

Skin Infection due to *Trichophyton tonsurans* Still Occurs in People in Korea but not as Outbreaks

Weon Ju Lee,¹ Hyun Bo Sim,¹
Yong Hyun Jang,¹ Seok-Jong Lee,¹
Do Won Kim,¹ Jae Bok Jun,²
and Yong Jun Bang²

¹Department of Dermatology, Kyungpook National University School of Medicine, Daegu; ²Institute of Medical Mycology, Catholic Skin Clinic, Daegu, Korea

Received: 17 June 2015
Accepted: 29 October 2015

Address for Correspondence:

Weon Ju Lee, MD

Department of Dermatology, Kyungpook National University School of Medicine, 130 Dongdeok-ro, Jung-gu, Daegu 41944, Korea
Tel: +82.53-200-5838, Fax: +82.53-426-0770
E-mail: weonju@knu.ac.kr

Since 1995, *Trichophyton tonsurans* has been one of the causative agents of dermatophytosis in Korea. Herein we evaluate 77 patients infected with *T. tonsurans* who visited an outpatient clinic between 2004 and 2014. Infections due to *T. tonsurans* were diagnosed by mycological examination, which included direct microscopic examination using 15% KOH and culture in potato dextrose agar complemented with 0.5% chloramphenicol. The annual prevalence of infection due to *T. tonsurans* was the highest in 2014 (15 cases) but remained constant in non-gladiators between 2004 and 2014. The ratio of male to female patients was 1:0.3. The spring season presented the highest incidence compared with other seasons, with 27 cases. The incidence of infections due to *T. tonsurans* among gladiators was highest in spring compared with the other seasons whereas the incidence in non-gladiators was the highest in the winter. The body site most commonly affected was the face. Tinea corporis was the most common subtype of dermatophytosis caused by *T. tonsurans*. Herein, we demonstrate that the prevalence of infection with *T. tonsurans* remain constant throughout the study period in Korea.

Keywords: *Trichophyton tonsurans*; Korea; Epidemiology; Dermatophytosis

INTRODUCTION

Trichophyton tonsurans is an anthropophilic dermatophyte, responsible for infections of the scalp and sometimes of the glabrous skin or nails. Unlike dermatophytosis caused by other dermatophytes, the clinical features of infection due to *T. tonsurans* are not very apparent initially. Tinea corporis due to *T. tonsurans* appears as small, erythematous, scaly plaques, often measuring only 1-2 cm in diameter, have no central clearing, and are similar in appearance to eczema. Tinea capitis due to *T. tonsurans* can be subdivided into three types: the seborrheic subtype, which is primarily characterized by the presence of dandruff and crusts; the kerion celsi subtype; and the black dot subtype. Epidemiological data regarding *T. tonsurans* infections have emerged from different studies and countries (1-4). Infection due to *T. tonsurans* is common in Mexico, in other countries of Latin America, and in large cities in the United States. By contrast, such infections are rare in Korea; in addition, since its first diagnosis in Korea in 1995, a small number of cases have been found. In 1995, South Korean gladiators were reported to be infected with *T. tonsurans* during international competitions (1). Since 2000, infections due to *T. tonsurans* have spread to non-gladiators. Moreover, cases of intrafamilial infections have been reported in the Korean dermatological literature (2). This study aimed to investigate the epidemiological characteristics of infections due to *T. tonsurans* in Korea.

MATERIALS AND METHODS

Patients

The epidemiological and mycological characteristics of 77 patients diagnosed with *T. tonsurans* were retrospectively investigated by examining the medical records obtained from the Catholic skin disease clinic between 2004 and 2014.

