Epidemiology of dermatophytosis in junior combat and non-combat sports participants

Aylin Doğen,1 Ramazan Gümrul,2 Zehra Öksüz,1 Engin Kaplan,3 Mehmet Sami Serin1 and Macit Ilkit4

1Department of Pharmaceutical Microbiology, Faculty of Pharmacy, University of Mersin, Mersin, Turkey, 2Department of Microbiology, Gülhane Military Medical Academy, Ankara, Turkey, 3Advanced Technology Education, Research, and Application Center, Mersin University, Mersin, Turkey and 4Department of Microbiology, Division of Mycology, Faculty of Medicine, University of Çukurova, Adana, Turkey

Summary

Participation in competitive sports is popular and widely encouraged worldwide. Herein, we investigated 252 male and 67 female sports players, aged 16.4 ± 1.3 years, active in 15 different types of combat (n = 143) and non-combat (n = 176) sports. Of the 319 participants in this study, 11 (3.5%) players, including six wrestlers, four football players and one handball player, all of whom were men, harboured dermatophytic fungi. Briefly, Trichophyton tonsurans was present in three athletes, who were scalp carriers of the fungus. Furthermore, T. rubrum (4), T. interdigitale (3) and Arthroderma simii (1) were recovered from eight participants with tinea inguinalis (4), tinea pedis (2) or both (1). One patient was a trunk carrier of concomitant tinea pedis. All dermatophytic fungi were identified using both direction sequence of the rDNA regions spanning the internal transcribed spacers (ITS1 and ITS2) and 5.8 rRNA gene. Although sports-active individuals are active and sweat more, we observed a low prevalence of dermatophytosis, both in combat (5.2%) and non-combat sports participants (3.4%) (P > 0.05). However, dermatophyte infections require more attention and appropriate management to eradicate the infection and to prevent possible outbreaks. This study also documents the first case of zoophilic A. simii in Turkey.

Key words: Dermatophytes, football, scalp carriage, tinea inguinalis, tinea pedis, wrestling.

Introduction

Clinical forms of dermatophytosis in sports-active individuals are sport specific. For instance, participants in combat sports, such as wrestling and judo, are more likely to acquire tinea corporis gladiatorum or tinea capitis gladiatorum.1 On the other hand, the incidence of tinea cruris and tinea pedis does not differ across combat and non-combat sports.1 The anthropophilic dermatophyte Trichophyton tonsurans is an emerging pathogen that is responsible for several tinea gladiatorum outbreaks in North America,2,3 as well as Europe,4–7 the Middle-East8–10 and Japan.11 These worldwide outbreaks reflect the potential spread of this fungus across contact sports players. However, this infection is not adequately controlled, and effective methods of prevention and treatment have not yet been clearly defined.12 Therefore, clinicians and mycologists have focused on the spread of T. tonsurans, particularly in sports participants worldwide6–12 and in primary school children in endemic foci, such as the USA.13,14 Typically, the prevalence of asymptomatic carriers related to T. tonsurans remains higher than the apparent infection in primary school children.13,14 Importantly, Abdel-Rahman et al.14 reported that the vast majority (>89%) of primary school children from whom T. tonsurans can be recovered were persistent carriers, and transient acquisition accounted only for a minority of the infections. This finding may explain why outbreaks occur frequently in combat sports participants.
Epidemiological studies revealed that tinea pedis (athlete’s foot) has a prevalence of 3–51%, depending on the population group. Tinea pedis is closely associated with sports players and is one of the most common dermatophytoses in sports-active individuals. The most likely predisposing factors are: (i) exposure to shared showers, locker rooms or saunas, or contact with swimming pool floors; (ii) the athlete’s synthetic clothing and occlusive shoes; and (iii) the presence of minor foot trauma, which favours fungal growth. Tinea pedis is mainly caused by worldwide distributed anthropophilic dermatophytes, such as *T. rubrum* and *T. interdigitale*. Unfortunately, it is frequently misdiagnosed and inadequately treated. To the best of our knowledge, there are no data reporting the actual incidence and clinical presentations of dermatophytic infections in combat and non-combat sports participants and, consequently, more frequently transmitted fungal pathogens across sports participants.

### Materials and methods

#### Data collection

In January 2012, we enrolled a total of 319 participants of non-combat (*n* = 176) and combat (*n* = 143) sports, including 252 male players and 67 female players (Table 1). The mean age of the players was 16.4 ± 1.3 (range, 15–21) years. All the participants provided consent and were subjected to a short interview, which included a brief introduction to the present investigation and questions concerning their type of sport, lifestyle, body mass index, underwear characteristics, diabetes and history of use of antifungal drugs or steroids in the past year. Table 2 presents the dermatophyte isolates according to the participants’ anatomical sites and particular sports. Informed consent was obtained from the players and athletic directors before clinical sampling. On the basis of the clinical and mycological findings, the participants were classified as symptomatic, carriers or uninfected. The participants from whom dermatophytes were recovered, but who lacked clinical symptoms, were classified as asymptomatic carriers. We recorded the clinical diagnoses, mycological results and detailed history of each patient. This study was reviewed and approved by the Ethics Committee of Clinical Research at Mersin University.

