

# Clinical Features of Onychomycosis and its Causative Organisms: A Retrospective, Single-centre Analysis

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## Abstract

**Introduction:** Onychomycosis is a common nail infection caused by dermatophytes, non-dermatophyte moulds (NDMs) and yeasts. Contrary to global data, numerous studies conducted in Malaysia have identified NDMs as the most predominant causative organisms. We performed a retrospective analysis to determine the clinical features of onychomycosis, identify the common causative organisms and assess treatment outcomes in our centre. **Materials and Methods:** Data were collected from all patients with clinical suspicion of onychomycosis who had nail clippings cultured between January 2011 and December 2015. The data were subsequently analysed. **Results:** A total of 225 nail specimens were collected. Toenails were the most common site affected ( $n = 93$ , 41.3%), followed by fingernails ( $n = 71$ , 31.6%), both toenails and fingernails ( $n = 42$ , 18.7%) and not stated ( $n = 19$ , 8.4%). The median age of patients was 60 years (interquartile range: 26). Of the 104 positive cultures, NDMs ( $n = 46$ , 44.2%) were most frequently identified, followed by yeasts ( $n = 33$ , 31.7%) and dermatophytes ( $n = 25$ , 24.0%). Of 68 patients who received oral antifungals, 45.6% ( $n = 31$ ) still had dystrophic nails, while improvement was seen in 19.1% ( $n = 13$ ) of patients. In addition, 29.4% ( $n = 20$ ) of patients required a second pulse of antifungal treatment within a year after the first treatment. **Conclusion:** As previously published, onychomycosis is more commonly seen in the elderly and typically affects the toenails. The causative organisms were predominantly NDMs. A large proportion of patients had persistent dystrophic nails despite antifungal treatment. Hence, treatment may be challenging, as non-dermatophyte onychomycosis is more resistant to treatment.

**Keywords:** Antifungal, dermatophytes, non-dermatophyte moulds, onychomycosis, yeasts

## INTRODUCTION

Onychomycosis is a common nail infection caused by dermatophytes, non-dermatophyte moulds (NDMs) and yeasts. It has a worldwide prevalence of 5.5%.<sup>[1]</sup> Although not life-threatening, onychomycosis constitutes an important public health problem due to its high prevalence and associated morbidity. Patients with onychomycosis may experience negative health consequences such as pain, discomfort and physical impairment, which can lead to psychological and social limitations.<sup>[2]</sup>

Onychomycosis often presents with nail discoloration, thickening, deformity and pain. The clinical classification includes distal lateral subungual onychomycosis (DLSO),

superficial white (SWO), proximal subungual (PSO) and total dystrophic onychomycosis. In recent years, endonyx onychomycosis has been acknowledged as a new variant. Risk factors for onychomycosis include trauma, increasing age, male gender, diabetes mellitus, obesity, immunosuppression, occupation, occlusive footwear, smoking, poor hygiene and tinea pedis.<sup>[1]</sup>

Dermatophytes are the most common causative organisms (60%–70%) identified worldwide, followed by

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Submitted: 02-Nov-2024 Revised: 23-Mar-2025 Accepted: 25-Mar-2025

Published: 05-Jul-2025

### Access this article online

Quick Response Code:



Website:  
<https://journals.lww.com/mjd>

DOI:  
10.4103/MJD.MJD\_22\_24

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**How to cite this article:** Khiew MA, Bakrin IH, Masri SN, Tay ME, Ho WC, Kammal WS, *et al.* Clinical features of onychomycosis and its causative organisms: A retrospective, single-centre analysis. *Malays J Dermatol* 2025;53:17-22.

NDMs (30%–40%) and yeasts.<sup>[1]</sup> *Trichophyton rubrum* and *Trichophyton mentagrophytes* are the most frequently identified dermatophytes.<sup>[1,3]</sup> NDMs commonly contribute to DLSO, with *Scytalidium dimidiatum* being the most common organism identified.<sup>[3]</sup> Other organisms, such as *Aspergillus* spp., *Scopulariopsis brevicaulis*, *Acremonium*, *Fusarium* spp., *Alternaria alternata* and *Neoscytalidium*, are also commonly reported.<sup>[1,3]</sup> Yeasts, such as *Candida* spp., account for 10%–20% of onychomycosis cases.<sup>[1]</sup>

