Risk Factors Associated with Onychomycosis in Patients Attending Dermatology Units of Some Hospitals in Benue State, Nigeria

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ABSTRACT

Onychomycosis is caused by different organisms especially the genus *Trichophyton* responsible for fungal nail infection. If left untreated, infection can spread to every nail and over time, the nails become thick, brittle, and ingrown causing pain and discomfort. To investigate the risk factors associated with onychomycosis in patients attending some hospitals within Benue state. A total of 384 finger and toenail samples were collected, disinfected, and subjected to laboratory examination using standard microbiological procedures. Some risk factors for onychomycosis including age, occupation, gender, diabetes mellitus condition, household contacts with animals, use of occlusive footwears, obesity, immune status, family history of onychomycosis, exposure to humid environments among others were investigated using structured questionnaire. The logistic regression for multivariate analysis was further used to identify the relationship between risk factors and onychomycosis. From the 384 samples collected, 226 fungal species were isolated from culture of toeand fingernails samples. *Tinea rubrum* was identified in159 (70.36%) followed by *As per gillus*spp., 30 (13.27%), *Candida* (Yeast), 19 (8.41%), *Trichophytoninterdigitale*,11 (4.87%) and *Epidermophy tonfloc cosum* was8 (3.54%). Age was statistically significant toony chomycos is with a positive association (OR=3.06, P=0.02; ≤ 0.05), while gender (OR=0.85, P=0.45>0.05)and occupationwas not statistically significant (OR=1.21, P=0.66; >0.05). Use of occlusive footwear, keeping of long nails, and wearing used shoes showed statistically significant associations with onychomycosis. Individuals who engaged in the afore mentioned risk factors had high odds ratio (39.0, 5.95 and 1.26 respectively). Diabetes mellitus condition, trauma/damage to nails, nail psoriasis, obesity, and immunosuppression also showedstatistically significant associations with onychomycosis. Odds ratio was (1.27, 1.86, 4.12, 1.05 and 3.14) respectively. Onychomycosis remains the most common nail disorder with a significant burden. There is need for prevention through practice of good personal hygiene and prescribed treatment of onychomycosisas it can have a considerable impact on patients' quality of life.

INTRODUCTION

Onychomycosis is a fungal infection of the nails which poses a significant public health concern globally. Its etiological agents include various dermatophytes, with *Trichophyton rubrum* standing out as one of the most common causative agents (de Berker *et al.*, 2007). This condition can significantly impact patients' emotional, social, and occupational functioning. Patients with onychomycosis may feel embarrassed in social and workplace situations and unwilling to expose their hands or feet due to the perception of being blighted or unclean. Several factors may predispose individuals to onychomycosis, including diabetes

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mellitus, age, nail trauma, poor peripheral circulation, immunosuppression, tightly fitting shoes, long nails, fixing of artificial nails, going barefoot in public places, sharing shoes, and exposing hands or feet to damp environments (Westerberg and Voyack, 2013).

Aging is the commonest risk factor associated with onychomycosis, most likely due to poor peripheral circulation, longer exposure to pathologic fungi, repeated nail trauma, suboptimal immune function, and slower nail growth. (Pierard, 2001)

Onychomycosis has been increasingly linked to genetic factors. Several studies suggest that individuals may be genetically predisposed to developing this fungal infection (Kara *et al*., 2018). Certain genes play a significant role in the body's immune response, and variations in these genes could influence an individual's susceptibility to infections, including onychomycosis (De Vries *et al*., 2008). Immunodeficiency, whether due to underlying condition, medication-induced, or therapy-related, significantly increases the risk for onychomycosis. (Gupta *et al*., 1998)

The environment, particularly those of health facilities and pedicure outlets, could exacerbate the risk of onychomycosis in genetically susceptible individuals. Suh environments often harbor a variety of fungi and provide an optimal climate for their growth. If the immune system of a genetically predisposed individual is unable to adequately fight off these fungi, it could lead to an infection (Shemer *et al*., 2009).

MATERIALS AND METHODS

Ethical Consideration

The study was proved by the ethics committee of the Benue State Ministry of Health and Federal Medical Centre, Makurdi respectively, with an issuance of letters of ethical clearance.

