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INCIDENCE OF MYCOTIC INFECTION AMONG INMATES IN CORRECTIONAL CENTRES IN KANO AND JIGAWA STATES – NIGERIA

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ABSTRACT
A survey was conducted to assess incidence of mycoses among inmates in selected correctional facilities in Kano and Jigawa States. This study was aimed at determining the occurrence of mycosis infection with objective to identifying causal agents, determining antifungal susceptibility patterns, and explore demographic factors influencing the spread of aetiological agents within these facilities. A total of 300 inmates were enrolled, and data were collected using a structured questionnaire that recorded information on age, gender, marital status, living conditions, and history of previous mycotic infections. Additionally, 507 samples including skin scrapings, nail clippings, urine, hair strand, sputum, high vaginal, wound, and mouth swabs were collected. These samples were cultured on Sabourauds Dextrose Agar, microscopically examined using direct potassium hydroxide, and stained with lactophenol cotton blue to observe fungal hyphae. Positive fungal isolates were identified using various biochemical methods, including Gram staining, Germ tube tests, and Analytical Profile Index (API) identification kits. Antifungal susceptibility was tested using the agar-well diffusion method. Out of the 507 samples, 24.3% (123/507) were positive for mycosis. Candida species were the most common isolates 76(61.70%), with Candida albicans being the most prevalent at 33.3%. Dermatophytes accounted for 27 cases (22.00%), and Aspergillus species were identified in 20 cases (16.30%). Drug resistance was observed among the isolates against fluconazole with (73.2%), clotrimazole with 67.5%, and ketoconazole with 46.3%. In conclusion, the study provides updated information on the occurrence of mycosis and associated demographic factors in the study areas. It indicates a potential localized mycosis epidemic with 24.3%, incidence rate, highlighting the need for enhanced health awareness campaigns, periodic mycological screenings, and ongoing surveillance with prompt supportive treatment.
Keywords: Antifungal, Incidence, Inmates, Mycoses, Resistance.

INTRODUCTION

Mycological infections are medically significant not only in the community and hospital settings but also among inmates and among all age group resulting in high rates of morbidity and economic costs associated with its treatment (Oladele and Denning, 2014). The prevalence of infections is particularly high in children, adults with suppressed or compromised immunity, which tends to increase duration of morbidity, discomfort and mortality. However, the medical and economic implications are not widely appreciated as compared to other diseases. There is a great gap between access of fungal diagnostic and treatment services in developing countries (Van Seventer and Hochberg, 2017). There are very few available reports and publications on the prevalence of mycological infections in Nigeria and presenting varying degrees of prevalence. This is because the medical implications of fungi are not appreciated like those of other microorganisms.

Mycological infections are common among prisoners, due to overcrowding along with sharing of personal effects and fomites, poor hygiene and lack of access to treatment all results in increased mycological infections inside the prison (Echeta *et al.,* 2021). However, still there is a paucity of studies on the prevalence, occurrence and associated factors of Mycological

infections among inmates in Kano and Jigawa States, Nigeria.

Therefore, establishing the prevalence and identification of different types of fungi as well as yeast incriminated in the cause of mycological infections within inmates will aid the successful study of the different types of mycological infections and this will translate into the development of better surveillance tools that will help in monitoring and maintaining active surveillance on the occurrence, source, distribution pattern and contribute to the understanding of these infections within correctional centres. Findings from this study can assist researchers and policies makers in the formulation of strategies for control, management and prevention of the spread of mycological infections within such facilities and more importantly providing data based evidence that was improving medical care and livelihood of inmates thereby reducing the annual disease burden. The aim of the study is to investigation the incidence level of mycological infections among inmates within selected correctional centres in Kano and Jigawa States.

MATERIAL AND METHODS

Study Area

The study was conducted in some selected correctional centres within the senatorial zones of Kano and Jigawa States, located in the north western region of Nigeria. Kano State is situated between latitudes 12°N and 13°N and longitudes 8°E and 9°E, while Jigawa lies between latitudes 11°N to 13°N and longitudes 8°E to 10.15°E. The states are bordered by Katsina, Bauchi, Yobe, and Kaduna States, and Jigawa shares an international border with the Republic of Niger.

A cross-sectional, prospective survey was carried out among inmates in seven selected correctional facilities across both states. Kano and Jigawa have six geographical zones with a total of 21 correctional facilities housing 3,966 inmates at the time of the study. The seven facilities chosen for the study include Kurmawa and Goron Dutse (Kano Central), Dawakin Tofa (Kano North), Wudil (Kano South), Hadejia (Jigawa North-East), Dutse (Jigawa South-West), and Gumel (Jigawa North-West).