Contrary to global trends, published literature from Southeast Asia (SEA), including Malaysia,<sup>[4–6]</sup> Singapore<sup>[7]</sup> and Thailand,<sup>[8]</sup> identified NDM or yeasts as the predominant causative organisms of onychomycosis. Two studies conducted in Malaysia identified NDMs (around 70%) as the most common, followed by yeasts (20%–30%) and dermatophytes (1%–7%).<sup>[4,6]</sup> *Aspergillus* spp. was the most common NDM isolated, and *Candida* spp. was the most common yeast. The most common dermatophyte identified was *Trichophyton* spp.<sup>[4,6]</sup> Thailand observed a similar trend, where NDMs (51.6%) were the most common organism contributing to onychomycosis, followed by dermatophytes (36.3%) and *Candida* spp. (6.0%).<sup>[8]</sup>

Available treatment options for onychomycosis include oral and topical antifungals, laser therapies, surgical nail avulsion, nail debridement and combination therapies.<sup>[9,10]</sup> Broad-spectrum antifungal terbinafine, an allylamine that inhibits squalene epoxidase, is effective against dermatophytes and some NDMs and *Candida* spp.<sup>[11]</sup> It has a complete cure rate of 59% and 38%, with mycological cure rates of 79% and 70% for fingernails and toenails, respectively.<sup>[12]</sup> Another widely used antifungal, itraconazole, a triazole that inhibits lanosterol 14 $\alpha$ -demethylase, is effective against dermatophytes, NDMs and *Candida* spp.<sup>[11]</sup> It has a complete cure rate of 47% and 14%, with mycological cure rates of 61% and 54% for fingernails and toenails, respectively.<sup>[12]</sup> Terbinafine has been shown to be more effective than azoles in terms of clinical and mycological healing, as demonstrated in a Cochrane data analysis.<sup>[13]</sup>

This study was designed to identify the clinical features of onychomycosis, the common causative organisms identified from nail fungal cultures and the treatment outcomes amongst patients treated with oral antifungals at Hospital Serdang.

## MATERIALS AND METHODS

This was a retrospective cross-sectional analysis conducted on patients who were suspected to have onychomycosis at the Dermatology Unit, Hospital Serdang, between 1 January 2011 and 31 December 2015. Demographic data, such as age, gender and the site of the disease, were retrieved from the eHospital Information System. Clinical data, including the choice of oral antifungal treatment, the frequency of repeated oral antifungal treatment within a year and treatment outcomes amongst patients treated with oral antifungals, were also collected.

## Causative organism

A total of 225 nail clippings were retrieved from the mycology laboratory at Hospital Serdang. Fungal culture results were obtained and analysed. All nail samples were inoculated onto Sabouraud dextrose agar (SDA) and incubated at temperatures ranging from 22°C to 30°C for 2–14 days to allow for NDM and yeast recovery. If dimorphic fungi were suspected, isolates were subcultured onto brain–heart infusion agar and incubated at 37°C for 3–5 days to demonstrate the conversion from mould to yeast form. Significant growth was defined as the presence of pure or predominant fungal growth at the inoculated site. Isolates were further identified based on macroscopic and microscopic morphological characteristics and using a commercial biochemical identification kit (API 20C AUX, bioMérieux, Lyon, France) for yeast. The lactophenol cotton blue (LPCB) wet mount was used to prepare slides for microscopic examination of fungi.

## Treatment outcome

Data were collected based on clinical documentation. Upon review of medical records, treatment outcomes for non-responders or those with ‘still dystrophic’ nails were considered based on documentation of ‘still dystrophic,’ ‘no improvement,’ ‘still dyskeratotic’ or ‘the same.’ Those with clinical documentation of ‘getting better,’ ‘better’ or ‘recovered’ were considered to have recovered or improved.

## Research ethics

The study was registered under the Malaysia National Medical Research Registry (NMRR-18-800-41001) and approved by the Malaysia Research Ethical Committee (KKM.NIHSEC.P18-987(6)).

## Statistical analysis

Statistical analysis was performed using SPSS 22.0 IBM Corp, Armonk, NY, USA, with significance set at  $P < 0.05$ . For categorical variables, proportions and frequency counts were calculated. For continuous variables, means and standard deviations were computed. Missing data, extreme values and variable distributions were explored. Group comparisons of categorical variables were made using Pearson’s Chi-square test and Fisher’s exact test.

