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Research Article

Prevalence and associated factors of occupational Onychomycosis in South India

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Article Info

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Abstract

Onychomycosis is a fungal infection that found in the nails and its surrounding skin regions. It is predominantly defined as a physical and psychological morbid state thereby the routine activities get affected. Increased prevalence is largely recorded among diabetes, immunocompromized patients and trauma including sports injury. In view of having meagre literature related to occupational onychomycosis, this study aimed to study the prevalence of onychomycosis among various occupational groups and also identify the associative factors that trigger the disease. This is a cross sectional study including 432 onychomycosis patients enrolled thereby 276 observed due to their occupation. Sociodemographic details, co-morbid status, hygienic practices and other personal details were collected using standard profroma. Nail samples were aseptically collected and were directly examined microscopically by KOH mount and further cultured in chloromphenicol supplemented Sabouraud Dextrose agar medium. Among the patients, maximum belongs to the age group between 30 and 40 years (35.5%) and male dominated with 70.6%. Blood group A positive dominated (37.7%) followed by O positive (32.2%), mixed diet (84.2%), 56.5% have secondary education. Associating the occupational observation, construction workers are leading with 18.8% followed by farmers (13%). Poor hand and foot hygiene is largely observed followed by diabetes and hypertension. Among the risk factor evaluation, obesity observed maximum followed by alcoholic and nail biting. Clinical presentations like Distal and lateral subungal (64.5%) dominated; laterality of left hand and both legs showed maximum with 13.8%. Culturing was possible only with 211 patients but direct microscopy using KOH mount provide 100% positivity. *Trichophyton rubrum* (34.7%), *T. mentagrophytes* (22.1%) and *Candida* (14.1%) are the possible fungal identification from the clinical samples. This study revealed the importance of direct microscopy to determine the exact etiology of onychomycosis as the culture report delay, and occupation that affect and damage the nails play a major role in acquiring such infections.

Keywords: Onychomycosis, Occupation, construction workers, *Trichophyton, Candida*

Introduction

Onychomycosis is a common occupational fungal infection largely observed among male populations, and highest among onychopathies. It mainly infected nails of both hands and toes where sociodemographic and cultural factors varied. Tissues beneath and around the nails are also get damaged due to fungal invasion, with

mechanical and chemical diffusion where polymicrobial fungal isolation are low [1,2]. Species specific competitions and understanding the microbial communications are the newer biomics that intensively play a vital role in mono or poly microbial invasions and infections [3,4].

Discoloration, wheal and flare reactions, thickening and severance of nails from nail beds are the possible visual observations of nail infections. In general hands are the very important vehicle that communicate with all parts of our body, where nails act as a reservoir; thus nail infections may spread to all parts superficially and if invaded subcutaneously and occasionally systemic infections. Risk factors that invite and increase the nail infections are immunocompromised state, diabetes, smoking, poor hand and toe hygiene, life style with largely exposed to water, nail damage and disturbances in peripheral circulation [5,6,7,8].

Clinical and diagnostic observations of onychomycosis are still unclear and neglected, treatment done with broad spectrum. It is very tough to identify the profile of onychomycosis because of misdiagnosis of discoloration of nails due to malnutrition, lichen planus, nail damage, onychogryphosis and psoriasis as microbial infections of nails [9,10]. The etiology of onychomycosis is easy to determine, if the Dermatology clinic has some diagnostic ideas on appropriate clinical and microscopic investigations. Dermatophytes including the species of *Trichophyton* and *Microsporum*; yeasts like *Candida* and non-dermatophytic moulds including *Fusarium, Rhizopus* etc [11,12].

Overall maintaining the hygienic nails and cleaning the nails with antiseptics properly during bathing reduce the damage and infections. As this is a cosmetic problem, defigurements of nails leads to affect the quality of life, increase stress and depression, and deviation in self manage of sufferers. By understanding the literature gap, this study is aimed to identify the prevalence of onychomycosis, etiology and risk factors of the patients and samples included.

Materials and Methods

This study was done in a tertiary care teaching hospital, where more number of outpatients found in the Dermatology department for the period of one year (March 2025 to February 2026). This study was approved by the Institutional Ethics Committee, study protocol was designed in strict accordance of the ethical principles of declaration of Helsinki. Written informed consent and assent was obtained before initiating the study and strict confidentiality was maintained by storing the detailed results in the password secured system.

