Trichophyton tonsurans scalp carriage among wrestlers in a national competition in Turkey

Macit Ilkit • Ramazan Gümrä • Mehmet Ali Saraçlı • Refik Burgut

Abstract  Trichophyton tonsurans tinea gladiatorum is an emerging epidemic among combat-sport athletes across the globe. In the present study, we investigated the prevalence of symptomatic and asymptomatic dermatophytic infections among wrestlers in the National Greco-Roman Championship in Turkey. In total, 194 wrestlers from 32 provinces and 72 clubs were examined for scalp, trunk, groin, and toe web dermatophytic infections. We also administered a questionnaire to obtain information on the participants’ lifestyles, wrestling characteristics, and risk factors for dermatophytic infections. The hairbrush method was used for scalp and trunk sampling, whereas a cotton swab was used for groin, toe web, and mat sampling. Three wrestling mats in the gymnasium were surveyed for dermatophytes using the touch preparation method. A total of 17 (8.8%) wrestlers harbored dermatophytes, and 22 strains were isolated: 13 (59.1%) T. tonsurans and 9 (40.9%) T. rubrum. These isolates were found on the scalp (8), trunk (2), forearm (1), hand (1), groin (3), and feet (7). In addition, we recovered 8 dermatophyte strains from the 150 mat samples (5.3%): T. rubrum in 6 samples (75%) and T. tonsurans in two samples (25%). T. tonsurans was only recovered from 11 out of 194 (5.7%) wrestlers. Scalp carriage represents the predominant (72.7%) clinical picture of a T. tonsurans infection in these Greco-Roman wrestlers in Turkey.

Keywords  Anthropophilic · Asymptomatic carrier · Dermatophyte · Trichophyton tonsurans · Wrestling

Introduction

Due to the anthropophilic dermatophyte Trichophyton tonsurans, tinea capitis gladiatorum and tinea corporis gladiatorum (TCG) are widely discussed clinical pictures that are observed in the participants of combat sports, e.g., wrestling and judo practitioners [1–3]. The transmission patterns of these organisms appear to be through man-to-man and mat-to-man contact [4]. In addition, the acquisition of these organisms through sporting devices, clothing, and bedding has been reported [1, 3, 4]. Infections may occur sporadically or epidemically, and an increase in the incidences has been noted over the last few decades [5, 6]. Hence, the epidemic spread of
T. tonsurans, particularly in wrestlers and in their teammates, competitors, families, and living areas, is well known and has gained importance worldwide [3, 7–11]. Tinea capitis may also present as a minimal infection, termed carrier state. An asymptomatic carrier state is observed in an individual who exhibits no signs or symptoms of tinea capitis and in an individual who also has a dermatophyte-positive culture. Importantly, anthropophilic dermatophytes, T. tonsurans and T. violaceum, have been generally associated with high rates of asymptomatic carriage [12].

Wrestling is the national sport of Turkey and is popular throughout the country. Recently, two tinea gladiatorum outbreaks (due to T. tonsurans) were identified among wrestlers in the Denizli [11] and Adana [3] provinces of Turkey. However, no data exist about the prevalence, clinical types, and etiological agents of these dermatophytoses. To the best of our knowledge, the present work is the first non-outbreak report to investigate the prevalence and clinical forms of dermatophytic infections among wrestlers in Turkey.

Materials and methods

Data collection

The present study was conducted from March 5th to the 7th 2010, during the National Junior Greco-Roman Championship in Kayseri, Turkey. At the championship, 370 athletes from 34 provinces participated, representing 102 clubs. Of these athletes, 159 consented and were subjected to a short interview, which included a brief introduction to the present investigation and questions concerning their lifestyle, wrestling characteristics, and risk factors for dermatophytic infections. In addition, 31 wrestlers, who were aged 13–17 years, from the Kayseri Wrestling Training Center and four coaches from four different clubs were tested for the presence of dermatophytic infections.

Informed consent was obtained from the wrestlers and athletic directors before sampling. The wrestlers were classified as cases, carriers, or uninfected, based on the combination of the clinical and mycological findings. The wrestlers from whom dermatophytes were recovered, but who lacked clinical symptoms, were considered to be asymptomatic carriers. We recorded the clinical diagnoses, mycological results, and detailed histories of each wrestler [3]. The wrestlers who tested positive were advised to consult a dermatologist and to undergo treatment. The present study was reviewed and approved by the Faculty of Medicine’s Ethics Committee of Çukurova University.