#### Sample collection

Each player was visually examined for indicative lesions on the scalp (papules, pustules, broken hairs or alopecia), and aimed to describe the prevalence and clinical presentations of dermatophytic infections in combat and non-combat sports participants and, consequently, more frequently transmitted fungal pathogens across sports participants.

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Sport types</th>
<th>Dermatophyte</th>
<th>CBS no</th>
<th>Clinical picture (colony count)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>FW</td>
<td><em>T. tonsurans</em></td>
<td>132 348</td>
<td>Scalp carriage (23)</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>Football</td>
<td><em>T. tonsurans</em></td>
<td>132 349</td>
<td>Scalp carriage (10)</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>GRW</td>
<td><em>T. tonsurans</em></td>
<td>–</td>
<td>Scalp carriage (26)</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>GRW</td>
<td><em>T. interdigitale</em></td>
<td>132 350</td>
<td>Trunk carriage (9) + <em>T. pedis</em></td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>Football</td>
<td><em>T. interdigitale</em></td>
<td>132 351</td>
<td><em>T. inguinalis</em> + <em>T. pedis</em></td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>FW</td>
<td><em>T. interdigitale</em></td>
<td>132 353</td>
<td><em>T. inguinalis</em></td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>Football</td>
<td><em>T. rubrum</em></td>
<td>–</td>
<td><em>T. inguinalis</em></td>
</tr>
<tr>
<td>8</td>
<td>17</td>
<td>Football</td>
<td><em>T. rubrum</em></td>
<td>–</td>
<td><em>T. pedis</em></td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>Handball</td>
<td><em>T. rubrum</em></td>
<td>–</td>
<td><em>T. pedis</em></td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>FW</td>
<td><em>T. rubrum</em></td>
<td>–</td>
<td><em>T. inguinalis</em></td>
</tr>
<tr>
<td>11</td>
<td>18</td>
<td>FW</td>
<td><em>A. simii</em></td>
<td>132 352</td>
<td><em>T. inguinalis</em></td>
</tr>
</tbody>
</table>

FW, freestyle wrestling; GRW, Greco-roman wrestling.
trunk (papules, pustules, erythematous or scaly patches),
groin (scaling and well-defined border patches) and toe
webs (scaling, maceration or vesicles).\textsuperscript{10,18,19} Samples of
the scalp and trunk were obtained from all the
participants, regardless of clinical symptoms, by using
the hairbrush method described previously. Bilateral
groin and toe web samples were also taken separately
from all the participants, regardless of clinical symptoms,
by vigorously brushing each side of the groin four times
with a cotton swab dipped in sterile physiological saline.
Furthermore, 25 and 16 samples, were collected from
a wrestling mat and a taekwondo mat, respectively,
from two gymnasiums, and screened as described
previously.\textsuperscript{10,19}

Fungal culture
We used Sabouraud glucose agar (SGA; Merck, Darm-
stadt, Germany) plates containing 100 μg ml\textsuperscript{-1}
cyclo-
heximide (Sigma, Steinheim, Germany), 100 μg ml\textsuperscript{-1}
chloramphenicol (Sigma) and 50 μg ml\textsuperscript{-1} gentamicin
(Sigma) for the culture of samples. All the samples were
plated on site, and the plates were then transferred to
the Microbiology Laboratory at the Faculty of Phar-
macy, University of Mersin. The cotton swabs were
inoculated onto the study medium by rotating the swab
head while streaking it along the surface of the medium.
The cultures were incubated at 25 °C on the bench and
examined for evidence of growth 7, 14 and 21 days
after inoculation.

Colony count
The colonies on each plate were counted, and a total
colony count (equivalent to the number of spores
retrieved) was obtained for each participant. The
samples were classified as light, moderate and
heavy for 1–5, 6–10 and for >10 colonies
respectively.\textsuperscript{10,19}

Fungal DNA isolation, PCR amplification, sequencing and
analysis of the ITS region
DNA isolation and PCR amplification were performed
according to the protocol described by Turin \textit{et al}.\textsuperscript{20} The
rDNA regions spanning the internal transcribed spacer
(ITS)1, 5.8 rRNA and ITS2 regions were amplified using
the universal fungal primers ITS1 and ITS4. The
amplified DNA products were sequenced in both direc-
tions using PCR primers on an ABI PRISM 3130XL
Genetic Analyzer at Refgen Biotechnologies, Ankara,
Turkey. The DNA sequences of the forward and reverse
strands were analysed and aligned with the CAP Contig
assembly software included in the BioEdit Sequence
Alignment Editor 7.0.9.0 software package.\textsuperscript{21} The
assembled DNA sequences were examined using the
Basic BLAST (nucleotide-nucleotide) software from
the National Center of Biotechnology Information
A part of the study isolates have been deposited at the
Centraalbureau voor Schimmelcultures (CBS) Fungal
Biodiversity Centre culture collections, Utrecht, the
Netherlands (Table 2).