Sample Collection

Three hundred and eighty-four (384) patients participated in this study and had their nails clinically examined. Written informed consent with a structured questionnaire form on sociodemographic risk factors; (age, gender, occupation), behavioral risk factors; (performing manicure/pedicure, use of occlusive shoes, keeping of nails, wearing used shoes), environmental risk factors; (contact with pets, exposure to humid environment, family history of onychomycosis), comorbidities health history information (Diabetes, trauma/damage to nails, nail psoriasis, obesity, immune status) and lifestyle was obtained from the patients before the collection of samples. The fingernails and/or toenails were disinfected by applying 70% ethyl alcohol before the sample collection to avoid contamination (Cheesbrough, 2000). Nail scrapings and trimmings were carried out using a sterile surgical blade to scrap and trim a small portion of the affected nail plate, this was put in a properly labelled and sealed sterile polythene envelopes. Samples were transported to the Joseph Sarwuan Tarka University Makurdi department of Microbiology Laboratory for further mycological analysis.

Preparation of Culture Media

Sabouraud Dextrose Agar (SDA) was weighed and reconstituted in freshly measured distilled water in a conical flask according to the manufacturer's specifications. The media was shaken gently in a rotational manner to completely dissolve and closed tightly using a cotton plug in a foil paper, this was then sterilized at 121^{o}C for 15 minutes in an autoclave, allowed to cool to approximately 50^{o}C. A five (5) ml ciprofloxacin antibiotic injection was added into the medium using a sterile syringe to inhibit the growth of bacteria and other contaminants.

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Laboratory methods

Each sample was collected in duplicates; the first aliquot was used for direct microscopy while the second aliquot was used for fungal culture.

Microscopy Examination of Samples

The nail samples were soaked in cryovate tubes containing 1ml each of potassium hydroxide (KOH) for thirty minutes; this was fixed onto a voltage mixer machine to agitate the sample and then removed. A drop wasp petted onto a sterile slide, with another drop of lactophenol cotton blue added and covered with a clean slip, this was allowed to stand at room temperature until a clear material was obtained. Using a compound microscope, the sample was viewed under x40 and x10 magnification at different intervals to observe the presence of filamentous septate hyphae, chlamydospores, yeast cells and macro or micro-conidia. Slides with no visible growth were considered negative.

Cultural Method

Each nail sample was cultured using the pour plate method on sterilized Sabouraud Dextrose Agar (SDA) in sterile Petri dishes. It was wrapped with masking tape and kept at room temperature (about $30^{O}C$) on the working bench for 5 to 21 days and observed periodically for colonial growth. Fungi color, form, relief (flat, cerebriform, and pleated), consistency and morphology were also observed to confirm identification.

Method of Data Analysis

Logistic regression for multivariate analysis was used to identify independent demographic risk factors, ascertain the relationship between environmental factors and to examine associations between comorbidities and onychomycosis.

RESULTS

From the total of 384 samples collected, two hundred and twenty-six (226) fungal species including comorbidities were isolated from finger and toenails samples through culture technique, 159 (70.36%) were identified as *Tinea rubrum* followed by *Aspergillus* spp., 30 (13.27%), *Candida* (Yeast), 19 (8.41%), *Tineainterdigitale*,11 (4.87) and *Epidermophyt on floccosum*,8 (3.54). See Table1.

Tabel 1: Frequency of Occurrences and Percentage of Different Fungal Species Isolated from Fingernails and Toenails of Patients

Species	**Site of Infection**			**Frequency**	**Percentages**
	Toenails	**Fingernails**	**Toe/Fingernails**		
T. rubrum	154	2	3	159	70.36
E. floccosum	8	0	0	8	3.54
T. interdigitale	10	1	0	11	4.87
Candida (Yeast)	15	3	1	19	8.41
Aspergillus Spp.	23	2	4	30	13.27
Total	**210**	**8**	**8**	**226**	**100**

Table 2 displays the demographic risk factors of onychomycosis. Age was a statistically significant predictor with a positive association (OR=3.06, CI= 0.80-1.71, P=0.02). This implies that for a one-unit

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increase in age, the odds of having onychomycosis are 3.06 times higher, while gender and occupation were not statistically significant (OR=0.85, CI= 0.56-1.29, P=0.45 and OR=1.21, CI= 0.52-2.84, P=0.66) respectively.