Methods

The medical records were used to evaluate the annual prevalence and patients' distribution according to age, sex, season, site, and infection mode. Patients were divided into three groups: gladiators, intrafamilial infection among non-gladiators, and non-gladiators. In addition, microscopic examination using a 15% KOH solution had been performed in all patients. Diagnosis of infections due to *T. tonsurans* had been confirmed using fungal culture in potato dextrose agar corn meal Tween 80 media. The culture media were maintained at 24-26°C and examined after 1 to 2 weeks. The patients with *T. tonsurans*-positive cultures were enrolled in this study. Furthermore, microscopic examination with lactophenol cotton blue stain was performed to identify filamentous fungi.

Ethics statements

This study was approved by the institutional review board of Kyungpook National University Hospital (IRB No. 2015-05-

036). Informed consent was waived by the board.

RESULTS

Positivity of KOH wet mount

Of the 77 patients, 68 (88.3%) showed positive KOH wet mount results.

Prevalence of infection due to *T. tonsurans*

The annual number of patients infected with *T. tonsurans* was the lowest in 2010 (2 cases, 2.6%) and the highest in 2014 (15 cases, 19.5%). Infections due to *T. tonsurans* still occurred in Korea until quite recently. Gladiators, including wrestlers, judoists, and Ssireum players (Korean traditional wrestlers), showed the highest incidence in both 2004 and 2014 whereas the prevalence in non-gladiators and intrafamilial infection remained constant during this period (Fig. 1A). The proportion of *T. tonsurans* infection in dermatophytosis was maintained steadily (0.02%-0.07%), but in 2014, the proportion was increased (0.12%) (Fig. 1B).

Distribution of infection according to sex and age

Of the 77 patients, 58 were men and 19 were women (ratio of 1:0.3). The mean age was 19.3 years among the total population, 17.3 years among male patients and 25.3 years among female patients. Fifty-five patients were teenagers (71.4%) (Fig. 2). Gladiators were in the age group 10-20 years (Table 1). Approximately 50% of the patients among the non-gladiators and intra-

familial infection were in the age group 10-20 years.

Seasonal distribution

A total of 27 cases (35.1%) occurred in the spring, representing the highest incidence compared with the other seasons, followed by 26 cases (33.8%) in the winter, 15 cases (19.5%) in the fall, and 9 cases (11.7%) in the summer. The incidence of infections due to *T. tonsurans* among gladiators was the highest in the spring compared with other seasons, conversely, among the non-gladiators and intrafamilial group, the incidence was the highest in the winter (Fig. 3).

Topographical distribution

The most common site of infection due to *T. tonsurans* was the face (Fig. 4A). Of the 77 patients, 20 cases (25.9%) had infections of the face. The scalp and arms were the second most common sites of infection, followed by the arms, neck, back, and chest. The number of cases of infection due to *T. tonsurans* was 13 cases (16.9%) on the scalp, 13 cases (16.9%) on the arms, 11 cases (14.3%) on the neck, 7 cases (9.1%) on the back, and 4 cases (5.2%) on the chest. The legs, feet, hands, nail, and hip were less common sites of infection due to *T. tonsurans*. Only 9 cases had

Table 1. Age and sex distribution among patients infected with *Trichophyton tonsurans*

Age	Sex	Gladiators	Intrafamilial infection	Non-gladiators	Total
10s-20s	Male	32	0	18	50
	Female	8	0	4	12
Non 10s-20s	Male	0	2	6	8
	Female	0	4	3	7

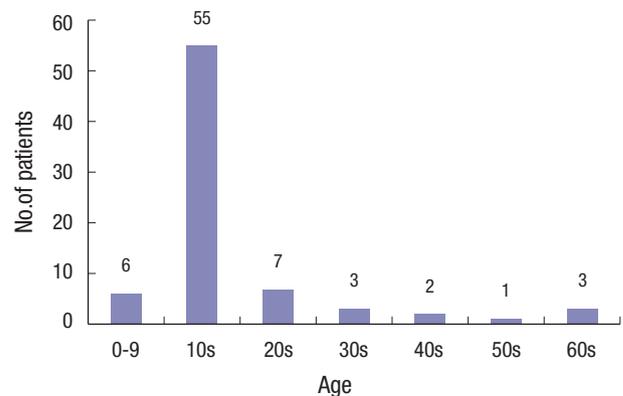


Fig. 2. Age distribution of patients infected with *Trichophyton tonsurans*.

