

Report

Occult tinea pedis in an Israeli population and predisposing factors for the acquisition of the diseaseNicole Sakka^{1,*}, MD, Avner Shemer^{1,*}, MD, Aviv Barzilai¹, MD, Renata Farhi², MD, and Ralph Daniel^{3,4}, MD¹Department of Dermatology and Dermatomyology, Chaim Sheba Medical Center, Sackler School of Medicine, Tel-Aviv University, Tel Hashomer, Israel,²Faculdade Técnico Educacional Souza Marques (Souza Marques Technical Education Foundation), Santa Casa da Misericórdia, Rio de Janeiro, Brazil,³Department of Dermatology, Faculty of Medicine, University of Mississippi, Jackson, MS, USA, and ⁴Department of Dermatology, Faculty of Medicine, University of Alabama, Birmingham, AL, USA**Correspondence**Nicole Sakka, MD
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Abstract**Background** Tinea pedis is a commonly encountered dermatophytic infection with a clinical prevalence of 15–25%. Limited studies have evaluated the prevalence of occult tinea pedis.**Objectives** The aims of this study were to evaluate the prevalence of occult tinea pedis in asymptomatic subjects with feet that appeared healthy and to identify possible related risk factors.**Methods** A prospective study of 221 asymptomatic subjects with apparently normal feet was conducted. All subjects completed a questionnaire covering anamnestic details (personal and family histories of tinea pedis, preferred footwear) and were examined for foot odor and the clinical presence of tinea pedis and onychomycosis. Samples were taken from the foot for direct microscopic examination and culture.**Results** Among the 221 patients, 31 (14.0%) were positive for occult tinea pedis. Positive cultures from both the anterior and posterior aspects of the foot were obtained in 22 patients. The most common pathogen isolated was *Trichophyton rubrum*. Strong correlations emerged between occult tinea pedis and characteristics such as male gender, foot odor, previous personal and family histories of tinea pedis, and clinical and mycological evidence of onychomycosis. No significant associations were found between occult tinea pedis and age or preferred footwear.**Conclusions** The prevalence of occult tinea pedis is similar to that of clinical tinea pedis. This may imply that patients with subclinical infection carry a risk for transmitting disease similar to that of clinical carriers. This is of great importance in the prevention and management of the disease as high-risk asymptomatic carriers can be identified.**Introduction**

Tinea pedis is the most commonly encountered fungal infection in adults in developed countries, with prevalences estimated in the range of 15–25%.^{1–3} Usually, tinea pedis manifests in the interdigital space between the toes, as well as in skin elsewhere on the foot. A large percentage of patients suffering from tinea pedis are co-infected with tinea unguium.⁴ Tinea pedis is caused by dermatophyte fungi, of which *Trichophyton rubrum* is the pathogen most commonly involved in its pathogenesis, followed by *Trichophyton mentagrophytes*.^{1,5} In many cases, tinea pedis elicits only minor skin changes without any unpleasant odor and thus represents an

occult infection. Several predisposing risk factors for the development of superficial mycoses have been identified, including living in close communities,^{6,7} wearing of occlusive shoes,^{7–9} a hot and humid climate,^{7,9,10} professional involvement in sports,^{11–15} use of public swimming pools,^{11,15} and hyperhidrosis.^{14,16,17} It is well established that communal sports practice and swimming pool attendance and activity in a generally hot and humid milieu can promote the transmission of tinea pedis.^{18,19} Few studies have evaluated the prevalence of occult tinea pedis in the absence of clinical symptoms in subjects with feet that appear to be clinically normal. Epidemiological studies using questionnaires to screen populations for factors related to occult tinea pedis are limited. In this prospec-

tive study, we evaluated the prevalence of occult tinea pedis. The results were analyzed to determine the potential risk factors for the acquisition of occult tinea pedis.