Sample collection

Scalp samples were taken from all of the wrestlers, regardless of their clinical symptoms, by vigorously brushing each side of the scalp four times with a plastic hairbrush. The hairbrush had 167 plastic prongs, was circular in shape, and could fit in a Petri dish. This method was also conducted to obtain trunk samples, regardless of whether clinical lesions were present. For the sampling of the groin and toe web, a cotton swab was rubbed on the surface of the skin after the swab was dipped in sterile saline. The latter sampling method was also applied to the right and fourth interdigital surfaces.

Wrestling mats

The mats that were used for the matches were made of polyvinyl chloride (PVC) leather and cross-linked polyethylene (XPE) foam. The touch preparation of the damp mats was carried out using a sterile cotton swab that was moistened with a sterile saline solution to improve the adherence of the dermatophytes. The three wrestling mats in the gymnasium were screened immediately at the end of the competitions each day. Briefly, 25 samples were collected from each mat daily. Hence, 75 mat samples were collected each day. At the end of the 2nd day, a total of 150 mat samples were collected. However, we were unable to sample the wrestling mats at the end of the 3rd day of the competition.

Fungal culture

Each athlete was visually examined for indicative lesions on the scalp (broken hairs and/or alopecia), trunk (erythematous and scaly patches), groin (scaling and well-defined border patches), and the right toe web (scaling and fissuring). The scalp and trunk specimens were dislodged when the brushes were
inoculated onto the surface of the agar. Each hairbrush was stabbed into the medium, creating 167 inoculation points that corresponded to the 167 prongs of the hairbrush. The cotton swabs were inoculated onto the study medium by rotating the swab head while streaking it along the surface of the medium. Sabouraud glucose agar (SGA; Merck, Germany) plates that contained 100 µg/ml cycloheximide (Sigma, Germany), 100 µg/ml chloramphenicol (Fluka, China), and 50 µg/ml gentamicin (Sigma) were used as the study medium. All of the clinical and mat samples were plated on site, and then the plates were transferred to the Mycology Laboratory at the Faculty of Medicine, University of Çukurova. The cultures were incubated at 25°C on the bench and were examined after 7, 14, and 21 days for evidence of growth [3]. The T. tonsurans and T. rubrum isolates were identified using conventional methods, including their colonial and micro-morphological characteristics, as described previously [2, 4, 11, 13].

Colony count

The colonies on each plate were counted, and a total colony count (which was equivalent to number of spores retrieved) was obtained for each participant. A colony count system was assigned as follows: light for 1–5 colonies, moderate for 6–10 colonies, and heavy for >10 colonies [3, 12] per plate.

Statistical analysis

All of the data on the wrestlers were compiled, edited, and analyzed using statistical software (Statistical Packages for Social Sciences (SPSS), version 18). From the analyses, descriptive measurements and summary tables were obtained. Chi-squared tests were used to evaluate the factors that may be associated with the recovery of T. tonsurans and T. rubrum. A P value <0.05 was assumed to be statistically significant.

Results

The mean age of the wrestlers was 18.0 ± 4.2 (min: 12, max: 45) years. The mean duration of participation in wrestling was 68.1 ± 55.9 months (min: 1, max: 408), and the mean number of wrestling matches was 155.6 ± 238 (min: 1, max: 2,000). A total of 22 dermatophyte strains were recovered from 8.8% (17/194) of the participants. The human-derived isolates were found on the scalp (8), trunk (2), forearm (1), hand (1), groin (3), and feet (7). The remaining 177 wrestlers (91.2%) were found to be uninfected. Out of the 15 T. tonsurans strains that were recovered in the present study, 13 originated from a human body site and two originated from the mats (Table 1). Of the 15 T. rubrum strains recovered, nine were human-derived and six were mat isolates. As a result, T. tonsurans (50%) and T. rubrum (50%) were the two anthropophilic species that were recovered from both human and mat samples.