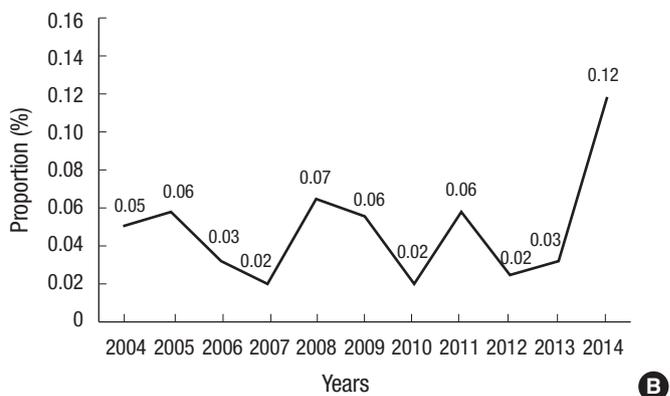
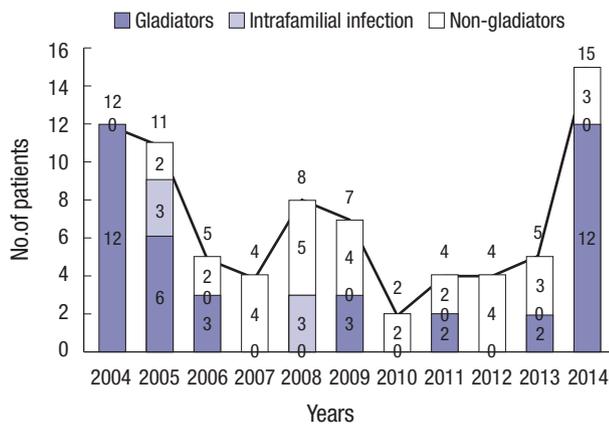


Fig. 1. Prevalence of *Trichophyton tonsurans* between 2004 and 2014. (A) The annual number of patients infected with *Trichophyton tonsurans*. (B) The annual proportion of *Trichophyton tonsurans* infection in dermatophytosis.

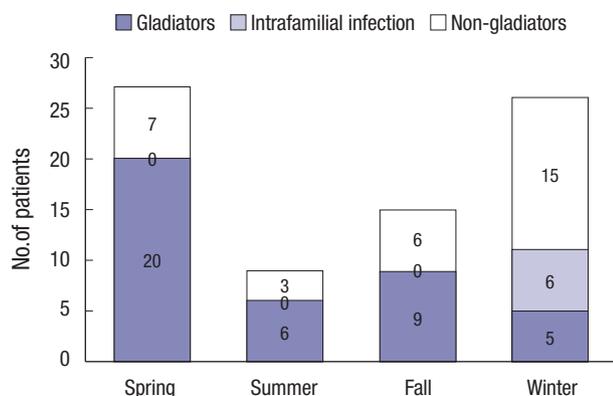


Fig. 3. Seasonal distribution of patients infected with *Trichophyton tonsurans*.

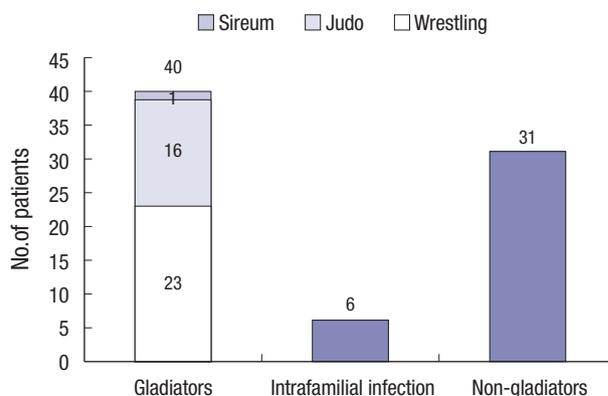


Fig. 5. Distribution of patients infected with *Trichophyton tonsurans* according to infection mode.

