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. *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.

Etiologically, high levels of blood glucose in combination with low skin-lactate levels foster yeast and mold growth. This may predispose diabetic individuals to fungal infection; however, the data are inconsistent. Alteras and Saryt found a higher incidence of onychomycosis in diabetic versus nondiabetic individuals. However, Lugo-Somolinos et al. found no correlation between the frequency of dermatophytic pedal infections and blood glucose levels. In their...
study population of 100 individuals, 31% of diabetic patients had fungal infections versus 33% of patients in the control group. Romano et al,5 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 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-
The rate of recovery decreased from 84% to 55%. In their study of 710 patients, Roujeau et al. 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.

Tinea pedis is most commonly caused by *Trichophyton rubrum*, which may have entered the United States following World War I. 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 non-diabetic patients. The results of our study agree with the individual findings of Romano et al. and Lugo-Somolinos et al., whose studies showed no significant difference in dermatophytic infections between diabetic and non-diabetic patients.

An increase in BMI may be associated with an increase in hyperhidrosis of the feet. Lecerf et al. 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/m²), 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).

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 non-diabetic group were 6.3 years older than those in the diabetic group. In addition, patients with interdigital macerations yielding positive fungal cultures in the non-diabetic 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 found that as dermatophytosis progressed from mild to moderate,

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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. 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-

![Figure 3. Types of fungi observed in diabetic and nondiabetic groups.](image)

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

<table>
<thead>
<tr>
<th>Study Group</th>
<th>No. of Patients</th>
<th>Mean BMI (kg/m²)</th>
<th>Mean Age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic patients</td>
<td>40</td>
<td>32.4</td>
<td>64.8</td>
</tr>
<tr>
<td>With fungal growth</td>
<td>17</td>
<td>30.5</td>
<td>64.8</td>
</tr>
<tr>
<td>Without fungal growth</td>
<td>23</td>
<td>33.8</td>
<td>64.7</td>
</tr>
<tr>
<td>Nondiabetic patients</td>
<td>40</td>
<td>30.3</td>
<td>65.4</td>
</tr>
<tr>
<td>With fungal growth</td>
<td>15</td>
<td>29.7</td>
<td>71.1</td>
</tr>
<tr>
<td>Without fungal growth</td>
<td>25</td>
<td>30.6</td>
<td>62.0</td>
</tr>
</tbody>
</table>

Abbreviation: BMI, body mass index.
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.

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Conflict of Interest: None reported.

References