Ethical Clearance

Ethical clearance was obtained from each of the selected correctional facilities that engaged before the commencement of the study, with the Reference Number (CHKN.27/VOL.XVII/126; CJHG.105/VOL.1/153). In addition, the consent of all selected inmates that was recruited into the study was obtained by oral interactions and they were assured of anonymity and confidentiality of the exercise.

Questionnaires was used to obtained information on the age, history of any previous skin infections, length of stay in the Correctional facility, presence of any skin lesions and other conditions that support infections.

Sampling Technique

Purposive and convenience sampling technique was used to select the correctional facilities and inmates. Among all the correctional facilities located in each geopolitical zones of each state, selection was based on the total number of the inmates who consented to participate in the study.

Study Population, Sample Size, and Ethical Considerations

The study included consented male and female inmates from selected correctional facilities with or without clinical manifestations of various mycoses. Inmate selection was proportionally based on the total number of inmates in each facility. A sample size of 300 inmates was determined using a conventional statistical method, with a minimum calculated sample size of 173.45, rounded to 300 for more statistical relevance (Table 1).

Table 1: The distribution of inmates across the selected correctional facilities was as follows:

Study Site	Inmate Population	Percentage (%)	Assumed Sample Size
Dawakin Tofa	35	1.1	7
Goron Dutse	1,224	36.9	92
Kurmawa	1,426	43.0	108
Wudil	88	2.7	16
Sub -Total	**2773**	**83.7**	**223**
Dutse	113	3.4	33
Gumel	210	6.3	28
Hadejia	218	6.6	16
Sub -Total	**514**	**16.3**	**77**
Total	**3,314**	**100.0**	**300**

The calculation was based on a 95% confidence level, an allowable error of 5%, and a previous prevalence rate of 13.0% (Ahamd *et al.*, 2016) for mycological infections.

Inclusion Criteria: Male and female inmates who were available at the time of the study and provided consent for participation.

Exclusion Criteria: Inmates who were unavailable at the time of the study, did not provide consent, or were currently on antibiotics. Ethical clearance was obtained from each correctional facility, and informed consent was acquired from all inmates before participation. Anonymity and confidentiality were assured throughout the study. Data were collected using questionnaires that gathered information on inmates' age, history of skin infections, length of stay in the facility, presence of skin lesions, and other conditions supporting infections.

Mycological Analysis: Sample Collection and Identification

Sample Collection: Samples were collected from consented participants as described by Cheesbrough (2006). The specimens included hair strands, skin scrapings, nail clippings, urine, high vaginal swabs, sputum, and mouthwash. All samples were appropriately labelled and transported in a cold chain to the laboratory at Bayero University's Microbiology Department within 2 hours of collection.

Collection Procedures:

- **Skin Scraping**: Collected from inmates showing visible fungal lesions. Lesions were swabbed with 70% alcohol, scraped with a sterile surgical blade, and stored in a labelled envelope for transport.
- **Nail Clipping**: Collected from inmates with nail fungal infections. After cleaning with 70% ethanol, clippings were gathered with a sterile scalpel and stored similarly.
- **Hair Strand**: Infected areas were wiped with 70% alcohol, and fractured or infected hair was removed with forceps and scraped from the lesion.
- **Sputum**: Collected in clean, dry, wide-mouth containers by instructing participants to cough deeply first thing in the morning.
- **Urine**: Collected using sterile containers, with participants instructed to provide midstream urine.
- **High Vaginal Swab**: Collected using a sterile swab inserted about 2 inches into the vagina and rotated for 10–30 seconds.

The 300 inmates enrolled in the study, contributed to 507 samples collected from both Kano and Jigawa States, Nigeria. The highest proportion of samples was urine (196 samples, 38.7%), followed by skin scrapings (112 samples, 22.1%) and sputum (71 samples, 13.9%). The least collected samples were nail clippings (7 samples, 1.3%) and mouth swabs (9 samples, 1.8%) as summarized in Table 2.

