

# The Incidence of Tinea Pedis in Diabetic versus Nondiabetic Patients with Interdigital Macerations

## A Prospective Study

NOTICE

ALL MATERIAL MAY BE PROTECTED BY COPYRIGHT LAW

© 2008 American Podiatry Association

Bradford S. Legge, DPM\*

John F. Grady, DPM†

Autum M. Lacey, BA‡

**Background:** We sought to determine the incidence of tinea pedis in patients with otherwise asymptomatic pedal interdigital macerations. Both diabetic and nondiabetic populations were compared. Age and body mass index were also examined for their significance.

**Methods:** Fungal cultures of skin scrapings from 80 patients (77 male and 3 female; mean age, 65 years) with interdigital macerations were performed; 40 patients had previously been diagnosed with type 2 diabetes and 40 did not have diabetes.

**Results:** Cultures revealed a 40% prevalence of tinea pedis in the total study population. The prevalence in the nondiabetic group was 37.5% and 42.5% for the diabetic group. This was not a statistically significant difference. Among patients with interdigital macerations that yielded positive fungal cultures, those in the nondiabetic group were 6.3 years older than those in the diabetic group. It was also observed that the nondiabetic patients with interdigital macerations yielding positive fungal cultures were 9.1 years older than patients with negative fungal cultures in the nondiabetic group.

**Conclusion:** The results of this study provide the practitioner with a guide for treating pedal interdigital macerations. Because the likelihood of a tinea pedis infection is 40%, it seems prudent to treat these macerations with an antifungal agent. In regard to age, the results suggest that as nondiabetic patients age, the likelihood of an otherwise asymptomatic interdigital maceration yielding a positive fungal culture increases, and that diabetic patients may be susceptible to interdigital fungal infections at a younger age than those without diabetes. (J Am Podiatr Med Assoc 98(5): 353-356, 2008)

Interdigital pedal macerations are commonly encountered in podiatric practice. These macerations are often incidental findings that lack associated symptoms, such as pruritus and erythema, which are commonly associated with interdigital tinea pedis. Fungi that typically invade the skin are called dermatophytes. Three genera of fungi comprise the dermatophytes: *Trichophyton*, *Microsporum*, and *Epidermophyton*. Dermatophytes produce keratinases

that enable them to colonize the keratinized layers of the cornified skin and use keratin as an energy source.<sup>1</sup> *Candida* can also infect moist interdigital spaces and is more commonly seen in individuals with compromised immune systems. Mold, which originates from soil, can occasionally invade the skin and nails and cause indolent tinea pedis infections in both healthy individuals and those with compromised immune systems.<sup>2</sup>

Etiologically, high levels of blood glucose in combination with low skin-lactate levels foster yeast and mold growth.<sup>3</sup> This may predispose diabetic individuals to fungal infection; however, the data are inconsistent.<sup>4-8</sup> Alteras and Saryt<sup>4</sup> found a higher incidence of onychomycosis in diabetic versus nondiabetic individuals. However, Lugo-Somolinos et al<sup>5</sup> found no correlation between the frequency of dermatophytic pedal infections and blood glucose levels. In their

\*Department of Podiatry, Jesse Brown VA Medical Center, Chicago, IL. Dr. Legge is now in private practice, Indianapolis, IN.

†Department of Podiatry, Department of Veteran's Affairs Chicago Westside, Chicago, IL.

‡Dr. William M. Scholl College of Podiatric Medicine, North Chicago, IL.

Corresponding author: Bradford S. Legge, DPM, Podiatry Associates of Indiana, PC, 5471 Georgetown Rd, Ste C, Indianapolis, IN 46254. (E-mail: bradleggedpm@hotmail.com)

study population of 100 individuals, 31% of diabetic patients had fungal infections versus 33% of patients in the control group. Romano et al,<sup>6</sup> in their study of dermatophytic infections in a group of 447 patients, found no significant difference between diabetic and nondiabetic individuals.

The purposes of our study were to 1) determine the incidence of tinea pedis in patients with otherwise asymptomatic interdigital macerations, 2) identify the fungi responsible for the infection, 3) compare results for the diabetic and nondiabetic groups, and 4) evaluate whether age, obesity (measured by body mass index [BMI, measured as kilograms divided by the square of the height in meters]), or both are influencing factors.