Table 2: Demographic Risk Factors of Onychomycosis

Risk factor	Category	Onychomycosis		OR	CI	P
		+ve (n=226)	-ve (n=158)			
Age	18-30	6	8			
	31-45	99	56			
	46-60	73	55	3.06	0.80-1.71	0.02
	61-above	48	40			
Gender	Male	93	64	0.85	0.56-1.29	0.45
	Female	133	94			
Occupation	Athletes/MP	22	15			
	Farmers	49	32			
	Construction/FW	87	59	1.21	0.52-2.84	0.66
	Healthcare Workers	39	28			
	Hairdressers/Manicurists/Pedicurists	29	24			

Abbreviations: CI, confidence interval at 95%; OR odds ratio; P, P value; MP, Military Personnel; FW, Factory Workers

Table 3 explains how all behavioural risk factors i.e. (performance of manicure/pedicure services, use of occlusive footwear, keeping of nails, and wearing used shoes) showed statistically significant associations with onychomycosis. Individuals who engaged in these behaviours recorded a high odd ratio (1.52, 39.0, 5.95 and 1.26 respectively) for onychomycosis compared to their counterparts who did not engage in those behaviours.

Table 3: Behavioral Risk Factors of Onychomycosis

Risk factor	Category	Onychomycosis		OR	CI	P
		+ve (n=226)	-ve (n=158)			
Manicure/Pedicure services	Yes	136	21	1.52	1.06-2.17	0.02
	No	90	137			
Occlusive Footwear	Yes	117	3	39.0	2.01-6.06	0.00
	No	109	155			
Keeping Nails	Long	207	45	5.95	1.02-4.07	0.00
	Short	19	133			
Used shoes	Yes	118	22			
	No	108	136	1.26	1.09-1.25	0.00

Abbreviations: CI, confidence interval at 95%; OR odds ratio; P, P value.

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Table 4 indicates the environmental risk factors i.e. (contact with pets, exposure to humid environment, and family history of onychomycosis). There was a statistically significant associations with onychomycosis. Individuals associated with these environmental risk factors recorded a high odd ratio (3.00, 2.31 and 3.17 respectively) compared to those who do not have any affiliation with the environmental risk factors.

Table 4: Environmental Risk Factors of Onychomycosis

Risk factor	Category	Onychomycosis		OR	CI	P
		+ve (n=226)	-ve (n=158)			
Contact with pets	Yes	117	3	3.00	1.01-1.58	0.00
	No	109	155			
Expose to humid environment?	Yes	175	40	2.31	1.06-1.16	0.00
	No	51	118			
Family history of Onychomycosis	Yes	192	50	3.17	1.05-1.35	0.00
	No	34	108			

Abbreviations: CI, confidence interval at 95%; OR odds ratio; P, P value.

Comorbidities and health history risk factors like (Diabetes, trauma/damage to nails, nail Psoriasis, obesity, and Immune status) show statistically significant associations with onychomycosis. Individuals with one or more of these health conditions recorded high odd ratio values viz: (1.27, 1.86, 4.12, 1.05 and 3.14) respectively compared to those who were normal. (Table 5)

Table 5: Comorbidities and Health History risk factors of Onychomycosis

Risk factor	Category	Onychomycosis		OR	CI	P
		+ve (n=226)	-ve (n=158)			
Diabetes	Yes	133	40	1.27	1.15-1.37	0.00
	No	93	118			
Trauma/damage to nails	Yes	66	18	1.86	1.18-1.55	0.00
	No	160	140			
Nail psoriasis	Yes	160	39	4.12	1.08-1.21	0.00
	No	53	119			
Obesity	Yes	98	24			
	No	124	134	1.05	1.14-1.39	0.00
Immune status	Suppressed	104	16			
	Compromised	67	32	3.14	1.07-1.20	0.00
	Strong	35	110			

Abbreviations: CI, confidence interval at 95%; OR odds ratio; P, P value.

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DISCUSSION

The demographic risk factors associated with onychomycosis indicates that age was statistically significant predictor of onychomycosis with a positive association. Similarly, in a survey-based study of 254 patients attending a vascular clinic, 22.4% of patients were diagnosed with onychomycosis, and onychomycosis was also associated with increasing age. (Gupta *et al.,* 2000). Another cross-sectional study of 86 patients (44 onychomycosis patients and 42 controls) carried out by Fukunaga *et al*. (2013) similarly identified age as a significant risk factor for onychomycosis, they however reported a lower odd ratio (OR 1.11) compared to ours which was (OR=3.06). The aging process encompasses multiple alterations in nail physiology, immune function, and overall health, which can increase susceptibility to onychomycosis. (Kara *et al*.,2018).