## RESULTS

### Demographics [Table 1]

A total of 225 nail samples were sent, of which 104 (41.6%) yielded a positive culture. The subjects were predominantly male (Male: Female = 1.2:1), with a median age of 60 years (interquartile range: 26). Toenails were the most common site affected ( $n = 93$ , 41.3%), followed by fingernails ( $n = 71$ , 31.6%), both toenails and fingernails ( $n = 42$ , 18.7%), and cases where the site was not stated ( $n = 19$ , 8.4%).

### Causative organisms

Out of the 104 significant cultures, NDM ( $n = 46$ , 44.2%) was the most frequently identified, followed by yeasts ( $n = 33$ , 31.7%) and dermatophytes ( $n = 25$ , 24%).

**Non-dermatophyte moulds**

*Aspergillus niger* (n = 16, 34.8%) was the most common NDM identified, as shown in Table 2, followed by *Aspergillus versicolor* (n = 3, 6.5%), *Aspergillus fumigatus* (n = 3, 6.5%), *Penicillium* sp.(n = 3, 6.5%), *Curvularia* sp.(n = 2, 4.3%),

*Rhizopus* sp.(n = 2, 4.3%) and *Fusarium* sp. (n = 2, 4.3%). Some other genera or species identified include *Nigrospora* sp., *Phialemonium* sp., *Scytalidium* sp., *Acremonium* sp., *A. alternata*, *Exophiala werneckii*, *Trichoderma* sp. and *Pseudallescheria* sp.

**Table 1: Demographic data, age, gender, site of lesion, treatment provided and outcome**

Variables	Categories	Frequency, n (%)
Age (years)	Median (IQR)	60.00 (26.00)
Gender	Male	120 (53.3)
	Female	105 (46.7)
	Total	225 (100.0)
Site of lesion	Toenail	93 (41.3)
	Fingernail	71 (31.6)
	Toenail and fingernail	42 (18.7)
	Not stated	19 (8.4)
	Total	225 (100.0)
Oral antifungal	Yes	68 (30.2)
	No	157 (69.8)
	Total	225 (100.0)
Choice of oral antifungal	Itraconazole	59 (86.8)
	Terbinafine	9 (4)
	Total	68 (100.0)
Treatment outcome	Still dystrophic	31 (45.6)
	Improved	13 (19.1)
	Not mentioned	20 (29.4)
	Lost to follow-up	4 (5.9)
	Total	68 (100.0)

IQR: Interquartile range

**Candida**

*Candida* spp. was the most common yeast identified (n = 25, 75.8%), followed by *Candida albicans* (n = 4, 12.1%), *Candida parapsilosis* (n = 1, 3.0%) and *Candida tropicalis* (n = 1, 3.0%).

**Dermatophyte**

*Trichophyton* sp. (n = 13, 52.0%) was the most common dermatophyte identified, followed by *Trichophyton tonsurans* (n = 4, 16.0%), *T. rubrum* (n = 1, 4.0%) and *Trichophyton terrestre* (n = 1, 4.0%). Other dermatophytes identified included *Epidermophyton floccosum*, *Microsporum ferrugineum*, *M. canis* var. *distortum*, *M. audouinii*, *M. nanum* and *M. sp.*

**Antifungal prescription pattern in hospital Serdang**

A total of 68 (30.2%) out of 104 patients were prescribed oral antifungal treatment. Oral itraconazole was the most commonly prescribed antifungal (n = 59, 86.8%), followed by terbinafine (n = 9, 13.2%). Of those who received antifungal treatment, 45.6% (n = 31) still had dystrophic nails. Improvement was seen in 19.1% (n = 13) of patients. The remaining data were missing. In addition, 29.4% (n = 20) of patients were retreated with another pulse of antifungal treatment within a year after the first treatment.

