*Original Article*

# Dermatomycoses Among People Living with Diabetes Mellitus in Kano, Nigeria

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## ARTICLE INFO

## ABSTRACT

**Background and aims**. Dermatomycoses can cause debilitating effects on a person's quality of life, or become invasive in immuno-compromised individuals such as People Living with Diabetes Mellitus (PLWDM). PLWDM are highly susceptible to various kinds of dermatomycoses because of their immunocompromised state, autonomic neuropathy, impaired peripheral circulation and inability to maintain good foot hygiene due to obesity, impaired vision or advanced age. Dermatomycoses can in turn, result in diabetic foot, and together with their attending sequelae result in prolonged hospital stay, increasing risks of amputations, other associated morbidities and mortality. Thus, this study aimed to detect and identify the fungal pathogens associated with dermatomycoses among PLWDM attending some diabetic clinics in Kano. **Methods**. Three hundred (300) diabetic individuals with superficial lesions were selected and enrolled. Socio-demographic data, medical history and other risk factors of dermatomycoses were also assessed and analysed. Skin scrapings, nail clippings and swabs from foot ulcers were collected and cultured on Sabouraud Dextrose Agar (SDA). Identification of yeasts and moulds isolates was done using Gram stain, germ tube test, Chrom agar, lactophenol cotton blue mount and slide cultures. **Results**. The prevalence of fungal pathogens detected from various lesions was 28.3%. The spectrum of fungal pathogens isolated includes; dermatophytes, yeasts and non-dermatophytes moulds. Trichophyton mentagrophytes, Trichophyton rubrum, Epidermophyton floccosum, Candida albicans, Candida tropicalis, Candida glabrata, Aspergillus species and Fusarium spp were the predominant isolates recovered. Poor glycaemic control, prolonged duration of DM, use of oral antidiabetic drugs and exposure to domestic animals were some of the risk factors identified. **Conclusion**. the study shows high prevalence of superficial mycoses in a cohort of People Living with Diabetes Mellitus studied in Kano, and therefore calls for routine screening and prompt institution of appropriate management in order to minimize or eliminate all possible complications.

## INTRODUCTION

Dermatomycoses constitute a group of superficial fungal infections that involve stratum corneum or outermost layer of the skin, hair and nails [1]. Globally, the condition affects about 20% to 25% of the world population and the burden is more in low- and middle income countries [2].  It can be classified as dermatophytic and non-dermatophytic.

The dermatophytic superficial mycoses are caused by a group of fungi that generally, in parasitic life, affect keratinized tissues (i.e. skin, hair and nails) and are also known as tinea or ringworm [3]. The causative agents of most dermatophytoses belong to the seven newly recognized genera of dermatophytic fungi: *Epidermophyton, Trichophyton, Arthroderma, Microsporum, Nannizzia, Paraphyton, and Lophophyton* [4]. The non-dermatophytes are fungi that affect the stratum corneum but do not depend on keratin for survival [5] and they cause a diverse condition such as cutaneous candidiasis, tinea versicolor, cutaneous fusariosis, and other non-dermatophytes moulds infections [1]. Dermatomycoses can cause debilitating effects on a person's quality of life, or become invasive in immuno-compromised individuals such as people living with diabetes mellitus (PLWDM) [6].

Diabetes mellitus (DM) is an endocrine disorder due to inadequate insulin production and/or secretion by pancreas which leads to hyperglycemia and can result in long-term damages, dysfunction, and failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels [7]. The diabetic patients, due to their condition, lack adequate immunity to defend their body system against invading pathogenic fungal organisms thus they can be exposed to these agents either by inhalation of the spores of these fungal agents from the environment or by close contacts [8]. This study aimed to detect and identify the fungal pathogens associated with superficial mycoses and their antifungal susceptibility profile among people living with diabetes mellitus (PLWDM) attending some diabetic clinics in Kano.

