination due to pre-existent lesions is common and can be favored by the continuity of cutaneous lesions.

In the Chinese group, fungus was easily controlled on the plantar area, perishing in the interdigital area and nails. It is a known fact that mycosis affects primarily the skin of the feet, later on infecting the nails, where the fungus stays and can lead to a chronic stage, or to a stage where it comes and goes [3,14]. Histopathological exams carried out in nail fragments [19] added to the mycological exams from nail scrapings were in agreement (Table 5).

When compared between these groups, the expression "athlete's foot" is unfairly used, once the non-athletes show a higher frequency of tinea pedis. The possibility of developing skin and nail mycosis is higher in sports activities [4]; however, constant vigilance reduces its transmission and progression.

This research concludes that the prevalence of *tinea pedis* is higher in non-athletes than in soccer players, mostly because athletes carefully watch their feet minimizing this problem.

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