**Table 2: Summary of causative organisms found in order of frequency**

Dermatophyte (n=25), n (%)	NDM (n=46), n (%)	Yeast (n=33), n (%)
<i>Trichophyton</i> spp.: 13 (52)	<i>A. niger</i> : 16 (34.8)	<i>Candida</i> spp.: 25 (75.7)
<i>T. tonsurans</i> : 4 (16.0)	<i>A. versicolor</i> : 3 (6.5)	<i>C. albicans</i> : 6 (18.2)
<i>T. rubrum</i> : 1 (4.0)	<i>A. fumigatus</i> : 3 (6.5)	<i>C. parapsilosis</i> : 1 (4)
<i>T. terrestre</i> : 1 (4.0)	<i>Penicillium</i> spp.: 3 (6.5)	<i>C. tropicalis</i> : 1 (4)
<i>M. ferrugineum</i> : 1 (4.0)	<i>Curvularia</i> spp.: 2 (4.3)	
<i>M. canis</i> var. <i>distortum</i> : 1 (4.0)	<i>Rhizopus</i> spp.: 2 (4.3)	
<i>M. audouinii</i> : 1 (4.0)	<i>Fusarium</i> spp.: 2 (4.3)	
<i>M. nanum</i> : 1 (4.0)	<i>F. solani</i> : 2 (4.3)	
<i>Microsporum</i> spp.: 1 (4.0)	<i>A. flavus</i> : 2 (4.3)	
<i>E. floccosum</i> : 1 (4.0)	<i>A. terreus</i> : 1 (2.2)	
	<i>Cladosporium</i> spp.: 1 (2.2)	
	<i>Nigrospora</i> spp.: 1 (2.2)	
	<i>Phialemonium</i> spp.: 1 (2.2)	
	<i>Scytalidium</i> spp.: 1 (2.2)	
	<i>Acremonium</i> spp.: 1 (2.2)	
	<i>A. alternata</i> : 1 (2.2)	
	<i>E. wernickii</i> : 1 (2.2)	
	<i>Trichoderma</i> spp.: 1 (2.2)	
	<i>Pseudallescheria</i> spp.: 1 (2.2)	
	<i>R. oryzae</i> : 1 (2.2)	

NDM: Non-dermatophyte mold, *T. tonsurans*: *Trichophyton tonsurans*, *T. rubrum*: *Trichophyton rubrum*, *T. terrestre*: *Trichophyton terrestre*, *M. ferrugineum*: *Microsporum ferrugineum*, *M. canis*: *Microsporum canis*, *M. audouinii*: *Microsporum audouinii*, *M. nanum*: *Microsporum nanum*, *E. floccosum*: *Epidermophyton floccosum*, *A. niger*: *Aspergillus niger*, *A. versicolor*: *Aspergillus versicolor*, *A. fumigatus*: *Aspergillus fumigatus*, *F. solani*: *Fusarium solani*, *A. flavus*: *Aspergillus flavus*, *A. terreus*: *Aspergillus terreus*, *A. alternata*: *Alternaria alternata*, *E. wernickii*: *Exophiala wernickii*, *R. oryzae*: *Rhizopus oryzae*, *C. albicans*: *Candida albicans*, *C. parapsilosis*: *Candida parapsilosis*, *C. tropicalis*: *Candida tropicalis*

**Factors associated with treatment outcome**

Fisher’s exact test analysis revealed a statistically significant association between age and treatment outcome ( $P = 0.040$ ), with  $P < 0.05$  considered statistically significant, as shown in Table 3. No significant association was found between gender, site of infection and fungal classification.

**DISCUSSION**

Onychomycosis is well known to affect toenails and the elderly population,<sup>[1]</sup> which aligns with our study. The contributing factors include poor peripheral circulation, diabetes, repeated nail trauma, prolonged exposure to pathogenic fungi, suboptimal immune function, inactivity and the inability to properly care for toenails or maintain good foot hygiene.<sup>[14]</sup> Slight male predominance was observed in our study, similar to findings from a European study and survey.<sup>[15]</sup> This may be explained by increased outdoor activity and certain occupations, which make males more vulnerable to trauma and subsequent fungal entry.

Similar to some previous studies conducted in SEA,<sup>[4-6,8,16]</sup> NDM appears to be the most common organism identified through nail fungal culture in our centre. These findings contrast with the results of Gupta *et al.* in Canada, where dermatophytes (71.9%) were the predominant organisms, followed by NDM (20.4%) and yeasts (7.6%), as illustrated in Table 4.<sup>[3]</sup> Another study by Sigurgeirsson *et al.* also showed dermatophytes as the predominant organism (65%), followed by yeasts (21.1%) and NDM (13.3%).<sup>[18]</sup> These differences may be attributed to geographical and socioeconomic factors that distinguish studies conducted in the West.