Statistical analysis
Statistical analysis was performed using the SPSS
statistical package computer software program version
17.0 for Windows (SPSS Inc., Chicago, IL, USA). The
categorical data between groups were analysed by using
Fisher’s exact chi-squared test. A \textit{P} value > 0.05 was
not considered statistically significant.

Results
In this investigation, we recovered dermatophytic fungi
in 11 of the 252 (4.4%) male participants, whereas no
fungi were isolated from any of the 67 girls. Notably,
there were no statistically significant differences among
sports type (combat or non-combat), lifestyle, body mass
index, underwear characteristics or diabetes (\textit{P} > 0.05;
Table 2). Briefly, three athletes- two wrestlers and one
football player- were diagnosed as \textit{T}. \textit{tonsurans} scalp
carriers. \textit{T}. \textit{tonsurans} was the only dermatophyte
obtained from the scalp samples. In addition, eight
athletes, including four wrestlers, three football players
and one handball player, had tinea inguinalis and/or
interdigital tinea pedis. We recovered \textit{T}. \textit{rubrum}, \textit{T}
interdigitale and \textit{A}. \textit{simii} from the glabrous skin of the
individuals. Notably, the participants had no underlying
dermatoses, and all lesions were assigned as primer
dermatophyte infections.

Specifically, we noted a higher prevalence of dermat-
ophytic fungi in male football players (4 of 63, 6.4%)
than in any of the other sports groups (\textit{P} > 0.05). There
were no statistically significant differences among free-
style (4 of 70, 5.7%) and Greco-Roman (2 of 53. 3.8%)
wrestlers (\textit{P} > 0.05). Notably, no dermatophytic fungi
were recovered from other sports groups or women. All
dermatophyte-positive participants were recommended
for an additional dermatologist visit to receive appro-
priate antifungal therapy. Both the mats sampled were
negative for fungi.
Discussion

Contact sports involve close skin-to-skin contact, facilitating the transmission of dermatophytes between competitors and team members. Recent studies have revealed that, although it is not spreading rapidly, T. tonsurans still exists in wrestlers throughout Turkey. We previously reported a clonal outbreak of EvSO3 type T. tonsurans in 14 wrestlers in Adana, Turkey. The molecular type EvSO3 (which corresponds to non-transcribed spacer 1) has been previously described in the USA, Canada and Japan. Notably, we reported that in both a clonal outbreak and a longitudinal study, the most common clinical presentation of T. tonsurans in wrestlers was scalp carriage. Recently, we investigated 194 wrestlers (17–20 years of age) from 34 provinces participating in a national competition in Turkey, and we found that only 17 wrestlers (8.8%) had T. tonsurans (11) and T. rubrum (6) infection or carriage. Specifically, in this study, T. tonsurans was recovered from eight scalp carriers, of whom six were only scalp carriers and two harboured T. tonsurans in the scalp as well as either the trunk or groin. In this study, we detected three scalp carriers of T. tonsurans who did not harbour dermatophytes in any other anatomical site.

In this investigation, we recovered dermatophytic fungi in 7 of 134 (5.2%) combat-sport participants and in 4 of 118 (3.4%) non-combat-sport participants (P > 0.05). Notably, dermatophyte fungi were recovered from only 11 men. The frequency of dermatophyte isolation according to the type of sport is as follows: football, 6.4%; Greco-Roman wrestling, 5.7%; freestyle wrestling, 3.8%; and handball, 12.5%. Importantly, in contrast to some other studies, no dermatophytes were isolated in 30 actively athletic men (Table 1). Scalp carriage was the only clinical entity related to T. tonsurans in three players. However, we observed high and moderate colony counts in two wrestlers and one football player, respectively, suggesting the potential spread of T. tonsurans in combat sports (Table 2). The transmission of tinea gladiatorum seems to occur by skin-to-skin contact; however, wrestling mats contaminated with T. tonsurans may also play a crucial role in the transmission of infection to wrestlers. In this study, although we screened wrestling and taekwondo mats with a total of 41 samples, no dermatophytes were isolated.