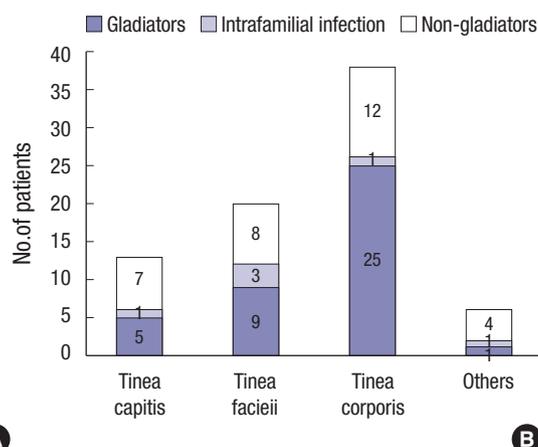
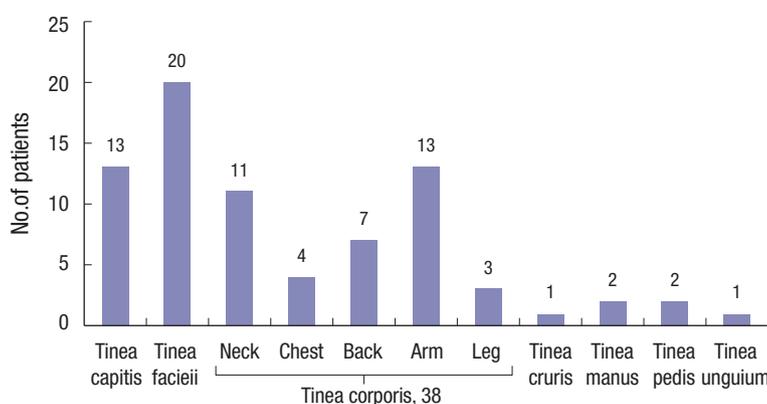


Fig. 4. Topographical distribution of *Trichophyton tonsurans*. (A) The number of patients according to the subtype of dermatophytosis. (B) The number of patients according to infection mode in each subtype of dermatophytosis.

infections in the legs, feet, hands, nail, and hip, accounting for 11.7% of the cases. Tinea corporis was the most common subtype of dermatophytosis caused by *T. tonsurans* (Fig. 4B). Thirty-eight cases (49.4%) involved tinea corporis, including infections of the neck, chest, back, arms, and legs. The second most common subtype was tinea faciei, with 20 cases (25.9%). The third most common subtype was tinea capitis, with 13 cases (16.9%). Only 3 cases involved tinea pedis or tinea unguium (3.9%). The most common subtype among gladiators infected with *T. tonsurans* was tinea corporis, followed by tinea capitis and tinea faciei (Fig. 4B). In tinea corporis of gladiators by *T. tonsurans*, 9 cases (34.6%) were infected on the arm, 8 cases (30.8%) on the neck, and 4 cases (15.4%) on the back, but in non-gladiators and intrafamilial infection, 5 cases (35.7%) on the back, 3 cases (21.4%) on the arm and neck.

Analysis of infection mode

Of the 77 patients, 40 cases (51.9%) were gladiators, including wrestlers, judoists, or Ssireum players (Fig. 5). They were infected through contact during combat sports events. Seven cases were developed through intrafamilial infection (9.1%). The re-

maining 31 cases occurred in non-gladiators (40.3%).