The diagnosis of onychomycosis requires both clinical assessment and confirmatory laboratory tests, such as potassium hydroxide (KOH) microscopy preparations, fungal culture, histopathology and polymerase chain reaction.<sup>[19]</sup> In particular, diagnosis of NDM onychomycosis requires special attention, as these organisms are notoriously difficult to treat and are often deemed contaminants. Studies in SEA have not consistently applied stringent diagnostic criteria to exclude the possibility of contamination.<sup>[4-7]</sup> Gupta *et al.* suggested that at least 3 out of 6 major criteria should be used to classify an organism as pathogenic.<sup>[16]</sup> The 6 major criteria are: identification of the moulds in the nail by microscopy (using KOH preparation), isolation in culture, repeated isolation in culture, inoculum counting, failure to isolate dermatophyte in culture and histology.<sup>[3]</sup> Therefore, future studies in SEA should implement these suggested diagnostic criteria to validate the findings regarding the causative organisms.

*Aspergillus* spp. was the most commonly identified NDM in most studies conducted in Malaysia.<sup>[4,5]</sup> However, *Fusarium* spp. was more commonly identified in Singapore, while *S. dimidiatum* was the predominant organism in Thailand.<sup>[8]</sup> The lack of standardisation in methods for reporting NDM onychomycosis may explain the differences in geographical distribution. *Aspergillus* spp. is often considered a colonizer of dystrophic nails, possibly due to suboptimal sampling techniques.<sup>[16]</sup> Microdrilling, proximal sampling and subungual curettage yield better results than nail clipping.<sup>[4]</sup> However, certain *Aspergillus* species, such as *A. versicolor* and *A. niger*, have been reported as primary causes of onychomycosis.<sup>[16]</sup> In our laboratory, nail clippings were cultured only on SDA,

**Table 3: Association between age, gender, site affected, fungal classification and choice of antifungal with treatment outcome**

Variables	Treatment outcome		$\chi^2$	P
	Still dystrophic nail, n (%)	Improved, n (%)		
Age (years)				
Teenage	1 (50.0)	1 (50.0)		0.040 <sup>a</sup>
Adult	19 (86.4)	3 (13.6)		
Elderly	11 (55.0)	9 (45.0)		
Gender				
Male	18 (72.0)	7 (28.0)	0.066	0.797
Female	13 (68.4)	6 (31.6)		
Site affected				
Toenail	14 (82.4)	3 (17.6)	2.802	0.246
Toenail and fingernail	13 (68.4)	6 (31.6)		
Fingernail	4 (50.0)	4 (50.0)		
Fungal classification				
Mould	10 (76.9)	3 (23.1)		1.000 <sup>a</sup>
Dermatophyte	6 (75.0)	2 (25.0)		
Yeast	3 (100.0)	0		
Choice of antifungal				
Itraconazole	28 (70.0)	12 (30.0)		1.000 <sup>a</sup>
Terbinafine	3 (75.0)	1 (25.0)		