The study on the behavioural risks factors indicates that factors such as engagement in manicure/pedicure services, use of occlusive footwear, keeping of nails, and wearing of used shoes had statistically significant associations with onychomycosis. It has previously been reported in several studies that application of artificial nails is another factor associated with an elevated risk of onychomycosis. Whether in the form of extensions or full coverings, artificial nails create a sealed environment that promotes fungal growth. This simulated setting often leads to increased moisture retention, creating an ideal condition for fungal growth like *Trichophyton rubrum*, the primary causative agent of onychomycosis. Essentially, the artificial nail acts as a protective barrier for the fungus, facilitating its undisturbed proliferation (Roberts, 1999; Elewski, 1997). The risk of fungal infection may be influenced by fashion choices, particularly when improper footwear compromises nail structure. This risk can arise from wearing shoes with pointed toes, excessively closed designs, or high heels that shift body weight toward the toes. Additionally, intensive nail care practices like manicures, involving cuticle removal and potential microtraumas from the absence of proper sterilized instruments, can elevate the risk of proximal fungal infections. Personal habits such as nail biting or finger sucking also expose individuals to a higher risk of fungal infection (Gupta *et al*., 2000).

Environmental risk factors, such as contact with pets, exposure to a humid environment, and a family history of onychomycosis, exhibit statistically significant correlations with the condition. Individuals linked to these environmental risk factors have elevated odds ratios (3.00, 2.31, and 3.17, respectively) for developing onychomycosis compared to those without these associations. The p-values, all below 0.05, indicate that the relationships between the presence of pets, exposure to a humid environment, and a family history of onychomycosis are statistically significant. Jazdarehee*et al*. (2022), reported that potential mechanisms contributing to the household spread of onychomycosis include: (i) shared surfaces within the household, acting as potential sources of transmission. These surfaces may encompass patios, balconies, washrooms, showers, bathtubs, and common areas like entrances and hallways; (ii) the sharing of household items such as footwear, bedding, and nail tools could facilitate the transmission of onychomycosis; (iii) cleaning tools, linens, and pets, acting as continuous reservoirs for infection.

Moreso, dermatophytes can persist on various surfaces, particularly damp areas that individuals traverse barefoot. Walkways, changing rooms, and foot washing stations in swimming pool facilities have been identified as locations where multiple species, such as *T. rubrum* and *T. mentagrophytes,* thrive well despite routine chlorine disinfection. (Watanabe *et al.,* 2017; Yenişehirli *et al.,* 2012)

The presence of concurrent health conditions and factors in one's medical history (such as Diabetes, nail trauma/damage, nail psoriasis, obesity, and Immune status) demonstrates statistically significant correlations with onychomycosis. Individuals with any of these health issues had notably higher odds ratios. Obesity serves as a risk factor for onychomycosis (Frazier *et al*., 2021; Lipner and Scher, 2019, Elewski and Tosti, 2015), emerging as one of the most significant contributors to the onset of this condition (Elewski and Tosti, 2015). Furthermore, the rise in body mass index and the sustained overweight status have contributed to an

increased occurrence of onychomycosis (Ha *et al.*, 2018). According to Gulcan *et al*. (2011), the correlation between the accumulation of excess fat tissue, which alters the local microvasculature and induces increased perspiration, creates a conducive environment for fungal infections (Gulcan *et al.*, 2011). Additionally, some authors have documented a connection between the presence of onychomycosis in adult patients and the simultaneous existence of risk factors such as obesity and diabetes mellitus (Lipner and Scher, 2019, Elewski and Tosti, 2015). Diabetes is a significant underlying condition in individuals with onychomycosis. Nearly one-third of diabetes patients also experience onychomycosis.

CONCLUSION

Age was a predictor of onychomycosis while gender and occupation were not significantly associated with onychomycosis. Behavioral and environmental risk factors such engagement of manicure/pedicure services, use of occlusive footwear, keeping of nails, wearing of used shoes, contact with pets and exposure to humid environment showed significant associations with onychomycosis. Furthermore, health conditions like diabetes mellitus, nail trauma/damage, nail psoriasis, obesity and immuno suppression were identified as significant risk factors. These findings highlight the multifactorial nature of onychomycosis and the need for proper care, management, and treatment of infections.