DISCUSSION

The incidence of infection due to *T. tonsurans* differs among countries (3-6) and such infections were not reported in Korea before the 1990s. Since the first report in 1995, this organism has also been observed in gladiators in Korea, including wrestlers, judoists, and Ssireum players. Suh et al. (1) reported the first case of the black dot subtype of tinea capitis caused by *T. tonsurans* in a middle school wrestler. Subsequently, Choi et al. (7) reported three cases of kerion celsi caused by *T. tonsurans* in high school wrestlers in 1998. Sung et al. (8) reported eight cases of infection due to *T. tonsurans* both wrestlers and non-gladiators. This is the first report of infection due to *T. tonsurans* in non-gladiators. Of interest, Kim et al. (9) reported one case of tinea corporis caused by *T. tonsurans* in an American girl living in Korea.

There have been various reports of infections due to *T. tonsurans* in the Korean dermatological literature. Kim et al. (10) reported one case of kerion celsi caused by *T. tonsurans* in an

11-year-old boy. Lim et al. (11) reported the cases of 2 boys with kerion celsi caused by *T. tonsurans*: one in a 16-year-old high school judoist and the other 7-year-old non-gladiator.

Jun and Kim (12) conducted a large study on the epidemiological, clinical, and mycological characteristics of dermatophytosis in 1,394 Korean amateur wrestlers through a nationwide group examination between July 1995 and April 1996. Infections due to *T. tonsurans* were detected in 575 (42.5%) wrestlers. The head and neck areas were the preferred sites among the skin lesions. Jun and Choi (13) also performed a large study involving 316 cases of infection due to *T. tonsurans* in 2004. This same study showed the epidemiological, clinical, and mycological characteristics of the patients infected with *T. tonsurans* between 1999 and 2000. The majority of their patients (204, 64.6%) were high school judoists, followed by middle school judoists (18.7%), and those attending college or university (16.7%). The scalp was the most common infection site, followed by the upper extremities, including the hands, face, neck, trunk, and legs. Twenty-six patients (8.2%) infected with *T. tonsurans* had a family history of the disease. Family members including mother, brothers, father, sisters, and aunt were reported to be affected by the disease in decreasing order of frequency. Jun and Chung (14) also reported two cases of infection due to *T. tonsurans* through intrafamilial transmission. Park et al. (15) evaluated the clinical and epidemiological characteristics of 105 patients infected with *T. tonsurans* between March 1995 and December 2003, among them, 73 were gladiators, including wrestlers and judoists, and 32 were non-gladiators. The results of KOH wet mount were positive in 87.6% cases. The preferred anatomical sites were the scalp (37 cases), face (37 cases), upper extremities (17 cases), and neck (15 cases), in decreasing order. The number of infections between the sexes was 89 cases in men and 16 cases in women. The mean age was 16.1 years. The most common season was winter (47 cases). In addition, the occurrence of infection among gladiators reached the peak in 1997 but has remained constant since 1995. In contrast, the number of cases in non-gladiators increased gently until 2003.

In our study, 51.9% of the patients infected with *T. tonsurans* were gladiators, including wrestlers, judoists, and Ssireum players. With regard to seasons, most cases (27 cases) occurred in the spring, followed by the winter, fall, and summer. Because international or domestic competition for combat sports was frequently held in the spring, the prevalence of *T. tonsurans* infection to gladiators was highest in the season. The most common site of infection due to *T. tonsurans* was the face, followed by the scalp, arms, neck, back, and chest. Tinea corporis was the most common subtype of dermatophytosis caused by *T. tonsurans*, followed by tinea faciei and tinea capitis. It is probably explained by frequent physical contact during strenuous exercises like wrestling and judo.

In both Park's study (15) and our own, teenagers showed the

highest prevalence and the face was the most common infection site. However, comparing with Park's study, our study showed a decrease in tinea capitis and the prevalence of *T. tonsurans* in non-gladiators was steady.