P-value with asterisk ‘a’ shows P value from Fisher’s exact test

**Table 4: Comparison of studies on the causative organisms of onychomycosis**

	Lim et al. (1990–1991) <sup>[7]</sup> skin centre, Singapore	Ng et al. (1996–1998) <sup>[5]</sup> UMMC, Malaysia	Gupta et al. (1995–2002) <sup>[3]</sup> Canada	Lau (2004–2008) <sup>[6]</sup> Malaysia	Ranawaka et al. (2012) <sup>[17]</sup> Sri Lanka	Ramalingam et al. (2011–2015) <sup>[4]</sup> HKL, Malaysia	Current study (2011–2015)
Total number of isolates	Total: 65	Total: 500	Total: 2046	Total: 217	Total: 85	Total: 1357	Total: 104
Dermatophytes, n (%)	Total: 21 (32.3) <i>T. rubrum</i> : 12 (57.1) <i>T. mentagrophyte</i> : 3 (14.3) <i>T. interdigitale</i> : 5 (23.8) <i>T. violaceum</i> : 1 (4.8)	Total: 177 (35.4) <i>T. rubrum</i> : 118 (66.7) <i>T. mentagrophytes</i> : 62 (35.0) <i>Malbranchea</i> spp.: 2 (1.1)	Total: 1472 (71.9) <i>T. rubrum</i> : 1058 (71.9) <i>T. mentagrophytes</i> : 400 (27.2) <i>E. floccosum</i> : 5 (0.3)	Total: 3 (1.4) <i>Trichophyton</i> spp.: 2 (66.7) <i>M. nanum</i> : 1 (33.3)	Total: 17 (20.0) <i>T. rubrum</i> : 11 (64.7) <i>T. mentagrophytes</i> : 6 (35.3)	Total: 101 (7.4) <i>T. tonsurans</i> : 35 (34.7) <i>T. rubrum</i> : 28 (27.7) <i>T. mentagrophytes</i> : 16 (15.8)	Total: 25 (24.0) <i>Trichophyton</i> spp.: 13 (52.0) <i>T. tonsurans</i> : 4 (16.0) <i>E. floccosum</i> : 1 (4.0)
NDM, n (%)	Total: 12 (18.5) <i>Fusarium</i> : 6 (50.0) <i>Aspergillus</i> : 3 (25.0) <i>S. brevicaulis</i> : 1 (8.3) <i>Aureobasidium</i> spp.: 1 (8.3) <i>Penicillium</i> spp.: 1 (8.3)	Total: 182 (36.4) <i>A. niger</i> : 63 (34.6) <i>A. fumigatus</i> : 30 (16.5) <i>H. toruloidea</i> : 27 (14.8) <i>Fusarium</i> spp.: 16 (8.8) <i>Aspergillus</i> spp.: 9 (4.9)	Total: 418 (20.4) <i>S. brevicaulis</i> : 120 (28.7) <i>Acremonium</i> : 70 (16.7) <i>A. sydowii</i> : 38 (9.1)	Total: 155 (71.4) <i>Aspergillus</i> spp.: 45 (29.0) <i>Fusarium</i> spp.: 22 (14.2) <i>S. dimidiatum</i> : 19 (12.2)	Total: 39 (45.9) <i>A. niger</i> : 19 (48.7) <i>A. flavus</i> : 5 (12.8) <i>Fusarium</i> spp.: 5 (12.8)	Total: 941 (70.0) <i>A. niger</i> : 245 (26.0) <i>Fusarium</i> spp.: 234 (24.9) <i>Penicillium</i> spp.: 140 (14.9)	Total: 46 (44.2) <i>A. niger</i> : 16 (34.8) <i>A. versicolor</i> : 3 (6.5) <i>A. fumigatus</i> : 3 (6.5)
Yeasts, n (%)	Total: 39 (60.0) <i>C. albicans</i> : 38 (97.4) <i>C. parapsilosis</i> : 1 (2.6)	Total: 136 (27.2) <i>C. albicans</i> : 132 (97.1) <i>C. parapsilosis</i> : 3 (2.2) <i>C. tropicalis</i> : 1 (0.7)	Total: 156 (7.6) <i>Candida</i> spp.: 118 (75.6) <i>C. albicans</i> : 38 (24.4)	Total: 59 (27.2) <i>C. parapsilosis</i> : 35 (59.3) <i>C. albicans</i> : 13 (22.0) <i>C. tropicalis</i> : 7 (11.9)	Total: 29 (34.1) <i>Candida</i> spp.: 20 (69.0) <i>C. albicans</i> : 2 (6.9)	Total: 302 (22.3) <i>Candida</i> spp.: 130 (43.0) <i>Trichosporon</i> spp.: 90 (29.8) <i>C. albicans</i> : 58 (19.2)	Total: 33 (31.7) <i>Candida</i> spp.: 25 (75.8) <i>C. albicans</i> : 6 (18.2) <i>C. parapsilosis</i> : 1 (3.0)

*T. tonsurans*: *Trichophyton tonsurans*, *T. rubrum*: *Trichophyton rubrum*, *T. mentagrophytes*: *Trichophyton mentagrophytes*, *E. floccosum*: *Epidermophyton floccosum*, *T. interdigitale*: *Trichophyton interdigitale*, *M. nanum*: *Microsporium nanum*, *T. violaceum*: *Trichophyton violaceum*, *A. niger*: *Aspergillus niger*, *S. brevicaulis*: *Scopulariopsis brevicaulis*, *A. fumigatus*: *Aspergillus fumigatus*, *A. flavus*: *Aspergillus flavus*, *Aspergillus sydowii*: *A. sydowii*, *H. toruloidea*: *Hendersonula toruloidea*, *C. albicans*: *Candida albicans*, *C. parapsilosis*: *Candida parapsilosis*, *C. tropicalis*: *Candida tropicalis*, NDM; Non-dermatophyte molds, UMMC: University Malaya Medical Centre, *A. versicolor*: *Aspergillus versicolor*, *S. dimidiatum*: *Scytalidium dimidiatum*

and the morphology was described using LPCB stain. Further confirmation was sent to the Institute for Medical Research if there was doubt regarding morphology. No further steps were taken to exclude the possibility of contamination, as previously suggested.<sup>[16]</sup> This may increase the chance of a false-positive result.