Table 2: Distribution of the samples collected from participants

Sample Type	Frequency	Percentage (%)
Hair Strand	29	5.8
Mouth Swab	9	1.8
Nail Clip	7	1.3
Skin Scrapping	112	22.1
Sputum	71	13.9
Urine	196	38.7
Vaginal Swab	58	11.4
Wound Swab	25	4.9
Total	**507**	**100.0**

Microscopic Examination:

Direct Microscopy for Dermatophytosis: Hair, skin, and nail samples were treated with potassium hydroxide (KOH) and examined for fungal hyphae or yeast buds, using X40 objective lens.

Fungal Isolation and Identification:

Fungal Isolation: Collected samples were cultured on Sabourauds Dextrose Agar (SDA), incubated at 37°C (for fungi) and 25°C (for yeast) for 7 days. The morphology of fungal colonies was observed and identified using a mycological Atlas and biochemical tests.

Gram Staining and Lactophenol Cotton Blue Staining: Large, mucoid colonies were Gram-stained to observe cell shapes, and fungal structures were examined using Lactophenol Cotton Blue Stain for confirmation of species.

Germ Tube Test: Used to identify *Candida albicans* by observing hyphal formation in sterile human serum after 2 hours of incubation.

Characterization of Candida species By Analytical Profile Index (API Candida)

Candida species presumptively identified were further characterized using the API Candida identification system, following the method described by Kangogo *et al.* (2011). The API system includes a strip of ten dehydrated substrates designed to carry out 12 biochemical tests, primarily involving sugar fermentation and enzymatic reactions. These reactions produce color changes during incubation, which are then visually interpreted to generate a four-digit profile code.

Identification was performed according to the manufacturer's protocol. A portion of an 18-hour-old culture grown on Sabouraud Dextrose Agar (SDA) was transferred aseptically into API NaCl 0.85% medium to create a suspension equivalent to 1% McFarland standard. This suspension was used to inoculate each well of the API Candida strip. The first five and the final test wells were covered with mineral oil after inoculation.

The inoculated strips were then placed in the provided incubation tray, loosely covered, and incubated at 37°C for 18 hours in ambient air. After incubation, results were interpreted visually by assessing color changes as indicated by the manufacturer. Based on these observations, a weighted score was assigned to positive results, producing a unique four-digit code. This code was then manually matched with those in the API database to identify the *Candida* species accurately.

Antifungal Susceptibility:

Agar Well Diffusion Method: Antifungal susceptibility was determined by placing antifungal agents into wells punched into SDA plates, allowing for diffusion. After 48-hour of incubation at 37°C, the zone of inhibition were measured to classify isolates as resistant, intermediate, or sensitive based on established standards (Echeta *et al.*, 2021).

Statistical Analysis

Data Obtained was analysed using statistical package for social sciences (SPSS) Version 25 (2020, IBM Califonia, USA). The incidence of fungal species was expressed in simple frequency and percentages for the study groups.

RESULTS

Out of the 507 samples cultured on Sabouraud Dextrose Agar (SDA), 123 samples (24.3%) showed fungal growth after an incubation period of 5 days at 25°C. The remaining 384 samples (75.7%) did not yield any fungal growth, as indicated in Figure 1**.**

Table 3 presents the distribution of fungal isolates obtained from the positive samples. The majority of the isolates were *Candida* species, accounting for 76 (61.7%) of the positive cultures. Dermatophytes were the second most occurrence, with 27 isolates (22.0%), followed by *Aspergillus* species, which constituted 20 (16.3%) of the fungal isolates. The overall incidence of fungal infections across all samples was 24.3% (123/507).

A higher prevalence was observed in inmates from Kano Central, particularly in the Goron Dutse and Kurmawa areas, which accounted for 35.8% (44/123) of the fungal infections identified in the study, as shown in Table 4.

Candida albicans were confirmed to be the most dominant isolate 41(33.33 %), followed by *Trichophytum rubrum* 25 (20.32 %), *Candida glabrata* 19(15.5%), *Candida krusei* 16 (13.00 %), *Aspergillus niger* 11 (8.94 %), *Aspergillus fumigatus* 9 (7.31 %) and *Blastomycosis dermatitis* was found to be the least at 2(1.6%) as indicated in Table 5.

Table 6 shows the resistance pattern of six (6) selected commonly used antifungal agents use in treatment of mycosis. Isolates exhibited the highest resistance to Fluconazole (73.2 %), closely followed by Clotrimoxazole (67.5 %) and Ketoconazole (46.3 %). Generally, all isolates were sensitive to Amphotericin-B exhibiting low resistance at 1.6 %.

