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Identification of Fungi Causing Onychomycosis in Patients with Type 2 Diabetes Mellitus at Tangerang District Hospital

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ABSTRACT

Onychomycosis is a fungal infection of the nails that is frequently encountered in patients with diabetes mellitus (DM) because impaired immune, vascular, and neuropathic functions may increase susceptibility to infection. This study aimed to determine the distribution of the duration of type 2 diabetes mellitus among patients with onychomycosis at Tangerang District Hospital and to identify the fungi causing onychomycosis based on macroscopic and microscopic characteristics using Lactophenol Cotton Blue (LPCB) staining. This descriptive laboratory-based study examined 25 nail-scraping specimens from patients with type 2 diabetes mellitus. Fungal isolation was performed on Sabouraud Dextrose Agar (SDA), followed by macroscopic observation of colony characteristics and microscopic examination using LPCB staining. A total of 52 fungal isolates were recorded. The identified fungi consisted of dermatophytes, non-dermatophyte fungi, yeast, and one isolate that could not be identified. Dermatophytes included *Trichophyton* sp. (3 isolates; 5.8%) and *Epidermophyton* sp. (1 isolate; 1.9%). Non-dermatophytes included suspected *Suspected Aspergillus niger* (15; 28.8%), *Aspergillus* sp. (24; 46.2%), *Cladosporium* sp. (2; 3.8%), *Penicillium* sp. (2; 3.8%), *Fusarium* sp. (1; 1.9%), and *Mucor* sp. (1; 1.9%). *Candida* sp. accounted for 2 isolates (3.8%). Most patients with onychomycosis had experienced type 2 diabetes mellitus for more than five years (17; 68%). The findings indicate that non-dermatophyte fungi predominated in the examined samples, with *Aspergillus* sp. being the most frequently identified fungus. The identified fungi comprised dermatophytes, non-dermatophytes, and yeast.

Keywords: type 2 diabetes mellitus; onychomycosis; fungal identification; dermatophytes; non-dermatophyte fungi

INTRODUCTION

Diabetes mellitus is a chronic metabolic disease characterized by persistent hyperglycemia and is associated with various systemic complications. Long-standing hyperglycemia can impair immune function and contribute to vascular and neuropathic complications, thereby increasing susceptibility to infection. Patients with diabetes may therefore be more vulnerable to fungal infections, including infections involving the nails.

Onychomycosis is a fungal infection of the nail that may cause changes in nail color, thickness, texture, and structure. In patients with diabetes mellitus, impaired host defense, reduced peripheral circulation, neuropathy, and structural changes of the nail may create conditions that facilitate fungal colonization and infection. Onychomycosis in diabetic patients is clinically important because chronic nail changes may contribute to discomfort and may complicate foot care.

Diagnosis of onychomycosis requires identification of the causative organism because the fungi involved may include dermatophytes, non-dermatophyte molds, and yeasts. Conventional laboratory identification can be performed through fungal culture followed by macroscopic and microscopic examination. Lactophenol Cotton Blue (LPCB) staining facilitates observation of fungal structures such as hyphae, conidia, and spores. Recent studies have also reported the involvement of non-dermatophyte fungi, including Aspergillus species, in onychomycosis among patients with diabetes.

Based on these considerations, this study was conducted to determine the distribution of the duration of type 2 diabetes mellitus among patients with onychomycosis at Tangerang District Hospital and to identify the fungi causing onychomycosis based on macroscopic and microscopic characteristics using LPCB staining.

MATERIALS AND METHODS

This study used a descriptive analytic design with a laboratory approach. The study was conducted using nail-scraping specimens obtained from patients with type 2 diabetes mellitus who experienced onychomycosis at Tangerang District Hospital. Laboratory examinations were performed at the Mycology Laboratory, Department of Medical Laboratory Technology, Poltekkes Kemenkes Banten, during May 2026.

The study population consisted of patients with type 2 diabetes mellitus who experienced onychomycosis at Tangerang District Hospital during May 2026. Total sampling was used, resulting in 25 patients and 25 nail-scraping specimens. Inclusion criteria were physician-diagnosed type 2 diabetes mellitus, clinical signs of onychomycosis of the toenails, and willingness to participate through written informed consent. Patients who had received topical or systemic antifungal therapy within the previous three months, had severe nail trauma that could mimic onychomycosis, or had other immunocompromising conditions were excluded.

Nail scrapings were collected using sterile instruments from the most clinically suspicious area of the affected nail. Specimens were inoculated onto Sabouraud Dextrose Agar (SDA) containing chloramphenicol. The cultures were incubated at room temperature for 7–14 days. Fungal growth was first assessed macroscopically based on colony form, color, and texture. Microscopic examination was subsequently performed using LPCB staining, and fungal morphology was observed under 10× and 40× objective magnification. Identification was based on the observed macroscopic and microscopic characteristics.