T. tonsurans isolates

A total of 13 T. tonsurans isolates that were derived from 8 cases without clinical lesions, and 3 cases with clinical lesions were recovered from 11 (5.7%) wrestlers. T. tonsurans was the only dermatophyte species that was isolated from asymptomatic scalp and trunk samples. The scalp carriers had no evidence of scalp scaling and had no clinical evidence of other symptoms of tinea capitis. Asymptomatic scalp carriage was detected in eight of the wrestlers; trunk and groin carriage due to T. tonsurans was detected concurrently in two of the scalp carriers. In addition, this anthropophilic fungus was isolated from the clinical lesions (e.g., trunk, forearm, and hand). The number of colonies, which were formed by the 167 prongs per hairbrush that were stabbed into the culture medium, ranged from 1 to 5 in 5 (62.5%) of the scalp isolates, from 6 to 10 in 2 (25%) of the scalp isolates, and from 11 to 99 in the remaining 1 (12.5%) scalp isolate. The only trunk carrier had a colony count of two, and this count was derived from a patient with a large (n = 99) colony count. In addition, 11 T. tonsurans carriers were identified among the wrestlers from seven different provinces: Istanbul (n = 4), Erzurum (n = 2), Artvin (n = 1), Ordu (n = 1), Kayseri (n = 1), Gaziantep (n = 1), and Isparta (n = 1) (Fig. 1). Five of the 11 (45.5%) wrestlers had a history of international wrestling (Table 1).
geographic regions or the duration of their participation in wrestling ($P > 0.05$). However, international wrestling including any country was associated with an increase in the risk of dermatophytosis by 3.85-fold (95% CI: 1.4–10.6). There were no risk factors associated with personal hygiene or the sharing of belongings ($P > 0.05$). Furthermore, no significant relationship was observed between the cases that harbored dermatophytes and a family history of dermatophytic infections ($P = 0.46$). The frequency of *T. tonsurans* recovery was highly prevalent among those wrestlers who shared showers, wrestling trunks, and slippers.

*T. rubrum* isolates

This anthropophilic fungus was detected in seven wrestlers with nine isolates. In detail, *T. rubrum* was recovered from the clinical lesions [e.g., groin (1), toe web (4), and sole (1)]. In addition, one case demonstrated four separate concurrent infected sites, including the scalp (due to *T. tonsurans*), groin, dorsum of the feet, and toe web (due to *T. rubrum*). *T. rubrum* was the only dermatophyte that was inoculated with the samples from the toe web, sole, and dorsum of the feet.

Mat samples

We isolated a total of 8 (5.3%) dermatophyte strains from the 150 mat cultures, comprising six *T. rubrum* [mat A (2), mat B (2), and mat C (2)] and 2 *T. tonsurans* [mat A (1) and B (1, 1st day)]. Interestingly, only one isolate was detected on the 1st day (*T. tonsurans* from mat B), but seven isolates were detected on the 2nd day ($P = 0.03$).

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**Table 1** Descriptive characteristics of *T. tonsurans* infection

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Weight</th>
<th>Province</th>
<th>Clinical picture (colony count)</th>
<th>National match</th>
<th>International match</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
<td>35</td>
<td>Kayseri</td>
<td>Tinea corporis</td>
<td>50</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>49</td>
<td>Istanbul</td>
<td>Scalp carrier (7)</td>
<td>150</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Groin carrier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>60</td>
<td>Istanbul</td>
<td>Scalp carrier (99)</td>
<td>300</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Trunk carrier (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>50</td>
<td>Artvin</td>
<td>Scalp carrier (8)</td>
<td>10</td>
<td>–</td>
</tr>
<tr>
<td>5</td>
<td>18</td>
<td>55</td>
<td>Ordu</td>
<td>Scalp carrier (1)</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
<td>56</td>
<td>Erzurum</td>
<td>Scalp carrier (1)</td>
<td>350</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>18</td>
<td>63</td>
<td>Erzurum</td>
<td>Scalp carrier (2)</td>
<td>200</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>18</td>
<td>68</td>
<td>Gaziantep</td>
<td>Tinea corporis</td>
<td>250</td>
<td>–</td>
</tr>
<tr>
<td>9</td>
<td>18</td>
<td>74</td>
<td>Isparta</td>
<td>Scalp carrier (1)</td>
<td>200</td>
<td>–</td>
</tr>
<tr>
<td>10</td>
<td>19</td>
<td>80</td>
<td>Istanbul</td>
<td>Scalp carrier (1)</td>
<td>200</td>
<td>–</td>
</tr>
<tr>
<td>11</td>
<td>44</td>
<td>116</td>
<td>Istanbul</td>
<td>Tinea manuum</td>
<td>2,000</td>
<td>5</td>
</tr>
</tbody>
</table>