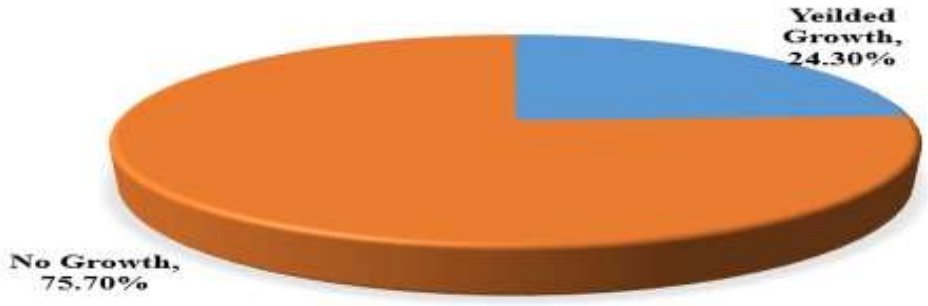

Figure 1 Distribution of the positive fungal culture samples from inmates in Kano and Jigawa states

Table 3 Occurrence of Fungal instant in the samples examined.

Isolated Organism	**Frequency**	**Percentage**
Aspergillus species	20	16.30
Candida species	76	61.80
Dermatophytes	27	22.00
Total	**123**	**100.0**

Number of positive = 123 (24.3 %)

Table 4 Distribution of the Samples Collected for the Study

Study site	No. Inmates Enrolled	No. Samples	No. Positive
Dawakin Tofa	7	7	4(3.3)
Goron Dutse	92	92	44(35.8)
Kurmawa	108	108	44(35.8)
Wudil	16	16	5(4.1)
Subtotal	**223**	**223**	
Dutse	33	56	14(11.4)
Gumel	28	47	12(9.8)
Hadejia	16	27	0 (0.0)
Subtotal	**77**	**130**	
Total	**300**	507	123(100.0)

Table 5: Occurrence of Identified Fungal Isolates

Source of Isolates	No. Positive	Isolated Fungi						
		Aspergillus		*C. albican*	Non albican		Dermatophytes	
		A. niger	*A. fumigatus*		*C. galabrata*	*C. krusei*	*T. rubrum*	*B. dermatitis*
Hair Strand	10(8.10)	0(0.00)	0(0.00)	3(30.00)	0(0.00)	0(0.00)	7(70.00)	0(0.00)
Nail Clip	5(4.10)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	5(100.00)	0(0.00)
Skin Scrapping	22(17.90)	0(0.00)	0(0.00)	4(18.18)	0(0.00)	3(13.63)	13(59.09)	2(9.09)
Sputum	27(22.00)	11(40.74)	9(33.34)	0(0.00)	5(18.51)	2(7.41)	0(0.00)	0(0.00)
Urine	36(29.30)	0(0.00)	0(0.00)	20(55.56)	9(25.00)	7(19.44)	0(0.00)	0(0.00)
Vaginal Swab	23(18.70)	0(0.00)	0(0.00)	14(60.87)	5(21.74)	4(17.39)	0(0.00)	0(0.00)
Total	**123(100.0)**	**11(8.94)**	**9(7.31)**	**41(33.33)**	**19(15.45)**	**16(13.00)**	**25(20.32)**	**2(1.63)**
N = 123 (24.3 %)								

Table 6 Distribution of resistant isolates to selected antifungal agents

	Antifungal agents used					
Fungal Isolates	**KET**	**FLU**	**ITR**	**NYS**	**CLO**	**AMP-B**
***Candida* species**						
C. albicans (n = 41)	27	39	19	22	32	2
C. glabrata (n = 19)	9	17	7	11	12	0
C. krusei (n = 16)	2	6	1	4	9	0
***Aspegillus* species**						
A. niger (n = 11)	0	4	0	NA	9	0
A.fumigatus (n = 9)	1	1	3	NA	4	0
Dermatophytes						
Trichophytum rubrum(n = 25)	18	22	4	NA	16	0
Blastomycosis dermatitis(n = 2)	0	1	0	NA	1	0
Total (n = 123)	**57**	**90**	**34**	**37**	**83**	**2**
Percentage (24.3%)	**46.3**	**73.2**	**27.6**	**30.1**	**67.5**	**1.6**

NOTE: Figures are the frequencies of fungal isolates resistant to the antifungal agents.