REFERENCES

1. de Berker, D. A. R., André, J. and Baran, R. (2007). Nail biology and nail science. International Journal of Cosmetic Science, 29(4), 241–275.
2. De Vries, A.C., Van Grieken, N.C., Loooman, C.W., Casparie, M.K., de Vries, E., Meijer, G.A., and Kuipers, E.J. (2008). Gastric cancer risk in patients with premalignant gastric lesions:a nationwide cohort studies in the Netherlands. Gastroenterology, 134 (4):945-952
3. Cheesbrough, M. (2000). District laboratory practice in tropical countries, part 2. Cambridge University Press. 55-60
4. Elewski, B.E. (1998). Onychomycosis: pathogenesis, diagnosis, and management. Clinical Microbiology Reviews, 11(3):415-429.
5. Elewski BE, Tosti A (2015). Risk factors and comorbidities for onychomycosis. The Journal of Clinical and Aesthetic Dermatology 8:38–42.
6. Frazier WT, Santiago-Delgado ZM, Stupka KC (2021) Onychomycosis: rapid evidence review. American Family Physician. 104:359–67.
7. Fukunaga A., Washio K., Ogura K., Taguchi K., Chiyomaru, K., Ohno Y., Masaki T., Nagai H., Nagano T., Oka M (2013). Onychomycosis as a warning sign for peripheral arterial disease. Acta Dermatology. Venereology. 2013;93: 747–748.
8. Gulcan A, Gulcan E, Oksuz S, Sahin I, Kaya D (2011). Prevalence of toenail onychomycosis in patients with type 2 diabetes mellitus and evaluation of risk factors. Journal of the American Podiatric Medical Association. 101:49–54.
9. Gupta A.K., Gupta M.A., Summerbell R.C., Cooper E.A., Konnikov N., Albreski D., Macdonald P., Harris K.A (2000). The epidemiology of onychomycosis: Possible role of smoking and peripheral arterial disease. Journal of the European Academy of Dermatology and Venereology; 14:466–469.
10. Ha SJ, Han KD, Song Y, Lee JH (2018). Weight change and risk of onychomycosis: a nationwide cohort study in Korea. Journal of the American Academy of Dermatology. 78:613–4.
11. Jazdarehee, A.; Malekafzali, L.; Lee, J.; Lewis, R.; Mukovozov, I (2022). Transmission of Onychomycosis and Dermatophytosis between Household Members: A Scoping Review. Journal of Fungi, 8, 60.
12. Kara, Y.A., Erdogan, F.G. and Cologlu, D. (2018). Aa case of onychomycosis due to Aspergillus flavus in all fingernails and toenails of an Immunocompromised patient and healing with 5-fluorouracil chemotherapy. Turkiye Klinkleri Journal of case Reports. 26 (4):182-187

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13. Lipner SR, Scher RK. (2019) Onychomycosis: clinical overview and diagnosis. Journal of the American Academy of Dermatology. 80:835–51
14. Pierard G. (2001). Onychomycosis and other superficial fungal infections of the foot in the
15. elderly: a pan-European survey. Dermatology; 202:220-224.
16. Roberts, D.T. (1999). Prevalence of dermatophytes onychomycosis in the United Kingdom: results of an omnibus survey. British Journal of Dermatology, 126 (29): 23-27.
17. Shemer, A., Davidovici, B., Grunwald, M.H., Trau, H. and Amichai, B. (2009). New criteria for the laboratory diagnosis of nondermatophytemoulds in onychomycosis. British Journal of Dermatologic Therapy, 160 (1):37-39.
18. Watanabe, S.; Anzawa, K.; Mochizuki, T (2017). High Prevalence of Superficial White Onychomycosis by Trichophyton interdigitale in a Japanese Nursing Home with a Geriatric Hospital. Mycoses 60, 634–637.
19. Westerberg, D. P. and Voyack, M. J. (2013). Onychomycosis: Current trends in diagnosis and treatment. American Family Physician, 88(11), 762–770.
20. Yenişehirli, G.; Karat, E.; Bulut, Y.; Savcı, U (2012) Dermatophytes Isolated from the Mosques in Tokat, Turkey. Mycopathologia, 174, 327–330.