During the study period, a total of 432 onychopathies patients from the outpatient department of Dermatology in South Indian tertiary care teaching hospital. Among them, 276 (63.9%) were identified clinically for onychomycosis who are predominantly infected and diseased due to their occupation exposure like chemical contact, dryness and long duration of works. All types of onychomycosis who are clinically confirmed irrespective of age, gender, occupation, number of nails involved, clinical scenario with visual observation and onychoscopy (non-invasive dermoscopic examination) [3], history of comorbid states, duration of the disease were included. Patients confirmed with psoriasis, lichen planus, other nail dystrophys, topical drugs used were excluded. Predominant of occupational exposure

Nail samples of clinically confirmed onychomycosis patients were aseptically collected by surface cleaning with 70% alcohol. Discoloured nail at proximal end, proximal nail surface, tangential biopsy were collected from distal and lateral subungual, proximal subungual, superficial and endonyx onychomycosis, respectively. Further, the nail samples and debris were subjected to KOH direct microscopy and culture.

In a clean, grease and crack free slide, two drops of 20% potassium hydroxide was placed and a minute size of the nail sample was immersed. After placing the cover slip without air bubbles, the slide was gently exposed to heat for three to four times and kept in the room temperature for 20 minutes. Then the slide was observed under low and high power immersion and the presence of arthrospores or hyphae were noted.

Cultures were possible by inoculating the nail samples in the chloromphenicol incorporated Sabouraud Dextrose Agar (SDA) and incubated for ten days to three weeks. The dermatophytic and nondermatophytic fungal isolates were identified according to the days of incubation. Duplicates type of culturing was done for ruling out the laboratory contamination. All the prepared culture media plates were checked for sterility before inoculation for avoiding surface (improper media preparation) and underneath (improper glassware sterilization) contamination [13]. Further, all then growth were further confirmed by colony description and morphology, pigmentation and texture, lactophenol cotton blue staining and microscopy at low and high power to determine the fungal nature and types. All the data were compared with the initial direct KOH microscopic data. All the collected data were expressed in frequency and percentages.

Results

In this study, 276 clinically confirmed onychomycosis patients were included, among them, 59.8% belong to the age group between 31 and 50, and maximum of 70.8% patients were males, 1.9% were transgenders. Urban residing patients are recorded in high numbers (47.5%) and more patients are secondary school educators (56.5%) and very few are collegiate (7.7%) (Table 1).

Table 1: Sociodemographic details of the Onychomycosis patients (n=276)

Variables	Frequency	Percentage
Age groups		
Below 10	2	0.7
10-20	26	9.4
21-30	64	23.2
31-40	98	35.5
41-50	67	24.3
51-60	12	4.4
Above 60	7	2.5
Gender		
Males	195	70.6
Females	76	27.5
Transmen	1	0.4
Transwomen	4	1.5
Locality		
Urban	131	47.5
Rural	89	32.2
Semi-urban	39	14.1
Migrants (in urban)	17	6.2
Education		
Primary schooling	97	35.1
Secondary schooling	156	56.5
UG holder	20	7.3
PG holder	01	0.4
Illiterate	02	0.7

The associate factors are also studied thereby occupation play a vital role and construction workers (18.8%) with damaged nails in both hands and toes are recorded highly followed by farmers (13%). In order to assessing the blood group, patients with A group (37.7%) recorded high followed by O group (32.3%). Those who are including non-vegetarian diet (84.2%) in their meal are affected highly than vegetarian (Table 2).

Table 2: Associate factors of Onychomycosis patients

Associate factors	Frequency	Percentage
Occupation		
Cement workers	23	8.3
Construction workers	52	18.8
Farmers	36	13
Fishermen	10	3.6
Health care workers	22	8

Home makers	8	2.9
Housemaids	18	6.5
Market sales	16	5.8
Match box industry	22	8
Mechanic	14	5.1
Paper industry	6	2.2
Road workers	11	4
Sewage workers	17	6.2
100 day workers	21	7.6
Blood Group		
A positive	104	37.7
B positive	31	11.2
AB positive	49	17.8
O positive	89	32.2
A negative	0	0
B negative	2	0.7
AB negative	1	0.4
O negative	0	0
Diet		
Vegetarian	44	15.9
Mixed	232	84.1

Co-morbidities and risk factors are very important intrinsic and extrinsic analysis for determining the severity and triggering nature of onychomycosis. Poor hand finger hygiene (38.4%) followed by diabetes (33%) were found as a dominating co-morbidities. Unprescribed (counter the sales) medications trigger the fungal infections in general, and the same accounted in this study with 11.6%. Among the risk factors, obesity (37.3%) dominated followed by alcoholic (33.3%) and the detailed description was mentioned in table 3.