## METHODS

This was a cross sectional and hospital-based study conducted at Murtala Muhammad Specialist Hospital and Muhammadu Abdullahi Wase Teaching Hospital, all located in Kano State, North-Western Nigeria.  Ethical approval and informed consent were obtained from the research and ethics committee of Kano State Ministry of Health and respondents respectively, before commencement of the study.

Three hundred (300) people living with diabetes mellitus with superficial lesions were selected and enrolled in the study. People living with diabetes mellitus (PLWDM) with superficial lesions (either on skin, nail or hair) who consented were included in the study while those who denied consent and those who used any form of antifungal agent four weeks prior to presentation were excluded from the study. Together with the appropriate clinical samples, detailed history of all patients was taken using a structured questionnaire. This questionnaire was used to assess demographic associated factors (age, gender, diabetic clinic attended), social factors (occupation, level of education), and clinical factors (duration of diabetes, presence of foot ulcer, other co-morbid disease, family history of superficial mycoses).

A total of 251 skin scrapings, 30 nail clippings and 19 specimens from ulcer sites were collected from 300 diabetic individuals with superficial lesions from February to July, 2022. The affected areas of the body were disinfected with 70% alcohol and allowed to air dry. The affected skin sites were scraped from the advancing border of the lesions using No. 10 surgical blade. The affected nails were clipped and discoloured or friable areas were scraped Sterile cotton swab was used to collect samples from ulcer sites and then placed inside a sterile swab container (two swab samples were collected from each lesion) [9]. All the specimens were collected onto a paper and then put on a clean envelope and carefully labelled with the patient's code, age, sex, date and place of collection.

Small fragments or scrape material from the affected areas of the body and swab were placed on a glass slide containing a drop of 10% Potassium Hydroxide (KOH), covered with a cover-slip and allowed to digest for at least 30 min at room temperature, then examined with 10x and 40x objectives for the presence of unstained fungal elements. Scrapings or small fragments of specimen and swab from each participant irrespective of their microscopy results were cultured on two Sabouraud Dextrose Agar (SDA) plates supplemented with 0.05g of chloramphenicol. Each of the two set of plates were sealed with masking tape to prevent airborne contamination in the laboratory and incubated at room temperature and at $37^0C$, respectively. Observation for fungal growth was done daily for the first week and then twice weekly for subsequent weeks, till a period of 1 months, after which any culture plates devoid of observable growth was considered negative. Pure isolates were obtained by sub-culture on new SDA plates and colonies growing outside the inoculation area were regarded as contaminants.

Identification of fungus grown on culture plates was based on morphologic characteristics of the colony on SDA, the observable fruiting bodies or special hyphae on lactophenol cotton blue (LPCB) stain, in addition to gram stain and germ tube test on yeast cells. Identification to species level was done using the slide culture technique.

## RESULTS

A Cohort of 1500 PLWDM with superficial lesions were approached and 300 met the inclusion criteria and were therefore enrolled. The participant's age ranged from 16 to 80 years (52.05 years ±SD = 12.19). The greater part of participants (63.3%) was aged 45–64 years, majority were females (72.7%), and 56.7% had only qur'anic education (Table 1).

*Table 1. Patients' characterization and association with different risk factors*