## Materials and Methods

This study was performed at Jesse Brown VA Medical Center podiatry clinic (Chicago, Illinois) during a 6-month period. Skin scrapings from the otherwise asymptomatic interdigital macerations of 80 patients were obtained with a sterile no. 10 blade (Fig. 1). Forty patients had been previously diagnosed with type 2 diabetes and 40 did not have diabetes. The sample groups were selected at random. The age of the patients ranged from 38 to 88 years (mean, 65). Seventy-seven patients were male and three were female. All of the interdigital pedal macerations were incidental



Figure 1. Skin scraping obtained from a fourth inter-space maceration using a no. 10 scalpel.

findings on physical examination and were not treated previously.

Prior to the skin scrapings, the interspaces were cleaned with 70% isopropyl alcohol to remove any surface contaminants. The skin scrapings were then placed in inhibitory mold agar (Remel, Lenoxa, Kansas) and incubated at 30°C for 4 weeks. The plates were inspected periodically during that time for fungal growth. All the plates were analyzed at a single laboratory (Technology Laboratory Medical Center, Edward J. Hines, Jr. VA Medical Center, Chicago, Illinois) by the same technicians. The technicians were not informed of the nature of the study and were blind to the source of the plates (diabetic versus nondiabetic patients). If fungal growth was observed, the genus was identified by macroscopic and microscopic analysis. Differences in the frequency of positive fungal cultures in the diabetic versus nondiabetic groups were analyzed by using a Fisher's Exact Test.

## Results

Of the 80 fungal cultures performed, 48 (60%) exhibited no growth and 32 (40%) showed growth of various fungi (Fig. 2). Of the 32 positive cultures, 18 grew *Trichophyton* (56%), four *Candida* (13%), one *Epidermophyton* (3%), and the remainder various nondermatophytic molds (28%). Thus the prevalence of fungal infections in patients with otherwise asymptomatic interdigital macerations was 40%.

When the diabetic and nondiabetic groups were examined separately, the incidence of positive fungal growth in patients without type 2 diabetes was 37.5%; in patients with type 2 diabetes, the incidence was 42.5%. This was not a statistically significant differ-

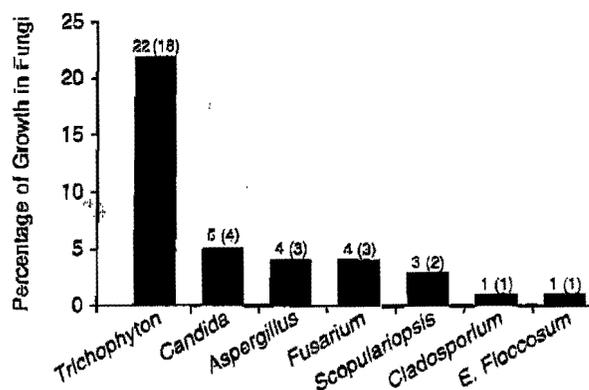


Figure 2. Fungal culture growth for total population (N = 80). Numbers in parentheses represent numbers of patients.

ence ( $P = .81$ ). The results of the fungal cultures for each respective population are shown in Figure 3. The fungi observed in each population remained relatively consistent.

The influence of obesity, as measured by BMI, was then considered. The results of our study showed a higher average BMI among patients in the diabetic group versus their nondiabetic counterparts. However, an increase in BMI did not correlate with an increase in the incidence of fungal infections in either the diabetic or nondiabetic groups (Table 1).

The relationship between age and fungal growth was then analyzed. When comparing the mean ages of the patients who had interdigital macerations yielding positive fungal cultures, patients in the nondiabetic group were 6.3 years older than those in the diabetic group. In addition, patients with interdigital macerations yielding positive fungal cultures in the nondiabetic group were 9.1 years older than patients with negative fungal cultures in the same group (Table 1). However, no age difference in regard to fungal growth was noted within the diabetic group.