Table 3: Co-morbidities and risk factors

Variables	**Frequency**	**Percentage**
Co-morbidities		
Diabetes	81	33
History of surgery	9	3.3
HIV/ AIDS	2	0.7
Hyperhidrosis	17	6.2
Hypertension	73	26.4
Lichen planus	4	1.5
Peripheral vascular disease	21	7.6
Poor foot hygiene	62	22.5
Poor hand hygiene	106	38.4
Nail psoriasis with discoloration	12	4.3
Unprescribed medications	32	11.6
Vaginal candidiasis	7	2.5
Tinea pedis	41	14.9
Risk factors		
Alcoholic	92	33.3
Lack of awareness about nail changes	192	69.6
Nail biting and tissue damage	92	33.3
Nail damage (undefined)	43	15.6
Obesity	103	37.3
Smoking	63	22.8
Trauma	62	22.5

Clinical presentations of the onychomycosis are found dominated as distal and lateral subungal type with 64.5% followed by total dystrophic (14.8%) and mixed patterns (11.6%). The monomicrobial and polymicrobial fungal isolates by culturing and direct microscopy are also studied and depicted in table 4. The laterality of the onychomycosis distribution was well defined thereby right hand only (monolaterality – 9.4%) and, left hand and both legs (polylaterality – 13.8%) dominated (Table 5).

Table 4: Clinical presentations and fungal isolates

Types of onychomycosis	Frequency	Monomicrobial fungus	Polymicrobial fungus
Distal and lateral subungal	178 (64.5)	167 (60.5)	11 (3.9)
Proximal subungal	17 (6.2)	14 (5.1)	3 (1.1)
Superficial white	3 (1.1)	2 (0.7)	1 (0.4)
Endonyx	5 (1.8)	4 (1.5)	1 (0.4)
Total dystrophic	41 (14.8)	37 (13.4)	4 (1.4)
Mixed patterns	32 (11.6)	29 (10.5)	3 (1.1)

[Figure in parenthesis denoted percentages]

Table 5: Onychomycosis versus laterality

Variables	Frequency	Percentage
Monolaterlity		
Right hand only	26	9.4
Left hand only	21	7.6
Both hands only	7	2.5
Rights toes only	18	6.5
Left toes only	16	5.8
Both toes only	12	4.3
Polylaterality		
Right hand and right leg	23	8.3
Left hand and right leg	19	7
Right hand and left leg	16	5.8
Left hand and left leg	23	8.3
Right hand and both legs	20	7.3
Left hand and both legs	38	13.8
Right leg and both hands	10	3.6
Left leg and both hands	23	8.3
All hands and legs	4	1.5

Pivotally, diagnosis plays a vital role to initiate the appropriate treatment and antifungal regimens; all samples were showed positive to direct KOH microscopy whereas SDA culturing was possible only with 211 samples (76.4%), and this variations are mainly due to the non-cultivable fungal strains. Among dermatophytes identified by both culturing and microscopy, *Trichophyton rubrum* dominated with 34.7% followed by *T. mentagrophytes* (22.1%). Non dermatophytic isolates including *Candida* (14.1%) were possible and maximum mixed fungal isolates were found as *T. rubrum, T. mentagrophytes* and *Fusarium* (2.2%) (Figure 1 and Table 6).