| Variables | Number of | Patients (%) | Total (%) | p-value |
|---|---|---|---|---|
| | Positive to dermatomycoses | Negative to dermatomycoses | | |
| **Age (years)** | | | | |
| <18 | 0 (0) | 3 (100) | 3 (1) | |
| 18-44 | 8 (19) | 34 (81) | 42 (14) | 0.250 |
| 45-64 | 60 (31.6) | 130 (68.4) | 190 (63.3) | |
| ≥65 | 17 (26.2) | 48 (73.8) | 65 (21.7) | |
| **Gender** | | | | |
| Male | 22 (26.8) | 60 (73.2) | 82 (27.3) | 0.723 |
| Female | 63 (28.9) | 155 (71.1) | 218 (72.7) | |
| **Level of education** | | | | |
| Quranic only | 44 (25.9) | 126 (74.1) | 170 (56.7) | |
| Primary | 5 (14.3) | 30 (85.7) | 35 (11.7) | *0.014 |
| Secondary | 21 (32.8) | 43 (67.2) | 64 (21.3) | |
| Tertiary | 15 (48.4) | 16 (51.6) | 31 (10.3) | |
| **Type of DM** | | | | |
| Type 1 | 1 (16.7) | 5 (83.3) | 6 (2.0) | 0.522 |
| Type 2 | 84 (28.6) | 210 (71.4) | 294 (98.0) | |
| **Duration of DM (years)** | | | | |
| ≤10 | 41 (17.6) | 192 (82.4) | 233 (77.7) | *<0.01 |
| >10 | 44 (65.7) | 23 (34.3) | 67 (22.3) | |
| **Diabetic medication used** | | | | |
| Oral | 82 (31.2) | 181 (68.8) | 263 (87.7) | |
| Insulin | 2 (9.1) | 20 (90.9) | 22 (7.3) | *0.014 |
| Both | 1 (6.7) | 14 (93.3) | 15 (5.0) | |
| **FBS (mmol/L)** | | | | |
| ≤10.0 | 51 (26.6) | 141 (73.4) | 192 (64) | |
| >10.0 | 33 (32) | 70 (68) | 103 (34.3) | *<0.01 |
| Not provided | 1 (20) | 4 (80) | 5 (1.7) | |
| **Comorbidities** | | | | |
| Hypertension | 50 (31.1) | 111 (68.9) | 161 (53.7) | |
| Obesity | 3 (15.8) | 16 (84.2) | 19 (6.3) | 0.506 |
| Hypertension & obesity | 6 (24) | 19 (76) | 25 (8.3) | |
| None | 26 (27.4) | 69 (72.6) | 95 (31.7) | |
| **Exposure to animals** | | | | |
| Cats | 13 (16.7) | 65 (18.3) | 78 (26) | |
| Sheep & goats | 2 (11.8) | 15 (88.2) | 17 (5.7) | *0.012 |
| Cattle's | 2 (40) | 3 (60) | 5 (1.7) | |
| None | 68 (34) | 132 (66) | 200 (66.6) | |

Regarding clinical condition of the respondents 98% had type II diabetes and the rest had type I diabetes. Most of the subjects (64%) had good glycaemic control with a fasting blood sugar (FBS) of ≤10.0mmol/L while the remaining 34.3% had poor glycaemic control (FBS >10.0mmol/L), 77.7% of the respondents had been diagnosed with diabetes mellitus (DM) for less than 10 years whereas, 22.3% had the disease for more than 10 years. The majority (87.7%) were being treated with oral hypoglycaemic agents, 5% with insulin, and 7.3% with the mixture of both. Moreover, 48.3% had normal body mass index (BMI=18.5 - 24.9), 1.7% underweight (BMI <18.5), 35% were overweight (BMI= 25-29.9) and 15% were obese (BMI ≥30) (Table 1).

Socio-demographic factors did not show positive association with the existence of fungal infections, namely regarding the age (p = 0.250), gender (p = 0.723), occupation (p = 0.119) and residential area (p = 0.688). However, only level of

education (tertiary) was found to have statistically significant association with dermatomycoses (Table 1).

Clinical factors and potential risk factors for the development of dermatomycoses in diabetic patients were also evaluated. Duration of DM (more than 10yrs) (p <0.01), use of oral hyperglycaemic agents [diabetic medication] (p = 0.014), poor level of glycaemic control (p<0.01) and exposure to domestic animals [e.g. cattle] (p = 0.012) were positively associated with the development of dermatomycoses whereas the other factors analysed, including type of DM (p = 0.522), BMI range (p = 0.499), previous use of antifungal agent (0.574), other diseases related with diabetes (p = 0.506), family history of dermatomycoses (p = 0.612) and sharing of fomites (p = 0.622) did not show positive association (Table 1).