Large studies on infection due to *T. tonsurans* reported several interesting cases in the Korean dermatological literature. Lee et al. (16) reported one case of tinea capitis caused by *T. tonsurans*. Park et al. (17) reported a single case of tinea capitis and two cases of tinea faciei due to *T. tonsurans* in a family, characterized by intrafamilial infection among a grandfather, grandmother, and grandson. Kim et al. (18) reported a single case of kerion celsi caused by *T. tonsurans* in a 21-year-old woman. Additionally, Ko et al. (19) reported a single case of kerion celsi caused by *T. tonsurans*. Oh et al. (20) reported an unusual case of onychomycosis due to *T. tonsurans*. Kim et al. (2) reported one case of mycosis of the scalp and one case of tinea corporis due to *T. tonsurans* in the Korean general population.

T. tonsurans is an anthropophilic dermatophyte. Therefore, it is transmitted by contact among humans. Intrafamilial infection and the increased prevalence among gladiators corroborate the contact transmission of *T. tonsurans*. Infection due to *T. tonsurans* can occur via contact with contaminated objects such as combs, clothing, and shavers. At the time of the first report of infection due to *T. tonsurans*, outbreaks occurred in South Korea. However, such outbreaks were reported only a few times among gladiators, who are frequently exposed to infected patients during international or domestic competitions. The prevalence of infection in non-gladiators has remained constant until recently. It results from the education and environment improvement for prevention of *T. tonsurans* infection.

Outbreaks of *T. tonsurans* infection also occurred in Japan. This emphasizes the importance of educational efforts and public awareness campaigns to prevent *T. tonsurans* infection. To this end, a study was performed within the judoists' federation of Tokyo from 2008 to 2014. The percentage of judoists with infection of *T. tonsurans* decreased over that period from approximately 10% to 5% (3).

In the United States, infections due to *T. tonsurans* are common as a consequence of changing patterns in global travel and immigration. In addition, the infection of *T. tonsurans* is especially common among individuals with curly hair, pomade users, and those of a lower economic status. However, the modes of dispersal are unclear, though it is associated with homes, schools, and other institutions. Transmission can occur through direct transfer, or through the use of shared resources and facilities such as pillows and couches. *T. tonsurans* has its persistent nature in indoor environments and its ability to be transmitted through asymptomatic carriers.

On the contrary to the US, there is low prevalence of *T. tonsurans* infection in our country. Although there is a low occurrence of outbreaks due to *T. tonsurans* in South Korea, *T. ton-*

surans infection should be monitored carefully in the country.

DISCLOSURE

The authors have no potential conflicts of interest to declare.

AUTHOR CONTRIBUTION

Conception and coordination of the study: Lee WJ. Design of ethical issues: Jang YH, Lee SJ, Kim DW. Acquisition of data: Bang YJ, Jun JB. Data review: Lee WJ, Sim HB, Jun JB. Statistical analysis: Lee WJ, Sim HB. Manuscript preparation & approval: all authors.

ORCID

Weon Ju Lee <http://orcid.org/0000-0001-5708-1305>
 Hyun Bo Sim <http://orcid.org/0000-0002-0462-4924>
 Yong Hyun Jang <http://orcid.org/0000-0003-1706-007X>
 Seok-Jong Lee <http://orcid.org/0000-0002-6131-632X>
 Do Won Kim <http://orcid.org/0000-0001-6632-1374>
 Jae Bok Jun <http://orcid.org/0000-0003-4834-4526>
 Yong Jun Bang <http://orcid.org/0000-0001-7242-9306>