*Candida* spp. accounts for about 10%–20% of onychomycosis cases.<sup>[1]</sup> *Candida* onychomycosis typically affects fingernails more than toenails and is common in patients with paronychia or those who are immunocompromised. In healthy individuals, DLSO with or without paronychia may be an early presentation of *Candida* onychomycosis.<sup>[20]</sup> Our study, in line with two other studies conducted in Malaysia,<sup>[5,6]</sup> demonstrated yeast as the second most common cause of onychomycosis. The reported prevalence of yeast as a causative organism in onychomycosis in Malaysia ranged from 22.3% to 30.2%,<sup>[4-6]</sup> which is much higher than the currently reported prevalence.<sup>[1]</sup> All three studies,<sup>[4-6]</sup>

including ours, were conducted retrospectively and did not report on clinical characteristics or laboratory methodology. It has been suggested that KOH preparation should be used to confirm the presence of yeast cells.<sup>[14]</sup> Future research should include details about the site of infection, comorbidities and characteristics of *Candida* onychomycosis to provide a better understanding of its significance.

Oral itraconazole is the treatment of choice in our centre. A large proportion (45.6%) of patients still had dystrophic nails, and nearly 30% were retreated with another pulse of itraconazole within a year after the first treatment. Onychomycosis is notoriously difficult to treat, with recurrence and relapse rates ranging from 10% to 53%. These relapses typically occur within 2.5 years after treatment.<sup>[21]</sup> A Sri Lankan trial<sup>[22]</sup> observed a higher clinical cure rate for NDM onychomycosis with itraconazole compared to terbinafine, though no statistically significant difference was noted. Studies in Sri Lanka,<sup>[17,22]</sup> Malaysia<sup>[4]</sup> and Thailand<sup>[8]</sup>

showed that NDM onychomycosis is the predominant organism. However, Lipner and Scher suggested that terbinafine is preferred over itraconazole due to its higher cure rate and fewer drug interactions.<sup>[1]</sup> A network meta-analysis also showed that terbinafine had the highest odds of success in treating toenail onychomycosis.<sup>[21]</sup> Both itraconazole and terbinafine demonstrate similar efficacy for dermatophytes and NDM onychomycosis.<sup>[23]</sup> The difference in statistical outcomes is likely due to varying definitions of cure. However, terbinafine is less effective for *Candida* onychomycosis, which is the second most common causative organism in our community and many other SEA countries. Therefore, it is unlikely that the prescription choices will change in the near future.

### Limitations

This is a retrospective cross-sectional study, limited by potential errors such as diagnostic accuracy and incomplete historical data. All data collected were secondary and retrieved from medical records at Hospital Serdang. Not all relevant information for the variables studied was fully recorded. For example, 25 specimens grew *Candida* spp. and 13 specimens grew *Trichophyton* spp., but were not further identified. Data on the dosing of oral antifungal medications, clinical variants and details of topical treatments were not included in this study. In addition, some information regarding the site of infection and treatment outcomes was missing. For treatment outcomes, the data collected were insufficient to classify cases as clinical or mycological cures.

### CONCLUSION

Similar to global trends, onychomycosis in our centre predominantly affects the elderly, males and toenails. Consistent with other studies from Malaysia and SEA, NDMs and yeasts are more commonly identified as causative organisms. Despite treatment, up to 45% of onychomycosis cases showed no improvement, and nearly 30% of treated patients required retreatment. Since most studies conducted in Malaysia are retrospective, the actual prevalence, clinical features and causative organisms of onychomycosis in our region remain unclear. Further prospective studies on these factors are needed to guide the treatment decision in our region.

### Acknowledgement

The author would like to thank the Director General of Health Malaysia for the permission to publish this article. We acknowledge all the staff of the Department of Dermatology Serdang Hospital in the data collection.

### Financial support and sponsorship

Faculty of Medicine and Health Sciences, UPM.

### Conflicts of interest

There are no conflicts of interest.