Eighty-five (85) of the respondents showed positive cultures of fungi, giving a prevalence of mycologically proven superficial mycoses among PLWDM to be 28.3%. The most prevalent group of fungi isolated were dermatophytes (55.3%), mainly (44.7%) from skin and nails (10.6%), with *Trichophyton mentagrophytes* as the most frequent dermatophyte species isolated, followed by *Trichophyton rubrum* and *Epidermophyton floccosum*. The second most common isolated fungi (28.2%) were yeasts, which constituted 15.3% of fungi isolated from skin, 2.3% from nail and 10.6% from foot ulcers, with *Candida albicans* being the most frequent *Candida* species isolated, followed by *Candida tropicalis* and the least was *Candida glabrata*. Interestingly, the non-dermatophyte moulds were the least isolated fungi (16.5%), with isolate from nails contributing 9.4% and 7.1% from foot ulcers. *Aspergillus niger*, *Aspergillus fumigatus*, *Aspergillus flavus* and *Fusarium* species were the non-dermatophytes moulds isolated (Table 2).

*Table 2. Prevalence and distribution of fungal species isolated from different clinical sites*

| Clinical diagnoses | | | | | |
|---|---|---|---|---|---|
| Fungal isolates | Tinea pedis | Tinea unguium/ Onychomycosis | Tinea cruris | Foot ulcer | Total (%) |
| Dermatophytes | | | | | |
| *Trichophyton mentagrophytes* | 21 (24.7) | 4 (4.7) | - | - | 25 (29.4) |
| *Trichophyton rubrum* | 12 (14.1) | 4 (4.7) | | | 16 (18.8) |
| *Epidermophyton floccosum* | 5 (5.9) | 1 (1.2) | | | 6 (7.1) |
| Yeasts | | | | | |
| *Candida albicans* | 10 (11.8) | 2 (2.3) | - | 5 (5.9) | 17 (20) |
| *Candida tropicalis* | 3 (3.5) | - | | 3 (3.5) | 6 (7.1) |
| *Candida glabrata* | - | - | | 1 (1.2) | 1 (1.2) |
| Non-dermatophytes | | | | | |
| *Aspergillus niger* | | 3 (3.5) | | 1(1.2) | 4 (4.7) |
| *Aspergillus fumigatus* | - | 2 (2.3) | - | 2 (2.3) | 4 (4.7) |
| *Aspergillus flavus* | | 2 (2.3) | | 2 (2.3) | 4 (4.7) |
| *Fusarium species* | | 1 (1.2) | | 1 (1.2) | 2 (2.3) |
| **Total (%)** | 51 (60) | 19 (22.2) | - | 15 (16.4) | 85 (100) |

## DISCUSSION

Superficial mycoses are a common health problem among PLWDM, although it is often misdiagnosed and consequently undertreated. In our study, the prevalence of dermatomycoses was found to be 28.3% and is comparable to the findings in earlier studies among PLWDM. The prevalence is similar to the 24.3% and 26% obtained in studies conducted by Ngwogu et al. [10] and Sani et al. [11], respectively. A higher prevalence of 34%, 45%, 48.7% and 78.5% were reported in studies conducted in India by Gupta et al. [12], Sheeba and Ponnammal [13], Saud et al. [14] and Cheikhrouhou et al. [15], respectively. This higher prevalence seen could be due to differences in geographical location/ region which can therefore, increase the risk of dermatomycoses.

The percentage of samples positive by microscopy was 24% whereas, positivity by culture was 28.3%, suggesting that culture is more sensitive than microscopy in the diagnosis of superficial mycoses (p<0.01). The findings correlate with a study conducted by Sheeba and Ponnammal [13] where, microscopy (43%) is proved to be less sensitive than culture (48%).

In our study, out of the 85 positive isolates, dermatophytes were the most common, followed by yeasts and the least were non-dermatophyte moulds. These findings concur with previous studies[10-13] that also reported dermatophytes as the commonest isolates causing dermatomycoses among PLWDM.