**Fig. 1** Distribution of *T. tonsurans* cases among wrestlers by provinces in Turkey
Discussion

Trichophyton tonsurans infections occur in various host populations, on various body sites, and with varying degrees of inflammation [14]. This organism is a widely distributed pathogen that demonstrates a significant degree of genetic and phylogenetic heterogeneity. To date, 65 distinct stable genetic strain types have been characterized across North America, Europe, Asia, and Australia [15]. Recently, we reported a clonal outbreak of T. tonsurans tinea capitis gladiatorum among wrestlers in Adana, Turkey [3]. The strain that was observed in our recent study [3] was also observed among the isolates that were recovered from the United States, Canada, and Japan [15]. Notably, all of the Japanese isolates derived from combat-sport athletes that share this genetic profile are believed to have been introduced into Japan during international competitions [3]. The detection, prevention, and treatment of T. tonsurans infection are crucial to control the T. tonsurans infection among wrestlers, their families, trainers, and coaches in clubs [16–19]. Ongoing surveillance, coupled with molecular analyses and effective management, will reveal whether the epidemic outbreaks that were observed in Japan and similar countries will be eradicated or whether these outbreaks will transition into an endemic disease, as in North America [6]. Therefore, we have suggested the use of a treatment strategy (e.g., ketoconazole shampoo body washes) with resampling to ensure resolution or the use of oral antifungals because the majority of our isolates were derived from the scalp.

In a previous review, it was reported that the dermatophytic lesions that are observed among wrestlers are typically found on the upper extremities, head, neck, and trunk and are rarely observed on the legs [1]. In the literature, the predominant cause of dermatophytic lesions is TCG [2, 3, 7, 8, 10, 19–21]. The most common etiologic agents of TCG cases have been reported and identified in several studies as T. tonsurans [2, 7, 8, 10, 11, 19–21], T. verrucosum [22], T. rubrum [9], and T. equinum [23]. In contrast, the most common causative organism of tinea corporis in non-athletes is T. rubrum [24].

The highest prevalence of TCG was observed in young wrestlers under the age of 20 years [3, 4, 10, 11, 18, 19]. In this present investigation, the majority of the wrestlers were in the 17–20 age group, which is in agreement with the current literature. However, we detected a very low [8.8% (17/194)] prevalence of dermatophytic pathogens in the athletes. In addition, as we have not conducted a microscopic examination (a negative microscopy result was an additional older criterion used to diagnose the carrier state), we may have overlooked a small number of infections. Moreover, T. tonsurans was only encountered in 11 wrestlers (5.7%) from seven different provinces (Fig. 1). The low level of T. tonsurans in Turkish wrestlers may be due to (1) limited participation in national and international matches, (2) relatively few matches with other athletes, or (3) a low level of contamination of the wrestling mats. In the literature, a slightly higher positive hairbrush culture than what was reported in the present study due to T. tonsurans has been reported: 11.3% [17] and 11.5% [2]. Interestingly, one previous study documented a TCG prevalence of 24% in a wrestling team that was without a known epidemic [25].

Ergin et al. [11] reported that 76% of wrestlers who were diagnosed with TCG had concomitant culture-positive tinea capitis. It was also noted that these athletes could harbor the fungus without any clinical indicators of disease, suggesting the presence of a carrier state [2, 3]. Recently, we detected that the carrier state, particularly scalp carriage, is more common than the cases of tinea capitis superficialis (31.1% vs. 17.2%) [3]. It is important to be aware of this finding because the untreated carriers remain a vector for spreading the infection to their teammates and are also susceptible to developing overt clinical infections [3, 24]. Interestingly, one study that investigated 193 athletes noted that 19 (9.8%) of these athletes had symptomatic tinea, whereas only 8 (4.2%) of the athletes had a mycologically proven infection (T. tonsurans) [5].

In the present investigation, a total of 30 dermatophyte strains were recovered: 22 from human samples and 8 from mat samples. T. tonsurans scalp carriage was the predominant clinical pattern, which was detected in eight cases, and a symptomatic infection was only detected in three cases. Tinea corporis was detected in two cases, and tinea manuum was detected in one case (Table 1). As mentioned in previous studies, the scalp and trunk area are the most common sites of infection due to the greater amount of direct contact to the mat and other athletes of these areas compared with other areas of
the body [1, 4, 20]. It is well established that asymptomatic carriage may play a critical role in the transmission and persistence of dermatophyte fungi within a population [2, 3, 12, 26]. Therefore, the detection and management of asymptomatic carriage is of great value. However, T. tonsurans is not a common cause of symptomatic or asymptomatic scalp ringworm in Turkey [12, 27].