## REFERENCES

- Lipner SR, Scher RK. Onychomycosis: Clinical overview and diagnosis. *J Am Acad Dermatol* 2019;80:835-51.
- Gupta AK, Mays RR. The impact of onychomycosis on quality of life: A systematic review of the available literature. *Skin Appendage Disord* 2018;4:208-16.
- Gupta AK, Gupta G, Jain HC, Lynde CW, Foley KA, Daigle D, *et al.* The prevalence of unsuspected onychomycosis and its causative organisms in a multicentre Canadian sample of 30 000 patients visiting physicians' offices. *J Eur Acad Dermatol Venereol* 2016;30:1567-72.
- Ramalingam R, Kunalan S, Tang MM. Mycology of onychomycosis: A 5-year retrospective review (2011 – 2015) in Hospital Kuala Lumpur. *Med J Malaysia* 2017;72:190-2.
- Ng KP, Saw TL, Madasamy M, Soo Hoo T. Onychomycosis in Malaysia. *Mycopathologia* 1999;147:29-32.
- Lau SL. A 5-year retrospective study on onychomycosis and its causative organisms in University Malaya Medical Centre (UMMC). *Malaysian J Dermatol* 2009;23:11-5.
- Lim JT, Chua HC, Goh CL. Dermatophyte and non-dermatophyte onychomycosis in Singapore. *Australas J Dermatol* 1992;33:159-63.
- Ungpakorn R, Lohapraphan S, Reangchainam S. Prevalence of foot diseases in outpatients attending the Institute of Dermatology, Bangkok, Thailand. *Clin Exp Dermatol* 2004;29:87-90.
- Falotico JM, Lipner SR. Updated perspectives on the diagnosis and management of onychomycosis. *Clin Cosmet Investig Dermatol* 2022;15:1933-57.
- Gupta AK, Mays RR, Versteeg SG, Shear NH, Piguat V. Update on current approaches to diagnosis and treatment of onychomycosis. *Expert Rev Anti Infect Ther* 2018;16:929-38.
- Elewski BE. Mechanisms of action of systemic antifungal agents. *J Am Acad Dermatol* 1993;28:S28-34.
- Gupta AK, Stec N, Summerbell RC, Shear NH, Piguat V, Tosti A, *et al.* Onychomycosis: A review. *J Eur Acad Dermatol Venereol* 2020;34:1972-90.
- Kreijkamp-Kaspers S, Hawke K, Guo L, Kerin G, Bell-Syer SE, Magin P, *et al.* Oral antifungal medication for toenail onychomycosis. *Cochrane Database Syst Rev* 2017;7:CD010031.
- Ghannoum MA, Hajjeh RA, Scher R, Konnikov N, Gupta AK, Summerbell R, *et al.* A large-scale North American study of fungal isolates from nails: The frequency of onychomycosis, fungal distribution, and antifungal susceptibility patterns. *J Am Acad Dermatol* 2000;43:641-8.
- Haneke E, Roseeuw D. The scope of onychomycosis: Epidemiology and clinical features. *Int J Dermatol* 1999;38 Suppl 2:7-12.
- Gupta AK, Drummond-Main C, Cooper EA, Brintnell W, Piraccini BM, Tosti A. Systematic review of nondermatophyte mold onychomycosis: Diagnosis, clinical types, epidemiology, and treatment. *J Am Acad Dermatol* 2012;66:494-502.
- Ranawaka RR, de Silva N, Ragunathan RW. Non-dermatophyte mold onychomycosis in Sri Lanka. *Dermatol Online J* 2012;18:7.
- Sigurgeirsson B, Olafsson JH, Steinsson JB, Paul C, Billstein S, Evans EG. Long-term effectiveness of treatment with terbinafine versus itraconazole in onychomycosis: A 5-year blinded prospective follow-up study. *Arch Dermatol* 2002;138:353-7.
- Gupta AK, Versteeg SG, Shear NH. Onychomycosis in the 21<sup>st</sup> Century: An update on diagnosis, epidemiology, and treatment. *J Cutan Med Surg* 2017;21:525-39.
- Gupta AK, Ryder JE, Baran R, Summerbell RC. Non-dermatophyte onychomycosis. *Dermatol Clin* 2003;21:257-68.
- Gupta AK, Daigle D, Foley KA. Network meta-analysis of onychomycosis treatments. *Skin Appendage Disord* 2015;1:74-81.
- Ranawaka RR, Nagahawatte A, Gunasekara TA, Weerakoon HS, de Silva SH. Randomized, double-blind, comparative study on efficacy and safety of itraconazole pulse therapy and terbinafine pulse therapy on nondermatophyte mold onychomycosis: A study with 90 patients. *J Dermatolog Treat* 2016;27:364-72.
- Jain S, Sehgal VN. Itraconazole versus terbinafine in the management of onychomycosis: An overview. *J Dermatolog Treat* 2003;14:30-42.