This study also revealed, among the dermatophytes isolated, *Trichophyton mentagrophytes* were the most frequent, followed by *Trichophyton rubrum* and the least in frequency were *Epidermophyton floccosum*. This was similar to the

findings of previous studies [10, 13, 16]. In contrast to our findings, other studies [12, 17-19] have reported *Trichophyton rubrum* as the most common fungi causing dermatomycoses followed by *Trichophyton mentagrophytes* and the least being *Epidermophyton floccosum*. *Candida albicans* were the most common yeasts isolated, followed by *Candida tropicalis* and *Candida glabrata*. While, among the non-dermatophytes moulds, *Aspergillus* species were the most frequent, followed by *Fusarium* species. This is in agreement with the findings of Ngwogu *et al*. [10] who reported *Candida albicans* as the most frequent yeasts isolated. In contrast, Parada *et al.* [18] reported *Candida parapsilosis* as the most common yeasts causing dermatomycoses. Several factors, such as life style, nature of geographical area, and climatic conditions might be responsible for the varied distribution of fungal isolates.

In our study, most mycologically confirmed cases were in the age group 45-64 years, although it was not statistically associated with dermatomycoses and this was similar to the previous findings[12, 13, 16] that reported the common age group affected in their study as 40-79 years, 45-54 years and 41-60 years, respectively. This was possibly because this age group have maximal outdoor activities and hence increase sweating.

The mycological detection rate of dermatomycoses (culture positive) was higher among females (28.9%) than in males (26.8%) although, there was no statistically significant association. This is in agreement with studies of Ngwogu *et al*. [10], who reported female to have high prevalence of the infection than male and it was found to be statistically significant while Surja *et al.* [20] reported same findings but the difference was statistically not significant. In contrast, other studies showed that male are more likely to have dermatomycoses than female, but the difference was not statistically confirmed in some studies [12, 16, 18, 21]. This disparity could be because dermatomycoses are associated with the physical activities that cause injuries and male's habits, such as water-related work.

All the sociodemographic characteristics were found to have no statistically significant association with dermatomycoses expect educational level which was statistically associated with superficial mycoses (p=0.014). In accordance with our findings, Sheeba and Ponnammal [13] showed that diabetic patients were susceptible to superficial mycoses irrespective of their age, gender and type of DM with bivariate analysis showing no statistical difference with occurrence of infection.

Patients with longer duration of diabetes more than 10 years have increased rate of fungal infection (65.7%) and the results of this study were similar to findings of Sanniyasi *et al.* [22] and Dogan and Karakas[23] who also reported more mycologically proven infections in patients diagnosed with diabetes more than 10 years prior to the research. Our study shows a definite association between duration of diabetes mellitus and incidence of dermatomycosis (p <0.01). This is possibly because longer duration of DM predisposes patients to various complications and immunosuppression that may lead to development of dermatomycoses, especially when there is poor glycaemic control.

Poor glycaemic control was associated with high prevalence (32%) of fungal infection in this study and was found to have statistically significant association (p <0.01). This corresponds with the findings of studies from India [12, 20] who revealed that superficial fungal infections were higher in patients with high level of fasting and postprandial blood sugar. This is because elevated blood glucose level, decreases the granulocytes' function, leading to tissue invasiveness and hence, provide a favourable environment for growth of superficial fungi. In contrast, Sheeba[13] identified blood sugar level to have no statistically significant association with occurrence of superficial mycoses.

Those on oral hypoglycaemic agents have highest frequency of mycologic positivity (31.2%) with statistically significant association (p=0.014). In contrast to our findings, Akkus *et al.* [21] found no association between treatment method and superficial mycoses.

Also, the risk factors of superficial mycoses assessed in this study, shows no statistically significant association (p>0.05) except exposure to domestic animals, which was found to be statistically significant with isolation of fungi (p=0.012). This could be because, contact with infected animals can increase the risk of the infection. Conversely, Cheikrouhou *et al.* [15] found no association between superficial mycoses and exposure to domestic animals.

