

# The role of tinea pedis and onychomycosis prevention in diabetic education: A literature review

by Ebony Love DPM<sup>1</sup>, Tracey Vlahovic DPM<sup>1\*</sup>, Lauren Christie DPM<sup>1</sup>

The prevalence of individuals with diabetes has steadily been increasing, creating both a health and economic crisis world-wide. Previous studies have suggested that foot fungal infections, including onychomycosis and tinea pedis, increase the risk of developing a diabetic foot ulcer. Through a thorough PubMed search, this article aims to review relevant literature relating to superficial fungal infections and patients with diabetes.

**Keywords:** Tinea pedis, diabetes, onychomycosis, patient education

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The prevalence of individuals with diabetes has steadily been increasing, creating both a health and economic crisis world-wide [1,2]. Diabetic foot infections, one of the major complications associated with diabetes, have significantly contributed to both an increase in mortality and financial burden in the diabetic population. The incidence of diabetic foot ulceration has been reported in up to 19% of the diabetic population, which has been associated with lower limb amputation and mortality [3,4]. In the efforts to prevent these complications from occurring, patients with diabetic foot infections tend to have more frequent outpatient visits, increase frequency of visits to the emergency room, increased frequency and duration of hospital stays, and an increased need for home health care; further increasing the economic crisis of this disease [2].

Previous studies have suggested that foot fungal infections, including onychomycosis and tinea pedis, increase the risk of developing a diabetic foot ulcer [5,6,7]. Diabetics are 2.77 times more likely to develop onychomycosis compared to non-diabetics, negatively impacting their physical and physiological health [8,9]. If left untreated, onychomycosis and tinea pedis can lead to cutaneous injury and ulceration due to dystrophic, brittle nails penetrating the skin and/or interdigital or moccasin skin fissuring, especially in

patients with neuropathy or peripheral vascular disease (PVD) [10].

Patient education is critical in diabetic foot care to help manage and prevent diabetic foot infections, other comorbidities, and mortality. The objective of this review is to assess the current literature on foot fungal infections in patients with diabetes as it relates to diabetic foot care education.

## Methods

A PubMed review of literature with keywords of tinea pedis and onychomycosis in patients with type II diabetes was reviewed.

## Results

The frequency of foot fungal infections is significantly higher in diabetics compared to non-diabetics. In a 2016 study, Oz et al., found that while elderly males are at an increased risk of developing onychomycosis regardless of whether they have diabetes, 14% of those in the diabetic group versus 5.9% of those in the control group had tinea pedis and/or onychomycosis [11]. According to Papini et al., in 2013, 69.3% of diabetics with a foot complication present with a foot fungal infection. Dermatophytes were the most common fungal species present, but non-dermatophytes, such as *Candida albicans* were also

1 - Temple University School of Podiatric Medicine, Philadelphia, PA

\* - Corresponding author: [traceyvlahovicdpm@yahoo.com](mailto:traceyvlahovicdpm@yahoo.com)

noted. Additionally, they found that diabetics with a previous toe amputation were significantly more likely to present with both tinea pedis and onychomycosis concomitantly. They concluded that specific treatment of the fungus involved is necessary for mycological cure to prevent diabetic foot complications, such as ulceration, loss of limb, and loss of life [12].

Another study by Gulcan et al., in 2014, found 25.3% of diabetic subjects mycologically had mycotic nails, out of the 161/321 diabetic patients who clinically presented with mycotic nails. Additionally, there was a significant association between onychomycosis and family history of the disease, BMI, longer duration of being diabetic, neuropathy, and retinopathy. They suggested that diabetic patients who have any of the risk factors found to be associated with onychomycosis in this study, should be properly educated diabetic and fungal infection education, to prevent the development of secondary lesions [13].

In addition to being more prevalent in the diabetic population, fungal foot infections occur in diabetics at a significantly earlier age compared to non-diabetics. In 2008, Legge et al., obtained scrapings from interdigital maceration of 40 diabetics and 40 non-diabetics. Of the 40% of samples collected that tested positive for fungal infection, patients in the diabetic group were on average 6.3 years younger than the non-diabetic group. They concluded that patients with diabetes may be more susceptible to developing tinea pedis at a younger age [14].

In 2017, Takehara et al., analyzed 30 patients with diabetes, 16 of which had tinea pedis, and found the number of times scrubbing between toes while washing with soap was significantly lower in subjects with tinea pedis compared to those who did not have tinea pedis. The number of times subjects scrubbed between toes with soap was also significantly lower in those who had difficulty reaching their feet. The authors suggested that each web space should be scrubbed 4-5 times for tinea pedis prevention and that proper education and intervention should be given to patients who have difficulty reaching their feet on more convenient foot washing positions [15].

It has well been known that foot fungal reinfection can occur from contaminated socks and sneakers. Broughton in 1955 found that individuals who wore cotton or wool socks were particularly susceptible to

reinfection in hot, moist conditions, even after six wash cycles [16]. To reduce the risk of relapse, they suggested modifications and materials used to make socks and footwear and improved hygiene could potentially help.

Modifications to cotton socks have been found to have antifungal properties for diabetic patients. In 2012, Tarbuk et al., found modified cotton socks worn by diabetic subjects with active carbon, natural mineral, or zeolite had antimicrobial properties against *Candida albicans* after 15 washing cycles, unlike the pure cotton control. Modified cotton socks with zeolite additionally had antimicrobial properties to *S. aureus*. The authors concluded that the active carbon and mineral particles found in the modified cotton socks did not directly prevent microbial infection, but through creating a drier environment for the foot by absorbing more moisture, were able to prevent microbial growth in patients with diabetes [17].

Another treatment that has been shown to be beneficial in reducing fungal load is ultraviolet treatment of shoes of those infected with dermatophytes. Ghannoum et al., in 2012, found that ultraviolet treatment of shoes infected with dermatophytes was significantly effective in reducing fungal load in shoes. There was a 76.28% mean reduction of colony-forming units/ml of *Trichophyton rubrum* after 3 cycles of UV C radiation treatment. They suggested that by sanitizing shoes, it can stop the cycle of reinfection while being treated for fungal infection by other means and it can help prevent relapse [18].

Prophylactic application of topical antifungals in diabetic patients has also been suggested, given the potential complications that onychomycosis can cause in diabetics and the high reinfection relapse [19]. A study by Sigurgeirsson et al., in 2010, found that patients previously cured from onychomycosis who were prophylactically treated with amorolfine twice a week statistically benefited from prophylaxis up to 12 months after cure. Although relapse rates at 12 months of those treated prophylactically was 8.3% compared to 31.8% of those who were not prophylactically, there were insignificant differences in relapse rates between study groups at 36 months post-cure. While it is unknown if increasing the frequency of dosing would create a better protection against onychomycosis, it is still unclear whether

prophylactic application of antifungal medications help prevent onychomycosis in diabetic patients [20].

## Conclusion

Onychomycosis and tinea pedis have been attributed to increasing the risk of diabetic foot ulceration and infections, especially in the elderly male population, individuals having diabetes for a longer duration, and diabetics with neuropathy and/or PVD. Based on this review, preventative measures for foot fungal infections including foot washing hygiene, wearing modified socks, shoe wear sanitation, potentially using prophylactic topical antifungal medication on nails, and stressing the importance of attending routine diabetic foot risk assessment appointments in accordance to the Lavery-Armstrong guidelines should be considered during diabetic foot care education [21].

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