Keys: Ketoconazole = KET, Fluconazole = FLU, Itraconazole = ITR, Nystatin = NYS, Clotrimazole = CLO, Amphothericin - B = AMP-B, Not Applicable = NA

DISCUSSION

The varying causal agent isolated from different types of mycosis in this present study concur with the findings of several researchers of Kangogo *et al.,* (2011); Pereiro Ferreirós *et al.,* (2012) and Linder and Kauffman (2019) from community and hospital acquired mycotic Infection. This could be attributed to the presence of these agent within the facilities either in beddings, environment or in the indoor air within the facilities as suggested by Chukwuma *et al*., (2021) which increases the rate of infections among inmates.

In this study, the overall incidence of fungal infection amongst the studied inmates 24.3 % which is comparable to the 25.5% reported by Zida *et al.* (2015) in a big prison of Ouagadougou in Burkina Faso. However, it differs with the 45.5% reported by Oninla and Onayemi (2021) in Osun state correctional facilities. This incidence rate may suggest an alarming health threat among inmates within Kano and Jigawa state which may be ascribed to changes in the characteristics of the study population, sample size, time of study, poor personal sanitary and environmental hygiene practices.

The high proportion of Candida species (61.79%) among inmates is lower than the 80 % reported by Kangogo *et al.* (2011) in Nairobi – Kenya and higher than the 22.8% by Oyeka and Eze (2008) among inmates in Abakiliki - Nigeria. The high occurrence of these Candida species in fungal infections probably reflect a low hygiene status, availability of immune compromised patients, availability of virulence factors such as adhesion capacity, ability to switch morphology between yeast and filamentous growth, biofilm formation, availability of enzymes such as lipases, phospholipases and proteinases (Talapko *et al*., 2021).

More so, the report of the dermatophytes and *Aspergillus* in this study is in tandem with the finding of several researchers (Zida *et al.,* 2015; Chukwuma *et al*., 2021 and Mohammed and Al-jaff, 2021). This type of dermatophytes infections primarily affects individuals with suppressed or compromised immunity, most especially prisoners in overcrowded area in association with supporting sanitary, environmental and socioeconomic factors (Mohammed and Al-jaff, 2021). The 22.0 % occurrence of dermatophytes reported in our study is comparative to the 28.7% reported in the review of dermatomycosis by Sadeghi *et al.,* (2011) in Tehran. However, Mohammed and Al-jaff (2021) reported a slightly higher occurrence of 33% among Suse inmates in Iraq. The spread of this infection in these correctional facilities might be attributed to favorable humid environmental condition, overcrowding, lack of proper treatment and poor sanitary conditions associated clothing, footwear and beddings.

The mycosis infection rate were at its highest among inmate between 21 – 30 years (38.2%), females (31.4%), married (51.2%), with previous history of varying underlying infection, who had stayed more than a year, living in a room of 10 and above and changes clothing on a weekly basis. This can be attributed to the fact that most of the inmates belonged to the aforementioned groups. This concurs with the findings of Sadeghi *et al.* (2011) and Oyeka and Eze (2008) with high infection among the younger and active inmates, however with a higher frequency of occurrence of 65.8 % and 52.1% among male inmates within the age group of 30 – 59years.

The highest resistance was observed with fluconazole (73.2%) and the least was amphotericin – B (1.6%). This implies that amphotericin – B is the most effective drug of choice this is attributed to the intravenous route of administration which prevent abuse and increases treatment outcome of a wide range of mycosis (Stone *et al.,* 2016), thus reducing human burden. Our finding differ from the reports of Echeta *et al.* (2021) which reported ketoconazole as the most sensitive antifungal drugs and amphotericin – B as the second most effective. This high resistance of isolates observed against fluconazole, clotrimazole and ketoconazole may be attributed to high level misuse due to their readily available nature as over the counter drugs and ease of administration leading selective pressure hence the development of resistance (Munita and Arias, 2016).

CONCLUSION

The study reveal that mycological infection was incident among inmates from Kano and Jigawa states at 24.3% occurrence rate while Amphotericin B is found to be the most effective drug against the isolated fungi.

Recommendations

Having established that mycological infections is an important multi-factorial condition among Kano and Jigawa states inmates, this study recommends that:

1. There should be proper monitoring of inmates' lifestyle, so that it can limit the spread of mycosis infections.
2. Government should provide adequate accommodation for inmates, in other to combat the spread of mycological infection

3. Government should provide periodic mycological screening exercise program to help reduce spread and prompt early treatment.
4. Sensitization programs should be organized to educate inmates on the risk factors of mycological infections.

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