A pan-European study investigated tinea pedis and toenail onychomycosis in sports-active (n = 43 592) and non-sports active individuals (n = 5924). The results of that study revealed that sporting activities had no favourable effect on fungal infections of the foot; however, the prevalence of tinea pedis and toenail onychomycosis were reported to be 64% and 69.5% respectively. Purim et al. reported no significant differences in the prevalence of tinea pedis and/or onychomycosis among Chinese (45.5%) and Brazilian (38.6%) soccer players compared to that in non-athletes (54.2%). In contrast, Pickup and Adams reported that prevalence of tinea pedis in professional soccer players (69%), male college soccer players (69%) and female college soccer players (43%) was significantly higher than that in non-athletic men (20%) and women (0%). Lacroix et al. included 147 marathon runners in their study and reported mycologically confirmed tinea pedis in 33 of 66 (50%) runners and in 12 of 81 (14.8%) runners without lesions. The authors recommended prophylactic measures to limit the transmission of tinea pedis in individuals who frequently go barefoot in communal places. Sabadin et al. examined 100 male athletes and 100 controls, 18–40 years of age, and reported an equal prevalence of tinea pedis and/or onychomycosis (32%) in the two groups. Bolaños et al. noted a higher incidence of tinea pedis in individuals participating in a swimming course on day 12 (22%) of the course as compared to the prevalence on day 1 (13%). Furthermore, the most common fungal cause was T. rubrum (82%) on day 1, while it was found to be T. mentagrophytes (70.6%) in the second analysis on day 12.

In this study, we detected eight individuals harbouring dermatophytes in the glabrous skin. Briefly, we observed interdigital tinea pedis (2), tinea inguinialis (4) or both (1). In addition, one wrestler with tinea pedis was found to be a T. rubrum trunk carrier. It is not surprising that the feet and groin are among the most common anatomical sites harbouring the dermatophyte (Table 2). We found that tinea inguinialis is not always complicated with tinea pedis. It should be noted that sports-active individuals may shed dermatophytic fungi without obvious clinical infection and act as reservoirs. Asymptomatic carriers may unwittingly transmit the organisms to other athletes in the shower or locker room, or while sharing equipment. Furthermore, we observed no cases of onychomycosis, which may be due to the ages of the study participants. We also recovered T. rubrum, T. interdigitale and A. simii from the toe webs and inguinal areas of the participants.

Trichophyton/Arthroderma simii, belonging to the T. mentagrophytes complex, is a rare zoophilic dermatophyte that causes lesions on monkeys, cattle, fowl and dogs, and is a rare cause of ringworm in humans. It is more prevalent in India.
however, several human cases have been reported in regions in the Middle-East, such as Saudi Arabia\textsuperscript{35} and Iran.\textsuperscript{33} It also causes tinea capitis,\textsuperscript{34,35} tinea corporis\textsuperscript{31,35} and tinea inguinallis.\textsuperscript{35} To the best of our knowledge, this is the first study to report \textit{A. simii} recovered from a wrestler with tinea inguinallis in Turkey. Our case also had been in contact with his grandmother’s chickens, which may explain the possible transmission of this zoophilic fungus. In addition to its positive in vitro hair perforation test and urease activity, the most common morphological characteristics of \textit{A. simii} include short-clavate microconidia, the absence of spirally twisted hyphae and, in older cultures, its cylindrical, 3–7 celled, thin-walled macroconidia converted into chlamydospores.\textsuperscript{30,31,33}

In conclusion, although a control group was not included in this study, our results revealed that sports-active individuals are not at high risk for dermatophytic infections. However, scalp carriage related to anthropophilic \textit{T. tonsurans} could represent a very early stage of ringworm and may be transmissible and cause possible outbreaks. Therefore, this study also revealed the need for enhanced infection-control measures, such as health education and foot care, particularly among male wrestlers and football players who harbour dermatophytic fungi. In addition, multidisciplinary health services, including mycological investigations, should be required for individuals engaging in sports.

\textbf{Acknowledgments}

The authors acknowledge Dr Semra Erdoğan for statistical analysis and Assoc. Professor Murat Durdu for critical reading of the manuscript. In addition, we gratefully appreciate Professor G. Sýbren de Hoog’s (Centraalbureau voor Schimmelcultures, Utrecht, the Netherlands) kind cooperation and verification of the isolates examined in this study.

\textbf{References}


23. Mochizuki T, Kawasaki M, Anzawa K et al. \textit{Extra-scalp black dot ringworm caused by \textit{Trichophyton tonsurans}}


31 Stockdale PM, Mackenzie DWR, Austwick PCK. *Arthroderma simii* sp. nov., the perfect state of *Trichophyton simii* (Pinoy) comb. nov. *Sabouraudia* 1965; 4: 112–23.