We believe that the close monitoring of the colony count may provide valuable information and may enable us to predict whether the carrier state will persist, convert to tinea capitis, or disappear [12]. It is interesting, although not surprising, that only one of the infected carriers exhibited a heavy colony count (i.e., >10 colonies) (Table 1). Therefore, a higher level of inoculum may be required to cause symptomatic disease [3]. Recently, Kawachi et al. [28] reported long-term recurrent and multiple disseminated eruptions of T. tonsurans tinea faciei and tinea corporis, which persisted for 10 years in a 12-year-old Japanese girl. The authors suggested that autoinoculation from asymptomatic scalp carriage was responsible for the presence of disease. In our study, Case 2 and Case 3 revealed groin and trunk carriage, respectively, which may be due to fungal elements being dropped from the scalp (Table 1). Hence, the scalp is a potential source of dermatophyte fungi in asymptomatic or symptomatic glabrous skin infections.

Shiraki et al. [2] identified the risk factors for becoming a carrier or for developing an active infection during the sporting season. These risk factors included a history of scalp and neck involvement, a failure to wear headgear, and a failure to launder clothes at least once a week. The authors also reported that a questionnaire form was a simple and useful tool to estimate the epidemiology of T. tonsurans. Recently, Mulic et al. [5] identified the risk factors for a T. tonsurans infection as the duration of participation in competition, the duration of club membership, age, and a history of treatment for the infection. We also observed that all of the 194 wrestlers failed to wear headgear. Interestingly, some sport organizations find themselves screening and recommending treatment for all of the culture-positive athletes, regardless of whether the athlete appears to be symptomatic [17].

Anthropophilic T. rubrum, a cosmopolitan fungus, was isolated from the human groin (n = 2), human feet (n = 7), and mat (n = 6) samples. This fungus has become the leading cause of glabrous skin and nail dermatophytic infections worldwide. In this investigation, T. rubrum was isolated mainly from patients with tinea pedis. To prevent the acquisition and spread of fungal pathogens, it has been suggested that athletes should always wear sandals in the locker room and showers [24].

In the present study, we detected a higher level of dermatophyte colonization of the wrestling mats on the 2nd day of sampling compared with the 1st day of sampling (seven isolates vs. one isolate) (P = 0.03). T. tonsurans was only isolated once during the 1st and 2nd day of the competition. In addition, we isolated T. rubrum and T. tonsurans from the same mat on the same day (2nd). It has been reported that wrestling mats may be efficient reservoirs for the maintenance and spread of dermatophytes among wrestlers [3–5, 18]. This finding may be explained by the presence of a large number of lesions on the lower extremities of the wrestlers [4]. In contrast, even though we isolated dermatophytic fungi from the mats, we only recovered fungi from the upper extremities of two of the wrestlers, and no lesions were detected on the lower extremities of these wrestlers. It is important to note that, in the Greco-Roman style of wrestling, it is forbidden to hold the opponent below the belt, to trip the opponent, or to actively use the legs in the execution of any action. Therefore, our results demonstrated that the horizontal transmission of T. tonsurans occurs mainly via man-to-man contact, despite the fact that mat-to-man contact can also transmit the disease.

In the literature, the isolation of T. tonsurans from mat cultures as one of the possible routes of transmission and its importance in the pathogenesis of tinea gladiatorum has been described [3, 8, 10, 18]. These findings are in agreement with the findings of the present study. Recently, one study reported the isolation of T. tonsurans from 4 of 80 (5%) damp mat samples, whereas no fungus was recovered from the same mats when they were dry, even though 160 samples were processed [5]. Fungal arthroconidia can survive in the environment; therefore, personal belongings and living areas may expose a subject to dermatophytic infections and/or re-infection and may also cause an outbreak [3].

In conclusion, we demonstrated a low prevalence of dermatophytic infections (8.8%), in particular
T. tonsurans (5.7%), among Greco-Roman wrestlers in Turkey. As was stated in a recent study by our group [3], asymptomatic T. tonsurans carriage, in particular scalp carriage, was the predominant dermatophytic infection. We observed that T. tonsurans infection is not yet spreading rapidly through Turkey. However, as shown in Fig. 1, T. tonsurans still exists in Turkey from east-to-west and north-to-south. Therefore, periodic clinical and mycological examinations among all of the age groups of wrestlers may highlight the actual prevalence of T. tonsurans. In addition, reliable control measures should be taken immediately to prevent the presence of the carrier state, infections, and possible outbreaks.

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Conflict of interest The authors report no conflicts of interest.

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