## Discussion

Our study assessed the prevalence of tinea pedis in patients presenting with otherwise asymptomatic interdigital macerations and the correlation between tinea pedis and diabetes, age, and BMI. Thirty-two patients (40%) were found to have tinea pedis. Because the prevalence of infection in this study is high, the treatment of these macerations with an antifungal agent may be indicated before associated symptoms of infection arise. Leyden and Kligman<sup>8</sup> found that as dermatophytosis progressed from mild to moderate,

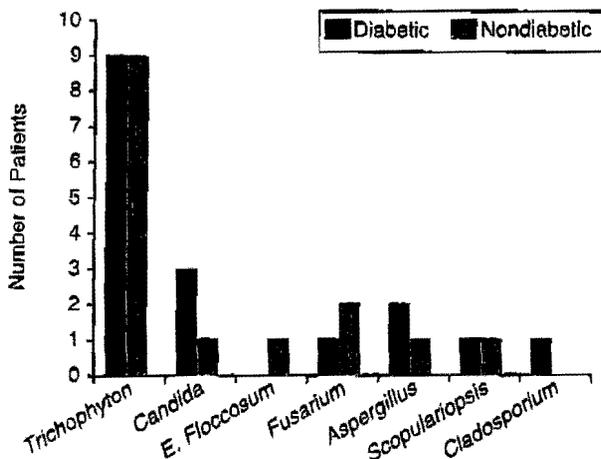


Figure 3. Types of fungi observed in diabetic and nondiabetic groups.

Table 1. Comparison of BMI and Mean Age of Patients in Diabetic and Nondiabetic Groups, With and Without Fungal Growth on Culture

Study Group	No. of Patients	Mean BMI (kg/m <sup>2</sup> )	Mean Age (years)
Diabetic patients	40	32.4	64.8
With fungal growth	17	30.5	64.8
Without fungal growth	23	33.8	64.7
Nondiabetic patients	40	30.3	65.4
With fungal growth	15	29.7	71.1
Without fungal growth	25	30.6	62.0

Abbreviation: BMI, body mass index.

the rate of recovery decreased from 84% to 55%. In their study of 710 patients, Roujeau et al<sup>10</sup> found interdigital tinea pedis to be a statistically significant risk factor for developing acute bacterial cellulitis. Because dermatophytic infection has also been correlated to a higher rate of gangrene and diabetic ulceration in high-risk patients, this early treatment could serve as an important prevention.<sup>7</sup>

Tinea pedis is most commonly caused by *Trichophyton rubrum*, which may have entered the United States following World War I.<sup>11</sup> Of the patients with positive cultures in our study, 56% were infected by *Trichophyton*. There was no significant difference between the fungi observed in the diabetic versus nondiabetic patients. The results of our study agree with the individual findings of Romano et al<sup>5</sup> and Lugo-Somolinos et al,<sup>6</sup> whose studies showed no significant difference in dermatophytic infections between diabetic and nondiabetic patients.

An increase in BMI may be associated with an increase in hyperhidrosis of the feet. Lecerf et al<sup>12</sup> reported in a study of 18,102 patients that hypersudation was a frequent concomitant disorder in overweight or obese patients (mean BMI = 34.6 kg/m<sup>2</sup>), occurring 23.8% of the time. Interdigital maceration may be a common presentation in overweight or obese patients owing to increased sweat accumulation between the toes. However, in our study, obesity did not appear to directly correlate with an increase in tinea pedis infections (Table 1).

Our study also examined the relationship between the age of patients and the prevalence of tinea pedis in the diabetic and nondiabetic groups. Studies have found that an increase in age correlates significantly with an increase in tinea pedis.<sup>13, 14</sup> Our study also supported this relationship. The mean age difference (9.1 years) noted between patients with positive cultures in the nondiabetic group and patients with neg-

ative cultures in the nondiabetic group suggests that as nondiabetic patients age, the likelihood of an otherwise asymptomatic interdigital pedal maceration being a tinea pedis infection increases. The difference in mean age (6.3 years) between the diabetic and nondiabetic groups with positive fungal cultures suggests that patients with type 2 diabetes may be susceptible to tinea pedis at a younger age. These relationships are illustrated by trendlines of the various populations in Figure 4. A larger sample population may be necessary to further validate these relationships.