Primary data were obtained from direct laboratory examination of nail-scraping specimens, while information on the duration of diabetes mellitus was obtained through a brief questionnaire/interview. The laboratory findings were recorded and documented. Data were processed using Microsoft Excel and presented descriptively as frequencies and percentages.

RESULTS AND DISCUSSION

FUNGAL GROWTH AND IDENTIFICATION

All 25 nail-scraping specimens were cultured on SDA and showed fungal growth. The colonies were subsequently examined macroscopically and microscopically. Macroscopic examination included colony form, color, and texture, while microscopic examination using LPCB evaluated fungal structures such as hyphae, conidia, and spores. The findings showed the presence of dermatophytes, non-dermatophyte fungi, and yeast, as well as one isolate that could not be identified with certainty.

Table 1. Frequency of fungi identified from nail-scraping specimens

Classification	Fungal type	Frequency (n)	Percentage (%)
Dermatophytes	*Trichophyton* sp.	3	5.8
	Epidermophyton sp.	1	1.9
Non-dermatophytes	*Suspected Aspergillus niger*	15	28.8
	Aspergillus sp.	24	46.2
	Cladosporium sp.	2	3.8
	Penicillium sp.	2	3.8
	Fusarium sp.	1	1.9
	Mucor sp.	1	1.9
Yeast	*Candida* sp.	2	3.8
Unidentified	—	1	1.9
Total		52	100.0

The frequency distribution shows that 52 fungal isolates were obtained from 25 nail-scraping specimens. Non-dermatophyte fungi constituted the largest group. *Aspergillus* sp. was the most frequently identified isolate, with 24 isolates (46.2%), followed by suspected *Suspected Aspergillus niger* with 15 isolates (28.8%). Dermatophytes comprised *Trichophyton* sp. (3; 5.8%) and *Epidermophyton* sp. (1; 1.9%). *Candida* sp. was identified in 2 isolates (3.8%), while one isolate (1.9%) could not be identified.

The predominance of non-dermatophyte fungi in this study indicates that fungi associated with onychomycosis in patients with type 2 diabetes mellitus were not limited to dermatophytes. *Aspergillus* species have been reported in diabetic patients with onychomycosis and may contribute to nail infection. However, because non-dermatophyte molds can also occur in the environment, their interpretation should be made cautiously and in relation to the clinical and laboratory findings.

The difference in distribution between dermatophytes and non-dermatophytes may be related to differences in pathogenic characteristics. Dermatophytes are primary pathogens with the ability to invade keratinized tissue through keratin-degrading enzymes, whereas non-dermatophyte fungi are generally opportunistic and may colonize nails that have undergone structural changes. In patients with diabetes, chronic hyperglycemia and impaired immune function may provide conditions that support the growth of various fungi.

DURATION OF TYPE 2 DIABETES MELLITUS

The distribution of respondents according to the duration of type 2 diabetes mellitus is presented in Table 2. Most respondents had experienced diabetes mellitus for more than five years.

Duration of diabetes mellitus	Number of patients (n)	Percentage (%)
<5 years	8	32
>5 years	17	68
Total	25	100

Among the 25 respondents, 8 (32%) had experienced type 2 diabetes mellitus for less than five years, whereas 17 (68%) had experienced the disease for more than five years. Thus, patients with onychomycosis in this study were predominantly in the group with a longer duration of diabetes mellitus.

The higher proportion of patients with diabetes for more than five years may be related to the cumulative effects of chronic hyperglycemia. Long-term diabetes can impair innate immune responses, including neutrophil function, and can contribute to oxidative stress and tissue damage. Microvascular complications may reduce peripheral blood flow and the supply of oxygen and nutrients to tissues, while peripheral neuropathy can reduce protective sensation and increase the possibility of unnoticed minor trauma. Changes in nail structure, including thickening, brittleness, and deformity, may further create an environment that supports fungal growth.

In this study, all dermatophyte isolates were found among patients who had experienced type 2 diabetes mellitus for more than five years. This finding may reflect increased susceptibility associated with longer disease duration. Previous research cited in the KTI has also reported an association between diabetes duration of more than five years and the risk of onychomycosis. Nevertheless, the present study is descriptive and does not establish a causal relationship between diabetes duration and fungal infection.

The study has limitations. The sample size was limited to 25 specimens, so the findings may not represent the full variation of onychomycosis among patients with diabetes mellitus. In addition, fungal identification relied on conventional culture and microscopic morphology, which may limit species-level identification for some isolates. One isolate in this study therefore remained unidentified.

CONCLUSION

Patients with onychomycosis in this study were predominantly those who had experienced type 2 diabetes mellitus for more than five years, comprising 17 of 25 respondents (68%). Laboratory examination of 25 nail-scraping specimens yielded 52 fungal isolates consisting of dermatophytes, non-dermatophyte fungi, and yeast, with one isolate remaining unidentified. The most frequently identified fungus was Aspergillus sp. (24 isolates; 46.2%), followed by suspected Aspergillus niger (15; 28.8%). Identification was based on macroscopic colony characteristics and microscopic morphology using LPCB staining.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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