REFERENCES

- Suh SB, Kim SW, Oh SH, Choi SK, Bang YJ. A case of block dot ringworm caused by *trichophyton tonsurans*. *Korean J Dermatol* 1998; 36: 918-23.
- Kim HY, Kim SL, Lee WJ, Lee SJ, Kim DW, Jun JB. Intra-familial infection due to *Trichophyton tonsurans* in Korean general population. *Korean J Med Mycol* 2014; 19: 105-9.
- Hiruma J, Ogawa Y, Hiruma M. *Trichophyton tonsurans* infection in Japan: epidemiology, clinical features, diagnosis and infection control. *J Dermatol* 2015; 42: 245-9.
- Alshawa K, Lacroix C, Benderdouche M, Mingui A, Derouin F, Feuilhade de Chauvin M. Increasing incidence of *Trichophyton tonsurans* in Paris, France: a 15-year retrospective study. *Br J Dermatol* 2012; 166: 1149-50.
- Mochizuki T, Tanabe H, Wakasa A, Kawasaki M, Anzawa K, Ishizaki H. Survey of *Trichophyton tonsurans* infection in Japan. *Molecular epidemiology and factors affecting adequate hairbrush sampling*. *Nippon Ishinkin Gakkai Zasshi* 2006; 47: 57-61.
- Fuller LC, Child FC, Midgley G, Higgins EM. Scalp ringworm in south-east London and an analysis of a cohort of patients from a paediatric dermatology department. *Br J Dermatol* 2003; 148: 985-8.
- Choi SK, Lee YH, Oh SH, Kim SW, Bang YJ, Suh SB. Three cases of kerion celsi caused by *Trichophyton tonsurans*. *Korean J Med Mycol* 1998; 3: 179-84.
- Sung SY, Kim HY, Kim HU, Ihm CW. *Trichophyton tonsurans* infection in wrestlers and a child. *Korean J Dermatol* 1998; 36: 732-6.
- Kim KH, Kim KS, Lee JM, Shin DH, Choi JS. A case of tinea corporis caused by *Trichophyton tonsurans* in an American girl living in Korea. *Korean J Dermatol* 1998; 36: 666-9.
- Kim GI, Yim YS, Park CW, Lee CH. A case of kerion celsi caused by *Trichophyton tonsurans*. *Korean J Dermatol* 2000; 38: 691-4.
- Lim JY, Jang HS, Oh CK, Kwon KS, Kim MB. Two cases of kerion celsi caused by *Trichophyton tonsurans*. *Korean J Dermatol* 2002; 40: 286-90.
- Jun JB, Kim YD. The epidemiological, clinical and mycological studies on *Trichophytosis Gladiatorum* prevailing among Korean wrestlers. *Korean J Med Mycol* 2004; 9: 28-44.
- Jun JB, Choi SK. Epidemiological, clinical and mycological studies of *Trichophytosis Gladiatorum* prevailing among Korean judoists. *Korean J Med Mycol* 2004; 9: 100-11.
- Jun JB, Chung H. *Trichophyton tonsurans* infection in a judoist girl and her mother. *Korean J Med Mycol* 2004; 9: 123-7.
- Park JS, Kim SW, Jun JB, Suh SB, Bang YJ. Clinical and epidemiologic study of *Trichophyton tonsurans* infections (1995-2003). *Korean J Med Mycol* 2004; 9: 197-205.
- Lee DK, Lee HW, Chang SE, Lee MW, Choi JH, Moon KC, Koh JK. A case of diffuse black dot tinea capitis caused by *Trichophyton tonsurans*. *Korean J Med Mycol* 2005; 10: 160-5.
- Park BC, Choi YS, Lee WJ, Jun JB. Intra-familial transmission of *Trichophyton tonsurans*. *Korean J Med Mycol* 2006; 11: 27-30.
- Kim MS, Kim DH, Choi KC, Chung BS. A case of kerion celsi caused by *Trichophyton tonsurans* in adult female patient. *Korean J Dermatol* 2006; 44: 1256-8.
- Ko WT, Kim SH, Suh MK, Ha GY, Kim JR. A case of kerion celsi caused by *Trichophyton tonsurans*. *Korean J Med Mycol* 2007; 12: 208-13.
- Oh S, Choi S, Lee S, Lee J, Choi Y. Toe nail onychomycosis caused by *Trichophyton tonsurans* in a healthy child. *Korean J Med Mycol* 2011; 16: 206-10.