Materials and methods

Subjects

A total of 221 subjects participated in the study. Subjects were recruited from among patients who attended the Dermatology Outpatient Clinic in Netanya, Tel-Aviv, Israel, for complaints other than tinea pedis during an 8-month period in 2012. All patients were informed that the study was intended to ascertain the prevalence of and risk factors for occult tinea pedis. Subjects with a recent (<2 months) previous diagnosis of tinea pedis and those who reported the use of oral or topical antifungal treatments within the preceding 12 months were excluded. Institutional ethics committee approval was obtained.

Methods

Patients were questioned using a questionnaire containing items on age, sex, and suspected predisposing factors such as past personal history of athlete's foot, family history of tinea pedis, and the type of footwear preferred (leather shoes, sandals, sports shoes, etc.). Subjects were examined by an experienced dermatologist for clinical signs suggestive of tinea pedis or tinea unguium and the presence of foot odor. Patients with clinical signs of onychomycosis were not excluded from the study. Specimens for microbiological analysis were collected from the intertriginous space between the fourth and fifth toes, the anterior and posterior surfaces of the sole of the foot, and the toenails. All specimens were subjected to direct microscopy in potassium hydroxide solution (KOH 20%). Positive KOH specimens were cultured in 4% Sabouraud glucose agar.

Occult tinea pedis (carrier group) was defined by the presence of a positive mycological culture from either the anterior or posterior sole of the foot, lack of clinical symptoms, and apparently healthy feet. Non-carrier status was defined by a negative mycological culture and, similarly, asymptomatic and apparently normal feet.

Statistical analysis

Statistical analysis included analysis for qualitative variables. The chi-squared test and *t*-test were used to analyze quantitative variables. A *P*-value of <0.05 was considered to indicate statistical significance. Statistical analyses were performed using PASW Statistics for Windows Version 18.0 (SPSS, Inc., Chicago, IL, USA).

Results

A total of 221 subjects participated in the study. These included 132 men and 89 women with a mean age of 42.7 years (range: 24–66 years). Positive cultures from

the anterior or posterior sole of the foot were obtained in 31 (14.0%) of the 221 subjects, who were thus considered to demonstrate occult tinea pedis. The mean age of the positive carriers was 43.5 years; there was no significant difference in mean age between the carrier and non-carrier groups. The occult tinea pedis group included a higher proportion of male subjects (28/31, 90.3%) than the non-carrier group (104/190, 54.7%), and thus male gender had a significant positive correlation with carrier status ($P < 0.001$). Most subjects in the carrier group demonstrated positive cultures from both the anterior and posterior sole of the foot (22/31, 71.0%), but there was no significant difference in the location (anterior or posterior) of the source of positive cultures. The most common pathogen cultured was *T. rubrum*, which was cultured from samples obtained from both the anterior ($n = 22$) and posterior ($n = 27$) surfaces, followed by *Epi-dermophyton floccosum* ($n = 2$) and *T. mentagrophytes* ($n = 2$). No significant difference between the carrier and non-carrier groups emerged in relation to preferred footwear type (sandals, sports shoes, leather shoes, canvas shoes) ($P = 0.543$). The prevalence of foot odor was significantly higher ($P < 0.001$) in the carrier group ($n = 20/31$) than in the non-carrier group ($n = 6/190$). Twenty-two individuals in the carrier group had a positive previous personal history of dermatophyte infection, whereas none of the non-carrier group did so. There was a statistically significant difference between the carrier and non-carrier groups ($P < 0.001$) in the presence of a positive family history. Clinical evidence of onychomycosis was found in the majority of positive carriers (30/31, 96.8%) but in few of the non-carrier group (19/190, 10.0%). In the carrier group, all 30 individuals with clinical onychomycosis demonstrated a positive culture, in which *T. rubrum* represented the pathogen most commonly cultured ($n = 27$), followed by *E. floccosum* ($n = 2$) and *T. mentagrophytes* ($n = 1$). Among the 19 subjects in the non-carrier group with clinical onychomycosis, 11 demonstrated a positive culture in which *T. rubrum* again represented the most commonly cultured pathogen ($n = 10$). *Trichophyton mentagrophytes* was cultured in one patient. There was a statistically significant difference between the carrier and non-carrier groups in the clinical presence of onychomycosis ($P < 0.001$). Results are summarized in Table 1.