## CONCLUSION

In conclusion, the study shows high prevalence of superficial mycoses in a cohort of People Living with Diabetes Mellitus studied in Kano, and therefore calls for routine screening and prompt institution of appropriate management in order to minimize or eliminate all possible complications. Poor glycaemic control, prolonged duration of DM, use of oral antidiabetic drugs and exposure to domestic animals might increase the risk of developing dermatomycoses among diabetic patients.

### *Conflict of Interest*

There are no financial, personal, or professional conflicts of interest to declare.

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# الفطريات الجلدية بين الأشخاص المصابين بمرض السكري في كانو، نيجيريا

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**المستخلص**

**الخلفية والأهداف.** يمكن أن تسبب الفطريات الجلدية آثارًا مدمرة على نوعية حياة الشخص، أو تصبح غازية لدى الأفراد الذين يعانون من ضعف المناعة مثل الأشخاص المصابين بداء السكري (PLWDM). الأشخاص المصابون بفيروس نقص المناعة البشرية PLWDM / معرضون بشدة لأنواع مختلفة من الأمراض الجلدية بسبب حالة ضعف المناعة لديهم، والاعتلال العصبي اللاإرادي، وضعف الدورة الدموية الطرفية وعدم القدرة على الحفاظ على نظافة جيدة للقدمين بسبب السمنة أو ضعف البصر أو التقدم في السن. يمكن أن تؤدي الفطريات الجلدية بدورها إلى القدم السكرية، وتؤدي إلى جانب عقابيلها إلى الإقامة لفترة طويلة في المستشفى، مما يزيد من مخاطر بتر الأطراف وغيرها من الأمراض والوفيات المرتبطة بها. وبالتالي، تهدف هذه الدراسة إلى اكتشاف وتحديد مسببات الأمراض الفطرية المرتبطة بالفطريات الجلدية بين PLWDM الذين يترددون على بعض عيادات مرض السكري في كانو. **طرق الدراسة.** تم اختيار وتسجيل ثلاثمائة (300) من مرضى السكري الذين يعانون من آفات سطحية. كما تم تقييم وتحليل البيانات الاجتماعية والديموغرافية والتاريخ الطبي وعوامل الخطر الأخرى للإصابة بالفطار الجلدي. تم جمع قصاصات الجلد وقصاصات الأظافر والمسحات من تقرحات القدم وزراعتها في Sabouraud Dextrose Agar (SDA). تم التعرف على عزلات الخمائر والعفن باستخدام صبغة جرام، اختبار الأنبوب الجرثومي، أجار الكروم، جبل اللاكتوفينول القطني الأزرق ومزارع الشرائح. **النتائج.** بلغ معدل انتشار مسببات الأمراض الفطرية المكتشفة من الآفات المختلفة 28.3٪. يشمل طيف مسببات الأمراض الفطرية المعزولة؛ الفطريات الجلدية والخمائر والقوالب غير الجلدية. كانت *Trichophyton mentagrophytes*، *Trichophyton Rubrum*، *Epidermophyton floccosum*، *Candida albicans*، *Candida Tropicalis*، *Candida glabrata*، أنواع *Aspergillus* و *Fusarium spp* هي العزلات السائدة التي تم استعادتها. كان ضعف التحكم في نسبة السكر في الدم، وطول مدة مرض السكري، واستخدام الأدوية المضادة لمرض السكر عن طريق الفم، والتعرض للحيوانات الأليفة من بين عوامل الخطر التي تم تحديدها. **الخاتمة.** تظهر الدراسة ارتفاع معدل انتشار الفطريات السطحية في مجموعة من الأشخاص المصابين بمرض السكري الذين تمت دراستهم في كانو، وبالتالي تدعو إلى إجراء فحص روتيني ومؤسسة سريعة للإدارة المناسبة من أجل تقليل جميع المضاعفات المحتملة أو القضاء عليها.

**الكلمات الدالة.** الفطار الجلدي، مرض السكري، القدم السكرية، العدوى الفطرية، كانو، نيجيريا.

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