Figure 1: Distribution of fungal identification

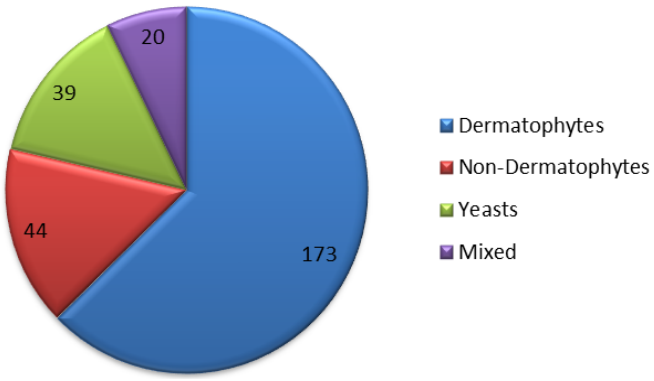


Table 6: Possible fungal identification

Fungal identication	Frequency	Percentage
Dermatophytes		
Trichophyton rubrum	96	34.7
T. mentagrophytes	61	22.1
Microsporum canis	16	5.8
Non Dermatophytes		
Aspergillus flavus	8	2.9

A. niger	10	3.6
Acremonium species	5	1.8
Penicillium species	7	2.5
Fusarium species	10	3.6
Rhizopus species	4	1.4
Candida albicans	36	13
Non albicans *Candida*	3	1.1
Mixed fungal isolates		
T. rubrum + *A. niger*	4	1.5
T. rubrum + *T. mentagrophytes* + *Fusarium*	6	2.2
T. rubrum + *Fusarium* + *Candida*	2	0.7
T. mentagrophytes + *Fusarium* + *Penicillium*	3	1.1
T. mentagrophytes + *Candida*	5	1.8

Discussion

Onychopathies are not a common or routine issue, it may caused by various factors including damage, trauma, infections. Onychomycosis are found increased now a days due to fungal invasion in the nail apparatus and affect adjacent tissues leads to partial and complete tissue damage, and rarely surgical removal of the infected tissues may happen. This nail infection affects people of all age groups; while analyzing the children, less common in that age group and their nail growth is faster thus damaged nails may grow faster; predominantly people between 30 and 60 are commonly affected [14,15], and the same was recorded in this study.

The impact of oncyhomycosis is higher in males than females and the same was supported by some impact reports [9,16]. While evaluating the occupational hazards, the females are determined higher in some studies [10,17,18,19] and in some studies recorded as both genders [20,21]. No studies defined the residential locality connected to onychomycosis but in our study, urban locality highlighted with 47.5%. There is no correlation of educational qualifications and onychomycosis patients and no such studies available.

Occupation plays a vital role in the fungal infections in nail apparatus. In this study, cement exposing construction workers, farmers and match box industry types of occupational patients are dominating with onychomycosis and the same was observed in many studies [10]. Chemical and animal product based industries are prime role in causing nail infections and related diseases [22,23,24]. Immigrant manual labourers are also very prone to severity of onychomycosis [25]. The measures of occupation and individual patients have to be further assessed for providing appropriate awareness to prevent such disease and infection.

Blood group A was most prevalent (37.7%), followed by group O (32.2%), group AB (17.8%), and group B (11.2%); Rh negative group was observed among 1.1% patients and the same type of prevalence was observed in many studies [26,27,28]. Interestingly, females with O group and males with A group were affected [29]. Literatures and our study suggested that blood group A is prone to onychomycosis, but does not establish that this blood group predisposes people to onychomycosis. In this study, 84.1% patients have non-vegetarian diet regularly, and that may trigger the disease state; but there is no proven scientific publications related non-vegetarian diet that associates the disease severity or cure. While interviewing with patients who are taking fish and mutton in their diet, it was recorded that triggering of infections and increase in clinical symptoms like itching, pain and irritation.

Poor hand and toe hygiene, diabetes and hypertension are the dominant co-morbidities observed in this study. Periphery artery disease is the independent predictor of onychomycosis [30,31,32]. Diabetes, obesity, tight shoes for longer time is found to be more dominant which trigger and increase the severity of onychomycosis [7,33,34,35,36,37].

While evaluating the risk factors, lack of awareness about nail changes dominating with 69.6%, and some studies also correlated the same [5,8,38]. Obese patients have higher severity of onychomycosis than the non-obese patients which was described well in several studies [7,39,40,41]. No serious studies are

found to integrate the alcohol intake and severity or risk factor of onychomycosis but in most of the studies the data related to alcohol intake was collected and included. Few studies indicated that cutaneous manifestations may occur due to severe alcoholism [6,42]. Further independent associations will be done in future for understanding the nature and biology of alcohol, obesity and smoking.