Discussion

To date, several studies have assessed the incidence of tinea pedis in the general population, but a very limited number of studies have focused on the prevalence of occult tinea pedis.^{12–14,20,21} In the studies that investigated the prevalence of occult tinea pedis, the populations

Table 1 Subject characteristics and risk factors for occult disease in carrier and non-carrier groups

Characteristic/factor	Carrier group (n = 31)	Non-carrier group (n = 190)	P-value
Age, years, mean	43.48	44.01	0.802
Male gender, n	28	104	<0.001
Preferred footwear, n			
Sandals	4	40	0.543
Sports shoes	16	74	
Leather shoes	10	67	
Foot odor, n	20	6	<0.001
Positive personal history, n	22	0	<0.001
Positive family history, n	28	87	<0.001
Clinical presence of onychomycosis, n	30	10	<0.001
Positive nail culture, n			
<i>Trichophyton rubrum</i>	27	10	
<i>Epidermophyton floccosum</i>	2	0	
<i>Trichophyton mentagrophytes</i>	1	1	

examined were characterized either by a lack of symptoms suggestive of tinea pedis^{20,21} or by feet that appeared clinically normal.¹³ Few studies have examined the prevalence of occult tinea pedis in subjects who demonstrate both the absence of clinical symptoms and apparently healthy feet.¹²

In the present study, we found the prevalence of occult tinea pedis in subjects without clinical symptoms and with clinically apparently healthy feet to be 14.0%. The prevalence of occult tinea pedis is very similar to the clinical prevalence of tinea pedis. Tinea pedis has a high prevalence in the general population and has been estimated to affect up to 25% of individuals.^{2,3,22} Carrier stage disease, or occult tinea pedis, can be considered to represent an early stage of the development of a dermatophytic infection because although subjects lack clinical symptoms and have apparently healthy feet, they are carriers of dermatophytes (positive mycological culture). This implies that subjects with occult disease are able to transmit the disease despite being asymptomatic and demonstrating an absence of clinical symptoms. Hence, it is very important to identify this population in order to reduce the numbers of people infected with tinea pedis and able to transmit infection. It has been speculated that the ability of some people to harbor dermatophytes while being asymptomatic may be attributable to immunological factors.¹³

In the present study of occult tinea pedis, the predominant species involved was found to be *T. rubrum*. This does not accord with the findings of other studies. A number of previous reports have found the most common etiological agent in subjects with asymptomatic athlete's

foot to be *T. mentagrophytes*, followed by *T. rubrum*.^{14,21}

The present results also showed that most of the subjects identified as positive carriers of occult tinea pedis were co-infected with tinea unguium. Several earlier studies have noted the tendency of tinea pedis and onychomycosis to cohabit.^{20,23–28}

Another finding of this study identified the frequency of occult tinea pedis as being higher in men; this is in accordance with the findings of previous studies.^{12–14,21}

One of the objectives of this study was to assess predisposing factors for occult tinea pedis. Important risk factors identified as correlating with occult disease included foot odor, and personal and family histories of tinea pedis. Age, predisposing disease, toe disposition, a past history of athlete's foot, and past treatment for the disease have also been suggested as risk factors for the development of tinea pedis.^{12,21} In the present study, no correlation was found between occult tinea pedis and type of footwear, as suggested in previous studies.^{7–9} Furthermore, previous research has identified the habit of not using sandals in public bathrooms and hyperhidrosis as predisposing factors for the development of tinea pedis.¹ The present findings of an increased susceptibility to the development of occult tinea pedis in subjects with previous episodes of tinea pedis is supported by previous research.¹²

In conclusion, awareness of occult tinea pedis is important because it may help to prevent the occurrence of tinea pedis or to improve its management. Subjects at risk should be identified before they become symptomatic. This may impact on advice on whether people should undergo routine examination and culture of the feet. This may help to diminish transmission as subjects at risk will be educated to consult a physician promptly. Further studies with larger populations are required because more information on occult tinea pedis will improve the management and treatment of the disease and help to minimize its prevalence.

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