## Conclusions

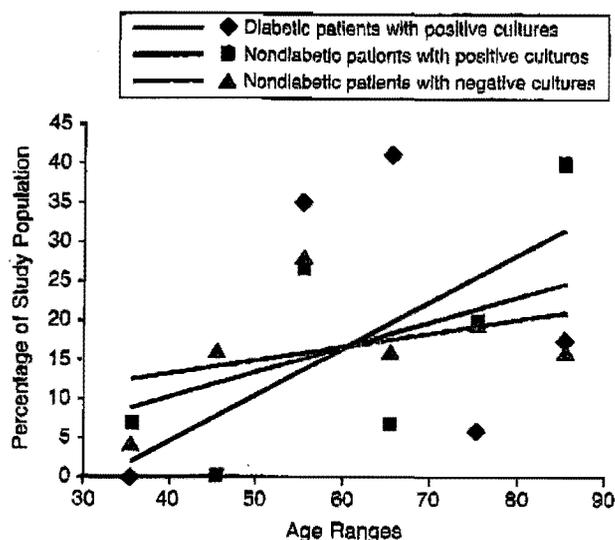
Our study focused on the male geriatric population and indicates a 40% likelihood of tinea pedis in patients with otherwise asymptomatic interdigital pedal macerations in this population. This result suggests that, in the absence of a fungal culture, it may be prudent to treat asymptomatic interdigital macerations with an antifungal agent. If the patient does not have diabetes, an increase in age appears to correlate with an increased incidence of interdigital tinea pedis. Therefore, the clinician should maintain a stronger suspicion for fungal infection in elderly nondiabetic patients with asymptomatic interdigital macerations. Our findings also suggests that the diabetic population may be susceptible to interdigital fungal infections at an earlier age.

**Financial Disclosure:** None reported.

**Conflict of Interest:** None reported.

## References

1. GEORG LK: Epidemiology of the dermatophytoses sources of infection: modes of transmission and epidemicity. *Ann NY Acad Sci* 69: 69, 1960.
2. UNGPAKORN R, LOHAPRATHAN S, REANGCHAINAM S: Prevalence of foot diseases in outpatients attending the Institute of Dermatology, Bangkok, Thailand. *Clin Exp Dermatol* 29: 87, 2003.
3. MACKROO B, LOWITT M, DOVER J: "Skin Manifestations of Diabetes Mellitus" in *Joslin's Diabetes Mellitus*, 13th ed, CR Kahn and GC Weir (Ed.), p 900, Lea & Febiger, Philadelphia, 1994.
4. ALTERAS I, SARYT E: Prevalence of pathogenic fungi in the toe-webs and toe-nails of diabetic patients. *Mycopathologia* 67: 157, 1979.
5. ROMANO C, MASSAI L, ASTA F, ET AL: Prevalence of dermatophytic skin and nail infections in diabetic patients. *Mycoses* 44: 83, 2001.



**Figure 4.** Correlation of patient age to fungal growth in diabetic and nondiabetic groups.

6. LUGO-SOMOLINOS A, SANCHEZ JL: Prevalence of dermatophytosis in patients with diabetes. *J Am Acad Dermatol* 26: 408, 1992.
7. GUPTA AK, HUMKE S: The prevalence and management of onychomycosis in diabetic patients. *Eur J Dermatol* 10: 379, 2000.
8. BUXTON PK, MILNE LJR, PRESCOTT RJ, ET AL: The prevalence of dermatophyte infection in well-controlled diabetics and the response to *Trichophyton* antigen. *Br J Dermatol* 134: 900, 1996.
9. LEYDEN JJ, KLIGMAN AM: Interdigital athlete's foot. The interaction of dermatophytes and resident bacteria. *Arch Dermatol* 114: 1466, 1978.
10. ROUJEAU JC, SIGURGEIRSSON B, KORTING HC, ET AL: Chronic dermatomycoses of the foot as risk factors for acute bacterial cellulitis of the leg: a case-control study. *Dermatol* 209: 301, 2004.
11. WEIDMAN FD: Laboratory aspects of epidermophytosis. *Arch Dermatol* 15: 415, 1927.
12. LECERF JM, REITZ C, DE CHASTEIGNER A: Evaluation of discomfort and complications in a population of 18,102 patients overweight or obese patients. *Presse Med* 32: 689, 2003.
13. AUGER P, MARQUIS G, JOLY J, ET AL: Epidemiology of tinea pedis in marathon runners: prevalence of occult athlete's foot. *Mycoses* 36: 37, 1992.
14. OGASAWARA Y, HIRUMA M, MUTO M, ET AL: Clinical and mycological study of occult tinea pedis and tinea unguium in dermatological patients from Tokyo. *Mycoses* 46: 119, 2003.