In common, the predisposing factors of onychomycosis are multifactoral. Instead, nail biting leads to cuticle manipulation cause disruption and damage tissues may leads to several infections including onychomycosis. In this study, 33.3% of patients having moderate to severe nail biting habits which is related to some clinical studies [39]. Smoking habit also trigger the severity of nail infections and in this study 22.8% patients having moderate to severe smoking habit [43,44,45]; another study suggested that no such correlation found between smoking and onychomycosis; thus further investigations with increased sample size required [46].

In this study, the prevalence of dermatophytic fungi in onychomycosis nail apparatus is higher than non-dermatophytic and yeasts which is highly supported by many studies [12,47]. These fungi are infected the nails through environment or from other infected patients, also it spreads to nearby and surrounding tissues subcutaneously due to keratinolytic properties [11]. Distal lateral subangul type is the commonest form where the fungus (*T. rubrum, T. mentagrophytes, T. floccosum*) migrates to nail plates cause paraketosis followed by hyperkeratosis and onycholysis [2,12].

Proximal subangul type is caused predominantly by *T. rubrum* which have the clinical presentation as leuconychia, complete destruction of nail apparatus due to hyperkeratosis found both in hands and toes. HIV associated and other immunosuppressive individuals are very prone to this type thereby lymphatic transmission, auto re-infection and endogenous reactivation. Superficial nail infections is a rare type where superficial white patches found initially and predominantly observed in toenails and the etiology is *T. mentagrophytes* and rarely by non-dermatophytic moulds like *Acremonium, Aspergillus* and *Fusarium* [12].

Endonyx is a special variant initially infect the nail plate lamelle (milky white discoloration, irregular wide waves) and invasion is possible by *T. violaceum*, and imitate its elevated affinity for rigid keratins. Total dystrophic onychomycosis presented with thickness of nail plate and its matrix where nail becomes crumbles down, dystrophic and thick. *Candida* infection is also common secondarily by other forms of dermatophytic and non-dermatophytic moulds [48,49].

Mixed type of nail infections were observed low with increased fungal load of 11.6% whereas other studies are observed with 26% [3]; 12% [4] where *Epidermatophyton* is not isolated in this study but in some studies it was possible [50]. Recurrence of onychomycosis is recorded [51] and three cases of recurrence were observed in this study. The major limitation of this study is to not include the treatment and follow up procedures in this study.

In this study, patients with not having much awareness about nail infections and changes, diabetes and obesity are the prime factors that are closely associated with onychomycosis. Further, the severity of the infection is significantly associated with the untreated, underdiagnosed patients; thereby awareness should be given appropriately to all clinicians and to learn the mechanism and action of antifungal drugs.

Conclusion

This clinical investigation describes the clinical manifestations, occupational exposures of patients and laboratory diagnosis of specimens with onychomycosis attending outpatient department of dermatology of a tertiary care teaching hospital in South India. Among the patients, construction workers and farmers characterized prominent occupational groups, while poor hand hygiene, diabetes, obesity and limited awareness of nail changes were frequently reported. Dermatophytes, particularly *Trichophyton rubrum* and *T. mentagrophytes*, were prominent among the reported fungal isolates. However, the observed occupational

distribution and risk-factor frequencies should not be interpreted as evidence of causation without appropriate comparison groups and statistical analysis. Further multicentre studies with clearly defined occupational exposure measures and consistent laboratory confirmation are required.

Declarations

Ethics approval

Ethical approval was obtained from the Institutional Ethics Committee of Trichy SRM Medical College Hospital and Research Centre (Ref: TSRMMCH&RC/ME-1/2025; IEC No. 081 dated 03.02.2025). The study protocol was conducted in accordance with applicable ethical guidelines and regulations.

Informed consent

Informed written signed consent was obtained from all participatns before their participation in the study.

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Conflict of interest

The authors declare that they have no conflict of interest.

Data availability

The data generated and/or analyzed during the present study are available from the corresponding author on reasonable request, subject to applicable ethical and institutional restrictions.

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Use of artificial intelligence

The authors declare that no generative artificial intelligence (AI) tools were used in the conception, conduct, analysis, interpretation, or writing of this manuscript.

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